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TECHNICAL STANDARDS DOCUMENT

No. 106, Revision 0

Brake Hoses

The text of this document is based on Federal Motor Vehicle Safety Standard No. 106, *Brake Hoses*, as published in the U.S. *Code of Federal Regulations*, Title 49, Part 571, revised as of October 1, 2004.

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Standards Research and Development Branch
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Technical Standards Document Number 106, Revision 0

Brake Hoses

(Ce document est aussi disponible en français.)

Introduction

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Identification of Changes

In order to facilitate the incorporation of a TSD, certain non-technical changes may be made to the foreign enactment. These may include the deletion of words, phrases, figures, or sections that do not apply under the Act or Regulations, the conversion of imperial to metric units, the deletion of superseded dates, and minor changes of an editorial nature. Additions are underlined, and provisions that do not apply are ~~stroked through~~. Where an entire section has been deleted, it is replaced by: “[CONTENT DELETED]”. Changes are also made where there is a reporting requirement or reference in the foreign enactment that does not apply in Canada. For example, the name and address of the U.S. Department of Transportation are replaced by those of the Department of Transport.

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(Original signed by)

Director, Standards Research and Development
for the Minister of Transport,
Infrastructure and Communities
Ottawa, Ontario

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Technical Standards Document
Number 106, Revision 0
BRAKE HOSES

The text of this document is based on Federal Motor Vehicle Safety Standard No. 106, *Brake Hoses*, as published in the U.S. *Code of Federal Regulations*, Title 49, Part 571, revised as of October 1, 2004.

S1. Scope

This Technical Standards Document (TSD) standard specifies labeling and performance requirements for motor vehicle brake hose, brake hose assemblies, and brake hose end fittings.

S2. Purpose

The purpose of this TSD standard is to reduce deaths and injuries occurring as a result of brake system failure from pressure or vacuum loss due to hose or hose assembly rupture.

S3. Application

[CONTENT DELETED] For applicability, see Schedule III and subsections 106(1) and (2) of Schedule IV to the *Motor Vehicle Safety Regulations*.

S4. Definitions

Armor means protective material installed on a brake hose to increase the resistance of the hose or hose assembly to abrasion or impact damage. (*Armure*)

Brake hose means a flexible conduit, other than a vacuum tubing connector, manufactured for use in a brake system to transmit or contain the fluid pressure or vacuum used to apply force to a vehicle's brakes. For a hose, a dimensional description such as "1/4-inch hose" refers to the nominal inside diameter. For tubing, a dimensional description such as "1/4-in tubing" refers to the nominal outside diameter. (*Boyau de frein*)

Brake hose assembly means a brake hose, with or without armor, equipped with end fittings for use in a brake system, but does not include an air or vacuum assembly prepared by the owner or operator of a used vehicle, by his employee, or by a repair facility, for installation in that used vehicle. (*Ensemble de boyau de frein*)

Brake hose end fitting means a coupler, other than a clamp, designed for attachment to the end of a brake hose. (*Raccord d'extrémité de boyau de frein*)

Free length means the linear measurement of hose exposed between the end fittings of a hose assembly in a straight position. (*Longueur libre*)

Permanently attached end fitting means an end fitting that is attached by deformation of the fitting about the hose by crimping or swaging, or an end fitting that is attached by the use of a sacrificial sleeve or ferrule that requires replacement each time a hose assembly is rebuilt. (*Raccord d'extrémité de boyau fixé en permanence*)

Rupture means any failure that results in the separation of a brake hose from its end fitting or in leakage. (*Rupture*)

Vacuum tubing connector means a flexible conduit of vacuum that (i) connects metal tubing to metal tubing in a brake system, (ii) is attached without end fittings, and (iii) when installed, has an unsupported length less than the total length of those portions that cover the metal tubing. (*Raccord de tuyau à vide*)

S5. Requirements — Hydraulic brake hose, brake hose assemblies, and brake hose end fittings

S5.1 Construction

- (a) Each hydraulic brake hose assembly shall have permanently attached brake hose end fittings which are attached by deformation of the fitting about the hose by crimping or swaging.
- (b) [CONTENT DELETED]

S5.2 Labeling

S5.2.1 [CONTENT DELETED]

S5.2.2 [CONTENT DELETED]

S5.2.3 [CONTENT DELETED]

S5.2.4 [CONTENT DELETED]

S5.2.4.1 At least one end fitting of a hydraulic brake hose assembly shall be etched, stamped or embossed with a designation at least 1.6 mm (one-sixteenth of an inch) high that identifies the manufacturer of the hose assembly ~~and is filed in accordance with S5.2.4(b).~~

S5.3 Test requirements

A hydraulic brake hose assembly or appropriate part thereof shall be capable of meeting any of the requirements set forth under this heading, when tested under the conditions of S11 and the applicable procedures of S6. However, a particular hose assembly or appropriate part thereof need not meet further requirements after having been subjected to and having met the constriction requirement (S5.3.1) and any one of the requirements specified in S5.3.2 through S5.3.11.

S5.3.1 Constriction. Except for that part of an end fitting which does not contain hose, every inside diameter of any section of a hydraulic brake hose assembly shall be not less than 64 percent of the nominal inside diameter of the brake hose.

S5.3.2 Expansion and burst strength. The maximum expansion of a hydraulic brake hose assembly at 6 895 kPa (1,000 psi) and 10 342 kPa (1,500 psi) shall not exceed the values specified in Table I (S6.1). The hydraulic brake hose assembly shall then withstand water pressure of 27 579 kPa (4,000 psi) for 2 minutes without rupture, and shall not rupture at less than 34 474 kPa (5,000 psi) (S6.2).

Table I — Maximum Expansion of Free Length of Brake Hose, mL/m (cc/ft.)

Hydraulic Brake Hose, Inside Diameter	Test Pressure			
	<u>6 895 kPa</u> (1,000 psi)		<u>10 342 kPa</u> (1,500 psi)	
	Regular Expansion Hose	Low Expansion Hose	Regular Expansion Hose	Low Expansion Hose
1/8 inch or 3 mm or less	<u>2.17</u> (0.66)	<u>1.08</u> (0.33)	<u>2.59</u> (0.79)	<u>1.38</u> (0.42)
3/16 inch or 4 to 5 mm	<u>2.82</u> (0.86)	<u>1.80</u> (0.55)	<u>3.35</u> (1.02)	<u>2.36</u> (0.72)
¼ inch or 6 mm or more	<u>3.41</u> (1.04)	<u>2.69</u> (0.82)	<u>4.27</u> (1.30)	<u>3.84</u> (1.17)

S5.3.3 Whip resistance. A hydraulic brake hose assembly shall not rupture when run continuously on a whip test flexing machine for 35 hours (S6.3).

