UL 21

STANDARD FOR SAFETY

LP-Gas Hose

UL Standard for Safety for LP-Gas Hose, UL 21

Eleventh Edition, Dated December 15, 2014

Summary of Topics

These revisions to ANSI/UL 21 include the following:

1. Revision to the moist ammonia-air stress cracking test

The revised requirements are substantially in accordance with Proposal(s) on this subject dated May 19, 2017.

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

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Standard for LP-Gas Hose

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

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INTRODUCTION

1 Scope

1.1 These requirements cover hose and hose assemblies in sizes up to and including a nominal internal diameter of 4 in (102 mm) for conveying liquefied petroleum gas (LP-Gas) intended to be installed in closed systems in compliance with the Standard of the National Fire Protection Association Liquefied Petroleum Gas Code, NFPA 58. The hose or hose assembly is intended for a maximum working pressure of 350 pounds per square inch gauge (psig) (2400 kPa) for use at temperatures within the range of minus 40°C (minus 40°F) to plus 60°C (140°F), or minus 54°C (minus 65°F) to plus 60°C. Hose and hose assemblies in sizes larger than 2 in (50.8 mm) are not intended for use on reels.

1.2 This standard does not apply to:

a) Flexible hose connectors for LP-Gas that are investigated under the Standard for Pigtails and Flexible Hose Connectors for LP-Gas, UL 569;

b) Gas appliance connectors for handling fuel gases at 5 psig (34.5 kPa) or less, which are investigated under Connectors for Gas Appliances, ANSI Z21.24, nor to metallic hose intended for use in oil transportation piping, in petroleum refinery piping, or in gas transmission and distribution piping systems; or

c) Hose intended for use in automotive applications or hose intended for use in confined areas.

d) Hose assemblies that are investigated under Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances, ANSI Z21.54.

2 General

2.1 Units of measurement

2.1.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

2.2 Undated references

2.2.1 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.

CONSTRUCTION

3 Tube and Cover

3.1 The tube or lining of a hose shall be made from an elastomeric material such as synthetic rubber, thermoplastic, or thermoplastic elastomer of the oil-resistant type. For hose up to and including the 2-in (50.8 mm) size, a similar elastomeric cover may be employed but is not required if the outer braid is impregnated with a rubber cement or compound. For hose larger than the 2-in size, an elastomeric cover shall be employed. A tube or a cover shall be smooth, of uniform thickness, free from defects in workmanship, and free from pitting, blisters, or other imperfections. Intentional pricking of a cover shall not be considered an imperfection. This requirement is not intended to exclude the use of a corrugated cover.

Exception: In the case of a coextruded multilayer tube or cover, the entire tube or cover will be used in all applicable tests, rather than the individual layers.

4 Reinforcement

4.1 A reinforcement shall be provided and shall be of cotton, synthetic fibers, or corrosion-resistant material such as stainless steel, or any combination thereof, evenly and firmly applied over the tube. The ply or plies shall be impregnated with a rubber compound which shall cause the plies to adhere firmly to each other and to the tube and cover.

5 Inside Diameter

5.1 The internal diameter of a hose shall be equal to the nominal diameter ±1/32 in (0.8 mm) for sizes up to and including 3/4 in (19.1 mm), and ±1/16 in (1.6 mm) for larger sizes.

5.2 A tapered plug gauge of wood or metal having a taper of 3/8 in per ft (31.3 mm/m) marked to indicate variation of 1/64 in (0.4 mm) in diameter, or a set of wood or metal plug gauges, straight or ball type, in increments no greater than 0.01 in (0.3 mm) for hoses in sizes 1 in (25.4 mm) and less and 0.02 in (0.5 mm) for hoses in sizes greater than 1 in (25.4) mm), or in some cases, see 5.3, an expanding ball gauge and micrometer or other equivalent means to accurately measure the expanded ball, is to be used.

5.3 The end of the hose is to be cut square. If a tapered plug gauge is used, the plug gauge is to be 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 in (0.4 mm), is to be recorded as the internal diameter of the hose. If a set of straight or ball-type plug gauges is used, the diameter of the gauge, which when inserted in the hose sample gives a close fit without forcing, is to be recorded as the internal diameter of the hose. If the end of a wire-braided hose is constricted or flared, the inside diameter is to be measured far enough from the end to be representative of the inside diameter by means of an expanding ball gauge.

