UL 569

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Pigtails and Flexible Hose Connectors for LP-Gas

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UL Standard for Safety for Pigtails and Flexible Hose Connectors for LP-Gas, UL 569

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Revisions: This Standard contains revisions through and including January 31, 2001.

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The revised requirements are substantially in accordance with UL's Bulletin(s) on this subject dated July 7, 2000. The bulletin(s) is now obsolete and may be discarded.

The revisions dated January 31, 2001 include a reprinted title page (page1) for this Standard.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

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4	April 26, 1995
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7	October 1, 1996
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UL 569

Standard for Pigtails and Flexible Hose Connectors for LP-Gas

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This ANSI/UL Standard for Safety is under periodic maintenance, whereby the ANSI approval is updated approximately every five years. The seventh edition (and revisions dated October 1, 1996, June 23, 1998, and January 31, 2001) are ANSI approved; any subsequent revisions are not part of the ANSI designated text. To obtain a copy of the ANSI approved version of the Standard, contact *comm 2000* at www.comm-2000.com.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc. and is not part of the ANSI Standard.

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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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover pigtails and flexible hose connectors used in the assembly of fuel-supply systems other than those outlined in 1.2(b) and (c), intended for liquefied petroleum gas (LP-Gas). Low or high pressure flexible hose connectors are also suitable for low pressure (1.0 psig (6.9 kPa) or less) natural gas service. LP-Gas systems use either Department of Transportation (DOT) cylinders or ASME tanks and are intended to be installed in accordance with the Liquified Petroleum Gas Code, NFPA/ANSI 58. Low pressure flexible hose connectors used in natural gas systems are intended to be installed in accordance with the National Fuel Gas Code, NFPA 54/ANSI Z223.1. Pigtails and flexible hose connectors are used to make connection between parts of equipment or between equipment and service piping.

1.1 revised January 31, 2001

1.2 This Standard does not apply to:

a) Gas appliance connectors for handling fuel gases at 5 psig (34.5 kPa) or less which are investigated under the Standard for Metal Connectors for Gas Appliances, ANSI Z21.24.

b) Flexible hose connectors for engine fuel applications which are investigated under the Outline of Investigation, Subject 1785, ″LP-Gas Fuel Hose and Hose Assemblies for Vehicle Engines.″

c) Flexible hose connectors for use in confined areas.

d) Hose connectors which are investigated under the Standard for Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances, ANSI Z21.54.

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

1.3 revised January 31, 2001

2 General

2.1 Units of measurement

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

2.1.1 revised January 31, 2001

2.2 Components

2.2.1 Except as indicated in 2.2.2, a component of a product covered by this standard shall comply with the requirements for that component.

2.2.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

2.2.2 revised January 31, 2001

2.2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.2.3 revised January 31, 2001

2.2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

2.2.4 revised January 31, 2001

2.3 Undated references

2.3.1 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.

CONSTRUCTION

3 General

3.1 The diameter and length of a pigtail or a flexible hose connector shall be not greater than those specified in 4.1.

3.2 After fabrication of a pigtail, the tubing used in its construction shall be round and without indentations or other imperfections. The passage through the connector shall not be restricted by solder, brazing material, or flux.

4 Flexible Hose Connector

4.1 As used in these requirements, a flexible hose connector is reinforced synthetic-rubber hose that has an inside diameter of 3/16 to 2 inches (4.8 to 50.8 mm) and a length not exceeding 60 inches (1.5 m) and is provided with a connecting fitting on each end. This connector is fabricated in two constructions:

a) Low-pressure type for handling LP-Gas in the gaseous phase at pressures not greater than 1 psig (0.007 MPa), and

b) High-pressure type for handling LP-Gas in the gaseous or liquid phase and having a working pressure of not less than 350 psig (2.4 MPa).

4.2 As used in these requirements, flexible hose connectors covered by this standard are intended for use at temperatures within the range of minus 40 to plus 140°F (minus 40 to plus 60°C).

5 Pigtail

5.1 A pigtail is seamless tubing (usually copper) that has an outside diameter of 3/16 to 3/8 inch (4.8 to 9.5 mm), a length not exceeding 60 inches (1.5 m), and is provided with a connecting fitting on each end. It is intended for use at pressures up to 250 psig (1.7 MPa).

5.1 revised January 31, 2001

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6 Materials

6.1 Metallic tubing used in the construction of a pigtail shall be of material having characteristics comparable to those of soft-annealed copper tubing.