S5.3.4 Tensile strength. A hydraulic brake hose assembly shall withstand a pull of 1 446 N (325 pounds) without separation of the hose from its end fittings (S6.4).

S5.3.5 Water absorption and burst strength. A hydraulic brake hose assembly, after immersion in water for 70 hours (S6.5), shall withstand water pressure of 27 579 kPa (4,000 psi) for 2 minutes, and then shall not rupture at less than 34 474 kPa (5,000 psi) (S6.2).

S5.3.6 Water absorption and tensile strength. A hydraulic brake hose assembly, after immersion in water for 70 hours (S6.5), shall withstand a pull of 1 446 N (325 pounds) without separation of the hose from its end fittings (S6.4).

S5.3.7 Water absorption and whip resistance. A hydraulic brake hose assembly, after immersion in water for 70 hours (S6.5), shall not rupture when run continuously on a whip test flexing machine for 35 hours (S6.3).

S5.3.8 Low-temperature resistance. A hydraulic brake hose conditioned at -40°C (-40°F) for 70 hours shall not show cracks visible without magnification when bent around a cylinder as specified in S6.6. (S6.6)

S5.3.9 Brake fluid compatibility, constriction, and burst strength. Except for brake hose assemblies designed for use with mineral or petroleum-based brake fluids, a hydraulic brake

hose assembly shall meet the constriction requirement of S5.3.1 after having been subjected to a temperature of 93.3°C (200°F) for 70 hours while filled with SAE RM-66-04 Compatibility Fluid, as described in Appendix B of SAE Standard J1703 JAN 1995, *Motor Vehicle Brake Fluid*. It shall then withstand water pressure of 27 579 kPa (4,000 psi) for 2 minutes and thereafter shall not rupture at less than 34 474 kPa (5,000 psi) (S6.2).
[SENTENCE DELETED]

S5.3.10 Ozone resistance. A hydraulic brake hose shall not show cracks visible under 7-power magnification after exposure to ozone for 70 hours at 40°C (104°F) (S6.8).

S5.3.11 End fitting corrosion resistance. After 24 hours of exposure to salt spray, a hydraulic brake hose end fitting shall show no base metal corrosion on the end-fitting surface, except where crimping or the application of labeling information has caused displacement of the protective coating (S6.9).

S6. Test procedures — Hydraulic brake hose, brake hose assemblies, and brake hose end fittings

S6.1 Expansion test

S6.1.1 Apparatus. Utilize a test apparatus (as shown in Figure 1) which consists of:

- (a) Source for required fluid pressure;
- (b) Test fluid of water without any additives and free of gases;
- (c) Reservoir for test fluid;
- (d) Pressure gauges;
- (e) Brake hose end fittings in which to mount the hose vertically; and
- (f) Graduated burette with 0.5 mL (0.05 cc) increments.

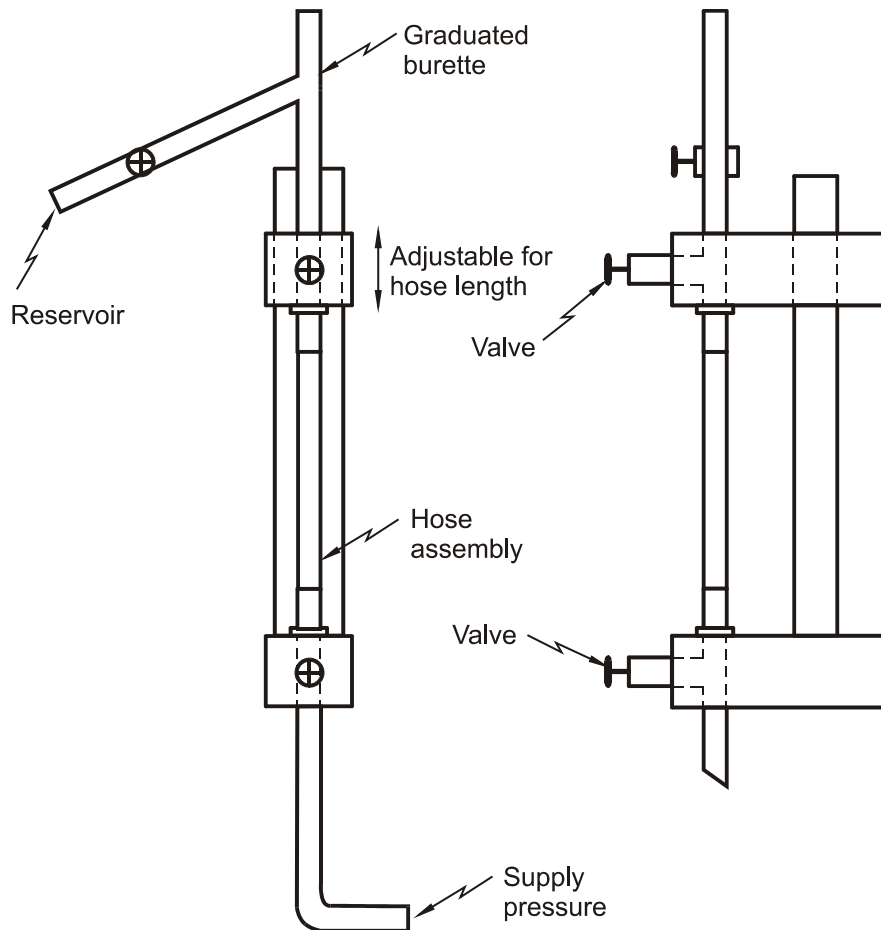


Figure 1 — Expansion Test Apparatus

S6.1.2 Preparation

- (a) Measure the free length of the hose assembly.
- (b) Mount the hose so that it is in a vertical, straight position without tension when pressure is applied.
- (c) Fill the hose with test fluid and bleed all gases from the system.
- (d) Close the valve to the burette and apply 10 342 kPa (1,500 psi) for 10 seconds; then release pressure.

S6.1.3 Calculation of expansion at 6 895 kPa (1,000 psi) and 10 342 kPa (1,500 psi)

- (a) Adjust the fluid level in the burette to zero.
- (b) Close the valve to the burette, apply pressure at the rate of 103 421 kPa (15,000 psi) per minute, and seal 6 895 kPa (1,000 psi) in the hose (10 342 kPa [1,500 psi] in the second series).
- (c) After 3 seconds, open the valve to the burette for 10 seconds and allow the fluid in the expanded hose to rise into the burette.

- (d) Repeat the procedure in steps (b) and (c) twice. Measure the amount of test fluid which has accumulated in the burette as a result of the three applications of pressure.
- (e) Calculate the volumetric expansion per metre (foot) by dividing the total accumulated test fluid by 3 and further dividing by the free length of the hose in metres (feet).

