UL 19

STANDARD FOR SAFETY

Lined Fire Hose and Hose Assemblies

UL Standard for Safety for Lined Fire Hose and Hose Assemblies, UL 19

Fourteenth Edition, Dated August 13, 2018

SUMMARY OF TOPICS

This revision of ANSI/UL 19 dated February 2, 2024 includes the following changes in requirements:

– Additional Fire Hose Trade Sizes, Internal and Outside Diameter Requirements, Additional Hose Pressure Options, Product Specification Sheet Requirements, and Other Clarifications/Corrections; 1.1, 4.1A, 4.3, Section 5A, 11.1.1, Table 11.1, 14.1.1, Table 14.1, Table 14.2, 16.1.1, 16.3.1, 17.4.1, Table 22.1, 22.2.1, 27.5.1, 37.1.3, 37.2.3, 37.4.7, 37.5.2, 38.1.2, 38.2.3, 38.4.1, 38.4.3, 38.5.2, Section 38A, 39.2, Section 41 and C.3.1

– Editorial revisions; Section 3, 10.2, 11.1.1, 16.3.1, 18.3.1, 22.3.1, 23.3.1, 25.3.1, 25.3.4, 25.3.5, 25.3.6, 25.4.1, 25.4.3, 25.4.7, 26.3.1, 27.1.1, 27.4.1, 31.4.1, 32.1.1, 32.3.1, 32.4.1, 32.4.2, 34.2.1, 34.3.1, 34.4.1 and 40.2.1

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated August 25, 2023 and December 22, 2023.

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AUGUST 13, 2018
(Title Page Reprinted: February 2, 2024)

ANSI/UL 19-2024

UL 19

Standard for Lined Fire Hose and Hose Assemblies

The First through Sixth editions were titled "Cotton Rubber-Lined Hose."

Fifth Edition – April, 1948
Sixth Edition – August, 1953
Seventh Edition – August, 1967
Eighth Edition – October, 1971
Ninth Edition – March, 1978
Tenth Edition – December, 1992
Eleventh Edition – December, 1995
Twelfth Edition – November, 2001
Thirteenth Edition – October, 2013

Fourteenth Edition

August 13, 2018

This ANSI/UL Standard for Safety consists of the Fourteenth Edition including revisions through February 2, 2024.

The most recent designation of ANSI/UL 19 as an American National Standard (ANSI) occurred on February 2, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 19 on April 5, 1999. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover single- and multiple-jacketed lined fire hose with or without couplings attached, in the trade sizes of 1-1/2, 1-3/4, 2, 2-1/4, 2-1/2, 2-3/4, 3, 3-1/2, 4, 4-1/2, 5, and 6 inch (38, 45, 51, 57, 65, 70, 76, 89, 102, 114, 127, and 152 mm nominal ID). Single-jacketed hose is intended for service test pressures of 150 psig (1035 kPa) and above in 25 psig (170 kPa) increments. Multiple-jacketed hose or covered hose judged equivalent to multiple-jacketed hose is intended for service test pressures of 200 psig (1380 kPa) and above in 25 psig (170 kPa) increments.

1.2 These products are intended for municipal and industrial fire protection purposes. Single-jacketed hose is for use at fire hydrants, standpipes, and similar places. They are not intended for hard usage nor where the hose will be subjected to chafing on rough or sharp surfaces. Multiple-jacketed hose or covered hose judged equivalent to multiple-jacketed hose are for use on pumpers and in places where service conditions require the additional protection against wear afforded by the extra woven jacket or cover.

1.3 The products covered by these requirements are intended to be periodically inspected and maintained while in service, as outlined in the Standard for the Care, Use, Inspection, Service Testing and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances, NFPA 1962.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 Referenced Publications

3.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

3.2 The following publications are referenced in this Standard:

ASTM B30, *Standard Specification for Copper Alloys in Ingot and Other Remelt Forms*

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM B584, *Standard Specification for Copper Alloy Sand Castings for General Applications*

ASTM D395, *Standard Test Methods for Rubber Property – Compression Set*

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension*

ASTM D573, *Standard Test Method for Rubber – Deterioration in an Air Oven*

ASTM D1149, *Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment*

ASTM D3183, *Standard Practice for Rubber – Preparation of Pieces for Test Purposes from Products*

ASTM E145, *Standard Specification for Gravity-Convection and Forced-Ventilation Ovens*

NFPA 1961, *Standard on Fire Hose*

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*

UL 19G, *Guidance for Lined Fire Hose and Hose Assemblies*

4 Glossary

4.1 For the purpose of this standard, the following definitions apply.

4.1A CHARGED HOSE – A hose that is pressurized with water.

4.2 EXPANSION RING – A ring that expands against the hose lining, forcing the hose tightly against the coupling.

4.3 WEFT or FILLER THREADS – The threads or yarns of the jacket or reinforcement that are helically wound throughout the length of the hose at approximately right angles to the warp threads.

4.4 HOSE ASSEMBLY – Hose furnished with couplings attached to each end.

4.5 MULTIPLE-JACKETED HOSE – Hose having two or more woven jackets or a covered hose that complies with all of the performance tests in this standard for multiple-jacketed hose. See 6.3.

4.6 PROOF PRESSURE – A specified pressure applied to new hose to indicate its acceptability at intended maximum normal highest operating pressures.

4.7 SERVICE TEST PRESSURE – The pressure to which the hose is periodically tested to determine that it can remain in service. The service test pressure is at least 10 percent greater than the maximum normal highest operating pressure.

4.8 WARP THREADS – The threads or yarns of the jacket or reinforcement that run lengthwise to the hose.

CONSTRUCTION

5 Diameter

Section 5 revised and relocated as Section 5A.

5A Diameter of Hose

5A.1 Internal diameter of uncharged hose

5A.1.1 Hose shall have an internal diameter of not less than the trade size of the hose.

5A.1.2 For a hose with a trade size of 1-1/2, 1-3/4, 2, 2-1/4, 2-1/2, or 2-3/4 inch, the internal diameter shall not exceed the trade size of the hose by more than 3/16-inch when measured per 5A.2.

5A.1.3 For a hose with a trade size of 3, 3-1/2, 4”, 4-1/2, 5, or 6 inch, the internal diameter shall not exceed the internal diameter of the next larger trade size hose when measured per 5A.2.

5A.1.4 A tapered plug gauge having a taper of 3/8 inch per foot (31.2 mm/m) marked to indicate variations of 1/64 inch (0.4 mm) in diameter, is to be used to measure the internal diameter. If the lining of the hose has a lap joint, the tapered plug gauge is to be provided with a slot to accommodate the lap joint.

5A.1.5 To determine the internal diameter, the end of the hose is to be cut square and the tapered plug gauge inserted in the hose sample until a close fit is obtained without forcing. The diameter of the gauge at the end of the sample, to the nearest 1/64 inch (0.4 mm), is to be recorded as the internal diameter of the hose.

5A.2 Internal diameter of charged hose

5A.2.1 The internal diameter of hose with a trade size less than 3 inches shall be determined at 50 psi (345 kPa) and 150 psi (1035 kPa) in accordance with the test in Section 38A and reported as part of the Product Specification Sheet.

5A.3 Outside diameter of charged hose

5A.3.2 The outside diameter of hose with a trade size less than 3 inches shall be determined at 150 psi (1035 kPa) in accordance with the test in Section 38A and reported in the Product Specification Sheet.

6 Jacket and Inner Reinforcements

6.1 A jacket shall be evenly and firmly woven, and free from visible defects, thread knots, lumps, and irregularities of twist provided that they would not impair its intended use. The threads shall be continuous, and any knots in the filler threads shall be tucked under the warp threads.

6.2 A jacket shall be seamless and shall have the fillers woven around the hose throughout its length and the warps interwoven with the fillers. A jacket may be made with a cover over the woven jacket.

6.3 Hose having a woven jacket or hose having an inner reinforcement and a protective cover may be considered equivalent to multiple-jacketed hose if it complies with the applicable performance requirements specified in this standard.

7 Lining

7.1 A lining shall be of uniform thickness and free from pitting or other irregularities or imperfections and shall comply with the applicable test requirements specified in Sections 24 – 27.

8 Cover

8.1 A cover shall be of uniform thickness and free from pitting, blisters, or other imperfections that would impair its intended use, and shall comply with the applicable test requirements in Sections 24 – 26.

8.2 A cover may have intentional pricking, ribs, corrugations, or a wrapped finish.

9 Coatings and Treatments

9.1 Hose may have jackets with treatments or coatings if the hose complies with the applicable performance requirements in this standard.

10 Couplings

10.1 The couplings of hose assemblies shall be made from metals having the strength and other characteristics necessary to comply with the applicable performance requirements in this standard.

10.2 A metal used in the construction of any part shall have corrosion-resistant properties equivalent to those of high-strength yellow brass, UNS No. C86500 in ASTM B30 and ASTM B584.

10.3 To determine if a metal has the properties mentioned in 10.2, it shall comply with the requirements of the Salt-Spray Corrosion Test, Section 32.

10.4 A copper-alloy part containing more than 15 percent zinc shall comply with the requirements of the Moist Ammonia Air-Stress Cracking Test, Section 31.

10.5 An expansion ring of a coupling shall be smooth and have rounded edges.

10.6 A swivel mechanism of a coupling shall turn freely by hand.

10.7 A surface shall have no sharp edges or projections that might abrade a hose. The inside surfaces shall be machine-finished.

Exception: Corrugations in a tail section need not be machine-finished.