6.2 Copper tubing used in the construction of a pigtail shall have a wall thickness not less than that specified in Table 6.1.

Table 6.1
Wall thickness of copper tubing

Outside diameter of tubing, inch (mm)		Minimum wall thickness of tubing, inch (mm)	
3/16	(4.8)	0.038	(0.97)
1/4–3/8	(6.4–9.5)	0.045	(1.14)

6.3 The hose used in the construction of a flexible hose connector shall be provided with a reinforced synthetic-rubber inner tube or liner of the oil-resistant type. A rubber cover is not required if the outer braid is impregnated with a rubber cement or compound. A tube or a cover shall be smooth, of uniform thickness, free from pitting, blisters, or other imperfections. Intentional pricking of a cover shall not be considered an imperfection. This requirement does not exclude the use of a corrugated cover.

6.4 The hose reinforcement shall be of cotton, synthetic fibers, or corrosion-resistant material such as stainless steel, evenly and firmly applied over the inner tube. The ply or plies shall be impregnated with a rubber compound that causes the plies to adhere firmly to each other and to the tube and cover.

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

6.6 Solder or brazing material used for attachment of end fittings shall have a melting point (solidus temperature) not less than 1000°F (538°C).

6.7 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 22A.

6.7 revised October 1, 1996

6.8 End-connecting fittings 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 6.9.

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

6.10 A flexible hose connector shall be fabricated of materials resistant to the action of LP-gas both as liquid and vapor.

7 End Connecting Fittings

7.1 Each end of a connector shall be provided with a connecting fitting consistent with the service for which the connector is designed.

7.2 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-1-1987.

7.3 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.

7.3 revised October 1, 1996

7.4 Pipe threads shall be in accordance with the Standard for Pipe Threads, General Purpose (Inch), ANSI/ASME B1.20.1-1983(R92).

7.5 A hose connector or pigtail shall not be constructed with end fittings that would permit the connection of an appliance with a female CGA 600 connection to a LP-Gas cylinder larger than 2 1/2 lb. (1 kg) water capacity.

8 Inside Diameter

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

8.2 A tapered plug gauge of wood or metal having a taper of 3/8 inch per foot (31.3 mm/m) marked to indicate variation of 1/64 inch (0.4 mm) in diameter, a set of wood or metal plug gauges, straight or ball type, in increments of 0.005 inches (0.13 mm), or in some cases (see 8.3), an expanding ball gauge and micrometer or other equivalent means to accurately measure the expanded ball, is to be used.

8.2 revised June 23, 1998

8.3 The end of the hose is to be cut square. When 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 inch (0.4 mm), is to be recorded as the internal diameter of the hose. When 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. When 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.

8.3 revised October 1, 1996

9 Thickness of Flexible Hose Tube or Cover

9.1 The thickness of the inner tube, and of the cover, when one is used, shall not be less than 0.047 inch (1.19 mm) when determined as described in 9.2 – 9.6.

9.1 revised October 1, 1996

9.2 A power-driven buffing machine (grinding wheel) or skiving machine outlined in the Practice for Rubber Preparation of Pieces for Test Purposes from Products, ASTM D3183-84, is to be used for buffing off irregularities on specimens. The abrasive wheel of a buffing machine is to be No. 30 – 36 grit; and its diameter and rotary velocity are to be such that the wheel will have a peripheral speed of 4000 ±700 feet per minute (20 ±3.6 m/s). The machine is to be provided with a slow feed to avoid overheating of the specimen.

9.3 A dial micrometer that is graduated to 0.001 inch (0.025 mm) and exerts a load of 80 – 85 grams by means of a weight is to be used. The load is to be applied through a flat contact foot 0.25 ±0.01 inch (6.35 ±0.25 mm) in diameter.

9.4 One piece, 6 – 8 inches 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 as specified in 9.5 and 9.6.

9.4 revised October 1, 1996

9.5 A strip, 6-8 inches (150-200 mm) in length and 1 inch (25.4 mm) in width, or as close to a 1 inch width as possible from small diameter hose, is to be cut from the hose, and the rubber part separated from the plies. When 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.

9.5 revised October 1, 1996

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9.6 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 9.2. 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 considered as the thickness of the rubber part.

PERFORMANCE

10 General

10.1 The number of samples of each type of connector required for tests and the length of the samples are specified in Table 10.1.