S6.2 Burst strength test

- (a) Connect the brake hose to a pressure system and fill it completely with water, allowing all gases to escape.
- (b) Apply water pressure of 27 579 kPa (4,000 psi) at a rate of 103 421 kPa (15,000 psi) per minute.
- (c) After 2 minutes at 27 579 kPa (4,000 psi), increase the pressure at the rate of 103 421 kPa (15,000 psi) per minute until the pressure exceeds 34 474 kPa (5,000 psi).

S6.3 Whip resistance test

S6.3.1 Apparatus. Utilize a test apparatus that is dynamically balanced and includes:

- (a) A movable header consisting of a horizontal bar equipped with capped end fittings and mounted through bearings at each end to points 101.6 mm (4 inches) from the center of two vertically rotating disks whose edges are in the same vertical plane;
- (b) An adjustable stationary header parallel to the movable header in the same horizontal plane as the centers of the disks, and fitted with open end fittings;
- (c) An elapsed time indicator; and
- (d) A source of water pressure connected to the open end fittings.

S6.3.2 Preparation

- (a) Except for the supplemental support specified in S6.3.2(d), remove all external appendages including, but not limited to, hose armor, chafing collars, mounting brackets, date band and spring guards.
- (b) Measure the hose free length.
- (c) Mount the hose in the whip test machine, introducing slack as specified in Table II for the size of hose to be tested, measuring the projected length parallel to the axis of the rotating disks. The manufacturer may, at his option, adapt the fitting attachment points to permit the mounting of hose assemblies equipped with angled or other special fittings in the same orientation as hose assemblies equipped with straight fittings.
- (d) In the case of a brake hose assembly equipped with a permanent supplemental support integrally attached to the assembly, the assembly may be mounted using the supplemental support and associated means of simulating its attachment to the vehicle. Mount the supplemental support in the same vertical and horizontal planes as the stationary header end of the whip test fixture described in S6.3.1(b). Mount or attach the supplemental support so that it is positioned in accordance with the

recommendation of the assembly manufacturer for attaching the supplemental support on a vehicle.

Table II — Hose Lengths

Free length between end fittings, <u>mm</u> (inches)	Slack, <u>mm</u> (inches)	
	Hose of <u>3 mm</u> (1/8 inch) or less	Hose of more than <u>3 mm</u> (1/8 inch)
203.2 to 393.7 (8 to 15½), inclusive	44.45 (1.75)	
254 to 393.7 (10 to 15½), inclusive		25.4 (1.0)
Over 393.7 to 482.6 (15½ to 19), inclusive	31.75 (1.25)	
Over 482.6 to 609.6 (19 to 24), inclusive	19.05 (0.75)	

S6.3.3 Operation

- Apply 1 620 kPa (235 psi) water pressure and bleed all gases from the system.
- Drive the movable head at 800 rpm.

S6.4 Tensile strength test

Utilize a tension testing machine conforming to the requirements of the *Methods of Verification of Testing Machines* (1964 American Society for Testing and Materials, Designation E 4)¹ and provided with a recording device to give the total pull in Newtons (pounds).

S6.4.1 Preparation. Mount the hose assembly to ensure a straight, evenly distributed machine pull.

S6.4.2 Operation. Apply tension at a rate of 25.4 mm (1 inch) per minute of travel of the moving head until separation occurs.

S6.5 Water absorption sequence tests

S6.5.1 Preparation. Prepare three hose assemblies as follows:

- Remove 2.86 cm (1 1/8 inches) of hose cover, if any, from the center of the hose assemblies without injury to any reinforcing material or elongation of the hose assemblies.
- Measure the free length of the hose assemblies.

¹ Please see subsection 106(3) of the *Motor Vehicle Safety Regulations* (MVSr) for an alternative requirement.

S6.5.2 Immersion and sequence testing

- (a) Immerse the hose assemblies in distilled water for 70 hours.
- (b) Thirty minutes after removal from water, conduct tests S6.2, S6.3, and S6.4, using a different hose for each sequence.

S6.6 Low temperature resistance test**S6.6.1 Preparation**

- (a) Remove hose armor, if any, and condition a hose in a straight position in air at -40°C (-40°F) for 70 hours.
- (b) Condition a cylinder in air at -40°C (-40°F) for 70 hours, using a cylinder of 63.5 mm (2½ inches) in diameter for the testing of a hose less than 3.2 mm (1/8 inch), 76.2 mm (3 inches) for the testing of 1/8-inch or 3-mm hose, 88.9 mm (3½ inches) for the testing of 3/16- and ¼-inch hose or of 4-to-6-mm hose, and 101.6 mm (4 inches) for the testing of hose greater than ¼ inch or 6 mm in diameter.

S6.6.2 Flexibility testing. Bend the conditioned hose 180 degrees around the conditioned cylinder at a steady rate in a period of 3 to 5 seconds. Examine without magnification for cracks.

S6.7 Brake fluid compatibility test**S6.7.1 Preparation**

- (a) Attach a hose assembly below a 0.473-L (1-pint) reservoir filled with 100 mL of SAE RM-66-04 Compatibility Fluid as shown in Figure 2. [SENTENCE DELETED]
- (b) Fill the hose assembly with brake fluid, seal the lower end, and place the test assembly in an oven in a vertical position.

