SAE International™ SURFACE VEHICLE STANDARD

SAE J1401 REV. JUN2003

Issued 1942-01
Revised 2003-06

Superseding J1401 SEP1999

Road Vehicle—Hydraulic Brake Hose Assemblies for Use With Nonpetroleum-Base Hydraulic Fluids

1. *Scope*—This SAE Standard specifies the performance tests and requirements for hydraulic brake hose assemblies used in the hydraulic braking system of a road vehicle. It also specifies the methods used for identification of the hose manufacturer.

This document applies to brake hose assemblies made of a hose fabricated from yarn and natural or synthetic elastomers and assembled with metal end fittings for use with nonpetroleum-base brake fluids as specified in SAE J1703 and SAE J1705.

The nominal internal diameter of the brake hose shall fall within one of the following values:

a. 3.5 mm or less (1/8 in or less)
b. 4 to 5 mm (3/16 in)

2. *References*

2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1703—Motor Vehicle Brake Fluid
SAE J1705—Low Water Tolerant Brake Fluids

2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117—Method of Salt Spray (Fog) Testing

2.1.3 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO R147—Load calibration of testing machines for tensile testing of steel

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2.2 **Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1288—Packaging, Storage, and Shelf Life of Hydraulic Brake Hose Assemblies
SAE J1406—Application of Hydraulic Brake Hose to Motor Vehicles

2.2.2 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 3996—Hydraulic brake hose assemblies—Non-Petroleum hose hydraulic fluid standard

3. Definitions

3.1 **Brake Hose Assembly**—A brake hose equipped with end fittings for use in a brake system.

3.2 **Brake Hose**—A flexible conduit manufactured for use in a brake system to transmit and contain the fluid pressure medium used to apply force to the vehicle's brakes.

3.3 **Brake Hose End Fitting**—A coupling, other than a clamp, designed for attachment to the end of a brake hose.

3.4 **Permanently Attached End Fitting**—A coupling designed for permanent attachment to the ends of a brake hose by crimping or swaging.

3.5 **Free Length**—The linear measurement of brake hose exposed between the end fittings of a brake hose assembly while maintained in a straight position.

3.6 **Leaks, Burst**—The loss of test fluid from the brake hose assembly other than by the designed inlet(s) and outlet(s).

3.7 **Cracking**—The interruption of a surface due to environment and/or stress.

3.8 **Hose Internal Diameter**—A dimensional description of the nominal inside diameter that is printed on the hose cover. This dimension is to be used to calculate the gage size for the constriction test.

EXAMPLE—3 mm

4. Performance Tests—Performance tests for hydraulic brake hose assemblies include all of the tests listed in Table 1. These tests shall be conducted on each I.D. size and type[1] from each hose manufacturer. A change in hose construction, that is, a change in material or a change in the manufacturing method, shall require a complete performance test. Accordingly, each coupler shall conduct the performance test on each coupling crimp design for each hose construction. A change of coupling crimp design shall require a complete performance test. Variations that do not influence the integrity of the hose coupling joint, such as variation in thread size, port dimensions, hex size, and the like, shall not be considered new design. The sample sizes listed in Table 1 represent minimums for validation of a production process. The manufacturer of the hydraulic brake hose assembly is responsible for conducting appropriate design verification exercises and for controlling the production processes such that any hose assembly provided for sale or use on a vehicle will be capable of meeting the performance requirements listed in Section 5 when subjected to the tests listed in Table 1, performed per the procedures and conditions described in 4.1 and 4.2.

1. Various reinforcing cord(s) and/or elastomer(s).

TABLE 1—HYDRAULIC BRAKE HOSE ASSEMBLY PERFORMANCE TEST SUMMARY[1]

Sample Size	Performance Test	Test Procedure (paragraph)	Performance Requirement (paragraph)
All	100% Pressure Test	4.2.1	5.1
All[2]	Constriction	4.2.2	5.2
4	Volumetric Expansion	4.2.3	5.3
	Followed by Burst	4.2.4	5.4
4	Brake Fluid Compatibility	4.2.5	5.5
4	Whip	4.2.6	5.6
4	Tensile	4.2.7	5.7
1	Cold Bend	4.2.8	5.8
1	Ozone	4.2.9	5.9
1	Salt Spray	4.2.10	5.10
	Water Absorption	4.2.11	5.11
4	Burst		
4	Whip		
4	Tensile		
4	Hot Impulse	4.2.12	5.12
4	Dynamic Ozone	4.2.13	5.13
39	Total Samples		

1. When the hose assembly configurations make it impractical to conduct tests such as tensile, whip, and constriction, hose assemblies produced from equivalent type end fittings, production type equipment, and processes must be used to make the substitute brake hose assemblies.
2. Four brake hose assemblies may be used if assemblies must be cut to conduct constriction tests.

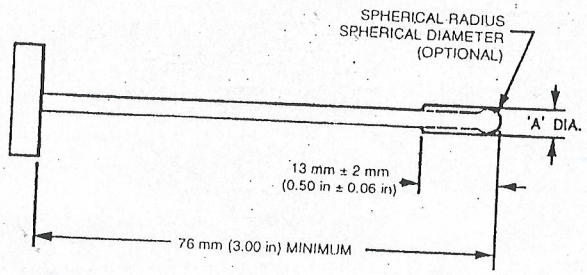
4.1 **Test Conditions**—The assemblies for each performance test shall be new and unused and shall be at least 24 h old. The last 4 h prior to testing shall be at a temperature of 15 to 32 °C (60 to 90 °F). Prior to installation of the hose assembly on a whip or cold bend test, all external appendages such as mounting brackets, spring guards, and metal collars shall be removed or long tubes shortened, or both. The temperature of the testing room shall be between 15 and 32 °C (60 and 90 °F) for all tests except brake fluid compatibility, cold bend, hot impulse, ozone, dynamic ozone, salt spray, and water absorption. SAE Referee Brake Fluid, RM 66-05, should be used for all tests requiring brake fluid. Different test results may be obtained using different fluids.

4.2 **Test Procedures**

4.2.1 100% PRESSURE TEST—The hose assembly shall be subject to a pressure test, using inert gas, air, water, or brake fluid as a pressure medium. Brake fluid shall meet SAE J1703/J1705. The test pressure shall be 10.3 MPa (1500 psi) minimum, 14.5 MPa (2100 psi) maximum for inert gas and air and 20.7 MPa (3000 psi) minimum, 24.8 MPa (3600 psi) maximum for water and nonpetroleum-base hydraulic brake fluid. Special care should be taken when gas or air is used. Under the pressure specified, gas or air is explosive if a failure should occur in the hose or hose assembly. The pressure shall be held for not less than 10 nor more than 25 s.

4.2.2 CONSTRICTION TEST—For qualification and lab testing, the constriction of the hose assemblies shall be measured with a gage plug as shown in Figure 1.

Hold the assembly vertically at the fitting and insert the "A" diameter portion of the constriction gage into the end of the fitting. Allow the gage to drop of its own weight for the full length of the probe. The time required for the gage to drop shall not exceed 5s. Repeat this step for the other end of the brake hose assembly.