10.8 A gasket of a coupling shall have uniform dimensions.

PERFORMANCE

11 Hydrostatic Proof-Pressure Tests

11.1 General

11.1.1 Hose shall comply with items (a) – (k) and hose assemblies shall comply with items (a) – (l), when subjected for at least 15 seconds to a hydrostatic proof-pressure of two times the service test pressure. The pressure may be maintained for up to 1 minute if necessary, to determine compliance with the requirements. See 11.4.5.

a) The elongation of single-jacketed hose shall not exceed 10 percent of the length measured at 10 psig (69 kPa). See 11.4.6.

b) The elongation of multiple-jacketed hose shall not exceed 8 percent of the length measured at 10 psig for sizes of 1-1/2 through 2-1/2 inches (38 – 65 mm nominal ID). See 11.4.6.

c) The elongation of multiple-jacketed hose shall not exceed 10 percent of the length measured at 10 psig for sizes of 2-3/4 inches through 3 inches (70 – 76 mm nominal ID). See 11.4.6.

d) The elongation of multiple-jacketed hose shall not exceed 13 percent of the length measured at 10 psig for sizes of 3-1/2 – 6 inches (89 – 152 mm nominal ID). See 11.4.6.

e) The hose shall not leak or balloon, and there shall be no breaking of any thread in the jacket.

f) The twist of the hose shall not exceed the values indicated in Table 11.1. Any final twist shall be in the direction to tighten couplings. A twist to the right, the direction that would tend to tighten couplings, is indicated by a clockwise rotation of the free end of the hose as viewed from the water supply end. The hose shall not twist to the left more than 2 degrees per foot (0.114 rad/m) while the pressure is being increased to the test value. See 11.4.7.

g) The warp of the hose shall not exceed 20 inches (508 mm) per 50 foot (15.2 m) length. See 11.4.8 and 11.4.9.

h) Single-jacketed hose shall not rise from the level of the test surface more than 7 inches (178 mm) for hose sizes of 1-1/2 through 2 inches (38 – 51 mm nominal ID). See 11.4.11.

i) Single-jacketed hose shall not rise from the level of the test surface more than 4 inches (102 mm) for hose sizes of 2-1/2 through 3 inches (65 and 76 mm nominal ID). See 11.4.11.

j) Single-jacketed hose shall not rise from the test surface for hose sizes of 3-1/2 inches (89 mm) and larger. See 11.4.11.

k) Multiple-jacketed hose shall not rise from the test surface. See 11.4.11.

l) A hose assembly shall show no slippage or leakage of the coupling or damage to the hose at the coupling.

11.2 Sample

11.2.1 The test is to be conducted on a nominal 50 foot (15.2 m) length or longer, unless otherwise specified, sample of the hose or hose assembly.

11.3 Equipment

11.3.1 A hand- or power-driven pump or an accumulator system capable of increasing the pressure in the sample at a rate of 300 – 1000 psig (2070 – 6900 kPa) per minute is to be used.

11.3.2 The test surface is to be inclined to facilitate removal of air from the sample and of such design and dimensions that the sample is free to move during the tests.

Table 11.1
Maximum twist of hose per 50 feet

Trade size of hose, Inches, (mm ID)	No. of jackets	Service test pressure, psi (kPa)	Maximum twist, turns per 50 feet (15.2 m)
1-1/2, 1-3/4, 2 (38, 45, 51)	Single	150 (1035)	7-1/2
2-1/2, 3 (65, 76)	Single	150 (1035)	3-3/4
3-1/2, 4, 5, 6 (, 89, 102, 127, 152)	Single	150 (1035)	1-3/4
1-1/2, 1-3/4, 2 (38, 45, 51)	Single	200 (1380) and above	10
2-1/2, 3, 3-1/2, 4, 5, 6 (65, 76, 89, 102, 127, 152)	Single	200 (1380) and above	5
1-1/2, 1-3/4, 2 (38, 45, 51)	Multiple	200 (1380) and above	4-1/4
2-1/4, 2-1/2, 2-3/4, 3, 3-1/2, 4, 4-1/2, 5, 6 (57, 65, 70, 76, 89, 102, 114, 127, 152)	Multiple	200 (1380) and above	1-3/4

11.4 Test method

11.4.1 If a hose assembly is being tested, it is to be marked prior to the tests with a pencil or other suitable means at a point immediately adjacent to each coupling.

11.4.2 One end of the sample is to be connected to the source of water supply by means of couplings or temporary test fittings, and the other end is to be free to move and is to be closed by a fitting provided with a petcock for the escape of air while the sample is being filled with water. For hose having a nominal length

of 50 feet (15.2 m), the connection between the end of the sample and the source of water supply is to be rigid. For hose having a nominal length greater than 50 feet, the connection between the end of the sample and the source of water supply may be flexible.

11.4.3 The sample is to be stretched out on the test surface so as to lie straight and without twist. To facilitate the complete removal of air from the sample, the surface on which the sample rests is to be inclined so that the supply end is lower than the other end. With the petcock open, water is to be admitted through the sample gradually until all air has been expelled and the sample is completely filled with water. The petcock is then to be closed and the pressure raised to 10 psig (69 kPa) and held at that pressure while the initial length measurement is taken. While at this pressure, the sample is to be straightened out in order to obtain an accurate measurement. The jacket construction and workmanship in weaving, particularly knots, loose ends, and skips in warp threads are to be noted and recorded.

11.4.4 The length of the sample between fittings is to be measured and recorded to the nearest inch (centimeter). The position of the sample with regard to twist is to be noted. From this point on, neither the sample nor the fittings are to be touched, moved, or interfered with in any way until all measurements and observations have been completed at the final test pressure.

11.4.5 Following measurement of the length at 10 psig (69 kPa), the pressure in the sample is to be increased at a rate of 300 – 1000 psig (2070 – 6900 kPa) per minute until the required proof pressure is reached. While the pressure is being increased, the sample is to be examined for leakage and other defects. The proof pressure is to be maintained for at least 15 seconds, but not more than 1 minute. During the time the test pressure is maintained, the observations and measurements for elongation, twist, warp, and rise are to be completed.

11.4.6 If the sample warps to any appreciable extent and particularly if the allowable limit of elongation is approached, the length at proof pressure is to be measured by following the contour of the sample. For samples that do not warp to any extent, the measurement is to be taken parallel to the edge of the test surface. For this purpose, an edge of the table is to be marked off in feet and inches (meters and centimeters). All measurements are to be taken to the nearest inch (centimeter) from the inside edges of the fittings. The elongation of the sample is to be calculated from the measurement taken at the proof pressure and the measurement taken at 10 psi (69 kPa).

11.4.7 The amount of twist at proof pressure is to 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 sample. The amount of twist is to be recorded to the nearest one-eighth turn or 45 degrees (0.79 rad), and the direction as either right or left.

11.4.8 For samples having a nominal length of 50 feet (15.2 m), or less if specified, the warp is the maximum deviation between the sample and a straight line that is drawn between reference points on the fittings at each end of the sample.

11.4.9 For samples having a length greater than 50 feet (15.2 m) but not exceeding 100 feet (30.5 m), the warp is the maximum deviation between the sample and each of two straight lines. One straight line is to be drawn between the reference point on one fitting to a reference point on the sample 50 feet from that fitting. The other straight line is to be drawn from the reference point on the other fitting to a reference point on the sample 50 feet from that fitting. All reference points are to be located on the centerline of the sample and the center of the fittings.

11.4.10 If a hose is not provided with a fitting at its free end, a lightweight fitting without lugs is to be attached to the free end. If a fitting with lugs is provided on the free end of the hose, an adaptor that does not weigh more than the fitting and that has a larger outside diameter than the lugs is to be attached to the fitting.

11.4.11 The maximum distance that the sample rises above the test surface while at the proof pressure is to be measured to the nearest inch (centimeter).

12 Kink Test

12.1 General

12.1.1 Hose, while kinked, shall withstand a hydrostatic test pressure of 1-1/2 times the marked service test pressure without leakage, rupturing, or breaking of any thread in the jacket or reinforcement.

12.2 Sample

12.2.1 The length of the sample is to be at least 3 feet (0.9 m).

12.3 Equipment

12.3.1 The hydrostatic equipment for this test is to be the same as that specified in 11.3.1.

12.4 Test method

12.4.1 The sample is to be filled with water with the petcock open to allow all air to escape. The petcock is then to be closed, the pressure raised to approximately (but not exceeding) 10 psig (69 kPa), and the sample kinked 18 inches (457 mm) from the free end by tying the hose back against itself as close to the fittings as practicable, so that there will be a sharp kink. The pressure is then to be increased at a rate of 300 – 1000 psig (2070 – 6900 kPa) per minute until 1-1/2 times the service test pressure is reached, and then immediately released.

13 Hydrostatic Strength Test

13.1 General

13.1.1 Hose, while lying straight, and curved around a surface having a radius of 27 inches (0.7 m), shall withstand a hydrostatic test pressure of three times the marked service test pressure without rupturing or breaking of any thread in the jacket or reinforcement.

13.1.2 Hose assemblies, while lying straight, and curved around a surface having a radius of 27 inches (0.7 m), shall withstand a hydrostatic test pressure of three times the service test pressure without leakage, rupturing, or breaking of any thread in the jacket or reinforcement, and without slippage, leakage, or damage of the couplings.

13.2 Sample

13.2.1 The length of the sample is to be 3 feet (0.9 m).

13.2.2 If a hose assembly is being tested, the sample is to be marked prior to the test with a pencil or other suitable means at a point immediately adjacent to each coupling.

13.3 Equipment

13.3.1 The hydrostatic equipment for this test is to be the same as that described in 11.3.1, except that a protective enclosure is also to be used.

13.3.2 A test frame or surface that is curved to a radius of 27 inches (0.7 m) is to be used for conducting the burst test while the hose is in the curved position. The test frame on the surface is to have provisions for firmly securing both ends of the sample while under test.

13.4 Test method

13.4.1 The sample is to be placed in a protective enclosure, connected to the source of water supply, the air expelled, and the pressure raised at a rate of 300 – 1000 psig (2070 – 6900 kPa) per minute until the hydrostatic test pressure specified in 13.1.1 or 13.1.2 is reached, and immediately released. The sample is to be tested in the straight and curved positions.

14 Repeated Bending Test

14.1 General

14.1.1 A coupled sample of hose in each size 1-1/2 through 3-1/2 inches (38 through 89 mm nominal ID) shall withstand 100,000 cycles of repeated bending to the radius specified in Table 14.1, while filled with water, without breakdown. Upon completion of the repeated bending, the sample, while lying straight, shall comply with the requirements of the Hydrostatic Strength Test, Section 13.