Table 10.1
Test samples required

Table 10.1 revised October 1, 1996

	Pigtail	Flexible hose connector	Recommended length of samples, inches (mm)	Remarks
Aerostatic Leakage Test	3	3	36 (914)	With end fittings
Hydrostatic Strength Test	–	–	–	Use above sample
Pull Test	3	3	12 (305)	With end fittings
Bending Test – Tubing	1	–	18–24 (457–610)	Without end fittings
Bending Test – Hose	–	1		With end fittings
a) Up to 1″ b) 1″ - 2″			30–40 (762–1016) 40–50 (1016–1270)	
Low Temperature Test	–	1		Without end fittings
a) Up to 1″ b) 1″ - 2″			18–24 (457–609.6) 24–48 (609.6–1219)	
Flexible Connector Tests	–	a	b	Without end fittings
Moist Ammonia-Air Stress Cracking Test	–	–	–	End fittings, three each, with appropriate companion fittings

[a] One 30 foot length, or equivalent, of the flexible connector hose, in the largest diameter, will provide material sufficient for all samples required for these tests.

[b] See individual test description.

10.2 For the Aerostatic Leakage Test, Section 11, a source of aerostatic pressure such as air or nitrogen is to be used. For the Hydrostatic Strength Test, Section 12, water or other liquids of comparable or lighter viscosity is to be used.

11 Aerostatic Leakage Test

11.1 A connector with end fittings that are factory assembled and tightened as intended shall not show evidence of leakage when subjected for 5 minutes to an aerostatic pressure of twice the intended working pressure but not less than 50 psig (0.34 MPa).

11.2 Each of three test samples is to be connected to a source of aerostatic pressure, and the free end is to be closed by the intended companion fitting. A positive shutoff valve and a pressure gauge having a pressure range of not less than 1-1/2 nor more than two times the test pressure are to be installed in the pressure supply piping. The pressure gauge is to be installed in the piping between the shutoff valve and the connector being tested.

11.3 Each sample is to be immersed in water while lying straight as aerostatic pressure is being applied slowly and in a uniform manner.

12 Hydrostatic Strength Test

12.1 A connector, with end fittings that are factory assembled and tightened as intended, shall not rupture when subjected to a hydrostatic pressure of five times the intended working pressure but not less than 500 psig (3.4 MPa).

12.2 The three connectors previously subjected to the aerostatic leakage test are to be used. Each sample is to be connected to a source of hydrostatic pressure. A positive shutoff valve and a pressure gauge having a pressure range of not less than 1-1/2 nor more than two times the test pressure are to be installed in the pressure supply piping. The pressure gauge is to be installed in the piping between the shutoff valve and the connector being tested.

12.3 One end of the sample is to be connected to a source of water pressure, and the fitting at the other end is to be left open while filling each sample with the test liquid to allow air to escape. After all air has been expelled, the fitting is to be capped, and the pressure in the sample is to be increased at a uniform rate of approximately 1000 psig (6900 kPa) per minute until the required test pressure has been reached. Pressure is to be released immediately upon reaching the required test pressure.

13 Pull Force Test

13.1 A connector shall withstand the longitudinal pull force specified in Table 13.1.

Table 13.1
Minimum pull force

Connector	Tubing OD, hose ID, inch (mm)	Minimum pull force, pounds (N)
Pigtail	3/16 (4.8)	375 (1650)
	1/4 (6.4)	500 (2200)
	5/16 (7.9)	625 (2750)
	3/8 (9.5)	750 (3300)
Flexible Hose Connector		
(Low-Pressure Type)	3/16 to 5/8 (4.8 to 15.9)	200 (880)
	11/16 to 2 (17.5 to 50.8)	300 (1320)
(High-Pressure Type)	3/16 to 5/8 (4.8 to 15.9)	400 (1760)
	11/16 to 2 (17.5 to 50.8)	750 (3300)

13.2 Three samples of the connector are to be subjected to this test. The connecting fitting on each end of the sample is to be assembled with a corresponding companion part and tightened. Next, the connector is to be placed in a tensile testing machine and connected so that both end fittings, fitting joints, and the tubing or hose of the connector are subjected to the pull force. With the testing machine adjusted for a rate of travel of 1/2 inch per minute (0.21 mm per second), the pull force is to be applied until breaking, cracking, or splitting occurs or until the minimum pull force has been attained.

14 Bending Test – Tubing

14.1 Tubing used in the construction of a pigtail shall withstand the test specified in 14.3 without evidence of cracking or splitting.