THE CONSTRICTION GAGE 'A' DIMENSION MIN. DIA.
IS 64% OF HOSE NOMINAL INSIDE DIAMETER
THE CONSTRICTION GAGE WEIGHT IS 57 g ± 3 g (2 oz ± 0.1 oz)

FIGURE 1—GAGE PLUG FOR TESTING CONSTRICTION OF BORE OF HOSE ASSEMBLY

The design of some fittings makes it impossible to insert the gage plug externally. For these assemblies, insert a special elongated gage plug into the opposite fitting and pass the probe through the hose, into and through the crimped area of the fitting being tested. If the gage plug becomes misaligned at the entrance to the second fitting, it may be necessary to align the hose to allow the plug gage to pass through. The special gage plug shall meet all the requirements of Figure 1, with the exception of the 76 mm (3 in) length, which must be increased appropriately so that its tip will extend past the hose opening.

Some brake hose assemblies have fittings on both ends, brackets, and/or center fittings that cannot be entered with a gage plug. Cut these assemblies 50 mm ± 3 mm (2 in ± 0.1 in) from the end of the fitting and then test with the plug gage. (Reference Table 1, footnote 2).

4.2.3 VOLUMETRIC EXPANSION TEST—The expansion test is designed to measure, by fluid displacement, the volumetric expansion of the free length of assembled hydraulic brake hose when subjected to specified internal pressures. Water or SAE Referee Brake Fluid RM 66-05 should be used as a pressure medium.

4.2.3.1 If the specimen used in this test has been subjected to a pressure above 20 MPa (2900 psi) using any medium prior to this test, allow it to recover for 15 min.

4.2.3.2 Carefully thread the hose assembly into the adapters designed to seal in the same manner as in actual use. Do not twist. Maintain the hose in a vertical, straight position, without tension, while under pressure.

4.2.3.3 Bleed all the air from the system by allowing approximately 0.25 L (0.5 pt) of brake fluid or water to flow through the hose assembly and into the buret. Removal of air bubbles may be facilitated by moving the hose back and forth. Close the valve to the buret and apply 20.0 MPa +0, −0.14 MPa (2900 psi +0, −20 psi) to the hose assembly. Within 10 s, inspect the hose assembly for leaks at the connections and then release the pressure completely in the hose. Adjust the brake fluid or water level in the buret to zero. With the valve to the buret closed, apply 6.9 MPa +0, −0.14 MPa (1000 psi +0, −20 psi) to hose assembly and seal this pressure in the hose within 5 s ± 3 s. Within 3 s, open the valve to the buret for 10 s +3, −0 s and allow the brake fluid or water level in the expanded hose to rise in the buret. The brake fluid or water level in the buret should be constant within that time period.

4.2.3.4 Repeat the preceding step two times, so the amount of brake fluid or water in the buret will be the total of the three expansions. Measure this buret reading to the nearest 0.05 cm^3.

4.2.3.5 The volumetric expansion is calculated by dividing the buret reading by three and subtracting the calibration factor. This figure divided by the free length in meters (feet) will give the volumetric expansion per meter (feet) of hose.

4.2.3.6 Readjust the brake fluid or water level in the buret to zero as previously stated and repeat the procedure to obtain the expansion at pressures of 10.3 MPa +0, −0.14 MPa (1500 psi +0, −20 psi) and 20 MPa +0, −0.14 MPa (2900 psi +0, −20 psi.) If the pressure in the hose should inadvertently be raised to a value above that specified, but not above 24 MPa (3500 psi), completely release the pressure and allow the hose to recover for at least 15 min and then repeat the test. If the hose was subjected to a pressure above 24 MPa (3500 psi), repeat the test using a new brake hose. If at any time during the test an air bubble flows out of the hose, repeat the test after allowing at least 3 min for the hose to recover.

4.2.3.7 *Test Apparatus*—Test apparatus shall consist essentially of the following:

a. A source for required fluid pressures, test fluid consisting of brake fluid or water without any additives and free of air or gas bubbles.
b. A reservoir for pressure gages, fittings where the hose assembly may be mounted vertically for application of pressure under controlled conditions.
c. A graduated buret with 0.05 cm^3 increments for measuring the volume of liquid corresponding to the expansion of the hose under pressure.
d. Plumbing hardware as required.

All piping and connections shall be smooth bore without recesses or offsets so all air may be freely removed from the system before running each test. Valves shall be capable of withstanding pressures involved without leakage. See Figure 2.

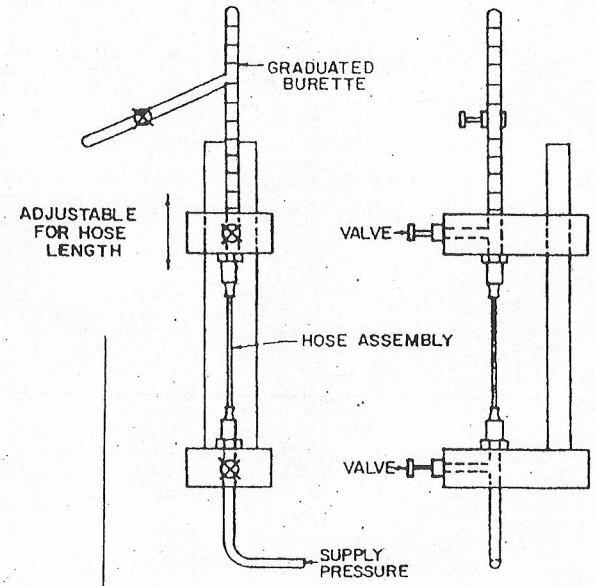


FIGURE 2—EXPANSION TEST APPARATUS

4.2.3.8 *Calibration of Apparatus*—The apparatus shall be tested prior to use to determine its calibration correction factors. These correction factors should be established at pressures of 6.9, 10.3, and 20 MPa (1000, 1500, and 2900 psi) using an assembly, which shall consist, for example, of 1.52 mm (0.060 in) minimum wall, hydraulic steel tubing with a free length of 305 mm ± 6 mm (12 in ± 0.2 in), and 6.3 mm (0.25 in) outside diameter. All fittings and adapters used in testing of the assembly shall be in this system. This may require the attachment of the tubing to the brake hose fittings in the case of special end configurations. The calibration correction factors shall be subtracted from the expansion readings obtained on the test specimens. The maximum permissible calibration correction factor shall be 0.08 cm^3 at 10.3 MPa (1500 psi).

4.2.4 BURST STRENGTH TEST—Connect the specimen to the pressure system and fill completely with water or SAE Referee Brake Fluid RM 66-05, allowing all air to escape. Removal of air bubbles may be facilitated by moving the hose back and forth. Apply 27.6 MPa +0, −1.4 MPa (4000 psi +0, −200 psi) pressure at the rate specified in 4.2.4.1 and hold for 2 min +0, −10 s. At the expiration of this hold period, increase the pressure at 172.5 MPa/min ± 69 MPa/min (25 000 psi/min ± 10 000 psi/min) until the hose bursts. Read the maximum pressure obtained on the calibrated gage to the nearest 1 MPa (100 psi) and record as the bursting strength of the hose assembly.

4.2.4.1 *Test Apparatus*—The apparatus shall consist of a suitable pressure system where hose is connected so that controlled and measured fluid pressure may be applied internally. The pressure shall be obtained by means of a hand- or power-driven pump or an accumulator system and it shall be measured with a calibrated gage. Provision shall be made for filling the hose with water or brake fluid and allowing all air to escape through a relief valve prior to application of pressure. This is important as a safety measure. The hold and burst pressures shall be applied at a rate increase of 172.5 MPa/min ± 69 MPa/min (25 000 psi/min ± 10 000 psi/min). Since this type of hose withstands a minimum bursting pressure of 49 MPa (7000 psi) for 3.2 mm (1/8 in) and 34.5 MPa (5000 psi) for 4.8 mm (3/16 in), care must be taken that all piping, valves, and fittings are sufficiently rugged and adapted to high-pressure work. The apparatus described for the expansion test may be used when it conforms to these requirements.