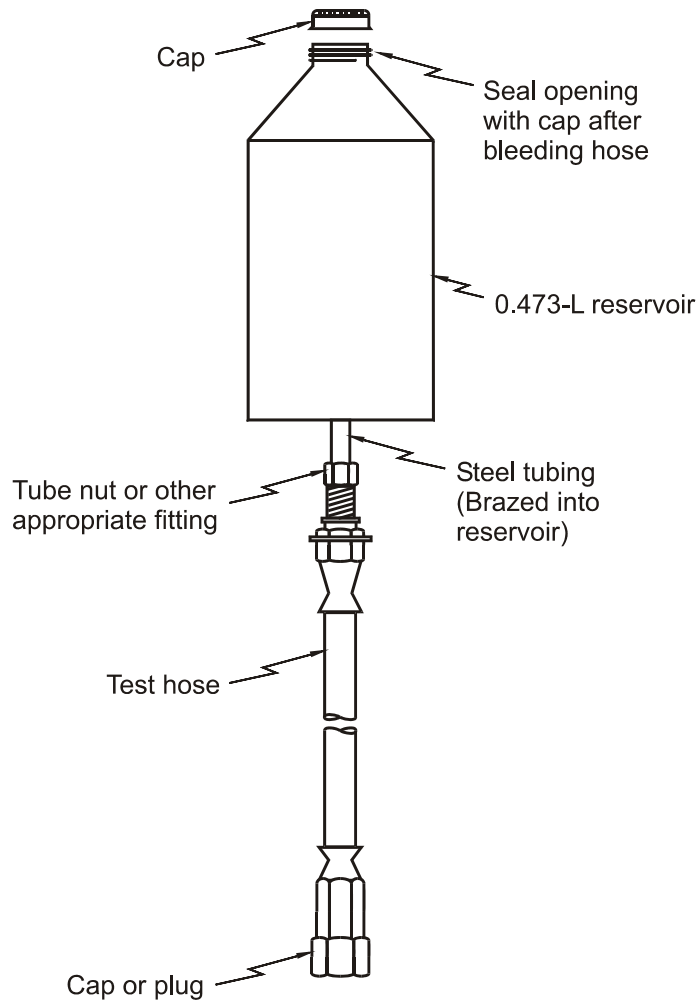


Figure 2 — Brake Fluid Compatibility Apparatus

S6.7.2 Oven treatment

- (a) Condition the hose assembly at 93.3°C (200°F) for 70 hours.
- (b) Cool the hose assembly at room temperature for 30 minutes.
- (c) Drain the brake hose assembly, immediately determine that every inside diameter of any section of the hose assembly, except for that part of an end fitting which does not contain hose, is not less than 64 percent of the nominal inside diameter of the hose, and conduct the test specified in S6.2.

S6.8 Ozone resistance test

Utilize a cylinder with a diameter eight times the nominal outside diameter of the brake hose, excluding armor.

S6.8.1 Preparation. After removing any armor, bind a hydraulic brake hose 360° around the cylinder. In the case of hose shorter than the circumference of the cylinder, bend the hose so that as much of its length as possible is in contact.

S6.8.2 Exposure to ozone

- (a) Condition the hose on the cylinder in air at room temperature for 24 hours.
- (b) Immediately thereafter, condition the hose on the cylinder for 70 hours in an exposure chamber having an ambient air temperature of 40°C (104°F) during the test and containing air mixed with ozone in the proportion of 50 parts of ozone per 100 million parts of air by volume.
- (c) Examine the hose for cracks under 7-power magnification, ignoring areas immediately adjacent to or within the area covered by binding.

S6.9 End fitting corrosion resistance test

Utilize the apparatus described in ASTM B 117-64, *Salt Spray (Fog) Testing*.²

S6.9.1 Construction. Construct the salt spray chamber so that:

- (a) The construction material does not affect the corrosiveness of the fog.
- (b) The hose assembly is supported or suspended 30° from the vertical and parallel to the principal direction of the horizontal flow of fog through the chamber.
- (c) The hose assembly does not contact any metallic material or any material capable of acting as a wick.
- (d) Condensation which falls from the assembly does not return to the solution reservoir for respraying.
- (e) Condensation from any source does not fall on the brake hose assemblies or the solution collectors.
- (f) Spray from the nozzles is not directed onto the hose assembly.

S6.9.2 Preparation

- (a) Plug each end of the hose assembly.
- (b) Mix a salt solution five parts by weight of sodium chloride to 95 parts of distilled water using sodium chloride substantially free of nickel and copper and containing on a dry basis not more than 0.1 percent of sodium iodide and not more than 0.3 percent total impurities. Ensure that the solution is free of suspended solids before the solution is atomized.
- (c) After atomization at 35°C (95°F), ensure that the collected solution is in the pH range of 6.5 to 7.2. Make the pH measurements at 25°C (77°F)
- (d) Maintain a compressed air supply to the nozzle or nozzles that is free of oil and dirt and between 68.9 and 172.4 kPa (10 and 25 psi.)

² Please see subsection 106(3) of the MVSR for an alternative requirement.

S6.9.3 Operation. Subject the brake hose assembly to the salt spray continuously for 24 hours.

- (a) Regulate the mixture so that each collector will collect from 1 to 2 mL of solution per hour for each 80 square centimeters of horizontal collecting area.
- (b) Maintain exposure zone temperature at 35°C (95°F).
- (c) Upon completion, remove the salt deposit from the surface of the hoses by washing gently or dipping in clean running water not warmer than 37.8°C (100°F) and then drying immediately.

S7. Requirements — Air brake hose, brake hose assemblies, and brake hose end fittings

S7.1 Construction

Each air brake hose assembly shall be equipped with permanently attached brake hose end fittings or reusable brake hose end fittings. Each air brake hose constructed of synthetic or natural elastomeric rubber intended for use with reusable end fittings shall conform to the dimensional requirements specified in Table III.

Table III — Air Brake Hose Dimensions for Reusable Assemblies

Size, <u>mm</u> (inches)	Inside Diameter Tolerance, <u>mm</u> (inches)	Type I Outside Diameter, <u>mm</u> (inches)		Type II Outside Diameter, <u>mm</u> (inches)	
		Minimum	Maximum	Minimum	Maximum
4.76 (3/16)	+0.66 (+0.026) -0.00	11.99 (0.472)	12.95 (0.510)	12.70 (0.500)	13.69 (0.539)
6.35 (1/4)	+0.79 (+0.031) -0.00	13.59 (0.535)	14.55 (0.573)	14.27 (0.562)	15.29 (0.602)
7.94 (5/16)	+0.79 (+0.031) -0.00	15.19 (0.598)	16.15 (0.636)	16.66 (0.656)	17.65 (0.695)
9.53 (3/8)	±0.58 (±0.023)	18.26 (0.719)	19.84 (0.781)	18.26 (0.719)	19.84 (0.781)
10.32 (13/32)	+0.79 (+0.031) -0.00	18.14 (0.714)	19.30 (0.760)	18.85 (0.742)	20.04 (0.789)
12.7 (1/2)	+0.99 (+0.039) -0.00	20.52 (0.808)	21.69 (0.854)	22.81 (0.898)	24.00 (0.945)
15.88 (5/8)	+1.07 (+0.042) -0.00	23.70 (0.933)	24.87 (0.979)	26.77 (1.054)	27.97 (1.101)
12.7 (1/2) special	±0.79 (±0.031)	21.44 (0.844)	23.01 (0.906)	21.44 (0.844)	23.01 (0.906)

S7.2 Labeling

S7.2.1 [CONTENT DELETED]

S7.2.2 End fittings. Except for an end fitting that is attached by deformation of the fitting about a hose by crimping or swaging, at least one component of each air brake hose fitting shall be etched, embossed, or stamped in block capital letters and numerals at least 1.6 mm (one-sixteenth of an inch) high with the following information:

- (a) ~~The symbol DOT, constituting a certification by the manufacturer of that component that the component conforms to all applicable motor vehicle safety standards.~~
- (b) A designation that identifies the manufacturer of that component of the fitting, ~~which shall be filed in writing with: Office of Crash Avoidance Standards, Vehicle Dynamics Division, National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.~~ The designation may consist of block capital letters, numerals, or a symbol.
- (c) The letter “A” shall indicate intended use in air brake systems. In the case of an end fitting intended for use in a reusable assembly with brake hose subject to Table III, “AI” or “AII” shall indicate use with Type I or Type II hose, respectively.
- (d) The nominal inside diameter of the hose to which the fitting is properly attached expressed in inches or fractions of inches or in millimeters, or the outside diameter of the plastic tubing to which the fitting is properly attached expressed in inches or fractions of inches or in millimeters followed by the letters OD. (See examples in S7.2.1(d).) The abbreviation “mm” shall follow hose sizes that are expressed in millimeters.