14.2 Sample

14.2.1 The length of sample as specified in Table 14.2 is to be used.

Table 14.1
Radius of bend and distance between center of reels for repeated bending test

Trade size of hose,		Radius of bending,		Distance between centers of reels, Inches (mm)			
				Vertical		Horizontal	
Inches	(mm)	Inches	(mm)				
1-1/2	(38)	8	(203)	19	(483)	8	(203)
1-3/4	(45)	8	(203)	19	(483)	8	(203)
2	(51)	14	(356)	34	(864)	14	(356)
2-1/4	(57)	14	(356)	34	(864)	14	(356)
2-1/2	(65)	14	(356)	34	(864)	14	(356)
2-3/4	(70)	14	(356)	34	(864)	14	(356)
3	(76)	14	(356)	34	(864)	14	(356)
3-1/2	(89)	14	(356)	34	(864)	14	(356)

Table 14.2
Length of test sample for repeated bending test

Trade size of hose,		Length of test sample,	
Inches	(mm)	feet	(m)
1-1/2	(38)	14	(4.3)
1-3/4	(45)	14	(4.3)
2	(51)	15	(4.6)
2-1/4	(57)	15	(4.6)
2-1/2	(65)	15	(4.6)
2-3/4	(70)	16	(4.9)
3	(76)	16	(4.9)
3-1/2	(89)	16	(4.9)

14.3 Equipment

14.3.1 The equipment for this test is to consist of a steel framework on which are mounted two wooden reels. A semicircular groove, wide enough to accommodate the sample without binding, is to be cut in the circumference of each reel to act as a guide for the sample. The radius of the reels, measured to the base of the circumferential grooves, is to be as specified in Table 14.1. The reels are to be mounted with their flat sides in the same vertical plane so that the distance between centers is as specified in Table 14.1. Each reel is to rotate freely about an axle at its center. A motor-driven mechanism is to be provided that pulls the sample up over the reels for a total distance of 4 ±0.5 feet (1.2 ±0.15 m) and then reverses to let the hose down, at a rate of 4 ±1 complete cycles per minute.

14.4 Test method

14.4.1 The sample is to be filled with water and capped at each end. It is then to be placed over the reels in an S-shaped curve with the end that passes over the top reel brought down and a weight just sufficient to make the sample conform to the reels is to be attached. The end that passes under the bottom reel is to be brought up and fastened to the motor-driven mechanism described in 14.3.1. The sample is to be subjected to 100,000 complete cycles of bending.

14.4.2 After completion of the bending, the sample is to be removed from the test equipment, examined for any evidence of damage, and then tested in accordance with the Hydrostatic Strength Test, Section 13, while the sample is lying straight. In lieu of subjecting the entire length to the burst test, a 3 foot or longer section can be cut from the central portion of hose that received bending in two directions, recoupled, and then subjected to the Hydrostatic Strength Test.

15 Alternating Pressure Test

15.1 General

15.1.1 Hose and hose assemblies shall withstand 2000 cycles of alternating low and high pressure, between 0 psig and the service test pressure, without breakdown. After cycling, the sample shall withstand the appropriate proof-pressure in Section 11, without leakage, ballooning or rupture.

15.2 Sample

15.2.1 The length of the sample is to be 12 feet (3.7 m).

15.2.2 If a hose assembly is being tested, the sample is to be marked prior to the test with a pencil or other suitable means at a point immediately adjacent to each coupling.

15.3 Equipment

15.3.1 The equipment for this test is to consist of a pump as described in 11.3.1, capable of increasing the internal pressure from 0 psig to the sample's service test pressure and means to decrease the internal pressure of the sample to 0 psig, at a rate of 3 ±1/2 cycles of pressure change per minute.

15.4 Test method

15.4.1 The sample is to be connected to the source of water under pressure, the air expelled, and the hydrostatic pressure within the sample alternately raised to the service test pressure and then lowered to 0 psig. The rate of increase and decrease is to be uniform and such that approximately 20 seconds are required to go from 0 psig to the maximum test pressure and back to 0 psig (1 cycle).

15.4.2 After completion of 2000 cycles of low and high pressure, the sample is to be subjected to the appropriate proof-pressure in Section 11.

16 Abrasion Test

16.1 General

16.1.1 Hose shall withstand 1-1/2 times the service test pressure without rupturing or breaking any thread in the jacket or reinforcement, after 300 cycles of abrasion for single-jacketed hose and after 500 cycles of abrasion for multiple-jacketed hose.

16.2 Sample

16.2.1 The length of the sample is to be 4 feet (1.2 m) or longer, depending on the design of the test equipment.

16.3 Equipment

16.3.1 The following equipment is to be used:

a) A horizontally reciprocating machine with a 12 inch (305-mm) stroke capable of 20 cycles per minute;

b) A stationary mandrel having a diameter of 2-1/4 inches (57.2 mm) and covered with No. 1-1/2 (coarse) emery cloth;

c) An 8-pound (3.6 kg) weight for 1-1/2, 1-3/4, and 2 inch (38, 45, and 51 mm nominal ID) size hose;

d) A 12-pound (5.4 kg) weight for 2-1/4, 2-1/2, 2-3/4, and 3 inch (57, 65, 70 and 76 mm nominal ID) size hose;

e) A 15-pound (6.8 kg) weight for 3-1/2 and 4 inch (89 and 102 mm) size hose;

f) An 18-pound (8.2 kg) weight for sizes greater than 4 inches (102 mm); and

g) The hydrostatic equipment specified in 11.3.1 and a protective enclosure.

16.4 Test method

16.4.1 The sample is to be clamped at one end to a horizontally reciprocating crossbar. The other end is to be allowed to hang down over the mandrel. The appropriate weight specified in 16.3.1 is to be attached to the free end of the sample. Coupled hose samples may be used for this test, but the total weight at the end of the hose, including the weight of the coupling, expansion ring, and any adapters or clamps, is to equal the weight given in 16.3.1.

16.4.2 The sample is to be drawn back and forth over the emery cloth at a rate of 20 ±2 cycles per minute by the motion of the crossbar. At the end of each 50 cycles, the emery cloth is to be cleaned by means of compressed air. New emery cloth is to be used for each test sample. After the applicable number of cycles specified in 16.1.1, the sample is to be removed from the test apparatus, coupled if necessary, connected to the source of water supply, the air expelled, and the pressure raised at a rate of 300 – 1000 psig (2.07 – 6.89 MPa) per minute until 1-1/2 times the service test pressure is reached.

17 Heat-Resistance Test

17.1 General

17.1.1 A coupled sample of hose, while lying straight, shall comply with the requirements of the Hydrostatic Strength Test, Section 13, after exposure to a heated steel block, as described in 17.4.1.

17.2 Sample

17.2.1 The length of the sample is to be 18 inches (457 mm).

17.3 Equipment

17.3.1 An oven capable of maintaining a temperature of 260.0 ±2.0°C (500.0 ±3.6°F), a solid steel block 2-1/2 by 1-1/2 by 8 inches (63.5 by 38 by 203 mm), the hydrostatic equipment specified in 11.3.1, and a protective enclosure are to be used for this test.

17.4 Test method

17.4.1 The sample is to be sealed at one end, filled with tap water, sealed at the other end, and conditioned for 24 hours in a room maintained at 23.0 ±2.0°C (73.0 ±3.6°F). The steel block is to be heated for at least 16 hours in an oven maintained at 260.0 ±1.0°C (500.0 ±1.8°F), removed from the oven, and within 5 seconds placed so that the longitudinal axis of the steel block is perpendicular to the longitudinal axis of the sample. The contact area is to be the midpoint of the 2-1/2 inch (63.5 mm) wide side of the steel block and the midpoint of the sample. A metal knife edge is to be used as a support near one end of the steel block to balance the steel block on the hose and obtain maximum force on the hose. After 60 seconds, the steel block is to be removed. After the hose has cooled, it is to be laid straight and subjected to the Hydrostatic Strength Test, Section 13.

18 Fold-Resistance Test

18.1 General

18.1.1 Hose, while lying straight, shall comply with the requirements of the Hydrostatic Strength Test, Section 13, after being subjected to folding described in 18.4.1.

18.2 Sample

18.2.1 The length of the sample is to be 3 feet (0.9 m).

18.3 Equipment

18.3.1 Equipment for this test is to consist of a Type II A oven as described in ASTM E145, a clamp fitted with calibrated springs capable of exerting a total force of 120 pounds (534 N), the equipment specified in 11.3, and a protective enclosure.

18.4 Test method

18.4.1 The sample is to be folded at the center of the length and held tightly folded by means of a clamp fitted with calibrated springs so that a total force of 120 pounds (534 N) is exerted on the fold. The assembly is then to be placed in a thermostatically controlled oven maintained at a temperature of 60 ±2.0°C (140.0 ±3.6°F), for 30 days. At the end of the test period, the assembly is to be removed from the oven and allowed to cool at room temperature. The clamp is then to be removed, and the sample is to be laid straight and subjected to the Hydrostatic Strength Test, Section 13. If the lining of the hose adheres to itself after the clamp is removed, the lining shall free itself by the time the service test pressure is reached during the Hydrostatic Strength Test.

19 Wet Hose Test

19.1 General

19.1.1 Hose and hose assemblies shall withstand 48 hours of immersion in water at room temperature without visible deterioration and shall then comply with the requirements of the Hydrostatic Strength Test, Section 13, while wet and lying straight.

19.2 Sample

19.2.1 The length of the sample is to be 3 feet (0.9 m).

19.3 Test method

19.3.1 A sample is to be immersed in tap water at room temperature for 48 hours. The sample is then to be removed from the water and, within 15 minutes, subjected to the Hydrostatic Strength Test, Section 13.

20 Low-Temperature Test

20.1 General

20.1.1 Hose not marked in accordance with 40.2.2 shall withstand the appropriate proof-pressure in Section 11, without leakage, ballooning, or rupture, after being subjected to cold flexing at a temperature of minus 4.0 ±3.6°F (minus 20.0 ±2.0°C) as described in 20.4.1.

20.1.2 Hose marked in accordance with 40.2.2 shall withstand the appropriate proof-pressure in Section 11, without leakage, ballooning or rupture, after being subjected to cold flexing at a temperature of minus 65.0 ±3.6°F (minus 54.0 ±2.0°C) as described in 20.4.1.

20.2 Sample

20.2.1 The length of the sample is to be 3 feet (0.9 m).

20.3 Equipment

20.3.1 The equipment for this test is to consist of that specified in 11.3.1, a protective enclosure, and a cold box capable of maintaining the appropriate temperature and of sufficient capacity to accommodate the test samples.