6 Thickness of Tube or Cover

6.1 The thickness of a tube, and of a cover if one is used, shall not be less than 0.047 in (1.19 mm).

6.2 A power-driven buffing machine (grinding wheel) or skiving machine outlined in the Practice for Rubber-Preparation of Product Pieces for Test Purposes from Products, ASTM D3183, is to be used for removing irregularities in specimens. The abrasive wheel of a buffing machine is to be No. 30 to 60 grit; and the diameter and rotary velocity of the wheel are to be such that it will have a peripheral speed of 4000 ±700 ft per min (20.3 ±3.6 m/s). The machine is to be provided with a slow feed to avoid overheating of the specimen.

6.3 A dial micrometer graduated to 0.001 in (0.025 mm) which exerts a load of 80 – 85 g by means of a weight is to be used. The load is to be applied through a flat contact foot 0.25 ±0.01 in (6.4 ±0.25 mm) in diameter.

6.4 One piece, about 6 – 8 in (150 – 200 mm) in length, taken from the sample selected for physical and detail tests, is to be used in determining the thickness of the lining and cover in accordance with the following.

6.5 A strip, about 6 – 8 in (150 – 200 mm) in length and 1 in (25.4 mm) in width, or as close to a 1-in width as possible from small diameter hose, is to be cut from the hose, and the rubber part separated from the plies. In case the thickness of the part is not uniform around the circumference of the hose, the strip is to be cut from the thinnest portion of the sample.

6.6 The strip specimen is to be buffed or skived to remove the impressions left by the fabric or braid or other surface irregularities, using the buffing or skiving machine described in 6.2. A series of five thickness measurements are to be taken within the area from which the impressions have been removed, and the maximum reading obtained is to be taken as the thickness of the rubber part.

7 Assembly Couplings

7.1 Each end of an assembly shall be provided with a metal-connecting coupling consistent with the service for which the connector is designed.

7.2 Aluminum shall not be used in combination with copper or copper alloy.

7.3 A part made of drawn-brass or machined from brass rod, containing more than 15 percent zinc shall withstand, without cracking, the Moist Ammonia-Air Stress Cracking Test, Section 20.

7.4 End-connecting couplings shall be of corrosion-resistant metal or of steel provided with a protective coating having corrosion-resistant qualities at least equivalent to those of the coatings specified in 7.5.

7.5 Cadmium plating shall not be less than 0.0003 in (0.008 mm) thick, and zinc plating shall not be less than 0.0005 in (0.013 mm) thick. However, on parts where threads constitute the major portion of the area, the cadmium or zinc plating shall not be less than 0.00015 in (0.0038 mm) thick.

7.6 A standard LP-Gas cylinder valve connecting fitting shall comply with the Standard for Compressed-Gas Cylinder Valve Outlet and Inlet Connections, ANSI/CGA V-1.

7.7 A compression-type tubing fitting shall not be used when it utilizes a slip-on ring or sleeve or a fitting requiring the use of a gasket to obtain a gas-tight joint.

Exception: This requirement is not applicable when a gas-tight joint can be obtained without the use of seal material as in the case of a gasket or an O-ring used as a secondary seal.

7.8 Pipe threads shall be in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1.

7.9 A hose assembly shall not be constructed with end fittings that are capable of connecting an appliance with a female CGA 600 connection to a LP-Gas cylinder larger than 2-1/2 pound (1 kg) water capacity.

PERFORMANCE

8 Proof-Pressure Test

8.1 General

8.1.1 A hose shall withstand a hydrostatic pressure of 700 psig (4830 kPa) for 5 min without leakage, ballooning, or rupture.

8.2 Apparatus

8.2.1 Hydrostatic pressure may be applied by means of a hand- or power-operated pump or an accumulator system capable of increasing the pressure in the hose at a rate of not less than 300 psig (2070 kPa) nor more than 1000 psig (6900 kPa) per minute. A calibrated pressure-indicating device is to be connected in the piping system. The pressure-indicating device shall comply with one of the following:

a) An analog gauge having a pressure range of at least 150 percent of the anticipated maximum working pressure;

b) A digital pressure transducer, or other digital gauge, that is calibrated over a range of pressure that includes the test pressure; or

c) Other device that is equivalent to the devices in (a) or (b).