14.2 Soft annealed copper tubing is not required to be tested.

14.3 Both ends of the specimen of metallic tubing are to be cut square and flanged with a 45 degree flaring tool. The flanged portion is to be examined for evidence of cracking or splitting. The sample of metallic tubing is then to be wrapped around a mandrel having a diameter of two times the outside diameter of the tube. The outside surface of the test specimen is then to be examined for evidence of cracking or splitting.

15 Bending Test – Hose

15.1 A flexible hose connector shall withstand 25,000 continuous cycles of 180-degree bends around a radius of four times the internal diameter of the hose without breakdown of the hose.

15.2 A sample connector that has complied with the requirements of the Aerostatic Leakage Test, Section 11, is to be used in this test.

15.3 Apparatus for this test is to consist of a machine that provides a reciprocating motion over a distance of not less than 12 inches (305 mm). One end of the connector is to be attached to the reciprocating rod or shaft of the machine. From this connection the hose is to be wrapped 180 degrees around a free-running pulley having a pitch radius of four times the inside diameter of the hose. The pitch radius of the pulley is to be on the line of the reciprocating motion.

15.4 The opposite end of the connector is to be attached to a length of flexible cable provided with a 25-pound (11.4-kg) weight to maintain the hose in contact with the pulley. When the reciprocating motion is horizontal, the cable is to pass over a guide pulley to provide for 180-degree contact of the hose with the pulley used for bending. When the midpoint of the sample hose is on the pulley, the two ends of the hose are to be equidistant from the pulley.

15.4 revised October 1, 1996

15.5 The reciprocating apparatus is to be adjusted so that the connector is moved alternately over a lineal distance of 12 inches (305 mm). A complete reciprocating cycle is to be recorded as two hose-bending operations. The reciprocating machine is to be adjusted to give not less than 30 nor more than 45 hose-bending operations per minute.

16 Low Temperature Test

16.1 A flexible hose connector shall not show cracking or other evidence of physical damage when maintained at a temperature of minus 40 ±2°C (minus 40 ±3.6°F) for 24 hours and then bent around a steel mandrel having a diameter of ten times the nominal inside diameter of the hose while at minus 40°C.

16.2 A length of hose of each diameter under investigation is to be subjected to this test. See Table 10.1. The hose samples and the mandrel are to be placed in the cold chamber and allowed to remain for 24 hours. While still in the cold chamber, each length of hose is to be bent around the mandrel in a movement taking 8 to 12 seconds to complete. Test personnel are to wear gloves while handling the hose and the mandrel to reduce the likelihood of heat transfer to the sample. The hose sample is then to be examined for evidence of cracking or other physical damage.

17 Tensile Strength and Elongation Tests of Rubber Tube and Cover

17.1 General

17.1.1 Rubber tubes and covers for flexible hose connectors shall have the properties specified in 17.2.1, when tested before aging in accordance with the requirements of 17.2.2 – 17.2.11, and the properties specified in 17.3.1, when tested after aging in accordance with the requirements of 17.3.2 and 17.4.1.

17.2 Before accelerated air-oven aging

17.2.1 After being exposed to room ambient for at least 30 minutes, samples of tubes and covers shall have the following properties when tested as specified in 17.2.2 – 17.2.11:

a) Minimum tensile strength – 1000 psi (6.9 MPa) for both tubes and covers and

b) Minimum ultimate elongation – 150 percent for tubes and 250 percent for covers.

17.2.2 Prior to being cut with a die, samples are to be buffed or skived by the equipment specified in 9.2.

17.2.2 revised October 1, 1996

17.2.3 The specimens are to be cut using Die C or Die D dumbbell-type, as described in the Tests for Rubber Properties in Tension, ASTM D412-92, and as permitted by sample size and shape. The enlarged ends are to be 1 inch (25.4 mm) wide, when possible. The constricted portion is to be 0.125 inch (3.2 mm) wide and 1.3 inches (33 mm) long (Die D), when cut from hose of 1/4 inch (6.4 mm) diameter or smaller. The constricted portion is to be 1/4 inch wide and 1.3 inches long (Die C), when cut from sizes of hose greater than 1/4 inch.

17.2.4 The specimens are to be cut longitudinally from the sample. Wetting the cutting edges of the die with water is a way to facilitate the cutting operation. The rubber is to rest on a smooth and slightly yielding surface that will not injure the cutting edges of the die such as a piece of belting or light cardboard.