20.4 Test method

20.4.1 The sample is to be placed in a container of water at room temperature for 24 ±1/2 hours. The sample is then to be removed from the water, exposed to room temperature for 15 minutes, and then placed in the cold box maintained at the appropriate test temperature. After 16 ±1-1/2 hours in the cold box, the sample is to be removed and immediately bent double on itself (180 degrees), first one way and then the other. The sample is then to be thawed at room temperature for 24 hours, laid straight, and subjected to the proof-pressure in Section 11.

21 Coupling Retention Test

21.1 General

21.1.1 Hose assemblies shall withstand a hydrostatic proof-pressure of two times the service test pressure for 10 minutes without slippage or leakage of the couplings or damage to the hose at the couplings.

21.2 Sample

21.2.1 The length of the sample is to be 3 feet (0.9 m).

21.3 Equipment

21.3.1 The equipment specified in 11.3.1 and 11.3.2 and a protective cover are to be used for this test.

21.4 Test method

21.4.1 The sample is to be marked prior to the test with a pencil or other suitable means at a point immediately adjacent to each coupling. The sample is then to be placed in the protective enclosure, connected to the source of water supply, the air expelled, and the pressure raised at a rate of 300 – 1000 psig (2070 – 6900 kPa) per minute until the appropriate proof-pressure is reached. After 10 minutes at the test pressure, the sample assembly is to be examined for slippage, leakage, or damage to the hose at the couplings.

22 Friction Loss Test

22.1 General

22.1.1 A hose shall not have a friction loss greater than the values specified in Table 22.1.

Table 22.1
Maximum friction loss of hose

Trade size of hose, inches (mm ID)		Flow rate gallons (L) per minute		Maximum acceptable friction loss per 100 feet (30.5 m) of hose, psig (kPa)	
1-1/2	(38)	120	(454)	45.0	(310)
1-3/4	(45)	120	(454)	30.0	(207)
2	(51)	150	(567)	20.0	(138)
2-1/4	(57)	190	(719)	15.0	(103)
2-1/2	(65)	220	(833)	12.0	(83)
2-3/4	(70)	280	(1060)	12.0	(83)
3	(76)	400	(1514)	15.0	(103)
3-1/2	(89)	600	(2271)	15.0	(103)

22.2 Sample

22.2.1 The length of the sample is to be 50 ±3 feet (15 ±1 m) between couplings. For the evaluation of hose of 2-3/4 inch and less nominal size, the attached couplings shall have a waterway diameter not less than 0.25 inch smaller than the nominal hose size. For the evaluation of hose of greater than 2-3/4 inch nominal size, the attached couplings shall have a waterway diameter not less than 0.5 inch smaller than the nominal hose size. For the evaluation of coupled hose assemblies, the diameter of the waterway may be smaller than the dimensions indicated above, depending on the design of the couplings.

22.3 Equipment

22.3.1 The following equipment is to be used:

a) Two piezometer fittings of the same nominal size as the sample test hose;

b) A calibrated water flow meter or equivalent water flow measuring device;

c) A differential pressure gauge connected to two piezometers to read the difference of pressure between the inlet and outlet ends of the hose;

d) A water supply system capable of providing the required flow rates specified in Table 22.1; and

e) A pressure gauge with a 200 ±50 psig range.

22.4 Test method

22.4.1 The upstream and downstream ends of the sample hose are to be connected to the piezometer fittings. A differential pressure gauge shall be connected to the two piezometer fittings. A nominal 200 psig pressure gauge shall be installed immediately before the upstream piezometer fitting and after the water supply connected to the flowmeter. The downstream piezometer fitting is to be connected to a valve capable of throttling the water flow.

22.4.2 The hose shall then be pressurized to 10 ±2 psi and the length of the hose between couplings is to be measured to the nearest inch.

22.4.3 The water flow rate specified in Table 22.1, is to be established through the hose at an inlet pressure of 100 ±2 psi and readings of the differential pressure gauge are to be made. If it is not possible to maintain a 100 ±2 psi inlet pressure at flow rates of 400 gpm and 600 gpm for 3 inch and 3-1/2 inch hose respectively, then the inlet pressure may be lowered.

22.4.4 The sample hose is then to be removed from the assembly and the loss-of-head for the test piping located between the piezometer fittings is to be determined for the same flow rate. The loss-of-head for the hose then is to be determined by subtracting the loss between the piezometer fittings from the loss between the piezometer fittings and hose.

22.4.5 The loss-of-head for the hose is to be converted to values in psig (or kPa) per 100 feet of hose.

23 Accelerated Aging Test of Threads

23.1 General

23.1.1 The breaking strength of the warp and filler threads that have been conditioned in an air-circulating oven as specified in 23.4.1 shall not be less than 40 percent of the strength of threads that have not been heated in air.

23.2 Sample

23.2.1 Six 8 inch (203 mm) long warp threads and six 8-inch long filler threads taken from the jacket or reinforcement of the hose are to be used.

23.3 Equipment

23.3.1 Breaking strength tests are to be conducted using a power-operated machine, as described in ASTM D412. The Type II A oven described in ASTM E145 is to be used for the conditioning.

23.4 Test method

23.4.1 Three warp threads and three filler threads are to be placed in an air-circulating oven at 165.0 ±2.0°C (329.0 ±3.6°F) for 168 ±1/2 hours. After the conditioning, the threads are to rest for at least 24 hours in a room maintained at 23.0 ±2.0°C (73.0 ±3.6°F) and 50 ±5 percent relative humidity. The threads are then to be subjected to a breaking strength test using a tensile-strength testing machine having a jaw separation of 2 inches (50.8 mm) per minute. The average of three samples is to be considered the breaking strength. This value is to be compared with the average breaking strength of the three warp and three filler thread samples that have not been heated in air.

24 Adhesion Tests

24.1 General

24.1.1 The adhesion between the lining and the jacket or reinforcement shall be such that the rate of separation of a 1-1/2 inch (38.1 mm) strip of the lining from the jacket or reinforcement shall not be greater than 1 inch (25.4 mm) per minute when a weight of 12 pounds (5.4 kg), is applied in accordance with 24.3.1 – 24.4.2.

24.1.2 If a rubber backing is used between the lining and the jacket or reinforcement, the adhesion between the lining and the backing and between the backing and the jacket or reinforcement shall be such that the rate of separation of a 1-1/2 inch (38.1 mm) strip is not greater than 1 inch (25.4 mm) per minute when a weight of 12 pounds (5.4 kg) is applied. See 24.4.2.

24.1.3 The requirements of 24.1.1 and 24.1.2 are not intended to exclude a construction that provides no adhesion between the jacket and lining along the fold, if the surface over which there is no adhesion is not greater than 35 percent of the total surface.

24.1.4 The adhesion between the cover and the woven jacket or reinforcement shall be such that the rate of separation of a 1-1/2 inch (38.1 mm) strip of the cover from the jacket or reinforcement shall not be greater than 1 inch (25.4 mm) per minute with a weight of 10 pounds (4.5 kg).

24.2 Sample

24.2.1 The sample is to be 2 inches (50.8 mm) wide and is to be cut through to give a rectangular sample 2 inches wide and the full circumference of the hose in length. A strip of lining or cover 1-1/2 inches (38.1 mm) wide is to be cut out accurately; the cut is to extend through the lining or cover but not entirely through the woven jacket or reinforcement. This strip is to be separated from the jacket for about 1-1/2 inches. A reference mark is to be placed on the jacket or reinforcement at the juncture of the jacket or reinforcement or cover.

24.3 Equipment

24.3.1 A supporting frame, clamps, weights, weight holders, and a timer are to be used. The supporting frame is to be constructed so that the sample, with weights attached, may be suspended vertically and hang freely during the duration of the test.

24.4 Test method

24.4.1 With the separated jacket or the reinforcement, or the reinforcement together with the cover or lining, gripped in a stationary clamp, the separated lining or cover is to be gripped in a freely suspended clamp hanging vertically, to which the prescribed weight is to be attached. Provisions are to be made for supporting and releasing the weight slowly without jerking. The distance through which separation takes place is to be noted for 10 minutes, or until complete separation occurs. The adhesion to the jacket or reinforcement is to be taken as the rate obtained by dividing the total distance separated in inches (mm), to the nearest 0.1 inch (2.5 mm), by the elapsed time in minutes.

24.4.2 If a rubber backing is used between the lining and the jacket or reinforcement, the adhesion between the lining and the backing and the adhesion between the backing and the jacket or reinforcement are to be determined using the methods described in 24.4.1. If the adhesion between the lining and the backing or between the backing and the jacket or reinforcement cannot be determined because the backing has a tendency to tear during the test, the rate of separation between the separating members is to be considered the adhesion.

25 Accelerated Aging Test of Linings and Covers

25.1 General

25.1.1 The tensile strength and ultimate elongation of specimens of a lining and cover, if any, that have been conditioned for 70 ±1/2 hours in an air oven at 100.0 ±2.0°C (212.0 ±3.6°F) shall not be less than 80 percent of the tensile strength and 50 percent of the ultimate elongation of specimens that have not been heated in air.

25.2 Sample

25.2.1 Six samples, each approximately 1 inch wide, of the lining and cover are to be cut transversely from a representative section of the hose. The test specimens described in 25.4.5 are to be obtained from these cut sections.

25.3 Equipment

25.3.1 Tensile strength and elongation tests are to be conducted using a power-driven machine as described in ASTM D412.

25.3.2 The rate of travel of the power-actuated grip is to be 20 ±1 inches (508 ±25.4 mm) per minute.

25.3.3 The elongation is to be measured by means of a scale or other device capable of indicating the elongation with an accuracy of 0.1 inch (2.5 mm) without damaging the specimens.

25.3.4 For removing irregularities in samples, the buffing machine or skiving machine outlined in ASTM D3183 is to be used.

25.3.5 Die C and the dial micrometer described in ASTM D412 are to be used for cutting and measuring the thickness of the specimens.

25.3.6 The Type II A oven described in ASTM E145 is to be used for the conditioning.

25.4 Test method

25.4.1 Tensile strength and ultimate elongation are to be determined in accordance with Method A of ASTM D412. Three specimens for oven conditioning and three specimens for comparison purposes are to be prepared as described in 25.4.2 – 25.4.7.