8.3 Method

8.3.1 Samples are to consist of at least one full length [nominally 11 ft (3.4 m)] of each size of hose.

8.3.2 By means of couplings or temporary test fittings, one end of the hose is to be connected to the source of water or other acceptable test liquid and the other end closed with a fitting which will allow all air to be expelled. The hose is to be placed on a test surface so as to lie straight and without twist.

8.3.3 The test liquid is to be admitted through the hose gradually until all of the air has been expelled and the hose is completely filled. The pressure in the hose is to be increased at a rate of not less than 300 psig (2070 kPa) nor more than 1000 psig (6900 kPa) per minute until the required test pressure is reached. While the pressure is being increased, the hose is to be carefully examined for leakage and other defects. When the test pressure has been reached, it is to be held at 5 min and the hose checked for leakage or ballooning.

9 Hydrostatic Strength Test

9.1 General

9.1.1 A hose or hose assembly shall withstand a hydrostatic pressure of 1750 psig (12,100 kPa) without leakage, ballooning, or rupture.

9.2 Apparatus

9.2.1 The apparatus for this test is to be the same as specified for the Proof-Pressure Test, Section 8, except that instead of the test table an enclosure is to be used to protect the operator.

9.3 Method

9.3.1 A sample is to consist of a 3-ft (0.9 m) hose assembly or a 3-ft (0.9 m) length of hose with temporary test fittings.

9.3.2 The hose sample, while lying straight, is to be connected to the pump and filled with the test liquid until all of the air has been expelled and the hose is completely filled. The pressure in the hose is to be increased at a uniform rate of approximately 1000 psig (6900 kPa) per minute until the required test pressure of 1750 psig (12,100 kPa) has been reached.

10 Adhesion Test

10.1 General

10.1.1 For 3/8-in (915 mm) size hose and smaller, the adhesion between the cover and the reinforcement, between the tube and the fabric reinforcement, and between the plies of fabric reinforcement shall be such that the rate of separation of a ring-shaped specimen, 1 in (25.4 mm) in width, is not greater than 1 in per min with a weight of 8 lbs (3.6 kg) for the adhesion determinations between the cover and the reinforcement and between the tube and the reinforcement and with a weight of 10 lbs (4.5 kg) for the adhesion determination between the plies of reinforcement.

10.1.2 For sizes of hose greater than 3/8 in (915 mm), the adhesion between the cover and the reinforcement, between the tube and the fabric reinforcement, and between the plies of fabric reinforcement shall be such that the rate of separation of a ring-shaped specimen, 1 in (25.4 mm) in width, is not greater than 1 in per min with a weight of 10 lbs (4.5 kg).

10.1.3 The adhesion between wire reinforcements and between the tube and a wire reinforcement shall be such that adjacent reinforcements, and the tube and the wire reinforcement, adhere firmly to each other by means of a compound impregnated in the reinforcements.

10.1.4 The above adhesion requirement is not intended for light fabric braids imbedded in or vulcanized to the rubber cover or tube for the primary purpose of improving the adhesion between the cover or tube and the reinforcement.

10.2 Apparatus

10.2.1 Adhesion tests are to be conducted with the type of apparatus described in the Test Methods for Rubber Property – Adhesion to Flexible Substrate, ASTM D413.

10.3 Method

10.3.1 The tests are to be conducted in accordance with the test methods outlined in the Test Methods for Rubber Hose, ASTM D380. Adhesion tests are to be conducted on only the cover of wire-reinforced hose. A hack saw with a sharp, fine (24 teeth/in) blade has been found acceptable for hose having a wire braided reinforcement, but a band saw with a fine blade gives cleaner edges and is preferable for preparing the ring specimens. The adhesion is to be taken as the rate obtained by dividing the total distance separated in inches (mm), to the nearest 1/32 in (0.8 mm), by the elapsed time in minutes.

10.3.2 If the adhesion of the reinforcement to the tube or cover is such that the parts cannot be separated sufficiently to permit attachment of the clamp, the adhesion is considered to be in compliance with the requirements.

11 Tensile Strength and Elongation Tests

11.1 General

11.1.1 The tensile strength of a tube shall not be less than 1000 psi (6.9 MPa), and the ultimate elongation of a tube shall not be less than 150 percent [from 1 to 2-1/2 in (25.4 to 63.5 mm)].