17.2.4 revised October 1, 1996

17.2.5 The constricted portion of the specimen is to be buffed or skived to remove fabric impressions or other surface irregularities.

17.2.5 revised October 1, 1996

17.2.6 Three measurements of thickness are to be made with a dial micrometer, in the constricted portion of the specimen. The smallest value obtained is to be used as the thickness of the specimen in calculating the tensile strength.

17.2.7 Two bench marks, 1 inch (25.4 mm) apart, are to be stamped centrally on the constricted portion of each specimen.

17.2.8 Tensile strength and elongation tests are to be made on a power-operated machine as described in the Tests for Rubber Properties in Tension, ASTM D412-92.

17.2.9 The rate of travel of the power-actuated grip is to be 20 ±1 inch per minute (51 ±2.5 cm/min).

17.2.10 The elongation is to be measured by means of a scale or other device, to be used so that it does not touch the specimen and is capable of indicating the elongation with an accuracy of 0.1 inch (2.54 mm).

17.2.11 When a dumbbell-type test specimen breaks outside the bench marks, when a straight specimen breaks at the jaws, or when the result of either the tensile strength or elongation testing is below the requirements, an additional specimen is to be tested, the results of which are to be considered final. Results of tests of dumbbell-type specimen that break in the curved portion just outside the bench marks and of straight specimens that break at the jaws may be acceptable when within the minimum requirements.

17.2.11 revised October 1, 1996

17.3 After accelerated air-oven aging test

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

17.3.2 The apparatus outlined in the Method of Test for Accelerated Aging of Vulcanized Rubber by the Oven Method, ASTM D573-88 is to be used for this test.

17.4 Method

17.4.1 Three tube and three rubber cover specimens are to be prepared in the same manner as specified in 17.2.2 – 17.4.1 before placing the specimens in the oven. However, in this case the 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 Method of Test for Accelerated Aging of Vulcanized Rubber by the Oven Method, ASTM D573-88. For comparative purposes, three tube and three rubber cover specimens that 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.

18 Adhesion Test

18.1A General

18.1A added June 23, 1998

18.1A.1 For 3/8-inch (9.5 mm) size hose and smaller, the adhesion between the cover and the reinforcement, between the tube and the fabric reinforcements, and between the plies of fabric reinforcement shall be such that the rate of separation of a ring-shaped specimen, 1 inch (25.4 mm) in width, is not greater than 1 inch per minute (0.42 mm/s) with a weight of 8 pounds (3.6 kg) for the adhesion determinations between the cover and the reinforcements and between the tube and reinforcement and with a weight of 10 pounds (4.5 kg) for the adhesion determination between the plies of reinforcement.

18.1 relocated as 18.1A.1 June 23, 1998

18.1A.2 For sizes of hose greater than 3/8 inch (9.5 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 inch (25.4 mm) in width, is not greater than 1 inch per minute (0.42 mm/s) with a weight of 10 pounds (4.5 kg).

18.2 relocated as 18.1A.2 June 23, 1998

18.1A.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.

18.3 relocated as 18.1A.3 June 23, 1998

18.1A.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 reinforcement.

18.4 relocated as 18.1A.4 June 23, 1998

18.1 Apparatus

18.1.1 Adhesion tests are to be conducted with the type of apparatus described for the Static Mass Method in ASTM D413–82(1993), Test Method Rubber Property–Adhesion to Flexible Substrate.

18.2 Method

18.2.1 The tests are to be conducted in accordance with the test methods outlined in ASTM D380–87, Method of Testing Rubber Hose. Adhesion tests are to be conducted on only the cover of wire-reinforced hose. A hack saw with a sharp, fine (24 teeth/inch) 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 inch (0.8 mm), by the elapsed time in minutes.

18.2.2 When 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.

18.2.2 revised October 1, 1996

19 Permeation Test

19.1 General

19.1.1 When subjected to the permeation test specified in 19.3.1, a high pressure hose shall not exceed a permeation rate of 561 cubic centimeters per meter per hour (171 cm^3/ft/hr).

19.2 Apparatus

19.2.1 The apparatus for conducting this test shall comply with the requirements outlined in ASTM D3902-90, Method Testing Rubber Hose for the Diffusion of Liquified Petroleum Gas.

19.3 Method

19.3.1 A 0.5 meter (1.6 ft) coupled length of hose is to be tested in accordance with the procedure outlined in ASTM D3902-90. The hose is to be tested with LP-Gas in the liquid phase.