25.4.2 The parts to be tested are to be separated from the hose jacket or reinforcement without the use of solvent, if practicable, and without excessive stretching of the parts. If it is necessary to use a solvent, commercial isooctane is to be used. The separated part is then to be placed so as to permit free evaporation of the solvent from the part for at least 1 hour before testing.

25.4.3 The samples of the lining and cover are to be buffed or skived prior to die-cutting to remove unevenness of surface or backing, if used, that would interfere with an accurate measurement of the specimen thickness. If the nature or thickness of the lining or cover is such that buffing or skiving cannot be accomplished without damaging the lining or cover, any of the following procedures are acceptable:

a) Determine tensile strength and elongation on specimens with no prior buffing or skiving, using the dial micrometer specified in 25.3.5, an optical micrometer, or an optical comparator to determine thickness; or

b) Determine tensile strength and elongation on specimens obtained from cured slabs of the material.

25.4.4 If the lining and cover are made from the same material, specimens for the tensile strength and elongation tests may be obtained from either component, and the results are to be considered representative of both components.

25.4.5 After buffing or skiving, dumbbell specimens are to be die-cut and have a constricted portion 0.25 inch (6.4 mm) wide and 1.3 inches (33.0 mm) long. The enlarged ends are to be 1 inch (25.4 mm) wide.

25.4.6 Three measurements for thickness are to be made in the constricted portion of each specimen. The minimum value obtained is to be used as the thickness of the specimen in calculating the tensile strength. The average tensile strength and elongation of three specimens is to be considered the tensile strength and elongation.

25.4.7 If an automatic extensometer is not used, two parallel bench marks for use in determining elongation are to be placed centrally 1 inch (25.4 mm) apart on the constricted portion of each of three samples. Care is to be taken not to injure the specimen. The 1-inch bench marks, if used, are to be placed on the other three specimens after conditioning. The specimens are to be conditioned as specified in 25.1.1 and tested in accordance with the test procedures specified in ASTM D573. The tensile strength and ultimate elongation of the aged specimens are to be compared with the tensile strength and elongation of specimens that have not been heated in air.

25.4.8 Results of tests of specimens that break in the curved portion may be acceptable if the measured strength and elongation values are at least equal to those for specimens that break within the bench marks. If such results are not obtained, the test is to be repeated with new specimens.

26 Ozone-Exposure Test of Linings and Covers

26.1 General

26.1.1 For hose and hose assemblies intended to be marked as ozone resistant in accordance with 40.2.3, the linings and covers shall show no visible signs of cracking when stressed and exposed for 70 ±1/2 hours to an atmosphere having an ozone partial pressure of 100 ±10 mPa at a temperature of 40.0 ±1.0°C (104 ±1.8°F).

26.2 Sample

26.2.1 Three specimens, 3-3/4 inches (95.3 mm) long by 1 inch (25.4 mm) wide, cut from the lining and cover of a representative sample are to be used for this test.

26.3 Equipment

26.3.1 The ozone test chamber and specimen holder is to be as described in ASTM D1149.

26.4 Test method

26.4.1 The three specimens are to be cut longitudinally from the lining and cover of the sample and mounted in the specimen holder in a looped position in accordance with the procedures outlined in Method B, Procedure B2 of ASTM D1149. The waterway surface of the lining specimens and the outer surface of the cover are to be on the outside of the looped specimen. The ozone test chamber is to be regulated to provide an ozone partial pressure of 100 ±10 mPa and a temperature of 40.0 ±1.0°C (104.0 ±1.8°F). When constant test conditions have been obtained in the ozone chamber and after the mounted specimens have remained in an ozone free atmosphere for 24 hours, the mounted specimens are to be placed in the test chamber for 70 hours. After exposure, the specimens are to be removed from the test chamber and visually examined with a 7-power hand magnifying glass while still mounted in the specimen holder.

27 Water Immersion Test of Linings

27.1 General

27.1.1 The tensile strength, ultimate elongation, and volume change of a lining shall comply with the requirements specified in items (a) – (c) after immersion for 168 ±1/2 hours in distilled or deionized water at a temperature of 70.0 ±2.0°C (158.0 ±3.6°F).

a) Minimum retention of tensile strength – 75 percent.

b) Minimum retention of ultimate elongation – 75 percent.

c) Maximum volume swell – 25 percent.

27.2 Sample

27.2.1 Six tensile strength and elongation specimens are to be prepared from the lining, as described in 25.4.2 – 25.4.8, and three volume change specimens, 2 inches (50.8 mm) long by 1 inch (25.4 mm) wide, are to be cut from the lining of a representative section of hose.

27.3 Equipment

27.3.1 A water or oil bath or oven capable of maintaining the test liquid at 70.0 ±2.0°C (158.0 ±3.6°F) is to be used for this test.

27.3.2 The equipment for the tensile strength and ultimate elongation determinations is to be as described in 25.3.1 – 25.3.5.

27.3.3 An analytical balance provided with a bridge for the support of a vessel of distilled or deionized water and a metal die for cutting rectangular specimens 1 by 2 inches (25.4 to 50.8 mm) are to be used.

27.4 Method – Effect on tensile strength and ultimate elongation

27.4.1 For the tensile strength and ultimate elongation determinations, six specimens of the lining are to be prepared in the same manner as for tensile strength and elongation tests described in 25.4.2 – 25.4.7 before immersing the specimens in the test liquids, except that 1 inch (25.4 mm) apart marks are to be placed on the specimens after the immersion unless an automatic extensometer is used. The specimens are to be immersed in such a manner that they do not touch each other or the sides of the container. Three tube specimens are to be immersed for 168 hours in distilled or deionized water. The water is to be maintained at 70.0 ±2.0°C (158.0 ±3.6°F) throughout the immersion period. At the end of the immersion period, the specimens that had been immersed are to be cooled for 30 to 60 minutes in new test liquid maintained at 23.0 ±2.0°C (73.4 ±3.6°F). Immediately upon removal from the liquid maintained at 23.0 ±2.0°C, the specimens are to be blotted dry with a soft cloth or filter paper, the 1 inch bench marks (if an automatic extensometer is not used) are to be placed on the specimens, and the specimens are to be subjected to tensile strength and elongation tests in accordance with Method A of ASTM D412. For comparative purposes, three specimens of the lining that have not been immersed in the test liquid are to be subjected to tensile strength and elongation tests.

27.5 Method – Effect on volume

27.5.1 For the volumetric swelling determinations, samples from the lining of the hose are to be buffed or skived smooth, and three specimens are to be cut by means of the die, see 25.3.5. The volume of each specimen is to be determined by weighing it first in air and then in water. The specimens are then to be immersed for 168 hours in distilled or deionized water. The water is to be maintained at 70.0 ±2.0°C (158.0 ±3.6°F) throughout the immersion period. At the end of the immersion period, the specimens are to be cooled for 30 to 60 minutes in new test liquid maintained at 23.0 ±2.0°C (73.4 ±3.6°F). The specimens are then to be removed one at a time from the water, rinsed in ethyl alcohol, blotted dry with a soft cloth or filter paper, and again weighed, first in air and then in water. The weight in air is to be taken within 30 seconds after the specimen is removed from the test liquid, and the weight in water is to be taken within 60 seconds after removal from the test liquid. The percent increase in volume is to be calculated for each specimen and the results for the three specimens are to be averaged.

28 Pull Test

28.1 General

28.1.1 The couplings of a hose assembly shall not be mechanically damaged at the threaded or swivel connections and shall not move or separate from the hose when subjected to a pull of not less than 2000 pounds-force (8.9 kN) times the diameter of the hose in inches (mm × 0.039).

28.2 Sample

28.2.1 A 10 ±2 inch (254 ±51 mm) length of hose assembly is to be used.

28.3 Test method

28.3.1 The male and female ends of the coupling are to be attached to threaded male and female adapters that, in turn, are to be fitted for installation in the testing machine.

28.3.2 The tension applied to the sample is to be at the rate of 0.1 inch (2.5 mm) per minute up to the value specified in 28.1.1.

29 Accelerated Aging Test of Hose Assembly

29.1 General

29.1.1 The couplings of a hose assembly that have been conditioned for 70 ±1/2 hours in an air-circulating oven at 100.0 ±2.0°C (212.0 ±3.6°F) shall not separate from the hose when subjected to the pull specified in 28.1.1.

29.2 Sample

29.2.1 The length of the sample is to be 10 ±2 inches (254 ±51 mm).

29.3 Equipment

29.3.1 The equipment specified in 25.3.6 is to be used.

29.4 Test method

29.4.1 The sample is to be conditioned as specified in 29.1.1. After the conditioning, the sample is to be subjected to the Pull Test, Section 28.

30 Rough Usage Test

30.1 General

30.1.1 A complete assembly of mating couplings connected together, unattached to hose, and a coupling with a swivel shall not be deformed or damaged to such an extent that the swivel mechanism cannot be turned by the exertion of a torque of 100 pounds-feet (136 N·m) or less after being subjected to the drop tests described in 30.4.1 and 30.4.2.

30.2 Sample

30.2.1 Three assemblies of mating couplings connected together and three couplings with swivels in each size are to be used.

30.3 Equipment

30.3.1 A torque wrench having a minimum force of 100 pounds-feet (136 N·m) is to be used.

30.4 Test method

30.4.1 Each sample is to be dropped three times from a height of 6 feet (1.8 m) onto a concrete surface in such a manner as to impact on the swivel portion of the coupling. The drop height is to be measured from the concrete surface to the lowest edge of the sample. Each sample is then to be examined for cracks, broken sections, distortion, and binding.

30.4.2 If the samples show distortion or binding of the swivel mechanism, the force required to turn the swivel mechanism is to be measured.

31 Moist Ammonia-Air Stress Cracking Test

31.1 General

31.1.1 After being subjected to the conditions described in 31.3.1 – 31.4.2 a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

31.2 Sample

31.2.1 A coupling or component in each size connected to a 6 inch (152 mm) length of hose in accordance with the manufacturer's instructions and then to an appropriate mating coupling tightened to the minimum torque necessary to produce a leaktight assembly is to be used.

31.3 Equipment

31.3.1 The equipment is to consist of a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm), a glass cover, aqueous ammonia having a specific gravity of 0.94, an inert grid to support samples 1-1/2 inches (38.1 mm) above solution, and an oven or water bath capable of maintaining a temperature of 34.0 ±2°C (93 ±3.6°F).