11.1.2 The tensile strength of a cover shall not be less than 1000 psi (6.9 MPa), and the ultimate elongation of a cover shall not be less than 250 percent [from 1 to 3-1/2 in (25.4 to 89 mm)].

11.2 Apparatus

11.2.1 Tensile strength and elongation tests are to be made on a power-operated machine, as described in the Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension, ASTM D412.

11.2.2 The rate of travel of the power-actuated grip is to be 20 ±1 in per minute (8.5 ±0.4 mm/s).

11.2.3 The elongation is to be measured by means of a scale or other device which is to be used in such a way as not to damage the specimen and is to be capable of indicating the elongation with an accuracy of 0.1 in (2.5 mm).

11.2.4 The specimens are to be buffed or skived with the equipment specified in 6.2.

11.2.5 Die C or Die D, as described in the Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension, ASTM D412, is to be used for cutting the specimens.

11.2.6 A dial micrometer, as described in 6.3, shall be used to measure thickness of specimens.

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11.3 Method

11.3.1 Tensile strength and elongation are to be determined in accordance with the test methods outlined in the Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension, ASTM D412, Method A.

11.3.2 Three dumbbell specimens are to be die cut and have a constricted portion 0.125 in (3.17 mm) wide and 1.3 in (33 mm) long (Die D) when cut from 1/4-in (6.4 mm) size hose and smaller and a constricted portion 0.250 in (6.35 mm) wide and 1.3 in long (Die C) when cut from sizes of hose greater than 1/4 in. The enlarged ends are to be 1 in (25.4 mm) wide, when possible.

11.3.3 The specimens are to be cut longitudinally from the sample. The cutting operation may be facilitated by wetting the cutting edges of the die with water. The rubber is to rest on a smooth and slightly yielding surface which will not injure the cutting edges of the die. A piece of belting or light cardboard is acceptable for the purpose.

11.3.4 The constricted portion of each specimen is to be buffed or skived to remove fabric impressions or other surface irregularities. The samples are to be buffed prior to cutting with the die.

11.3.5 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 of the three specimens is to be taken as the tensile strength of the rubber tube or cover.

11.3.6 If an automatic extensometer is not used, two bench marks 1-in (25.4 mm) apart are to be placed centrally on the constricted portion of each specimen. Care is to be taken so as not to damage the specimen.

12 Accelerated Air-Oven Aging Test

12.1 General

12.1.1 The tensile strength and ultimate elongation of specimens of a rubber tube and a cover which have been subjected to the action of air at a temperature of 100 ±2°C (212 ±3.6°F) for 70 ±1/2 h shall not be less than 80 percent of the tensile strength and 50 percent of the elongation of specimens which have not been heated in air.

12.1.2 The apparatus outlined in the Test Method for Rubber-Deterioration in an Air Oven, ASTM D573 is to be used for this test.

12.2 Method

12.2.1 Three tube and three rubber cover specimens are to be prepared, except for stamping the 1 in (25.4 mm) bench marks, in the same manner as for the tensile strength and elongation tests before placing the specimens in the oven. The 1 inch apart bench marks are to be stamped on the specimens after aging. The exposure is to be conducted in accordance with the test procedures outlined in the Test Method for Rubber-Deterioration in an Air Oven, ASTM D573. For comparative purposes, three tube and three rubber cover specimens which have not been exposed to air oven aging are to be subjected to physical tests at the same time that the exposed specimens are tested. The methods for preparing specimens and conducting the tensile strength and elongation tests are to be as described in 11.2.1 – 11.3.6.

13 Ozone Exposure

13.1 General

13.1.1 The rubber cover or impregnated outer braid of a hose shall show no visible signs of cracking when stressed and exposed for 70 to 72 h to an atmosphere regulated to give an ozone partial pressure of 100 ±10 mPa of ozone at a temperature of 40°C (104°F).

13.2 Apparatus

13.2.1 The ozone test chamber for this test is to comply with the requirements outlined in the Test Method for Rubber Deterioration – Surface Ozone Cracking in a Chamber (Flat Specimens), ASTM D1149. The specimen holder is to comply with the requirements outlined in Procedure B of the Test Method for Rubber Deterioration– Surface Cracking, ASTM D518.