4.2.5 BRAKE FLUID COMPATIBILITY, CONSTRICTION, AND BURST STRENGTH TEST

4.2.5.1 Attach a hose assembly or a manifold to which multiple hose assemblies may be attached, below a 0.5 L (1 pt) can reservoir filled with 100 mL of SAE Referee Brake Fluid, SAE RM 66-05 (see Figure 3).

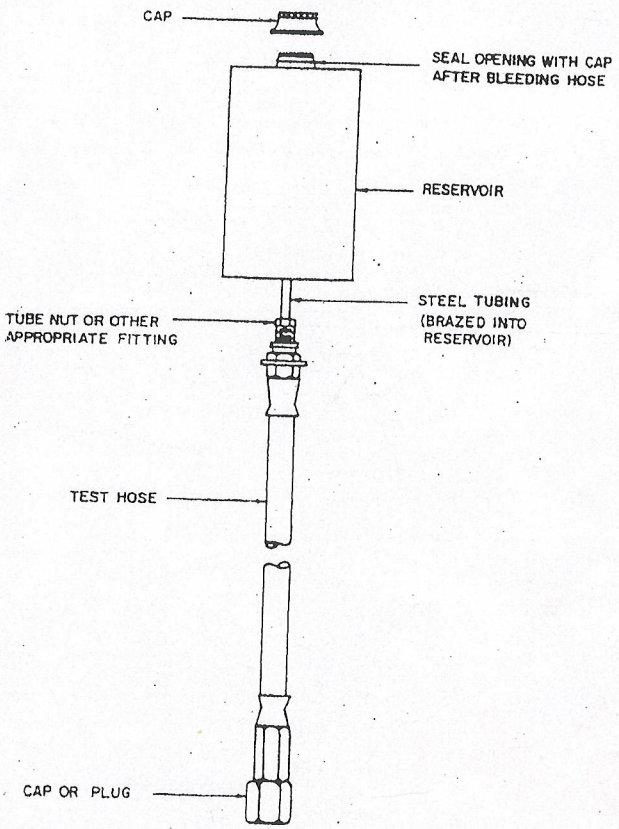


FIGURE 3—BRAKE FLUID COMPATIBILITY APPARATUS

4.2.5.2 Fill the hose assembly with SAE Referee Brake Fluid RM 66-05, seal the lower end, and place the test assembly in a vertical position in an oven.

4.2.5.3 Condition the hose assembly at 120 °C +5, –0 °C (248 °F +9, –0 °F) for 70 to 72 h.

4.2.5.4 After completion of the heat aging period, remove the hose assembly and cool at room temperature for 30 min ± 5 min.

4.2.5.5 Drain the brake hose assembly, and within 10 min, determine, per 4.2.2, that every applicable diameter of the hose assembly is not less than shown in Figure 1.

4.2.5.6 The brake hose assembly shall be burst within 3 h using the test specified in 4.2.4.

4.2.6 WHIP TEST

4.2.6.1 Measure the free length of the hose assembly with the assembly in a vertical position with a mass of 567 g ± 3 g (20 oz ± 0.1 oz) attached to one end. Use a vernier caliper scale or equivalent and report the length between fittings to within a tolerance of 0.5 mm (0.02 in).

4.2.6.2 Equip the nonrotating header to permit attachment of each assembly with individual adjustment for length. When mounted in the whip test machine (see Figure 4), the projected length of the hose assembly shall be less than the free length by the amount indicated as slack in Table 2 (see Figure 5).

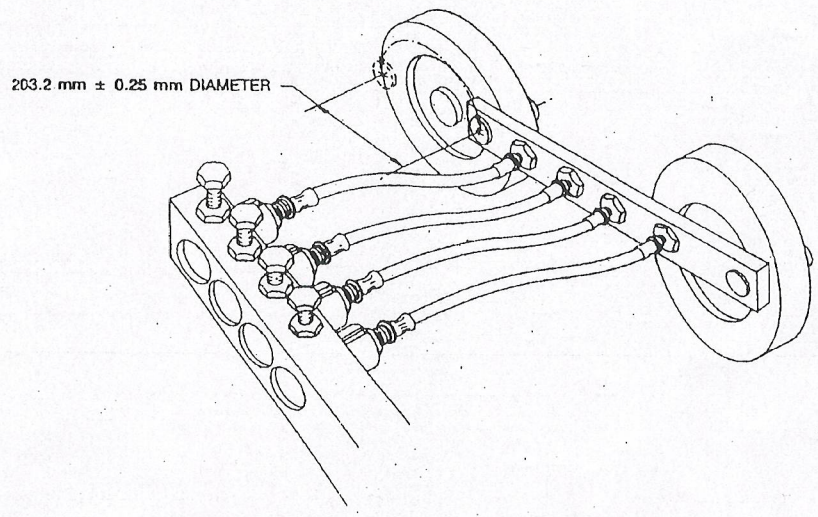


FIGURE 4—WHIP TEST MACHINE

TABLE 2—WHIP TEST SLACK SETTING

Internal Diameter mm (in)	Free Length mm (in)	Slack Length mm (in)
3.5 mm or less	200 to 400 (8 to 15-1/2) incl	44.45 ± 0.40 (1.750 ± 0.015)
(1/8 in or less)	Over 400 to 480 (15-1/2 to 19) incl	31.75 ± 0.40 (1.250 ± 0.015)
	Over 480 to 600 (19 to 24) incl	19.05 ± 0.40 (0.750 ± 0.015)
4 to 5 mm (3/16 in)	250 to 400 (10 to 15-1/2) incl	25.40 ± 0.40 (1.000 ± 0.015)