S7.2.3 [CONTENT DELETED]

S7.2.3.1 At least one end fitting of an air brake hose assembly made with end fittings that are attached by crimping or swaging shall be etched, stamped, or embossed with a designation at least 1.6 mm (one-sixteenth of an inch) high that identifies the manufacturer of the hose assembly ~~and is filed in accordance with S7.2.3(b).~~

S7.3 Test requirements

Each air brake hose assembly or appropriate part thereof shall be capable of meeting any of the requirements set forth under this heading, when tested under the conditions of S11 and the applicable procedures of S8. However, a particular hose assembly or appropriate part thereof need not meet further requirements after having met the constriction requirement (S7.3.1) and then having been subjected to any one of the requirements specified in S7.3.2 through S7.3.13.

S7.3.1 Constriction. Except for that part of an end fitting which does not contain hose, every inside diameter of any section of an air brake hose assembly shall be not less than 66 percent of the nominal inside diameter of the brake hose.

S7.3.2 High temperature resistance. An air brake hose shall not show external or internal cracks, charring, or disintegration visible without magnification when straightened after being bent for 70 hours at 100°C (212°F) over a cylinder having the radius specified in Table IV for the size of hose tested (S8.1).

S7.3.3 Low temperature resistance. The outer cover of an air brake hose shall not show cracks visible without magnification as a result of conditioning at -40°C (-40°F) for 70 hours when bent around a cylinder having the radius specified in Table IV for the size of hose tested (S8.2).

Table IV — Air Brake Hose Diameters and Test Cylinder Radii

Nominal diameter of hose in inches*	1/8	3/16	¼	5/16	3/8	13/32	7/16, ½	5/8
Nominal diameter of hose in mm	3	4.5	6	8		10	12	16
Test cylinder radius in inches	1.5	2	2.5	3	3	3.5	4	4.5
Test cylinder radius in mm	38	51	64	76	89	89	102	114

* These sizes are listed to provide test values for brake hoses manufactured in these sizes. They do not represent conversions.

S7.3.4 Oil resistance. After immersion in ASTM No. 3 oil for 70 hours at 100°C (212°F), the volume of a specimen prepared from the inner tube and cover of an air brake hose shall not increase more than 100 percent (S8.3).

S7.3.5 Ozone resistance. The outer cover of an air brake hose shall not show cracks visible under 7-power magnification after exposure to ozone for 70 hours at 40°C (104°F) (S8.4).

S7.3.6 Length change. An air brake hose (other than a coiled nylon tube for use in an assembly that meets the requirements of Sec. 393.45 of Title 49 of the Code of Federal Regulations ~~this title~~) shall not contract in length more than 7 percent nor elongate more than 5 percent when subjected to air pressure of 1 379 kPa (200 psi) (S8.5).

S7.3.7 Adhesion. Except for hose reinforced by wire, an air brake hose shall withstand a tensile force of 35.6 N (8 pounds) per 25.4 mm (1 inch) of length before separation of adjacent layers (S8.6).

S7.3.8 Air pressure. An air brake hose assembly shall contain air pressure of 1 379 kPa (200 psi) for 5 minutes without loss of more than 34.5 kPa (5 psi) (S8.7).

S7.3.9 Burst strength. An air brake hose assembly shall not rupture when exposed to hydrostatic pressure of 5 516 kPa (800 psi) (S8.8).

S7.3.10 Tensile strength. An air brake hose assembly (other than a coiled nylon tube assembly which meets the requirements of Sec. 393.45 of Title 49 of the Code of Federal Regulations ~~this title~~) designed for use between a frame and axle or between a towed and a towing vehicle shall withstand, without separation of the hose from its end fittings, a pull of 1 112 N (250 pounds) if it is ¼ inch or 6 mm or less in nominal internal diameter, or a pull of 1 446 N (325 pounds) if it is larger than ¼ inch or 6 mm in nominal internal diameter. An air brake hose assembly designed for use in any other application shall withstand, without separation of the hose from its end fitting, a pull of 222.4 N (50 pounds) if it is ¼ inch or 6 mm or less in nominal internal diameter, 667 N (150 pounds) if it is 3/8 or ½ inch or

10 mm to 12 mm in nominal internal diameter, or 1 446 N (325 pounds) if it is larger than ½ inch or 12 mm in nominal internal diameter (S8.9).

S7.3.11 Water absorption and tensile strength. After immersion in distilled water for 70 hours (S8.10), an air brake hose assembly (other than a coiled tube assembly which meets the requirements of Sec. 393.45 of Title 49 of the Code of Federal Regulations ~~this title~~) designed for use between a frame and an axle or between a towed and a towing vehicle shall withstand, without separation of the hose from its end fittings, a pull of 1 112 N (250 pounds) if it is ¼ inch or 6 mm or less in nominal internal diameter, or a pull of 1 446 N (325 pounds) if it is larger than ¼ inch or 6 mm in nominal internal diameter. After immersion in distilled water for 70 hours (S8.10), an air brake hose assembly designed for use in any other application shall withstand, without separation of the hose from its end fitting, a pull of 222.4 N (50 pounds) if it is ¼ inch or 6 mm or less in nominal internal diameter, 667 N (150 pounds) if it is 3/8 inch or ½ inch or 10 to 12 mm in nominal internal diameter, or 1 446 N (325 pounds) if it is larger than ½ inch or 12 mm in nominal internal diameter (S8.9).

S7.3.12 Zinc chloride resistance. The outer cover of an air brake hose shall not show cracks visible under 7-power magnification after immersion in a 50 percent zinc chloride aqueous solution for 200 hours (S8.11).

S7.3.13 End fitting corrosion resistance. After 24 hours of exposure to salt spray, air brake hose end fittings shall show no base metal corrosion on the end fitting surface, except where crimping or the application of labeling information causes a displacement of the protective coating.

S8. Test procedures — Air brake hose, brake hose assemblies, and brake hose end fittings

S8.1 High temperature resistance test

- (a) Utilize a cylinder having the radius indicated in Table IV for the size of hose tested.
- (b) Bind the hose around the cylinder and condition it in an air oven for 70 hours at 100°C (212°F).
- (c) Cool the hose to room temperature, remove it from the cylinder, and straighten it.
- (d) Without magnification, examine the hose externally and cut the hose lengthwise and examine the inner tube.

