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Underwriters Laboratories Inc. (UL)
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UL Standard for Safety
for
Lined Fire Hose and Hose Assemblies, UL 19

Eleventh Edition, Dated December 15, 1995

Revisions: This Standard contains revisions through and including May 23, 1996.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The new and/or revised requirements are substantially in accordance with UL's Bulletin on this subject dated February 16, 1996. The bulletin is now obsolete and may be discarded.

The revisions dated May 23, 1996 include a reprinted title page (page 1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety has been adopted by the Department of Defense.

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The requirements in this Standard are now in effect.

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Page	Date
tr1, tr2	May 23, 1996
1	December 15, 1995 (Reprinted: May 23, 1996)
2 – 6	December 15, 1995
7	May 23, 1996
8 – 11	December 15, 1995
12, 13	May 23, 1996
14, 15	December 15, 1995
16	May 23, 1996
17 – 24	December 15, 1995
25	May 23, 1996
26 – 28	December 15, 1995

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1

HISTORICAL NOTE

UL 19

Standard for

Lined Fire Hose and Hose Assemblies

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

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Eleventh Edition

December 15, 1995

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 19 on February 7, 1993. The publication of revised pages or a new edition of this standard will not invalidate the DoD adoption.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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CONTENTS**FOREWORD****INTRODUCTION**

1 Scope	5
2 General	5
3 Glossary	5

CONSTRUCTION

4 Length	6
5 Internal Diameter	6
6 Jacket and Inner Reinforcements	6
7 Lining	6
8 Cover	7
9 Coatings and Treatments	7
10 Couplings	7

PERFORMANCE

11 Hydrostatic Proof-Pressure Tests	7
12 Kink Test	10
13 Hydrostatic Strength Test	11
14 Repeated Bending Test	11
15 Alternating Pressure Test	13
16 Abrasion Test	13
17 Heat-Resistance Test	14
18 Fold-Resistance Test	15
19 Wet Hose Test	16
20 Low-Temperature Test	16
21 Coupling Retention Test	17
22 Friction Loss Test	17
23 Accelerated Aging Test of Threads	18
24 Adhesion Tests	19
25 Accelerated Aging Test of Linings and Covers	20
26 Ozone-Exposure Test of Linings and Covers	21
27 Water Immersion Test of Linings	22
28 Pull Test	23
29 Accelerated Aging Test of Hose Assembly	24
30 Rough Usage Test	24
31 Mercurous-Nitrate Immersion Test	25
31A Moist Ammonia-Air Stress Cracking Test	25
32 Salt-Spray Corrosion Test	25
33 Accelerated Aging Test of Gaskets	26
34 Compression Set Test	26
35 Ozone Resistance Test of Gaskets	27
36 Water Immersion Test of Gaskets	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 the Specification for Copper-Base Alloys in Ingot Form, ASTM B30-93a and in the Specification for Copper Alloy Sand Castings for General Applications, ASTM B584-93b.

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 31A.

10.4 revised May 23, 1996

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 – h 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 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 – 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 3 inches (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 – 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 and 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.

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 the sizes of 1-1/2, 1-3/4, 2, 2-1/2, 3, and 3-1/2 inches (38, 45, 51, 65, 76, and 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 ID)		Inches (mm)	
1-1/2	(38)	8	(203)	19 (483)
1-3/4	(45)			8 (203)
2	(51)	14	(356)	34 (864)
2-1/2	(65)			14 (356)
3	(76)	16	(406)	34 (864)
3-1/2	(76)			14 (356)

Table 14.2
Length of test sample for repeated bending test

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

Table 14.2 revised May 23, 1996

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 approximately 4 feet (1.2 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.

15.1.1 revised May 23, 1996

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 $3 \pm 1/2$ 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 Hydrostatic Proof-Pressure Tests, Section 11.

15.4.2 revised May 23, 1996

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 5 to 7 feet (1.5 to 2.1 m).

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 2-1/2- and 3-inch (65 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).
- 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 $260.0 \pm 1.0^{\circ}\text{C}$ ($500.0 \pm 1.8^{\circ}\text{F}$), a 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 $23.0 \pm 2.0^{\circ}\text{C}$ ($73.0 \pm 3.6^{\circ}\text{F}$). The steel block is to be heated for at least 16 hours in an oven maintained at $260.0 \pm 1.0^{\circ}\text{C}$ ($500.0 \pm 1.8^{\circ}\text{F}$), 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 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 the Specification for Gravity – Convection and Forced-Ventilation Ovens, ASTM E145-68(R1987), 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 $60 \pm 1^{\circ}\text{C}$ ($140.0 \pm 1.8^{\circ}\text{F}$), 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 subjected to the Hydrostatic Strength Test, Section 13.

20 Low-Temperature Test

20.1 General

20.1.1 Hose not marked in accordance with 38.2.2 shall withstand the appropriate proof-pressure in Hydrostatic Proof-Pressure Tests, Section 11, without leakage, ballooning, or rupture, after being subjected to cold flexing at a temperature of minus $4.0 \pm 1.8^{\circ}\text{F}$ (minus $20.0 \pm 1.0^{\circ}\text{C}$) as described in 20.4.1.

20.1.1 revised May 23, 1996

20.1.2 Hose marked in accordance with 38.2.2 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 $65.0 \pm 1.8^{\circ}\text{F}$ (minus $54.0 \pm 1.0^{\circ}\text{C}$) as described in 20.4.1.

20.1.2 revised May 23, 1996

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 $24 \pm 1/2$ 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 $16 \pm 1-1/2$ 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 Hydrostatic Proof-Pressure Tests, Section 11.

20.4.1 revised May 23, 1996

31 Mercurous-Nitrate Immersion Test

Section 31 deleted May 23, 1996

31A Moist Ammonia-Air Stress Cracking Test

Section 31A added May 23, 1996

31A.1 General

31A.1.1 After being subjected to the conditions described in 31A.3.1 – 31A.4.2 a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

31A.2 Sample

31A.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.

31A.3 Equipment

31A.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 $34.0 \pm 2^\circ\text{C}$ ($93 \pm 3.6^\circ\text{F}$).

31A.4 Method

31A.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 necessary to produce a leaktight assembly. Teflon tape or pipe thread compound are not to be used on the threads.

31A.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 approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover. Approximately 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 $34.0 \pm 2^\circ\text{C}$ ($93 \pm 3.6^\circ\text{F}$) 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 the Specification for Copper-Base Alloys in Ingot Form, ASTM B30-93a, and in the Specification for Copper Alloy Sand Castings for General Applications, ASTM B584-93b, 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 Method of Salt-Spray (Fog) Testing, ASTM B117-90, 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 Salt-Spray (Fog) Testing, ASTM B117-90.

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 Salt-Spray (Fog) Testing, ASTM B117-90.

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 $70 \pm 1/2$ hours in an air oven at a temperature of $100.0 \pm 1.0^\circ\text{C}$ ($212.0 \pm 1.8^\circ\text{F}$) 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 $22 \pm 1/2$ hours at a temperature of $60.0 \pm 2.0^\circ\text{C}$ ($140.0 \pm 3.6^\circ\text{F}$).

34.2 Samples

34.2.1 Type I samples of the gasket material are to be prepared as described in Method B of the Test Methods for Rubber Property – Compression Set, ASTM D395-89(R1994).