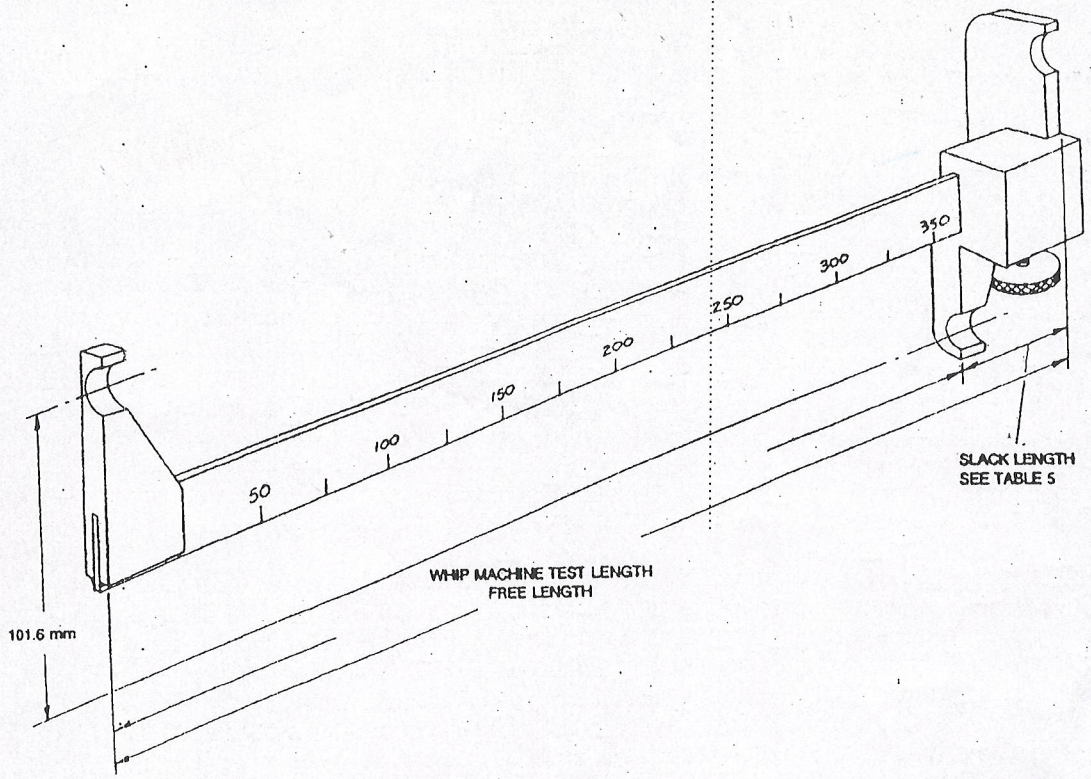


FIGURE 5—TYPICAL WHIP TEST SLACK SETTING FIXTURE

4.2.6.3 Since the whip test results are very sensitive to error in setting this length, the projected length on the machine shall be within the limits specified. Take the projected length parallel to the axis of the rotating head.

4.2.6.4 Install the test specimen assemblies in the apparatus without any twist. Apply the water pressure and bleed all hose and passages to eliminate air pockets or bubbles. Start the motor rotating the movable head. Periodically check the rpm. Failure of the specimen by water leakage and subsequent loss of pressure terminates the test. Note the elapsed time of the test prior to termination.

4.2.6.5 *Test Apparatus*—The test apparatus shall provide the same motion to the specimens as the following: a movable header consisting of a horizontal bar mounted at each end on vertically rotating disks through bearings with centers placed 101.6 mm (4 in) from the disk centers, and an adjustable stationary header parallel to the movable header in the same horizontal plane as the centers of the disks. Each header is provided with end connections in which the hose assemblies are mounted in a parallel manner. The disks are revolved at a speed of 800 rpm ± 10 rpm, whereby the hose ends fastened to the moving header are rotated at this speed through a circle 203.20 mm ± 0.25 mm (8.000 in ± 0.010 in) in diameter, while the opposite hose ends remain stationary. The end connections on the movable header are tightly capped, while those on the stationary header are open to a manifold through which water pressure is supplied by a suitable means. The hose assemblies are subjected during testing to a constant water pressure, which shall be maintained between 1.55 and 1.72 MPa (225 and 250 psi). A limit switch shall be used to stop the machine when the water pressure drops, as in the case of hose failure, since it is essential that the machine stop if the pressure drops. An elapsed time indicator shall be provided.

4.2.7 TENSILE TEST—Apply an increasing tension load such that the moving head of the testing machine travels at a speed as indicated in Table 3 until the hose assembly fails. Record the total load at the time of failure, the type of failure, and the separation rate.

TABLE 3—TENSILE SEPARATION RATE AND MINIMUM LOAD

Internal Diameter	Separation Rate mm/min (in/min)	Minimum Load N (lb)
All Internal Diameters	25 ± 3 (1 ± 0.1)	1446 (325)
All Internal Diameters	50 ± 3 (2 ± 0.1)	1646 (370)

4.2.7.1 *Test Apparatus*—A tension testing machine conforming to the requirements of ISO R147 shall be used for the tensile test of the hose assembly. The machine shall be provided with a recording device to give the total pull in Newtons (pounds) at the conclusion of the test. A machine of 4.5 kN (1000 lbf) will be found suitable. The specimen shall be held so that the hose fittings have a straight centerline corresponding to the direction of the machine pull.

4.2.8 COLD BEND TEST—Condition the hose (in a straight position) and a mandrel of the diameter specified as follows, in air at –45 to –48 °C (–50 to –55 °F) for 70 to 72 h. Then while still at this temperature, bend the hose at least 180 degrees around the mandrel at a steady rate in a period of 3 to 5 s.

4.2.8.1 Examine the cover of the brake hose with a naked eye for cracks or breaks.

4.2.8.2 *Test Apparatus*—The mandrel diameter shall be 76.2 mm +1, –0 mm (3 in +0.04, –0 in) for 3.5 mm or less (1/8 in or less) hose and 88.9 mm +1, –0 mm (3.50 in +0.04, –0 in) for 4 to 5 mm (3/16 in) hose.

4.2.9 OZONE TEST

4.2.9.1 Bend a brake hose around a cylinder, the diameter of which shall be eight times the nominal outside diameter of the brake hose, and bind the ends. The cylinder and binding shall be made of metal or materials that prevent the consumption of ozone. If the hose collapses when bent around the cylinder, provide for internal support of the hose.

4.2.9.2 Condition the hose on the cylinder for 24 h ± 0.5 h at room temperature, and then place it in an exposure chamber containing air mixed with ozone at the ozone partial pressure of 100 mPa ± 5 mPa (100 parts of ozone/100 million parts of air by volume ± 5 parts of ozone/100 million parts of air by volume) for 70 to 72 h. Ambient air temperature in chamber during test shall be 40 °C ± 3 °C (104 °F ± 5 °F).

4.2.9.3 Examine the cover of the hose for cracks under 7X magnification, ignoring the areas immediately adjacent to or within the area covered by the binding.

4.2.10 SALT SPRAY TEST

4.2.10.1 *Test Apparatus*—Utilize the apparatus described in ASTM B 117 Appendix B. Construct the salt spray chamber so that:

4.2.10.1.1 The construction material does not affect the corrosiveness of the fog.

4.2.10.1.2 The hose assembly is supported or suspended between 15 and 30 degrees from the vertical and within the principal plane of the horizontal flow of fog through the chamber.

4.2.10.1.3 The hose assembly does not contact any metallic material or any material capable of acting as a wick.

4.2.10.1.4 Condensation, which falls from the assembly, does not return to the solution reservoir for respraying.

4.2.7 TENSILE TEST—Apply an increasing tension load such that the moving head of the testing machine travels at a speed as indicated in Table 3 until the hose assembly fails. Record the total load at the time of failure, the type of failure, and the separation rate.

TABLE 3—TENSILE SEPARATION RATE AND MINIMUM LOAD

Internal Diameter	Separation Rate mm/min (in/min)	Minimum Load N (lb)
All Internal Diameters	25 ± 3 (1 ± 0.1)	1446 (325)
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4.2.8 COLD BEND TEST—Condition the hose (in a straight position) and a mandrel of the diameter specified as follows, in air at –45 to –48 °C (–50 to –55 °F) for 70 to 72 h. Then while still at this temperature, bend the hose at least 180 degrees around the mandrel at a steady rate in a period of 3 to 5 s.

4.2.8.1 Examine the cover of the brake hose with a naked eye for cracks or breaks.

4.2.8.2 *Test Apparatus*—The mandrel diameter shall be 76.2 mm +1, –0 mm (3 in +0.04, –0 in) for 3.5 mm or less (1/8 in or less) hose and 88.9 mm +1, –0 mm (3.50 in +0.04, –0 in) for 4 to 5 mm (3/16 in) hose.