S8.2 Low temperature resistance test

- (a) Utilize a cylinder having the radius indicated in Table IV for the size of hose tested.
- (b) Condition the cylinder and the brake hose, in a straight position, in a cold box at -40°C (-40°F) for 70 hours.
- (c) With the hose and cylinder at -40°C (-40°F), bend the hose 180 degrees around the cylinder at a steady rate in a period of 3 to 5 seconds.

S8.3 Oil resistance test

Utilize three test specimens and average the results.

S8.3.1 Preparation. Fashion a test specimen by cutting a rectangular block 50.8 mm (2 inches) long and not less than 8.47 mm (one-third of an inch) in width, having a thickness of not more than 1.6 mm (one-sixteenth inch), from the brake hose and buff the specimen on both faces to ensure smooth surfaces.

S8.3.2 Measurement

- (a) Weigh each specimen to the nearest milligram in air (W_1) and in distilled water (W_2) at room temperature. If wetting is necessary to remove air bubbles, dip the specimen in acetone and thoroughly rinse it with distilled water.
- (b) Immerse each specimen in ASTM No. 3 oil for 70 hours at 100°C (212°F) and then cool in ASTM No. 3 oil at room temperature for 30 to 60 minutes.
- (c) Dip the specimen quickly in acetone and blot it lightly with filter paper.
- (d) Weigh each specimen in a tared weighing bottle (W_3) and in distilled water (W_4) within five minutes of removal from the cooling liquid.
- (e) Calculate the percentage increase in volume follows:

$$\text{Percent of increase} = \frac{(W_3 - W_4) - (W_1 - W_2)}{(W_1 - W_2) \times 100}$$

S8.4 Ozone resistance test

Conduct the test specified in S6.8 using an air brake hose.

S8.5 Length change test

- (a) Position a test hose in a straight, horizontal position and apply air pressure of 68.9 kPa (10 psi) thereto.
- (b) Measure the hose to determine its original free length.
- (c) Without releasing the 68.9 kPa (10 psi), raise the air pressure to the test hose to 1 379 kPa (200 psi).
- (d) Measure the hose under 1 379 kPa (200 psi) to determine the final free length. An elongation or contraction is an increase or decrease, respectively, in the final free length from the original free length of the hose.

S8.6 Adhesion test

S8.6.1 Apparatus. A tension testing machine that is power-driven and that applies a constant rate of extension is used for measuring the force required to separate the layers of the test specimen. The apparatus is constructed so that:

- (a) The recording head includes a freely rotating form with an outside diameter substantially the same as the inside diameter of the hose specimen to be placed on it.
- (b) The freely rotating form is mounted so that its axis of rotation is in the plane of the ply being separated from the specimen and so that the applied force is perpendicular to the tangent of the specimen circumference at the line of separation.

- (c) The rate of travel of the power-actuated grip is a uniform 25.4 mm (one inch) per minute and the capacity of the machine is such that maximum applied tension during the test is not more than 85 percent nor less than 15 percent of the machine's rated capacity.
- (d) The machine produces a chart with separation as one coordinate and applied tension as the other.

S8.6.2 Preparation

- (a) Cut a test specimen of 25.4 mm (1 inch) or more in length from the hose to be tested and cut the layer to be tested of that test specimen longitudinally along its entire length to the level of contact with the adjacent layer.
- (b) Peel the layer to be tested from the adjacent layer to create a flap large enough to permit attachment of the power-actuated clamp of the apparatus.
- (c) Mount the test specimen on the freely rotating form with the separated layer attached to the power-actuated clamp.

S8.6.3 [Reserved]

S8.6.4 Calculations

- (a) The adhesion value shall be the minimum force recorded on the chart, excluding that portion of the chart which corresponds to the initial and final 20 percent along the displacement axis.
- (b) Express the force in Newtons per metre (pounds per inch) of length.

S8.7 Air pressure test

- (a) Connect the air brake hose assembly to a source of air pressure.
- (b) Apply 1 379 kPa (200 psi) air pressure to the hose and seal the hose from the source of air pressure.
- (c) After 5 minutes, determine the air pressure remaining in the test specimen.

S8.8 Burst strength test

- (a) Utilize an air brake hose assembly.
- (b) Fill the hose assembly with water, allowing all gases to escape. Apply water pressure at a uniform rate of increase of approximately 6 895 kPa (1,000 psi) per minute until the hose ruptures.

S8.9 Tensile strength test

Utilize a tension testing machine conforming to the requirements of the *Methods of Verification of Testing Machines* (1964 American Society for Testing and Materials,

Designation E 4)³ and provided with a recording device to register total pull in Newtons (pounds).

- (a) Attach an air brake hose assembly to the testing machine to permit a straight, even machine pull on the hose.
- (b) Apply tension at a rate of 25.4 mm (1 inch) per minute of travel of the moving head until separation occurs.

S8.10 Water absorption and tensile strength test

Immerse an air brake hose assembly in distilled water at room temperature for 70 hours. Thirty minutes after removal from the water, conduct the test specified in S8.9.

S8.11 Zinc chloride resistance test

Immerse an air brake hose in a 50 percent zinc chloride aqueous solution at room temperature for 200 hours. Remove it from the solution and examine it under 7-power magnification for cracks.

S8.12 End fitting corrosion resistance test

Conduct the test specified in S6.9 using an air brake hose assembly.

S9. Requirements — Vacuum brake hose, brake hose assemblies, and brake hose end fittings

S9.1 Labeling

S9.1.1 [CONTENT DELETED]

S9.1.2 End fittings. Except for an end fitting that is attached by heat striking or by interference fit with a plastic vacuum hose or that is attached by deformation of the fitting about a hose by crimping or swaging, at least one component of each vacuum brake hose fitting shall be etched, embossed, or stamped in block capital letters and numerals at least 1.6 mm (one-sixteenth of an inch) high with the following information:

- (a) ~~The symbol DOT, constituting a certification by the manufacturer of that component that the component conforms to all applicable motor vehicle safety standards.~~
- (b) A designation that identifies the manufacturer of that component of the fitting, ~~which shall be filed in writing with: Office of Crash Avoidance Standards, Vehicle Dynamics Division, National Highway Traffic Safety Administration, 400 Seventh Street, SW., Washington, DC 20590.~~ The designation may consist of block capital letters, numerals, or a symbol.
- (c) The letters “VL” or “VH” shall indicate that the end fitting is intended for use in a light-duty or heavy-duty vacuum brake system, respectively.
- (d) The nominal inside diameter of the hose to which the fitting is properly attached expressed in inches or fractions of inches or in millimeters, or the outside diameter of the plastic tubing to which the fitting is properly attached expressed in inches or

³ Please see subsection 106(3) of the MVSR for an alternative requirement.

fractions of inches or in millimeters followed by the letters OD. (See examples in S9.1.1(d).) The abbreviation “mm” shall follow hose sizes that are expressed in millimeters.

