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SURFACE VEHICLE STANDARD

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Hydraulic Wheel Cylinders for Automotive Drum Brakes

RATIONALE

It was agreed in the October 2012 committee meeting that this document was beneficial, but the document is "good as is." The committee supported the direction to stabilize this document.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE Hydraulic Brake Components Standards Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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1. SCOPE

This document specifies minimum performance and durability requirements for satisfactory vehicle usage, and it is applicable to wheel cylinder assemblies from commercial production, after production shipment, shelf storage, and remanufacture (factory rebuild).

1.1 Purpose

This document applies to wheel cylinder assemblies used on hydraulically operated, drum-type brakes of highway vehicles. It covers such cylinders where they are employed in passenger car, light-duty truck, bus, that are up to and including 4500 kg (10 000 lb), and like brake systems utilizing motor vehicle brake fluids that conform to SAE J1703, SAE J1704 or other OEM specified brake fluids.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1603 Rubber Seals for Hydraulic Disc Brake Cylinders

SAE J1703 Motor Vehicle Brake Fluid

SAE J1704 Borate Ester Based Brake Fluids

2.1.2 ASTM Publication

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 1149 Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber (Flat Specimens)

3. TEST PROCEDURES AND REQUIREMENTS

Tests shall be conducted in the sequence shown and at room temperature 20 °C ± 3 °C (70 °F ± 5 °F) except where otherwise specified. Wheel cylinders shall not be disassembled until after all tests are completed or unless testing is discontinued.

A wheel cylinder assembly shall, when tested in accordance with the following procedures, meet the following requirements.

3.1 Unrestricted Apply and Release

3.1.1 Procedure

3.1.1.1 Remove the shipping plug from the wheel cylinder hydraulic inlet port(s).

3.1.1.2 Fully stroke the cylinder five times by hand and allow it to return under the piston return spring load. In the absence of a piston return spring, apply 50 kPa (7 psi) air pressure to the inlet port until the cylinder returns to its original position. Record time for return on fifth stroke.

NOTE: Avoid stroking the wheel cylinder cups into the bleed screw and/or hydraulic inlet openings during this test.

3.1.2 Requirement

3.1.2.1 The piston(s) must move smoothly throughout full stroke after starting, and must be completely returned to original position on the fifth stroke within 30 s by the force of the piston return spring, or, in the absence of a return spring, by 35 kPa (5 psi) maximum air pressure at inlet port.

3.2 Ozone Resistance

3.2.1 Procedure

3.2.1.1 Seal the hydraulic port(s) from the atmosphere, install connecting link(s) where required to seal the small diameter of the boot, and to an ozone concentration of 50 pphm ± 5 pphm by volume at 40 °C ± 3 °C (100 °F ± 5 °F) for 70 h.

3.2.1.2 Remove the cylinder from the ozone chamber and visually inspect the boot(s) without disassembling.

3.2.2 Requirement

3.2.2.1 The boot(s) shall not be perforated or cracked through in any areas.

(This is a conditioning test of the wheel cylinder for other tests which follow, and the cylinder should be rejected if deterioration of the boot obviously precludes meeting subsequent test requirements.)

3.3 Pressure Test

3.3.1 Procedure

3.3.1.1 Install the wheel cylinder on its load fixture and tighten the mounting bolts by hand. (See Note of 4.3 for single-end wheel cylinders.) Making certain that the connecting link(s) has (have) 4 deg ± 0.5 deg angularity with the wheel cylinder bore longitudinal axis, tighten the mounting bolts to the nominal torque specified by the vehicle manufacturer. Adjust the connecting link(s) so that the piston(s) is (are) in the brake release position.

3.3.1.2 Assemble the hydraulic connector of the test apparatus to the wheel cylinder and tighten to the nominal torque specified by the vehicle manufacturer. Fill the test setup with new hydraulic fluid and bleed at all points in the system as necessary to remove air. Tighten the bleed screw to the nominal torque specified by the vehicle manufacturer.

3.3.1.3 Drop the connecting link lock(s) in place per Figure 2 and open the valve to the low pressure gage. Apply the master cylinder to build up 200 kPa ± 10 kPa (30 psi ± 1.5 psi) pressure in the system, shut off the valve to the master cylinder, and release the master cylinder.

3.3.1.4 Allow the pressure to the wheel cylinder to stabilize for 15 to 20 s, and then record the pressure at the beginning and end of a 30 s ± 1 s interval.

3.3.1.5 Open the valve to the master cylinder, close the valve to the low pressure gage, and open the valve to the high-pressure gage. Repeat 3.3.1.3 and 3.3.1.4 except apply the master cylinder to build up 12 MPa ± 1.2 MPa (1700 psi ± 170 psi) pressure in the system.