4.2.9 OZONE TEST

4.2.9.1 Bend a brake hose around a cylinder, the diameter of which shall be eight times the nominal outside diameter of the brake hose, and bind the ends. The cylinder and binding shall be made of metal or materials that prevent the consumption of ozone. If the hose collapses when bent around the cylinder, provide for internal support of the hose.

4.2.9.2 Condition the hose on the cylinder for 24 h ± 0.5 h at room temperature, and then place it in an exposure chamber containing air mixed with ozone at the ozone partial pressure of 100 mPa ± 5 mPa (100 parts of ozone/100 million parts of air by volume ± 5 parts of ozone/100 million parts of air by volume) for 70 to 72 h. Ambient air temperature in chamber during test shall be 40 °C ± 3 °C (104 °F ± 5 °F).

4.2.9.3 Examine the cover of the hose for cracks under 7X magnification, ignoring the areas immediately adjacent to or within the area covered by the binding.

4.2.10 SALT SPRAY TEST

4.2.10.1 *Test Apparatus*—Utilize the apparatus described in ASTM B 117 Appendix B. Construct the salt spray chamber so that:

4.2.10.1.1 The construction material does not affect the corrosiveness of the fog.

4.2.10.1.2 The hose assembly is supported or suspended between 15 and 30 degrees from the vertical and within the principal plane of the horizontal flow of fog through the chamber.

4.2.10.1.3 The hose assembly does not contact any metallic material or any material capable of acting as a wick.

4.2.10.1.4 Condensation, which falls from the assembly, does not return to the solution reservoir for respraying.

4.2.10.1.5 Condensation from any source does not fall on the brake hose assemblies or the solution collectors.

4.2.10.1.6 Spray from the nozzles is not directed onto the hose assembly.

4.2.10.2 Test Preparation

4.2.10.2.1 Mix a salt solution 5 parts ± 1 part 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% of sodium iodide and not more than 0.3% total impurities. Ensure that the solution is free of suspended solids before the solution is atomized.

4.2.10.2.2 After atomization at 35 °C +1, −2 °C (95 °F +1.8, −3.6 °F) ensure that the collected solution is in the pH range of 6.5 to 7.2. Make the pH measurements at 25 °C ± 3 °C (77 °F ± 5 °F).

4.2.10.2.3 Maintain a compressed air supply to the nozzle free of oil and dirt and between 68.9 and 172.4 kPa (10 and 25 psi).

4.2.10.3 Plug each end of the hose assembly.

4.2.10.4 Subject the brake hose assembly to the salt spray continually for 24 h +0.2, −0 h.

4.2.10.5 Regulate the mixture so that each collector will collect from 1 to 2 mL (0.06 to 0.12 in^3) of solution per hour for each 80 cm^2 (12.4 in^2) of horizontal collecting area.

4.2.10.6 Maintain exposure zone temperature at 35 °C ± 2 °C (95 °F ± 4 °F).

4.2.10.7 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 °C (98.6 °F) and then drying with air within 2 min.

4.2.10.8 Examine the brake hose end fitting for base metal corrosion and record results.

4.2.11 WATER ABSORPTION TESTS

4.2.11.1 Immerse brake hose assemblies in water heated at 85 °C ± 2 °C (185 °F ± 3.6 °F) for a period of 70 to 72 h.

4.2.11.2 Remove the brake hose assemblies from the water and allow 25 min ± 5 min before starting the burst test in 4.2.4, the tensile test in 4.2.7, and the whip test in 4.2.6.

4.2.12 HOT IMPULSE TEST

4.2.12.1 Test Equipment

a. Pressure Cycling Apparatus—The pressure cycling apparatus shall be capable of applying a pressure of 11 MPa (1600 psi). It shall have automatic control of the time for the pressure apply/release cycle.
b. Circulating Air Oven—An insulated circulating air oven with a suitable thermostatically controlled heating system is required to maintain a temperature of 146 °C ± 3 °C (295 °F ± 5 °F).
c. Pressure Hold and Burst Strength Test Apparatus—An apparatus conforming to the requirements described in 4.2.4.1.

4.2.12.2 Connect the hose assemblies to the pressure cycling apparatus.

4.2.12.3 Fill the pressure cycling apparatus and hose assemblies with SAE Referee Brake Fluid RM 66-05, and bleed free of air.

4.2.12.4 Place the assemblies in the circulating air oven, and within 30 min attain an oven temperature of 146 °C ± 3 °C (295 °F ± 5 °F).

4.2.12.5 Subject the assemblies to a cycling internal pressure of 11 MPa +0.5, –0 MPa (1600 psi +75, –0 psi) for 1 min ± 0.1 min and 0 pressure for 1 min ± 0.1 min; pressures to be attained within 2 s.

4.2.12.6 Pressure cycle assemblies for 150 cycles minimum.

4.2.12.7 Remove the assemblies from the oven. Disconnect the assemblies from the impulse apparatus, and drain the fluid.

4.2.12.8 Cool the assemblies in air at room temperature for 45 min minimum.

4.2.12.9 Subject the assemblies to the burst test in 4.2.4.

4.2.13 DYNAMIC OZONE TEST

4.2.13.1 *Test Apparatus*—Brake hose cut lengths of 218 mm ± 3 mm (8.6 in ± 0.1 in), SAE dynamic ozone test apparatus that will flex the brake hose as shown in Figure 6 and the ozone test chamber.

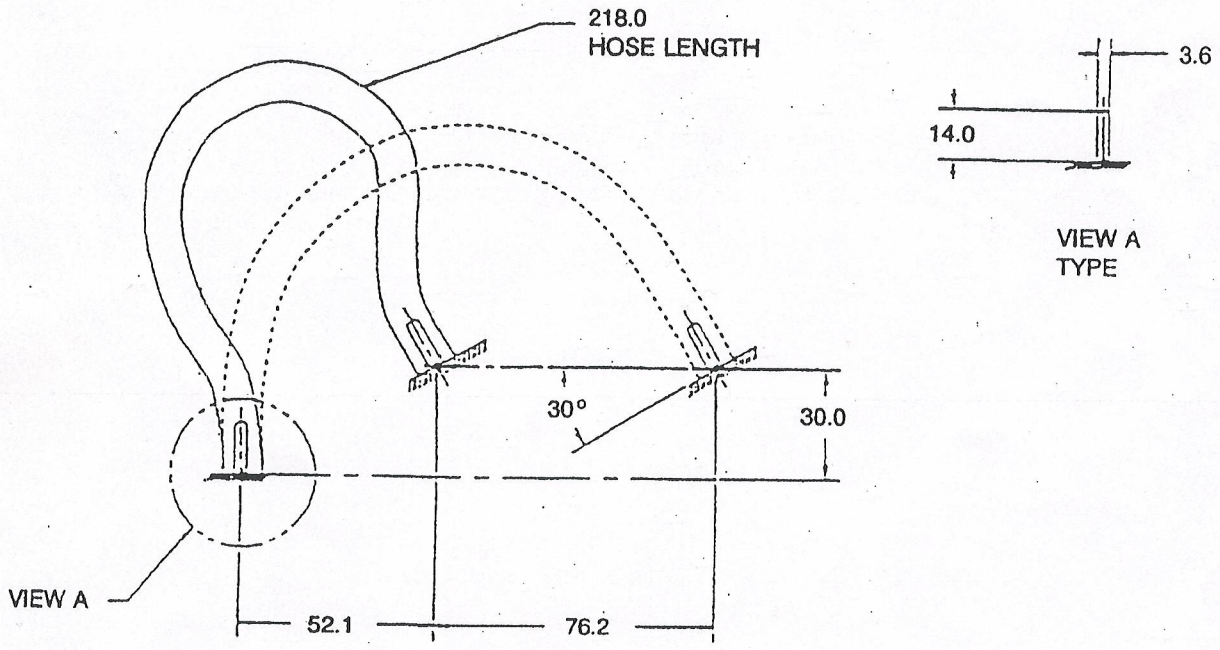

FIGURE 6—DYNAMIC OZONE FLEX PARAMETERS

4.2.13.2 Precondition all the brake hose samples in a nonstressed condition at 27 °C ± 6 °C (80 °F ± 10 °F) for at least 24 h prior to the start of the test.