31.4 Method

31.4.1 Each test sample is to be subjected to the physical stresses normally imposed on or within a part as the result of assembly with other components. Such stresses are to be applied to the sample prior to and maintained during the test. Threaded parts are to be engaged to an appropriate mating coupling and tightened to the minimum torque required to product a leaktight assembly. Polytetrafluoroethylene (PTFE) tape or pipe thread compound are not to be used on the threads.

31.4.2 Three samples are to be degreased and then continuously exposed in a set position for 240 hours to a moist ammonia-air mixture maintained in a glass chamber 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover. 600 ml of aqueous ammonia having a specific gravity of 0.94 are to be maintained at the bottom of the glass chamber below the samples. The samples are to be positioned 1-1/2 inches (38.1 mm) above the solution and supported by an inert grid. The glass chamber, with the cover in

place, is then to be placed in an oven or water bath maintained at a temperature of 34.0 ±2°C (93 ±3.6°F) for 240 hours.

32 Salt-Spray Corrosion Test

32.1 General

32.1.1 A coupling assembly having metallic parts of materials other than high strength, yellow brass, UNS No. C86500 in ASTM B30 and in ASTM B584 shall be subjected to the salt spray exposure as described in 32.4.1. After the exposure and drying, the torque required to disassemble the coupling assembly shall not be greater than 100 pounds-feet (136 N·m). If there is evidence of galvanic corrosion between dissimilar metals, the exposed couplings shall be connected to the type of hose for which they are intended to be used, and the hose assembly while lying straight, shall comply with the requirements in 13.1.1.

32.2 Sample

32.2.1 Samples are to include two assemblies in each size, each consisting of mating couplings, and two couplings of each design connected to mating couplings of brass as described in 32.1.1. The samples are to be tightened together with the minimum torque necessary to produce a leaktight assembly.

32.3 Equipment

32.3.1 The equipment described in ASTM B117 is to be used. A torque wrench having a minimum force of 100 pounds-feet (136 N·m) is also to be used.

32.4 Test method

32.4.1 Uncoated sample couplings are to be subjected to the salt spray exposure for 10 days in accordance with the methods specified in ASTM B117.

32.4.2 Samples that are coated for corrosion protection are to be preconditioned by being assembled with a torque of 50 pounds-feet (67.8 N·m) and then disassembled for a total of 50 assemble-disassemble cycles. The couplings are then to be assembled and subjected to the salt spray exposure for 10 days in accordance with the methods specified in ASTM B117.

33 Accelerated Aging Test of Gaskets

33.1 General

33.1.1 The tensile strength and ultimate elongation of specimens of a gasket that have been conditioned for 70 ±1/2 hours in an air oven at a temperature of 100.0 ±2.0°C (212.0 ±3.6°F) shall not be less than 80 percent of the tensile strength and 50 percent of the elongation of specimens that have not been conditioned.

33.2 Sample

33.2.1 Three straight specimens are to be obtained from the circumference of the gasket. In order to reduce the amount of buffing or skiving, gaskets may be cut around the circumference with a sharp knife or razor blade. The irregularities are then to be buffed or skived until they are removed. The buffed or skived specimens are not to be greater than 0.075 inch (1.9 mm) thick.

33.3 Equipment

33.3.1 The equipment is to be as described in 25.3.1 – 25.3.6, except no cutting die is necessary.

33.4 Test method

33.4.1 Tensile strength and elongation are to be determined in accordance with the applicable portions of the methods described in 25.4.1 – 25.4.7.

34 Compression Set Test

34.1 General

34.1.1 The compression set of samples of a gasket material shall not exceed 20 percent of the original thickness after they have been compressed to 75 percent of the original thickness and then conditioned for 22 ±1/2 hours at a temperature of 60.0 ±2.0°C (140.0 ±3.6°F).

34.2 Samples

34.2.1 Type I samples of the gasket material are to be prepared as described in Method B of ASTM D395.

34.3 Equipment

34.3.1 The oven described in 23.3.1 and equipment as described in Method B of ASTM D395 are to be used.

34.4 Test method

34.4.1 The test method is to be as described in Method B of ASTM D395.

35 Ozone Resistance Test of Gaskets

35.1 General

35.1.1 For hose assemblies intended to be marked as ozone resistant in accordance with 40.2.3, the gasket of a coupling shall show no visible signs of cracking when stressed and exposed for 70 ±1/2 hours to an atmosphere having an ozone partial pressure of 100 ±10 mPa at a temperature of 40.0 ±1.0°C (104.0 ±1.8°F).

35.2 Sample

35.2.1 Three straight specimens, 3-3/4 inches (95.3 mm) in length, are to be obtained from the circumference of the gasket. In order to reduce the amount of buffing, gaskets may be cut around the circumference with a sharp knife or razor blade. The specimens are to be buffed smooth and uniform until the thickness is 0.075 to 0.100 inches (1.9 to 2.5 mm).

35.3 Equipment

35.3.1 The equipment is to be as described in 26.3.1.

35.4 Test method

35.4.1 The test method is to be as described in 26.4.1. The specimens are to be exposed to ozone while bent in the direction of the natural curvature.

36 Water Immersion Test of Gaskets

36.1 General

36.1.1 The tensile strength, ultimate elongation, and volume change of the gasket of a coupling shall comply with the Water Immersion Test of Linings, Section 27.

36.2 Sample

36.2.1 Specimens obtained from representative gaskets as described in 33.2.1 are to be used for the tensile strength and ultimate elongation measurements. Specimens obtained from representative gaskets and approximately 2 inches long (50 mm) by the width or thickness of the gasket are to be used for volume change measurements.

37 Radiant Heat Test

37.1 General

37.1.1 Hose and hose assemblies in sizes 3 inches and less shall be tested to determine the time to a 20 psi pressure loss in accordance with the method in this section. After the pressure loss, the sample shall be removed from the radiant heat test apparatus and the leakage rate through the hose shall be determined.

37.1.2 Each color and uniquely striped or marked hose shall be tested.

37.1.3 A minimum of 3 hose samples shall be tested to evaluate a hose. All visibly unique surfaces of the hose, including but not limited to exposed stitching, striping, marking as required by Section 40, and manufacturer's logos shall be tested. More samples shall be tested as necessary to evaluate all visibly unique surfaces. Once the shortest time to pressure loss from the unique surfaces tested is determined, a minimum of two additional samples for that surface shall be tested. The results from the surface with the shortest time to pressure loss shall be averaged and reported. The results shall be rounded to the nearest whole gallon per minute. For leakage rates less than 0.5 gpm, the results shall be reported as < 1 gpm.

37.2 Samples

37.2.1 Samples shall be 10 ft ±6 in (3 m ±152 mm) in length (hose length between couplings) and with couplings on each end fitted to provide a static sample pressure of 150 psi.

37.2.2 Prior to testing, the dry sample shall be conditioned for 12 hours in a room maintained at 23.0 ±2.0°C (73.0 ±3.6°F).

37.2.3 For hose utilizing cotton materials, in addition to 37.2.2, the sample shall be conditioned at 65 ±2 % relative humidity.

37.3 Equipment

37.3.1 A test apparatus utilizing a burner head and a means for positioning and restraining the hose shall be used for testing. An example test apparatus is contained in Appendix A. Two burner heads are in the illustration for the test apparatus, however only one at a time is used for the test.

37.3.2 The test apparatus shall utilize a burner head with a length of 12-3/8 inches and width of 4-7/8 inches.

37.3.3 A water cooled Schmidt-Boelter heat flux gauge with a minimum range of 0 – 50 kw/m^2 but not greater than 0 – 75 kw/ m^2 shall be used to determine the heat flux output from the burner head assembly.

37.3.4 For post exposure leakage rate testing, a pump capable of supplying at least 40 gpm at 200 psi shall be used and a calibrated water flow meter or equivalent water flow measuring device capable of reporting the leakage rate at ±0.5 gpm.

37.4 Test method

37.4.1 The samples shall be secured in the test apparatus for exposure to radiant heat and charged to a static pressure of 150 psi ±5 psi. The ends of the active burner head shall be a minimum of 2 ft from the hose couplings. During the test set up and while charging the hose with water, the outer surface of the conditioned sample shall not be wetted or contacted with water in any way. Any air in the hose shall be bled from the line prior to the exposure to radiant heat. Freestanding hydrostatic test hand pumps and mechanical pumps are both acceptable for pressurizing the sample. One end of the sample is to be connected to the source of water supply by means of couplings or temporary test fittings, and the other end is to be closed by a fitting provided with a petcock for the escape of air while the sample is being filled with water. The test sample shall be pressurized to 150 psi ±5 psi and maintained for 60 seconds prior to exposure to the radiant heat.

37.4.2 A mixture of propane and air shall be fed to a burner head to generate a steady state heat flux of 30 kw/m^2. The heat flux shall be measured using a calibrated heat flux gauge at a location equal to the distance from the burner head to the top of the hose sample intended to be tested.