S9.1.3 [CONTENT DELETED]

S9.1.3.1 At least one end fitting of a vacuum brake hose assembly made with end fittings that are attached by crimping or swaging or of a plastic tubing assembly made with end fittings that are attached by heat shrinking or dimensional interference fit shall be etched, stamped, or embossed with a designation at least 1.6 mm (one-sixteenth of an inch) high that identifies the manufacturer of the hose assembly ~~and is filed in accordance with S9.1.3(b).~~

S9.2 Test requirements

Each vacuum brake hose assembly or appropriate part thereof shall be capable of meeting any of the requirements set forth under this heading, when tested under the conditions of S11 and the applicable procedures of S10. However, a particular hose assembly or appropriate part thereof need not meet further requirements after having met the constriction requirement (S9.2.1) and then having been subjected to any one of the requirements specified in S9.2.2 through S9.2.11.

S9.2.1 Constriction. Except for that part of an end fitting which does not contain hose, every inside diameter of any section of a vacuum brake hose assembly shall be not less than 75 percent of the nominal inside diameter of the hose if for heavy duty, or 70 percent of the nominal inside diameter of the hose if for light duty.

S9.2.2 High temperature resistance. A vacuum brake hose shall not show external or internal cracks, charring, or disintegration visible without magnification when straightened after being bent for 70 hours at 100°C (212°F) over a cylinder having the radius specified in Table V for the size of hose tested (S10.1).

S9.2.3 Low temperature resistance. A vacuum brake hose shall not show cracks visible without magnification after conditioning at -40°C (-40°F) for 70 hours when bent around a cylinder having the radius specified in Table V for the size of hose tested (S10.2).

S9.2.4 Ozone resistance. A vacuum brake hose shall not show cracks visible under 7-power magnification after exposure to ozone for 70 hours at 40°C (104°F) (S10.3).

S9.2.5 Burst strength. A vacuum brake hose shall not rupture under hydrostatic pressure of 2 413 kPa (350 psi) (S10.4).

S9.2.6 Vacuum. The collapse of the outside diameter of a vacuum brake hose under internal vacuum of 88 kPa (26 inches of Hg) for five minutes shall not exceed 1.6 mm (one-sixteenth of an inch) (S10.5).

S9.2.7 Bend. The collapse of the outside diameter of a vacuum brake hose at the middle point of the test length, when bent until the ends touch, shall not exceed the values given in Table V for the size of hose tested (S10.6).

Table V — Vacuum Brake Hose Test Requirements

Inside Diameter of Hose*		High Temperature Resistance				Low Temperature Resistance			
		Hose Length		Radius of Cylinder		Hose Length		Radius of Cylinder	
mm	inches	mm	inches	mm	inches	mm	inches	mm	inches
5	7/32	203.2	8.0	38.10	1.50	444.5	17.5	76.2	3.0
6	1/4	228.6	9.0	38.10	1.50	444.5	17.5	76.2	3.0
	9/32	228.6	9.0	44.45	1.75	482.6	19.0	88.9	3.5
8	11/32	228.6	9.0	44.45	1.75	482.6	19.0	88.9	3.5
10	3/8	254.0	10.0	44.45	1.75	482.6	19.0	88.9	3.5
	7/16	279.4	11.0	50.80	2.00	520.7	20.5	101.6	4.0
	15/32	279.4	11.0	50.80	2.00	520.7	20.5	101.6	4.0
12	1/2	279.4	11.0	50.80	2.00	520.7	20.5	101.6	4.0
16	5/8	304.8	12.0	57.15	2.25	558.8	22.0	114.3	4.5
	3/4	355.6	14.0	63.50	2.50	609.6	24.0	127.0	5.0
	1	406.4	16.0	82.55	3.25	723.9	28.5	165.1	6.5

Inside Diameter of Hose*		Bend Test				Deformation — Collapsed Inside Diameter (Dimension D)	
		Hose Length		Maximum Collapse of Outside Diameter			
mm	inches	mm	inches	mm	inches	mm	inches
5	7/32	177.8	7.0	4.37	11/64	1.19	3/64
6	1/4	203.2	8.0	2.38	3/32	1.59	1/16
	9/32	228.6	9.0	4.76	12/64	1.59	1/16
8	11/32	279.4	11.0	5.16	13/64	1.98	5/64
10	3/8	304.8	12.0	3.97	5/32	2.38	3/32
	7/16	355.6	14.0	6.75	17/64	1.98	5/64
	15/32	355.6	14.0	6.75	17/64	1.98	5/64
12	1/2	406.4	16.0	5.56	7/32	3.18	1/8
16	5/8	558.8	22.0	5.56	7/32	3.97	5/32
	3/4	711.2	28.0	5.56	7/32	4.76	3/16
	1	914.4	36.0	7.14	9/32	6.35	1/4

* These sizes are listed to provide test values for brake hoses manufactured in these sizes. They do not represent conversions.

S9.2.8 Swell. Following exposure to Reference Fuel A, every inside diameter of any section of a vacuum brake hose shall not be less than 75 percent of the nominal inside of the hose if for heavy duty, or 70 percent of the nominal inside diameter of the hose if for light duty. The vacuum brake hose shall show no leakage, and there shall be no separation of the inner tube from the fabric reinforcement of the hose in a vacuum test of 88 kPa (26 inches of Hg) for 10 minutes (S10.7).

S9.2.9 Adhesion. Except for hose reinforced by wire, a vacuum brake hose shall withstand a force of 35.6 N (8 pounds) per 25.4 mm (1 inch) of length before separation of adjacent layers (S10.8).

S9.2.10 Deformation. A vacuum brake hose shall return to 90 percent of its original outside diameter within 60 seconds after five applications of force as specified in S10.9, except that a wire-reinforced hose need only return to 85 percent of its original outside diameter. In the case of heavy-duty hose, the first application of force shall not exceed a peak value of 311.4 N (70 pounds), and the fifth application of force shall reach a peak value of at least 178 N (40 pounds). In the case of light-duty hose, the first application of force shall not exceed a peak value of 222.4 N (50 pounds), and the fifth application of force shall reach a peak value of at least 89 N (20 pounds) (S10.9).

S9.2.11 End fitting corrosion resistance. After 24 hours of exposure to salt spray, vacuum brake hose end fittings shall show no base metal corrosion of the end fitting surface, except where crimping or the application of labeling information has caused displacement of the protective coating.