13.3 Method

13.3.1 Three specimens 3-3/4 in (95.3 mm) in length by 1 in (25.4 mm) in width (or as close to 1-in width as possible from small diameter hose) are to be cut longitudinally from the rubber cover or impregnated outer braid of the hose sample. Rubber covered specimens are to be buffed or skived to remove any surface irregularities caused by reinforcement members and then mounted in the specimen holder in a looped position, in accordance with the procedures outlined in the Test Method for Rubber Deterioration – Surface Cracking, ASTM D518, Method B. The mounted specimens are to be allowed to remain in an ozone free atmosphere for 24 h before placing in the ozone test chamber, which is to be regulated to give an ozone partial pressure of 100 ±10 mPa and a temperature of 40°C (104°F). When constant test conditions have been obtained in the ozone test chamber, and after the mounted specimens have remained in the ozone free atmosphere for 24 h, the mounted specimens are to be placed in the test chamber and allowed to remain for 70 to 72 h. After the test exposure, the specimens are to be removed from the test chamber and examined with a hand, seven-power magnifying glass.

14 Repeated Bending Test

14.1 General

14.1.1 An empty hose, except a hose larger than 1-1/4 in (31.8 mm) not intended for use on a reel, shall withstand 3000 cycles of repeated bending to a radius as given in Table 14.1 without breakdown and, upon completion of the repeated bending, shall be capable of withstanding the Proof-Pressure Test Section 8, and the Hydrostatic Strength Test, Section 9.

Table 14.1
Radius of bend and center distance for test

Size of hose, in (mm)		Radius of bending, in (mm)	Distance between centers, in (mm)	
			Vertical	Horizontal
Up to 1/2	(12.7)	4 (102)	9.5 (241)	4 (102)
1/2–5/8	(12.7 – 15.9)	6 (152)	14 (356)	6 (152)
5/8–1	(15.9 – 25.4)	7 (178)	16.5 (419)	7 (178)
1–1-1/2	(25.4 – 38.1)	8 (203)	19 (483)	8 (203)
1-1/2–2	(38.1 – 50.8)	10 (254)	25 (635)	10 (254)

14.2 Apparatus

14.2.1 Apparatus for this test is to consist of a steel framework on which are mounted two wooden drums, or rollers, each about 5 in (127 mm) thick. A semicircular groove is to be cut in the circumference of each drum to act as a guide for the hose. The radii of the drums, measured to the base of the circumferential grooves, are to be as specified in Table 14.1. The drums are to be mounted with their flat sides in the same vertical plane so that the distances between centers are as specified in Table 14.1. Each drum is to rotate freely about an axle at its center. A motor-driven mechanism is to be provided for pulling the hose up over the drums and letting it down at a rate of four complete cycles per minute.

14.3 Method

14.3.1 An 11-ft (3.4 m) length of the hose is to be placed over the drums in an S-shaped curve, with the end which passes over the top drum brought down and a weight just sufficient to make the hose conform to the drums fastened to it. The end which passes under the bottom drum is to be brought up and fastened to the mechanism which pulls the hose up over the drums. The mechanism is to be adjusted so that the hose is moved a total distance of approximately 4 ft (1.2 m) in each direction. After the hose has completed 3000 cycles of bending it is to be removed and examined for any indication of weakness or breakdown. It is then to be subjected to the Hydrostatic Strength Test, Section 9.

15 Repeated Bending – Proof Pressure Test

15.1 General

15.1.1 A hose shall withstand 200,000 cycles of repeated bending without breakdown and shall, following the repeated bending, withstand the Proof-Pressure Test, Section 8.

Exception: Hose larger than 1-1/4-in (31.8-mm) size that is not intended for use on a reel need not comply with this requirement.

15.2 Apparatus

15.2.1 The apparatus for conducting the repeated bending is to be the same as described in 14.2.1.

15.3 Method

15.3.1 To comply with the requirements of 15.1.1, the empty hose is to be subjected to 200,000 cycles of repeated bending as described under the Repeated Bending Test, Section 14.

15.3.2 At the end of the bending the hose is to be examined for evidence of breakdown. It is then to be subjected to the proof-pressure test as described in 8.2 – 8.3.3.

16 Permeation Test

16.1 General

16.1.1 When subjected to the permeation test specified in 16.3.1, a hose shall not exceed a permeation rate of 561 cubic centimeters per meter per hour (171 cm^3 /ft/hr).