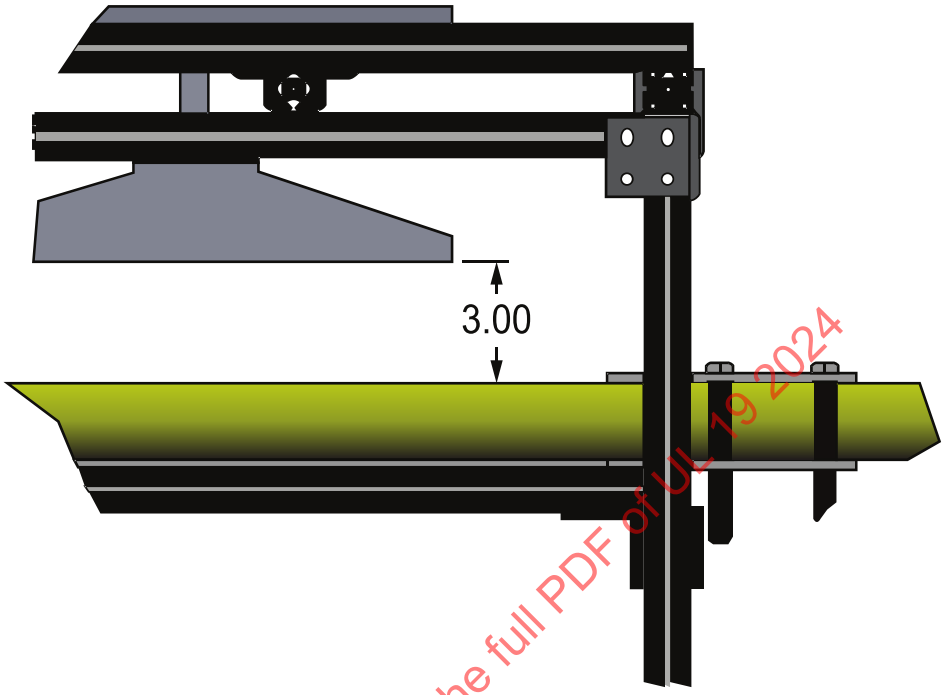
37.4.3 At the beginning of each day prior to testing, the linear distribution of heat flux along the length of the heating element shall be confirmed to be with ±5 % of the intended heat flux across a minimum of five measurement locations, at least 1inch from each other. Testing of the linear distribution shall be conducted by measuring the flux at not less than five locations along the length (long dimension) of the burner along the centerline of the burner width wise. If measured heat fluxes fall outside the desired range, repair or adjust the burner until the linear distribution of fluxes falls within the intended range.

37.4.4 Starting from a low flow rate of propane and air, ignite the burner and gradually increase the flow rates of the two gasses until the combustion is constrained to the surface of the heating element and a bright red glowing is achieved of the heating element mesh.

37.4.5 The heat flux measured shall remain constant within ± 5% of the desired value for a minimum of 180 seconds prior to starting the test. It may be necessary to reposition the gauge to a height at which the intended exposure heat flux is achieved. If the measured heat flux is not within the specified tolerance, the heights of the heat flux gauge and hose sample, or burner head shall be adjusted between a range of 2-1/2 inches to 3-1/2inches until the desired flux is measured. In all cases, the distance between the bottom of the burner head and top of the hose shall be 3 ±1/2 inch.

Figure 37.1

The burner head and top of the hose



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37.4.6 If the heat flux gauge is relocated, the positioning of the hose specimen shall be realigned such that the top of the pressurized hose is coplanar to the top surface of the heat flux gauge.

37.4.7 Once the steady state heat flux has been established, the heater assembly shall be positioned above the hose sample. The hose under test shall be exposed to the target heat flux until a 20 psi static pressure loss in the sample occurs through hose leakage at the exposed area. The radiant panel shall be removed from the hose 10 seconds ±2 seconds after the 20 psi pressure drop occurs. The time for this pressure drop shall be recorded. If no pressure loss is observed within 15 minutes, the test shall be terminated.

37.4.7A In cases where the hose under test ignites, the test shall be terminated at the time of ignition. The time to ignition shall be used as the time to leakage, even if no leakage occurred. The leakage rate shall be reported as "≥ 20 gpm".

37.4.8 Subsequent to the exposure test, the hose shall be removed from the test apparatus and the leakage rate of the sample shall be determined by charging the hose at 150 psi dynamic pressure and measuring the leakage through the hose in gpm.

37.5 Radiant heat test results

37.5.1 The time to a 20 psi pressure drop and the leakage rate shall be recorded for each hose sample tested. A radiant heat test result for a hose shall be reported based on the following:

a) The time to pressure loss results and leakage rate from the unique surface with the lowest time to pressure loss shall be averaged to determine the reported result; and

b) The hose sample tested with the highest leakage rate shall be reported, even if this is a different sample from those tested in (a).

37.5.2 The results shall be reported in the following format; the radiant heat exposure (30 kw/m^2), exposure duration (min:sec), and the leakage rate (gpm). Hose that withstands radiant heat for 15 min without pressure loss shall be reported as "> 15 minutes" and "no leakage". For hose that has a leakage rate less than 20 gpm, the time to pressure loss and leakage rate in gpm shall be reported as indicated in 37.5.1. Hose that has leakage greater than or equal to 20 gpm shall be reported as the time to pressure loss and leakage rate "≥ 20 gpm".

Example:

Radiant Heat Test Results

- Radiant heat exposure: 30 kw/m^2
- Exposure duration: 55 seconds
- Average leakage rate for samples tested @ 150 psi: 7 gpm
- Maximum leakage rate for samples tested @ 150 psi: 12 gpm

37.5.3 The manufacturer shall state the following language with the test results: "The results from the radiant heat test are based on controlled laboratory testing and do not represent actual conditions encountered during firefighting. These results are intended to be used as a baseline for hose comparison purposes only and are not indicative of specific field performance. Several factors can influence hose performance relative to radiant heat, please see Guidance for Lined Fire Hose and Hose Assemblies, UL 19G for further information on these results."

Note – The language found in UL 19G is a duplicate of the language in Appendix C.

38 Conductive Heat Test

38.1 General

38.1.1 Hose and hose assemblies in sizes 3 inches and less shall be tested to determine the time to a 20 psi pressure loss in accordance with the method in this section. After the pressure loss, the sample shall be removed from the test fixture and the leakage rate through the hose shall be determined.

38.1.2 A minimum of 3 hose samples shall be tested to evaluate the hose. The results from the samples tested shall be averaged and reported. The results shall be rounded to the nearest whole gallon per minute. For leakage rates less than 0.5 gpm, the results shall be reported as < 1 gpm.

38.2 Samples

38.2.1 Samples shall be 3 ft in length (hose length between couplings) with couplings on each end fitted to provide a static sample pressure of 300 psi.

38.2.2 Prior to testing, the dry sample shall be conditioned for 12 hours in a room maintained at 23.0 ±2.0°C (73.0 ±3.6°F).

38.2.3 For hose utilizing cotton materials, in addition to 38.2.2, the sample shall be conditioned at 65 ±2% relative humidity.

38.3 Equipment

38.3.1 An oven or furnace capable of maintaining a temperature of 400.0 ±5.0°C (752.0 ±9°F) shall be used to heat the solid steel block. The steel block shall be E C-1010/ C-1020, 2-1/2 by 2 1/4 by 8 inches (63.5 by 57.15 by 203 mm). The dimensions of the block and test fixture are indicated in Appendix B.

38.3.2 The hose fixture and block shall be clean, free from rust, and dry.

38.3.3 For post exposure leakage rate testing, a pump capable of supplying at least 40 gpm at 200 psi shall be used and a calibrated water flow meter or equivalent water flow measuring device capable of reporting the leakage rate at ±0.5 gpm.

38.4 Test method

38.4.1 The sample shall be secured in the test apparatus and charged to a static pressure of 300 psi ±5 psi. During test set up and while charging the hose with water, the outer surface of the conditioned sample shall not be wetted or contacted with water in any way. Any air in the hose shall be bled from the line prior to the heat. Freestanding hydrostatic test hand pumps and mechanical pumps are both acceptable for pressurizing the sample. One end of the sample is to be connected to the source of water supply by means of couplings or temporary test fittings, and the other end is to be closed by a fitting provided with a petcock for the escape of air while the sample is being filled with water. The test sample shall be pressurized to 300 psi ±5 psi and maintained for a minimum of 60 seconds prior to the exposure to the hot block.

38.4.2 The steel block is to be placed in a pre-heated oven or furnace for at least 8 hours and maintained at 400.0 ±5.0°C (752.0 ±9°F), removed from the oven, and within 10 seconds placed so that the longitudinal axis of the steel block is perpendicular to the longitudinal axis of the sample. The contact area is to be the midpoint of the 2-1/2 inch (63.5 mm) wide side of the steel block and the midpoint of the sample. The rods act as a guide to center the block.

38.4.3 The hose under test shall be exposed to the hot block until a 20 psi static pressure loss in the sample occurs through hose leakage at the exposed area. Pressure loss throughout the duration of the test attributed to stretching of the hose shall be disregarded and only pressure loss due to leakage shall be considered for the end of the test. The hot block shall be removed from the hose 10 seconds ±2 seconds after the 20 psi pressure drop occurs. The time for this pressure drop shall be recorded. If no pressure loss is observed within 15 minutes, the test shall be terminated.

38.4.4 Subsequent to the exposure test, the hose shall be removed from the test apparatus and the leakage rate of the sample shall be determined by charging the hose at 150 psi dynamic pressure and measuring the leakage through the hose in gpm.

38.5 Conductive heat test results

38.5.1 The time to a 20 psi pressure drop and the leakage rate shall be recorded for each hose sample tested. A conductive heat test result for a hose shall be reported based on the following:

a) The time to pressure loss results shall be averaged to determine the reported result; and

b) The hose sample tested with the highest leakage rate shall be reported and the average leakage rate for all samples tested shall be reported.

38.5.2 The results shall be reported in the following format; the conductive heat exposure (Steel Block at 400 °C), exposure duration (min:sec), and the leakage rate (gpm). Hose that withstands the conductive heat test for 15 min without pressure loss shall be reported as “> 15 minutes” and “no leakage”. For hose

that has a leakage rate less than 20 gpm, the time to pressure loss and leakage rate in gpm shall be reported as indicated in 38.5.1. Hose that has leakage greater than or equal to 20 gpm shall be reported as the time to pressure loss and leakage rate "≥ 20 gpm".

Example:

Conductive Heat Test Results

- Conductive heat exposure: Steel Block at 400 °C (752 °F)
- Exposure duration: 55 seconds
- Average leakage rate for samples tested @ 150 psi: 7 gpm
- Maximum leakage rate for samples tested @ 150 psi: 12 gpm

38.5.3 The manufacturer shall state the following language with the test results: "The results from the conductive heat test are based on controlled laboratory testing and do not represent actual conditions encountered during firefighting. These results are intended to be used as a baseline for hose comparison purposes only and are not indicative of specific field performance. Several factors can influence hose performance relative to conductive heat, please see Guidance for Lined Fire Hose and Hose Assemblies, UL 19G for further information on these results.

Note – The language found in UL 19G is a duplicate of the language in Appendix C.

38A Diameter of Charged Hose Tests

38A.1 General

38A.1.1 For a hose with a trade size less than 3 inches, the internal diameter of the hose shall be measured and reported when charged at 50 psi (345 kPa) and 150 psi (1035 kPa).