20 Ozone Exposure Test

20.1 The rubber cover or impregnated outer braid of a flexible hose connector shall show no visible signs of cracking when stressed and then exposed for 70 hours to an atmosphere containing 100 parts per hundred million (pphm) of ozone at a temperature of 40°C (104°F).

20.2 The ozone test chamber for this test is to comply with the requirements outlined in the Method of Test for Accelerated Ozone Cracking of Vulcanized Rubber, ASTM D1149-91. The specimen holder is to comply with the requirements outlined in Procedure B of the Method of Test for Resistance to Surface Cracking of Stretch Rubber Compounds, ASTM D518-86(1991).

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20.3 Three specimens, 3-3/4 inches (95.3 mm) long and 1 inch (25.4 mm) wide, are to be cut longitudinally from the rubber cover or impregnated outer braid of the hose sample and mounted in the specimen holder in a looped position, in accordance with the procedures outlined in the Method of Test for Accelerated Ozone Cracking of Vulcanized Rubber, ASTM D518-86(1991), Procedure B. The mounted specimens are to be allowed to remain in an ozone free atmosphere for 24 hours. They are then to be placed in the ozone test chamber, which is to be regulated to produce an ozone concentration of 100 pphm and a constant temperature of 40°C (104°F). The mounted specimens are to remain in the ozone test chamber for 70 hours. After the test exposure, the specimens are to be removed from the test chamber and examined for evidence of cracking with a hand magnifying glass of seven power magnification.

20.3 revised October 1, 1996

21 Immersion Test of Rubber Tube and Cover

21.1 Volumetric swelling

21.1.1 The volumetric swelling of specimens of the rubber inner tube of a flexible hose connector that have been immersed in n-hexane at 23 ±2°C (73.4 ±3.6°F) for 70 hours shall not exceed 30 percent.

21.1.2 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 hours shall not exceed 30 percent.

21.1.3 The volumetric swelling of specimens of a rubber cover which have been immersed in IRM 903 at 100 ±2°C (212 ±3.6°F) for 70 hours shall not exceed 100 percent.

21.1.3 revised June 23, 1998

21.1.4 IRM 903 referred to in 21.1.3, 21.1.6, 21.1.7, 21.2.2, and 21.2.4 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); an aniline point of 70 ±1.0°C (158 ±1.8°F) and a flash point (open cup) of 163°C (325°F). See ASTM D471-96, Test Method for Rubber Property–Effect of Liquids.

21.1.4 revised June 23, 1998

21.1.5 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-inch (25.4- by 50.8- mm) specimens.

21.1.6 For the volumetric swelling determinations, samples from the tube and cover of the hose are to be buffed smooth, and three specimens are to be cut by means of the die to 1 by 2 inches (25.4 by 50.8 mm), or as close to these dimensions as possible for small diameter hose. 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 hours in commercial n-hexane. Three cover specimens are to be dried and immersed for 70 hours in commercial n-hexane and another three cover specimens are to be immersed in IRM 903. The n-hexane is to be maintained at 23 ±2°C (73.4 ±3.6°F) throughout the immersion period. The IRM 903 is to be maintained at 100 ±2°C (212 ±3.6°F) throughout the immersion period.

21.1.6 revised June 23, 1998

21.1.7 At the end of the immersion period, the specimens that have been immersed in oil are to be cooled in fresh IRM 903 maintained at 23 ±2°C (73.4 ±3.6°F) for 30 to 60 minutes. The specimens are to be removed one at a time from the liquids maintained at 23 ±2°C (73.4 ±3.6°F), rinsed in ethyl alcohol, blotted dry with a soft cloth or filter paper, and again weighed, first in air and then in water and the volume is to be calculated. The weight in air is to be taken within 30 seconds of the time the specimen is removed from the test liquid, and the weight in water is to be taken within 60 seconds of the specimen's removal from the test liquid. The percent increase in volume is to be calculated for each specimen, and the results for three specimens are to be averaged.

21.1.7 revised June 23, 1998

21.2 Effect on tensile strength and elongation

21.2.1 The tensile strength and ultimate elongation of specimens of the rubber inner tube or rubber cover of a flexible hose connector that have been immersed in n-hexane at 23 ±2°C (73.4 ±3.6°F) for 70 hours shall be not less than 65 percent of the corresponding properties of specimens that have not been immersed in n-hexane.