16.2 Apparatus

16.2.1 The apparatus for conducting this test shall comply with the requirements outlined in the Test Method for Rubber Hose for Gas Diffusion of Liquefied Petroleum Gas, ASTM D3902.

16.3 Method

16.3.1 A 0.5 m (1.6 ft) coupled length of hose is to be tested in accordance with the procedure outlined in the Test Method for Rubber Hose for Gas Diffusion of Liquefied Petroleum Gas, ASTM D3902. The hose is to be tested with LP-Gas in the liquid phase.

17 Immersion Tests of Rubber Tube and Cover

17.1 Tensile strength and ultimate elongation

17.1.1 The tensile strength and ultimate elongation of specimens of a rubber tube or a rubber cover that has been conditioned in n-hexane as described in 17.1.3 – 17.1.5 shall not be less than 65 percent of the corresponding properties of specimens which have not been conditioned.

17.1.2 The tensile strength and ultimate elongation of specimens of a rubber cover which have been immersed in IRM Oil No. 903 at 100 ±2°C (212 ±3.6°F) for 70 h shall not be less than 40 percent of the corresponding properties of specimens which have not been immersed in the test liquid.

17.1.3 Apparatus for the tensile strength and ultimate elongation determinations shall be as described in 11.2.1 – 11.2.6.

17.1.4 For the tensile strength and ultimate elongation determinations, six specimens of the tube and nine specimens of the cover are to be prepared in the same manner as for the tensile strength and elongation tests described in 11.2.1 – 11.3.6, before immersion of the specimens in the test liquids. However, the 1-in (25.4 mm) apart bench marks are to be stamped on the specimens after the immersion. The specimens are to be immersed so that they do not touch each other or the sides of the container. Three tube specimens and three cover specimens are to be immersed for 70 h in commercial n-hexane. Three cover specimens are also to be immersed for 70 h in IRM Oil No. 903. The n-hexane is to be maintained at 23.0 ±2.0°C (73.4 ±3.6°F) throughout the immersion period. The IRM Oil No. 903 is to be maintained at 100.0 ±2.0°C (212.0 ±3.6°F) throughout the immersion period.

17.1.5 At the end of the immersion period, the specimens are to be removed from the test liquids, and the specimens that had been immersed in oil are to be cooled in fresh IRM Oil No. 903 maintained at 23.0 ±2.0°C (73.4 ±3.6°F) for 30 to 60 min. Immediately upon removal from the liquids maintained at 23.0 ±2.0°C, the specimens are to be blotted dry with a soft cloth or filter paper, the 1-in (25.4 mm) apart bench marks are to be stamped on the specimens, and the specimens are to be subjected to the tensile strength and elongation tests described in 11.2.1 – 11.3.6. For comparison, three specimens of the rubber tube and three specimens of the rubber cover that have not been immersed in the test liquids are to be subjected to the tensile strength and elongation tests at the same time the immersed specimens are tested.

17.2 Volumetric swelling

17.2.1 The volumetric swelling of specimens of a rubber tube which have been immersed in n-hexane at 23 ±2°C (73.4 ±3.6°F) for 70 h shall not exceed 30 percent.

17.2.2 The volumetric swelling of specimens of a rubber cover which have been immersed in n-hexane at 23 ±2°C (73.4 ±3.6°F) for 70 h shall not exceed 30 percent.

17.2.3 The volumetric swelling of specimens of a rubber cover which have been immersed in IRM Oil No. 903 at 100 ±2°C (212 ±3.6°F) for 70 h shall not exceed 100 percent.

17.2.4 IRM Oil No. 903 referred to in 17.1.4, 17.2.6, and 17.2.7 is a high swelling petroleum-base oil having a kinematic viscosity of 31.9 to 34.1 mm^2 /sec. (cSt) at 37.8°C (100°F) [Saybolt Universal viscosity of 155 ±5 sec at 98.9°C (210°F)]; an aniline point of 70 ±1.0°C (158 ±1.8°F) and a flash point (open cup) of 163°C (325°F). See the Test Method for Rubber Property – Effect of Liquids, ASTM D471.

17.2.5 Apparatus for the volumetric swelling determinations is to consist of a Jolly balance or an analytical balance provided with a bridge for the support of a vessel of distilled water over the left-hand pan, and a metal die for cutting rectangular 1- by 2-in (25.4 by 50.8 mm) specimens.