S10. Test procedures — Vacuum brake hose, brake hose assemblies, and brake hose end fittings

S10.1 High temperature resistance test

Conduct the test specified in S8.1 using a vacuum brake hose with the cylinder radius specified in Table V for the size of hose tested.

S10.2 Low temperature resistance test

Conduct the test specified in S8.2 using a vacuum brake hose with the cylinder radius specified in Table V for the size of hose tested.

S10.3 Ozone resistance test

Conduct the test specified in S6.8 using a vacuum brake hose.

S10.4 Burst strength test

Conduct the test specified in S8.8 using a vacuum brake hose.

S10.5 Vacuum test

Utilize a 30.5-cm (12-inch) vacuum brake hose assembly sealed at one end.

- (a) Measure the hose's outside diameter.

- (b) Attach the hose to a source of vacuum and subject it to a vacuum of 88 kPa (26 inches of Hg) for 5 minutes.
- (c) Measure the hose to determine the minimum outside diameter while the hose is still subject to vacuum.

S10.6 Bend test

- (a) Bend a vacuum brake hose of the length prescribed in Table V in the direction of its normal curvature until the ends just touch, as shown in Figure 3.
- (b) Measure the outside diameter of the specimen at point A before and after bending.
- (c) The difference between the two measurements is the collapse of the hose's outside diameter on bending.

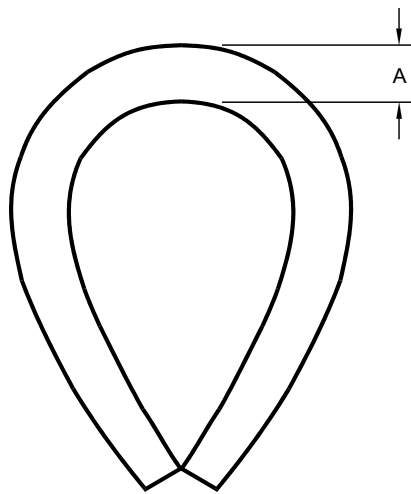


Figure 3 — Bend Test of Vacuum Brake Hose

S10.7 Swell test

- (a) Fill a specimen of vacuum brake hose 30.5 cm (12 inches) long with Reference Fuel A, as described in the *Method of Test for Change in Properties of Elastomeric Vulcanizers Resulting From Immersion in Liquids* (1964 American Society for Testing and Materials, Designation D 471)⁴.
- (b) Maintain reference fuel in the hose under atmospheric pressure at room temperature for 48 hours.
- (c) Remove the fuel and determine that every inside diameter of any section of the brake hose is not less than 75 percent of the nominal inside diameter of the hose for heavy-duty hose and 70 percent of the nominal inside diameter of the hose for light-duty hose.
- (d) Subject the hose specimen to a vacuum of 88 kPa (26 inches of Hg) for 10 minutes.

⁴ Please see subsection 106(3) of the MVSR for an alternative requirement.

S10.8 Adhesion test

Conduct the test specified in S8.6 using a vacuum brake hose.

S10.9 Deformation test

Table VI specifies the test specimen dimensions.

S10.9.1 Apparatus. Utilize a compression device equipped to measure force of at least 444.8 N (100 pounds) and feeler gauges of sufficient length to be passed completely through the test specimen.

S10.9.2 Operation

- (a) Position the test specimen longitudinally in the compression device with the fabric laps not in the line of the applied pressure.
- (b) Apply gradually increasing force to the test specimen to compress its inside diameter to that specified in Table VI (dimension D of Figure 4) for the size of hose tested.
- (c) After 5 seconds, release the force and record the peak load applied.
- (d) Repeat the procedure four times permitting a 10-second recovery period between load applications.

Table VI — Dimensions of Test Specimen and Feeler Gauge for Deformation Test

Inside Diameter of Hose*		Specimen Dimensions (See Figure 4)				Feeler Gauge Dimensions			
		Depth		Length		Width		Thickness	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
5	7/32	1.19	3/64	25.4	1	3.18	1/8	1.19	3/64
6	1/4	1.59	1/16	25.4	1	3.18	1/8	1.59	1/16
	9/32	1.59	1/16	25.4	1	3.18	1/8	1.59	1/16
8	11/32	1.98	5/64	25.4	1	4.76	3/16	1.98	5/64
10	3/8	2.38	3/32	25.4	1	4.76	3/16	2.38	3/32
	7/16	1.98	5/64	25.4	1	6.35	1/4	1.98	5/64
	15/32	1.98	5/64	25.4	1	6.35	1/4	1.98	5/64
12	1/2	3.18	1/8	25.4	1	6.35	1/4	3.18	1/8
16	5/8	3.97	5/32	25.4	1	6.35	1/4	3.97	5/32
	3/4	4.76	3/16	25.4	1	6.35	1/4	4.76	3/16
	1	6.35	1/4	25.4	1	6.35	1/4	6.35	1/4

* These sizes are listed to provide test values for brake hoses manufactured in these sizes. They do not represent conversions.

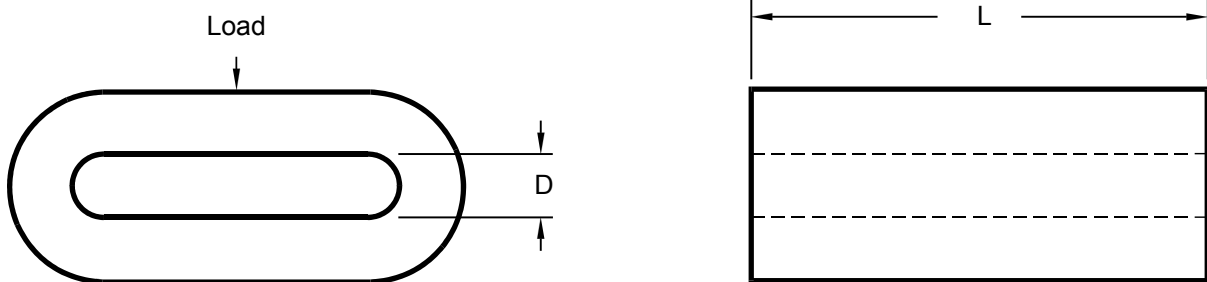


Figure 4 — Deformed Specimen of Vacuum Brake Hose

S10.10 End fitting corrosion resistance test

Conduct the test specified in S6.9 using a vacuum brake hose assembly.

S11. Test conditions

Each hose assembly or appropriate part thereof shall be able to meet the requirements of S5, S7, and S9 under the following conditions:

S11.1 The temperature of the testing room is 23.9°C (75°F).

S11.2 Except for S6.6, S8.2, and S10.2, the test samples are stabilized at test room temperature prior to testing.

S11.3 The brake hoses and brake hose assemblies are at least 24 hours old and unused.