4.2.13.3 Assemble the brake hose samples on the SAE dynamic ozone test apparatus so that they meet the relative position and flex parameters as shown in Figure 6. Install the brake hose over the fixture pins until the hose has bottomed out. Use band clamps to securely retain the brake hose on the pin. Install the test apparatus and assembled hoses in a stabilized ozone chamber. The chamber shall contain air mixed with ozone at the ozone partial pressure of 100 mPa ± 10 mPa (100 parts of ozone per 100 million parts of air by volume ± 10 parts of ozone per 100 million parts of air by volume.) The air temperature in the chamber shall be 40 °C ± 3 °C (104 °F ± 5 °F).

4.2.13.4 Start cycling when the chamber reaches the specified ozone concentration but no later than 1 h after putting the test apparatus in the ozone chamber. The flex rate shall be 0.30 Hz ± 0.05 Hz. The stroke shall be 76.2 mm ± 2.5 mm (3.0 in ± 0.1 in).

4.2.13.5 Examine the hoses for ozone cracks every 24 h ± 1 h. Remove the fixture from the cabinet and close the door immediately. Inspect for ozone cracks visible to the eye without magnification at the worst stress condition ignoring the areas immediately adjacent to or within the area covered by the band clamps. Do not remove the hoses from the fixture. Reinstall the fixture in the cabinet within 15 min of its removal. The test shall be run continuously except for the daily inspection periods. Inspection periods may be eliminated on non-work days if determined to be not critical.

4.2.13.6 Stop test when ozone cracks are observed. Record the hose identification and the number of days that elapsed until the first visible crack was observed.

5. Performance Requirements

5.1 100% Pressure Test—Hose assemblies showing leaks under this test shall be rejected and destroyed.

5.2 Constriction Test—Hose assemblies not allowing passage of the gage plug shall be rejected and destroyed. The constriction requirement does not apply to that part of the brake hose end fitting which does not contain hose.

5.3 Volumetric Expansion Test—The maximum expansion of any of the hose assemblies tested shall not exceed the values in Table 4.

TABLE 4—MAXIMUM EXPANSION OF FREE LENGTH HOSE

Hose ID	Test Pressure 6.9 MPa (1000 psi) Low Expansion Hose	Test Pressure 6.9 MPa (1000 psi) Regular Expansion Hose	Test Pressure 10.3 MPa (1500 psi) Low Expansion Hose	Test Pressure 10.3 MPa (1500 psi) Regular Expansion Hose	Test Pressure 20.0 MPa (2900 psi) Low Expansion Hose	Test Pressure 20.0 MPa (2900 psi) Regular Expansion Hose
3.5 mm or less (1/8 in or less)	1.08 cm^3/m (0.33 cm^3/ft)	2.17 cm^3/m (0.66 cm^3/ft)	1.38 cm^3/m (0.42 cm^3/ft)	2.59 cm^3/m (0.79 cm^3/ft)	2.0 cm^3/m (0.61 cm^3/ft)	4.0 cm^3/m (1.21 cm^3/ft)
4 to 5 mm (3/16 in)	1.81 cm^3/m (0.55 cm^3/ft)	2.82 cm^3/m (0.86 cm^3/ft)	2.36 cm^3/m (0.72 cm^3/ft)	3.35 cm^3/m (1.02 cm^3/ft)	3.0 cm^3/m (0.91 cm^3/ft)	5.5 cm^3/m (1.67 cm^3/ft)

5.4 Burst Test—When tested under hydraulic pressure, each sample of hose shall withstand a 2 min pressure hold at 27.6 MPa (4000 psi), and shall have a minimum burst pressure of 49 MPa (7000 psi) for 3.5 mm or less (1/8 in or less) hose, and 34.5 MPa (5000 psi) for 4 to 5 mm (3/16 in) hose.

5.5 Brake Fluid Compatibility Test—The hydraulic brake hose assembly shall meet the constriction requirement (4.2), and there shall be no leakage during a 2 min, 27.6 MPa (4000 psi) pressure hold, and the assembly shall not burst at less than 34.5 MPa (5000 psi).

5.6 Whip Test—The minimum life of any one of the sample hose assemblies on the flexing machine shall be 35 h.

5.7 **Tensile Test**—The hose assembly shall withstand the minimum load listed in Table 3 without the end fittings pulling off or rupture of the hose.

5.8 **Cold Bend Test**—The hose cover shall not crack (visible without magnification) or break.

5.9 **Ozone Test**—The outer cover of the hose shall show no cracking when examined under 7X magnification.

5.10 **Salt Spray Test**—The hose assembly end connections shall have no base metal corrosion. The area of the fitting where crimping or the application of labeling information has caused the displacement of the protective coating is exempt from the corrosion requirements. Brass fittings have adequate corrosion resistance; therefore, salt spray testing of brass fittings is not required.

5.11 **Water Absorption Tests**—Water conditioned hose assemblies shall pass all burst (5.4), whip (5.6), and tensile (5.7) requirements as outlined for nonaged brake hose assemblies.

5.12 **Hot Impulse Test**

5.12.1 The hose assemblies shall withstand impulsing for 150 cycles without leakage.

5.12.2 There shall be no leakage during a 2 min, 27.6 MPa (4000 psi) pressure hold.

5.12.3 The assembly shall not burst at less than 34.5 MPa (5000 psi).

5.13 **Dynamic Ozone Test**—The hose shall not crack after testing a minimum of 48 h.

6. *Construction*

6.1 **Hose**—The hose shall consist of an elastomeric inner tube, two or more layers of reinforcing cord imbedded in and/or bonded to the elastomeric inner tube and outer cover. The cover must be a black stock, free from sulfur bloom, which will not crack when subjected to long periods of weather aging. The inner tube of this hose must be a stock which will effectively resist deterioration by nonpetroleum-base hydraulic brake fluids as designated in Section 1.

6.2 **Hose Assembly**—Each hydraulic brake hose assembly shall have permanently attached brake hose end fittings.

7. ***Hose Identification***—The brake hose of each manufacturer shall be identified by one or more colored yarns incorporated into the construction. Embossed or imprinted (3-dimensional) marking on the brake hose cover may be used in lieu of marker yarn identification.

NOTE—The R.M.A.[2] approved marker yarn color and the name trademark on cover designations for each brake hose manufacturer shall be registered with SAE.