17.2.6 For the volumetric swelling determinations, samples from the tube and cover of the hose are to be buffed smooth, and three specimens, 1 by 2 in (25.4 by 50.8 mm) (or as close to these dimensions as possible for small diameter hose), are to be cut by means of the die. The volume of each specimen is to be determined by weighing it first in air and then in water. The tube specimens are then to be dried and immersed for 70 h in commercial n-hexane. Three cover specimens are to be dried and immersed for 70 h in commercial n-hexane and another three cover specimens are to be immersed in IRM Oil No. 903. The n-hexane is to be maintained at 23.0±2.0°C (73.4 ±3.6°F) throughout the immersion period. The IRM Oil No. 903 is to be maintained at 100.0 ±2.0°C (212.0 ±3.6°F) throughout the immersion period.

17.2.7 At the end of the immersion period, the specimens that have been immersed in oil are to be cooled in fresh IRM Oil No. 903 maintained at 23.0±2.0°C (73.4 ±3.6°F) for 30 to 60 min. The specimens are to be removed one at a time from the liquids maintained at 23.0 ±2.0°C, 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 sec after the specimen is removed from the test liquid, and the weight in water is to be taken within 60 sec after the removal from the test liquid. The percent increase in volume is to be calculated for each specimen, and the results for three specimens in each of the test liquids are to be averaged.

18 Low Temperature Test

18.1 General

18.1.1 Specimens of the rubber tube and of the rubber cover, if any, of a hose in sizes larger than 1-1/4 in (31.8 mm) shall not show any cracking or other damage when held at minus 40°C (minus 40°F) for 24 h and then wrapped around a mandrel having a diameter of 0.25 in (6.4 mm) while at minus 40°C. The complete hose in sizes 1-1/4 in and smaller shall not show cracking or other damage when held at minus 40°C for 24 h and then bent around a mandrel having a diameter of ten times the nominal inside diameter of the hose while at minus 40°C.

18.1.2 As an alternative, the hose may be subjected to a minus 54°C (minus 65°F) temperature test as described in 18.1.3 if it is to be marked as specified in 22.2.

18.1.3 For hose to be marked for use at minus 54°C (minus 65°F), specimens of the rubber tube and of the rubber cover, if any, of a hose in sizes larger than 1-1/4 in (31.8 mm) shall not show any cracking or other damage when held at minus 54°C (minus 65°F) for 24 h and then wrapped around a mandrel having a diameter of 0.25 in (6.4 mm) while at minus 54°C. The complete hose in sizes 1-1/4 in and smaller shall not show cracking or other damage when held at minus 54°C for 24 h and then bent around a mandrel having a diameter of ten times the nominal inside diameter of the hose while at minus 54°C.

18.2 Apparatus

18.2.1 Apparatus for this test is to consist of a chamber capable of maintaining a temperature of minus 40.0 ±2.0°C (minus 40.0 ±3.6°F) or minus 54 ±2°C (minus 65 ±3.5°F), a mandrel having a diameter of 0.25 in (6.4 mm), and mandrels having diameters equal to ten times the nominal inside diameters of the hoses, ±0.1 in (2.5 mm).

18.2.2 Specimens for this test are to consist of strips, 8 by 1/2 in (203 by 12.7 mm) (or as wide as possible), taken from the tube and cover, if any, of hose in sizes larger than 1-1/4 in (31.8 mm). For hoses in sizes 1-1/4 in (31.8 mm) and under, a 3 ft (915 mm) length of complete hose is to be tested. The strip specimens and hose samples are to be placed in the cold chamber along with the mandrel and allowed to remain for 24 h. While still in the cold chamber, the strips are to be wrapped around the 0.25-in (6.4 mm) diameter mandrel at a rate of 12 turns per minute. The length of complete hose is to be bent around a mandrel having a diameter of ten times the nominal inside diameter of the hose within a time period of 8 to 12 sec, while still in the cold chamber.

18.2.3 The mandrels used are to be equal to 10 times the nominal inside diameter of the hose, ±0.1 in (2.5 mm). The operator should wear gloves while handling the specimens and the mandrels to minimize heat transfer to the specimens. The specimens and hose samples are to be examined for evidence of cracking or other damage to the tube, cover, or reinforcement.