21.2.2 The tensile strength and ultimate elongation of specimens of a rubber cover which have been immersed in IRM 903 at 100 ±2°C (212 ±3.6°F) for 70 hours shall be not less than 40 percent of the corresponding properties of specimens which have not been immersed in the test liquid.

21.2.2 revised June 23, 1998

21.2.3 Specimens are to be prepared as described in 17.2.2 – 17.2.6, 17.2.9, and 17.2.10.

21.2.4 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 17.2.3 – 17.2.11, before immersion of the specimens in the test liquids. However, the 1 inch (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 hours in commercial n-hexane. Three cover specimens are also to be immersed for 40 hours in IRM 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 903 is to be maintained at 100.0 ±2.0°C (212.0 ±3.6°F) throughout the immersion period.

21.2.4 revised June 23, 1998

22 Mercurous Nitrate Immersion Test

22 deleted October 1, 1996

22A Moist Ammonia-Air Stress Cracking Test

22A added October 1, 1996

22A.1 After being subjected to the conditions described in 22A.2 – 22A.4, a brass part containing more than 15 percent zinc shall show no evidence of cracking when examined using 25X magnification.

22A.2 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. A ferrule or end-connecting fitting used in the assembly of a flexible connector is to be tested prior to crimping the hose.

22A.3 Pipe-threaded ends (NPT) are to be torqued to brass companion fittings as specified in Table 22A.1. Other threaded parts are to be tightened to the brass companion fittings to the degree necessary to produce a leaktight assembly. Teflon tape or pipe thread compound are not be used on the threads.

Table 22A.1
Torque requirements for pipe thread (NPT) connections

Nominal pipe size,[a] inches	Torque, pounds-inches	(N·m)
1/8	150	(16.9)
1/4	250	(28.3)
3/8	450	(51.9)
1/2	800	(90.4)
3/4	1000	(113.0)
1	1200	(135.5)
1-1/4	1450	(163.8)
1-1/2	1550	(175.1)
2	1650	(186.4)

[a] ANSI/ASME B1.20.1-1983(R92).

22A.4 Three samples are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber 305 by 305 by 305 mm (12 by 12 by 12 inches) having a glass cover.

22A.5 600 ml of aqueous ammonia having a specific gravity of 0.94 is 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 aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure and at a temperature of 34 ±2°C (93 ±3.6°F).

MANUFACTURING AND PRODUCTION TESTS

23 General

23.1 The manufacturer shall provide the necessary production control, inspection, and tests. The program shall include at least the following:

a) Each low-pressure flexible hose connector shall be tested and found free from leakage at an aerostatic pressure of not less than 25 psig (0.17 MPa).

b) Each high-pressure flexible hose connector shall be tested and found free from leakage at an aerostatic pressure of not less than maximum rated pressure.

c) Pigtails provided with end fittings attached by solder or brazing shall be checked to determine that the passage through the connector is not restricted.

23.2 As a substitute for the tests in 23.1(a) – (c), a connector shall be tested for leakage at a hydrostatic pressure of 1-1/2 times the pressure specified in 23.1(a) – (c).

23.2 revised October 1, 1996

MARKING

24 General

24.1 Each connector shall be marked to show the following information:

a) The manufacturer's or private labeler's name or identifying symbol.

b) A distinctive catalog designation to specifically identify the product.

24.2 A flexible hose connector shall also be marked with the working pressure.

24.3 When a manufacturer produces connectors at more than one factory, each connector shall have a distinctive marking to identify it as the product of a particular factory.

24.3 revised October 1, 1996

25 Permanence and Legibility of Marking

25.1 Markings required by 24.1 – 24.3 shall be legible and permanent. Acceptable permanence shall be afforded by metal stamping; by molding in a casting; or in the case of a flexible hose connector, by:

a) A molded rubber nameplate cemented in place,

b) A bracelet-type marking retained by the end connections,

c) Embossing or molding in the cover,

d) Ink stamping, or

e) Printing on a pressure-sensitive label of polyester film or other material having equivalent resistance to tearing.

25.1 revised October 1, 1996

25.2 To determine if a pressure-sensitive label or a label secured by cement or adhesive is permanent, representative samples are to be subjected to exposure conditions for indoor and outdoor use (standard atmosphere, water immersion, oven aging, low temperature, and ultraviolet light and water exposure), as specified in the requirements for permanence and legibility for marking and labeling systems, UL 969.