8. *Notes*

8.1 **Marginal Indicia**—The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE AUTOMOTIVE BRAKE AND STEERING HOSE STANDARDS COMMITTEE

2. Rubber Manufacturers Association, 1400 K Street, N.W., Washington, DC 20005.

APPENDIX A

HOSE MANUFACTURER IDENTIFICATION CODE-COLORED YARN ASSIGNMENTS AS OF DECEMBER 1998

TABLE A1—HOSE MANUFACTURER IDENTIFICATION CODE-COLORED YARN ASSIGNMENTS

Line Number New	Yarn Color Code	Year Assigned	Assignments
1	Yellow	*	The BF Goodrich Co., Akron, Ohio (Hose business terminated 1987)
2	Green	*	The Goodyear Tire & Rubber Co., Akron, Ohio
3	Red	*	
4	Black	*	General Motors Corp., Delco Products Division, Dayton, Ohio
5	Blue	1978	Goodall Rubber Co., Trenton, New Jersey (formerly Line 23)
6	Brown	*	Aeroquip Corp., Van Wert, Ohio
7	Violet	1959	Firestone Tire & Rubber Co., Akron, Ohio
8	Orange	1959	Dayco Products, Inc., Dayton, Ohio
9	Yellow Green	1972	Compagnie des Produits Industriels de l'Ouest, Nantes, France
10	Yellow Red		
11	Yellow Black	1959	Continental Gummi-Werke A.G., Hannover, F.R. Germany
12	Yellow Blue		
13	Yellow Brown	1959	Plumley Rubber Co., Paris, Tennessee
14	Yellow Violet	1979	Avon Industrial Polymers, Trowbridge, Wilshire, England
15	Yellow Orange	1981	Buckeye Rubber Products, Inc., Lima, Ohio
16	Green Red	1950	Thermoid/HBD Industries, Inc., Bellefontaine, Ohio formerly Thermoid Inc., Division of H.K. Porter Co.
17	Green Black	1950	The Gates Rubber Co., Denver, Colorado
18	Green Blue	1950	Crown Products Co., Ralston, Nebraska
19	Green Brown	1968	Toyota Gosei Co., Ltd., Aichi Pref., Japan
20	Green Violet	1981	Garrett Flexible Products Inc., Garrett, Indiana
21	Green Orange	1983	Citla, S.A., Mexico City, Mexico
22	Red Black	*	Uniroyal, Ltd., Montreal, Canada (since 1966)
23	Red Blue		Goodall Rubber Co., Trenton, New Jersey - Terminated 1978
24	Red Brown		Continental Rubber Works, Erie, Pennsylvania - Terminated 1982
25	Red Violet	1983	Epton Industries, Inc., Kitchener, Ontario, Canada
26	Red Orange	1983	Stratoflex, Inc., Ft. Worth, Texas
27	(T) Black Blue	2000	TG Kentucky Corporation, Lebanon, KY
28	Black Brown	1998	TG Pongpara Co. Ltd., Amphur Muang, Chonburi 20000
29	Black Violet	1982	Association of Automotive Engineers & Technicians (AITA), Argentina
30	Black Orange	1981	Dana Corp./Boston Industrial Products, Hohenwald, Tennessee
31	Blue Brown	1958	C.F.W. Division Simrit, Montrond Les Bains, France
32	Blue Violet	1982	Flexigom, S.A., Federal Capital, Argentina
33	Blue Orange	1982	ICEMAP Argentina S.R.L., Buenos Aires, Argentina
34	Brown Violet	1982	Farloc Argentina S.A., Buenos Aires, Argentina
35	(C) Brown Orange	1985	DUNLOP ARGENTINA S.A., Buenos Aires, Argentina

TABLE A1—HOSE MANUFACTURER IDENTIFICATION CODE-COLORED YARN ASSIGNMENTS (CONTINUED)

Line Number New		Yarn Color Code	Year Assigned	Assignments
36		Violet Orange	1981	Indomax, C.A., Caracas, Venezuela
37		Yellow Green Red		
38		Yellow Green Black	1963	The Polymer Corporation, Reading, Pennsylvania
39		Yellow Green Blue		
40		Yellow Green Brown	1973	Nephi Rubber Products, Inc., Nephi, Utah
41		Yellow Green Violet	1987	Insulated Duct & Cable Co., Armstrong Hose Division, Trenton, New Jersey
42		Yellow Green Orange	1989	Cadillac Rubber & Plastic, Inc., Cadillac, Michigan
43		Yellow Red Black	1985	Anchor Swan, Inc., Bucyrus, Ohio
44	(T)	Yellow Red Blue	1991	Delta Rubber Products, Inc., Clarksdale, Mississippi
45		Yellow Red Brown	1977	Productos Pirelli, S.A., Barcelona, Spain
46		Yellow Red Violet	1989	Plumley Marugo, Ltd., Paris, Tennessee
47		Yellow Red Orange		
48		Yellow Black Blue	1976	Manifattura Gomma Cazzaniga, Dormelleto, Italy
49		Yellow Black Brown	1976	Getoflex Metzeler Industria, Sao Paulo, Brazil
50		Yellow Black Violet		
51		Yellow Black Orange	1987	H.S. Parker Co., Ltd., Kyong-Nam, Korea
52		Yellow Blue Brown	1975	Shibami Industry Co., Ltd., Osaka, Japan
53		Yellow Blue Violet		
54		Yellow Blue Orange	1988	Morenci Engineered Rubber Products, Morenci, Michigan
55	(T)	Yellow Brown Violet	1994	Mold-EX Rubber Company, Inc., Milton, Florida
56		Yellow Brown Orange		
57		Yellow Violet Orange		
58		Green Red Black	1973	Parker-Hannifin Corp., Wickliffe, Ohio
59		Green Red Blue	1973	General Tire & Rubber Co., Evansville, Indiana (Business sold in 1981)
60		Green Red Brown	1974	Cooper Engineered Products Division, Bowling Green, Ohio
61	(C)	Green Red Violet	1991	Thermopol, Inc., Somersworth, New Hampshire
62		Green Red Orange	1991	Optimit a.s., Odry, Czechoslovakia
63		Green Black Blue	1978	Hadbar, Division of Purosil, Inc., Monrovia, California
64		Green Black Brown	1979	Republic Hose Manufacturing Corp., Youngstown, Ohio (Terminated 1989)
65	(T)	Green Black Violet	1991	Industrial de Artefatos de Borracha e Plasticos Paranoa Ltda, Sao Paulo, Brazil
66		Green Black Orange	1996	ANAND GATES (INDIA) PVT. LTD., New Delhi - 110008 (India)
67		Green Blue Brown		
68		Green Blue Violet		
69	(T)	Green Blue Orange	1993	Teleflex Inc., Suffield, Connecticut
70		Green Brown Violet		
71		Green Brown Orange		
72		Green Violet Orange		
73		Red Black Blue	1972	Dunlop Australia, Ltd., Victoria, Australia
74		Red Black Brown	1972	Societa Meridianale Accessori Elastomerici, Salerno, Italy
75		Red Black Violet		

TABLE A1--HOSE MANUFACTURER IDENTIFICATION CODE-COLORED YARN ASSIGNMENTS (CONTINUED)