38A.1.2 For a hose with a trade size less than 3 inches, the outside diameter of the hose shall be measured and reported when charged at 150 psi (1035 kPa).

38A.2 Samples

38A.2.1 The length of the uncharged sample shall be at least 18 inches.

38A.2.2 The length of the charged (pressurized) sample is to be at least 18 inches (457 mm).

38A.3 Equipment

38A.3.1 A pump capable of supplying at least 200 psi (1380 kPa) shall be used to pressurize the sample, a pi tape for measuring the outside diameter, and the equipment specified in 5A.1.

38A.4 Method

38A.4.1 The internal diameter of the open end of the uncharged hose shall be measured in accordance with 5A.1 on both ends of the hose and averaged. While the tapered plug is inserted in the hose sample, the outside diameter of the hose sample shall be measured with a pi tape at the location that the hose sample is in contact with the tapered plug on both ends and averaged.

38A.4.2 Another sample with couplings, shall be filled with water so that all air is allowed to escape. The pressure of the sample shall be raised to 50 psi ± 2 psi (345 kPa ± 14 kPa) and the outside diameter shall be measured with a pi tape in two locations at least 6 inches apart and averaged. Following measurement of the sample at 50 psi, (345 kPa), the pressure in the sample is to be increased 150 psi ± 5 psi (1035 kPa ± 34 kPa) and the outside diameter shall be measured with a pi tape in two locations at least 6 inches apart and averaged.

38A.5 Reported Results

38A.5.1 The thickness of the hose shall be determined while uncharged using the averaged values from the plugged internal diameter and measured outside diameter while plugged.

38A.5.2 The charged internal diameter at 50 psi (345 kPa) shall be determined using the average measured outside diameter at 50 psi (345 kPa) and the thickness of the hose measured in 38A.5.1 and reported.

38A.5.2 The charged internal diameter at 150 psi (1035 kPa) shall be determined using the averaged measured outside diameter at 150 psi (1035 kPa) and the thickness of the hose measured in 38A.5.1 and reported.

38A.5.4 The charged outside diameter at 150 psi (1035 kPa) shall be reported as measured in 38A.4.2.

MANUFACTURING AND PRODUCTION TESTS

39 General

39.1 To determine compliance with these requirements in production the manufacturer shall provide the necessary production control, inspection, and tests.

39.2 Each hose shall be subjected to the proof pressure test specified in 11.1.1.

39.3 The manufacturer is to furnish all necessary equipment and facilities for determining compliance with the requirements, including a pressure gauge, and the like. Provision is to be made for calibrating the pressure gauge as often as may be necessary to verify that it is accurate; but at least once every 3 months, the manufacturer shall calibrate each gauge used in the test work and record the readings.

MARKING

40 Details

40.1 General

40.1.1 If a manufacturer produces hose or hose assemblies at more than one factory, each length of hose shall have a distinctive marking to identify it as the product of a particular factory.

40.2 Hose

40.2.1 Each length of hose shall be indelibly marked in letters and figures at least 1 inch (25.4 mm) high with the following:

a) Manufacturer's name or coded designation;

b) Trade name or hose designation;

c) Month or quarter and year of manufacture; and

d) The words “Service Test to ___ psig (kPa),” where _____ is the appropriate pressure.

40.2.2 Hose complying with the requirements in 20.1.2 may be marked “For Use Down To minus 65°F (minus 54°C).”

40.2.3 Hose complying with the requirement in 26.1.1 may be marked “Ozone Resistant.”

40.2.4 The markings specified in 40.2.1 shall start at 3.5 – 4.5 feet (1.1 – 1.4 m) from both ends of each length of the hose.

40.3 Hose assemblies

40.3.1 Each coupling of hose assemblies shall be marked with the following information using stamped or cast figures and letters not less than 3/16 inch (4.8 mm) high:

a) Name or identifying symbol of the assembly manufacturer.

b) Distinctive catalog or model designation.

c) Type of thread.

40.3.2 The hose of each coupled hose assembly shall be marked in accordance with 40.1.1 – 40.2.4.

PRODUCT SPECIFICATION SHEET

41 General

41.1 The manufacturer shall provide a product specification sheet for each hose model and size that includes at least the following items:

a) Model designation

b) Trade size

c) Service test pressure

d) Construction type

e) Color and other applicable markings

f) Ozone resistant rating information, if applicable

g) Low-temperature rating information, if applicable

h) The inside diameter uncharged

i) The inside diameter of the hose charged at 50 psi and 150 psi

j) The outside diameter of the hose charged at 150 psi

k) The radiant heat test results

l) The conductive heat test results

41.2 The product specification sheet shall be permitted to be provided in a physical form (hard copy) or readily accessible electronically.

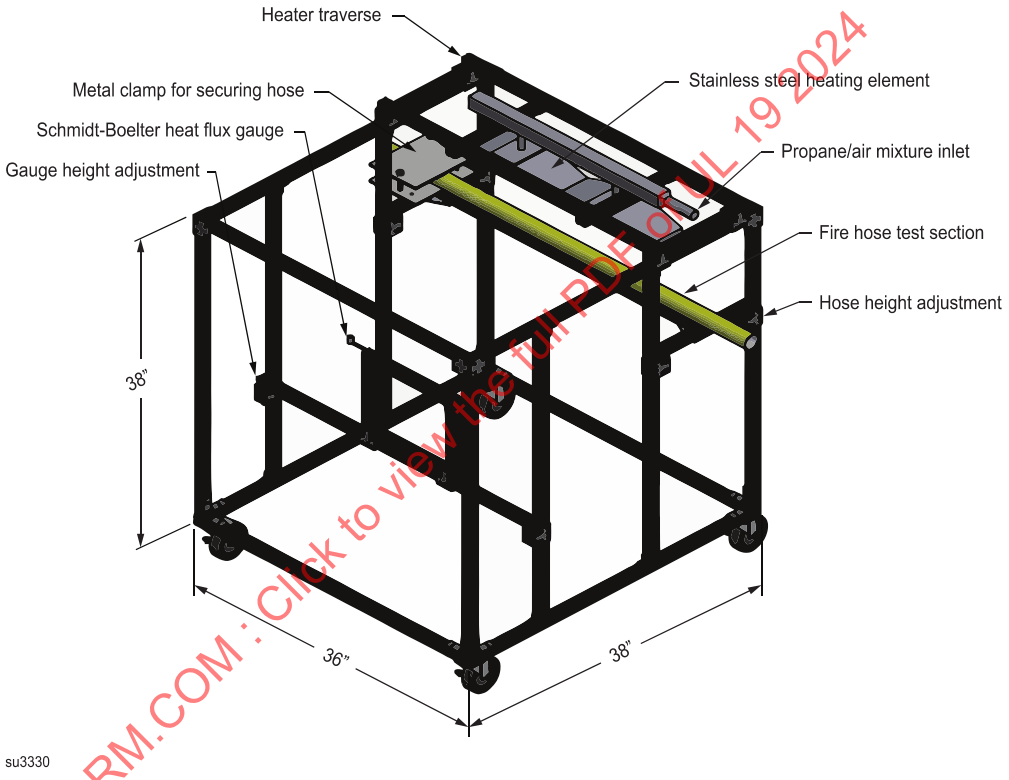
Appendix A – (Informative) – Example Radiant Heat Test Apparatus

A.1 General

A.1.1 An example test apparatus is located in Figure A.1 below. Examples of the burner head are located in Figure A.2 below. The example apparatus consists of the following subsystems with components identified in Figure A.1: support frame; stainless steel heating element; heat flux gauge measurement and positioning; and test specimen mounting and adjustment.

Figure A.1

Fire hose test apparatus



A.2 Support Frame

A.2.1 The apparatus support frame should be constructed of extruded aluminum T-slotted profiles and measure 38 inched wide, 38 inches high and 36 inches long. The frame will support the stainless-steel heating element, a heat flux gauge, and the hose specimen. Inclusion of casters are optional for on-site mobility.

A.3 Stainless Steel Heating Element

A.3.1 The thermal heating element shall be a surface combustion gas-fired infrared burner, 12-3/8 inches long, 4-7/8 inches wide extending 6 inches from the manifold piping as shown in Figure A.2. A single premixed gas line inlet shall feed the burner. The heating element face should be constructed of a fine, porous, extruded metal foam. See Figure A.3 through Figure A.5 for additional burner head illustrations.

Figure A.2
Burner Head Dimensions

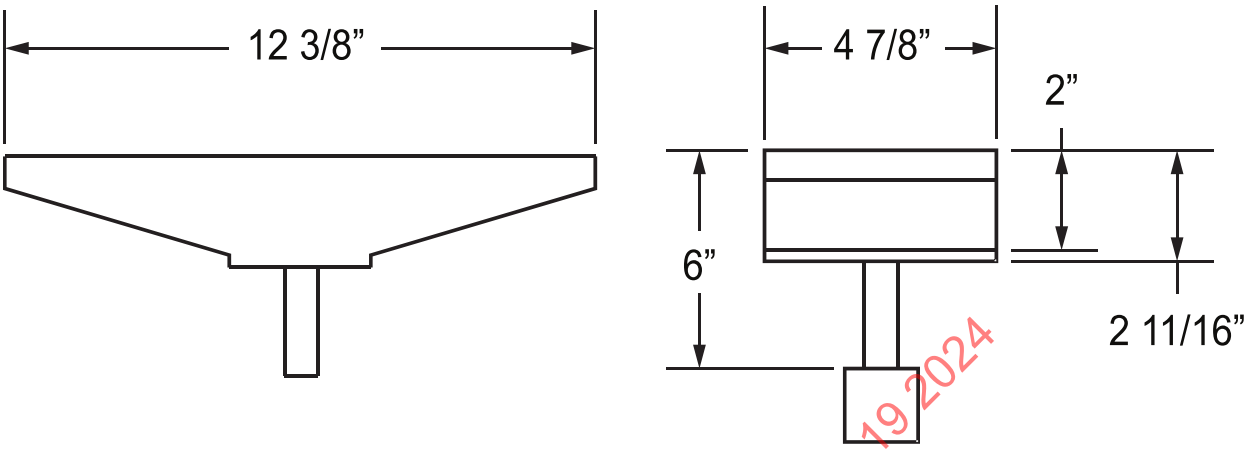


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Figure A.3
Burner Head Bottom View

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