Line Number New		Yarn Color Code	Year Assigned	Assignments
76		Red Black Orange	1998	Burke Industries Inc., Purosil Division, Santa Fe Springs, California
77		Red Blue Brown	1971	Pirelli Power Transmission Corporation, Minneapolis, Minnesota
78	(T)	Red Blue Violet	1996	Hutchinson, Automotive Extrusion Branch, Troy, Michigan
79	(T)	Red Blue Orange	1998	Teknik Kaucuk San A.S., Istanbul-Turkey
80		Red Brown Violet	1992	No. 6 Automotive Parts Factory Qingdao, China
81		Red Brown Orange		
82		Red Violet Orange		
83		Black Blue Brown	1979	Semperit, Vienna, Austria
84		Black Blue Violet		
85		Black Blue Orange		
86	(T)	Black Brown Violet	1992	Alfagomma S.p.A., San Damiano di Brugherio, Italy
87		Black Brown Orange		
88		Black Violet Orange		
89		Blue Brown Violet		
90		Blue Brown Orange		
91	(T)	Blue Violet Orange	1991	Kleber Industrie, Versailles, France
92		Brown Violet Orange	1985	Tong Yang Chemical Co., Ltd., Kyoung Nam, Korea
93		Yellow Yellow Green	1972	SAIAG, Torino, Italy
94		Yellow Yellow Red	1968	Ages & Co., Torino, Italy
95		Yellow Yellow Black	1967	Meiji Rubber & Chemical Co., Ltd., Tokyo, Japan
96	(C)	Yellow Yellow Blue	1967	FTE Automotive GmbH, Ebern, Germany
97		Yellow Yellow Brown	1962	Reserve - Tecalemit Ltd., Plymouth, England
98		Yellow Yellow Violet		
99		Yellow Yellow Orange		
100		Green Green Yellow	1971	Dunlop Industrial Products (Pty) Ltd., Benoni, Transvaal, Africa
101		Green Green Red	1971	Moldeados Industriales, S.A., Naucalpan, Mexico
102		Green Green Black	1978	Codan Gummi A/S, Koge, Denmark
103		Green Green Blue	1970	Vincke S.A., Palamos, Spain
104		Green Green Brown		
105		Green Green Violet	1969	P.B. Cow (Special Products) Ltd., Bucks, England
106		Green Green Orange		
107		Red Red Yellow	1968	STOP, Freins Hydrauliques, Saint-Ouen, France
108		Red Red Green	1971	BTR Hose Ltd., Farington, Leyland, Lancs., England
109		Red Red Black	1967	The Dunlop Co., Ltd. Polymer Engineering Div., Leicester, England
110		Red Red Blue	1962	Tecalemit Pty. Ltd., Finsbury, S. Australia
111		Red Red Brown	1962	Tecalon Brasileria de Autopecas, Sao Paulo, Brazil
112		Red Red Violet	1987	Tubex Australia Pty. Ltd., Bayswater, Victoria, Australia
113		Red Red Orange	1985	First Trust Industrial Corp., Taipei, Taiwan, ROC
114		Black Black Yellow		
115		Black Black Green	1969	Dunlop India Ltd., Calcutta, India

TABLE A1—HOSE MANUFACTURER IDENTIFICATION CODE-COLORED YARN ASSIGNMENTS (CONTINUED)

Line Number New		Yarn Color Code	Year Assigned	Assignments
116		Black Black Red	1962	Deutsche Tecalemit G.M.B.H., Bielefeld, Germany
117		Black Black Blue	1962	Tecalemit S.A., Paris, France
118		Black Black Brown		
119		Black Black Violet		
120		Black Black Orange		
121		Blue Blue Yellow	1967	Nichirin Rubber Industrial Company, Ltd., Kobe, Japan
122		Blue Blue Green	1970	Nelson Stokes Ltd., Camelford, Cornwall, England
123		Blue Blue Red	1962	Tecamec Limited, Plymouth, Devon, England
124		Blue Blue Black	1961	Imperial Eastman Div., Manitowoc, WI
125		Blue Blue Brown	1959	Mundener Gummiwerk GmbH, Hann, Munden, Germany
126		Blue Blue Violet	1988	Dunlop Metaloflex Industrial Ltda., Sao Paulo, Brazil
127		Blue Blue Orange	1985	Companhia Saad do Brazil, Sao Paulo, Brazil
128		Brown Brown Yellow	1962	Reserve - Tecalemit Ltd., Plymouth, England
129		Brown Brown Green	1970	Hitachi Cable Ltd., Tokyo, Japan
130		Brown Brown Red	1962	Tecalemit (India) Ltd., Calcutta, India
131		Brown Brown Black	1962	Tecalemit Italia, Turin, Italy
132	(C)	Brown Brown Blue	1987	C. F. Gomma S.p>A., Passirano (BS), Italy
133	(T)	Brown Brown Violet	1998	LG Cable Co. Ltd., Kumi City, Kyeong-Buk South-Korea
134	(T)	Brown Brown Orange	1991	F.H. Flexiveis Hidraulicos Ind. Ecom. Ltda., Sao Paulo, Brazil
135	(T)	Violet Violet Yellow	1996	Technomeiji Rubber SDN, BHD., Maylasia
136		Violet Violet Green	1996	Teklas, Istanbul Turklye
137	(T)	Violet Violet Red	1996	Philatron International, Santa Fe Springs, California
138		Violet Violet Black	1997	
139		Violet Violet Blue	1998	Hutchings Hose Products, Inc., Sanford, Florida
140		Violet Violet Brown	1998	Brakes India Limited, Padi, Chennai
141	(T)	Violet Violet Orange	1999	Errecinque S.r.l., Torino - Italy
142	(T)	Orange Orange Yellow	1999	IVG Colbachini SPA - Italy
143	(T)	Orange Orange Green	2001	Esdan America!, Portland, Oregon
144		Orange Orange Red		
145		Orange Orange Black		
146		Orange Orange Blue		
147		Orange Orange Brown		
148		Orange Orange Violet		

* Exact assignment date unknown, prior to 1950
(C) Change in entry since last edition
(T) Tentative assignment

NOTE—The information shown in this publication is based on the best information available to the RMA. No claims are made as to the completeness or currency of the information shown.

SAE J1401 Revised JUN2003

Rationale—SAE J1401 specifies the requirements of hydraulic brake hose assemblies as used in the braking system of road vehicles. Updating the specification to reflect additional requirements is directly related to the increased operating conditions placed upon the brake hose assembly. The SAE Hydraulic Brake Hose Working Panel believes that the following changes should be incorporated into SAE J1401:

a. Change the referee fluid to RM 66-05. The new fluid is a more contemporary mixture of fluids and the current fluid RM 66-04 is no longer available.
b. Update the Hose Manufacturer Identification Code-Colored Yarn Assignments from the 1998 version to the 2003 version.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—This SAE Standard specifies the performance tests and requirements for hydraulic brake hose assemblies used in the hydraulic braking system of a road vehicle. It also specifies the methods used for identification of the hose manufacturer.

This document applies to brake hose assemblies made of a hose fabricated from yarn and natural or synthetic elastomers and assembled with metal end fittings for use with nonpetroleum-base brake fluids as specified in SAE J1703 and SAE J1705.

The nominal internal diameter of the brake hose shall fall within one of the following values:

a. 3.5 mm or less (1/8 in or less)
b. 4 to 5 mm (3/16 in)

Reference Section

SAE J1288—Packaging, Storage, and Shelf Life of Hydraulic Brake Hose Assemblies

SAE J1406—Application of Hydraulic Brake Hose to Motor Vehicles

SAE J1703—Motor Vehicle Brake Fluid

SAE J1705—Low Water Tolerant Brake Fluids

ASTM B 117—Method of Salt Spray (Fog) Testing

ISO R147—Load calibration of testing machines for tensile testing of steel

ISO 3996—Hydraulic brake hose assemblies—Non-petroleum hose hydraulic fluid standard

Developed by the SAE Automotive Brake and Steering Hose Standards Committee