3.3.2 Requirement

3.3.2.1 Per 3.3.1.4 there shall be no drop in pressure in excess of 7 kPa (1 psi) in a 30 s ±1 s interval.

3.3.2.2 Per 3.3.1.5 there shall be no drop in pressure in excess of 350 kPa (50 psi) in a 30 s ±1 s interval.

3.4 Physical Strength

3.4.1 Procedure

3.4.1.1 Open the valve to the master cylinder and apply the master cylinder to build up 35 MPa ± 3.5 MPa (5000 psi ± 500 psi) for wheel cylinders up to 30.2 mm (1-3/16 in). For wheel cylinders larger than 30.2 mm (1-3/16 in) and up to 50.8 mm (2 in), apply master cylinder pressure to 20 MPa ± 2 MPa (3000 psi ± 300 psi). Hold the pressure for 15 s ± 1 s and then release the master cylinder.

3.4.1.2 Observe the pressure gage during the test, and visually inspect the wheel cylinder and its mounting afterward for signs of leaks or structural failure.

3.4.1.3 Remove the connecting link lock(s).

3.4.2 Requirement

3.4.2.1 The gage shall show no abrupt pressure drop and the cylinder shall show no signs of mechanical failure.

3.5 Humidity Operation

3.5.1 Procedure

3.5.1.1 Place the load fixture(s) with the wheel cylinder(s) in the humidity cabinet. Set the pressure actuating mechanism for cyclic operation at 1000 cycles/h ± 100 cycles/h (3.3 to 4.0 s/cycle of apply and release stroke), and adjust it to build up a master cylinder output pressure of 3.4 MPa ± 0.3 MPa (500 psi ± 50 psi). Stroke 16 h at 46 °C ± 3 °C (115 °F ± 5 °F) temperature and 95 % ± 3 % relative humidity; and then cease stroking for 8 h while at 20 °C ± 3 °C (70 °F ± 5 °F) temperature and resultant relative humidity.

Periodically observe the wheel cylinder action during stroking.

3.5.1.2 Repeat this sequence.

3.5.1.3 Remove the load fixture(s) with the wheel cylinder(s) from the humidity cabinet at the end of the second day (32 000 cycles stroking and 16 h static).

3.5.1.4 DO NOT DISTURB WHEEL CYLINDER BOOT(S).

3.5.1.5 Perform pressure test per 3.3.

3.5.1.6 Open the valve to the master cylinder and remove the connecting link lock(s).

3.5.2 Requirement

3.5.2.1 The wheel cylinder piston(s) must fully apply the load fixture(s) to its bottom or stop and allow it to return to the full release stop within a stroke cycle of the master cylinder.

3.5.2.2 Also see requirements for 3.3.

3.6 High Temperature Durability

3.6.1 Procedure

3.6.1.1 Set the pressure actuating mechanism for cyclic operation at 1000 cycles/h ± 100 cycles/h (3.3 to 4.0 s/cycle of apply and release stroke). Empty the leak trap(s) and place the load fixture(s) with the cylinder(s) in the heat cabinet. Adjust the pressure actuating mechanism to build up a master cylinder output pressure of 7.0 MPa ± 0.7 MPa (1000 psi ±100 psi). Place the leak trap under each wheel cylinder boot and commence stroking while raising the temperature of the cabinet to 120 °C ± 5 °C (250 °F ± 10 °F) or 100 °C ± 5 °C (210 °F ± 10 °F) depending on the maximum service temperature of the application (100 °C or 120 °C) within 6 h.

3.6.1.2 Periodically observe the wheel cylinder action during stroking.

3.6.1.3 Discontinue stroking at the end of 70 000 cycles. Inspect the wheel cylinder for external leakage. Measure and record the fluid in each leak trap.

3.6.1.4 Empty the leak trap(s), shut off the valve to the master cylinder, and open the valve from the wheel cylinder(s) to the standpipe. Place the leak trap under each wheel cylinder boot and let the system stand idle for 12 to 18 h, during which the cabinet shall be allowed to cool to room temperature. Measure and record leakage.

3.6.1.5 Shut off the valve to the standpipe, open the valve to the master cylinder, and repeat 3.3 (Pressure Test)

3.6.1.6 Open the valve to the master cylinder, remove the connecting link lock(s), and remove the load fixture(s) from the heat cabinet.

3.6.1.7 Perform pressure test per 3.3.

3.6.2 Requirements

3.6.2.1 Per 3.6.1.3, there shall be no visible leakage at the wheel cylinder bleed screw or hydraulic connector(s) and leakage at each boot of the wheel cylinder shall not be measurable.

3.6.2.2 Per 3.6.1.4, leakage at each boot shall not exceed five drops.

3.6.2.3 Also see requirement for 3.3.

3.7 Cold Temperature Operation

3.7.1 Procedure

3.7.1.1 Empty the leak trap(s) and place the load fixture(s) with the wheel cylinder(s) in the cold chamber. Set the pressure actuating mechanism for cyclic operation at 500 cycles/h ± 50 cycles/h (6.6 to 8.0 s/cycle of apply and release stroke), and adjust it to build up a master cylinder output pressure of 3.5 MPa ± 0.3 MPa (500 psi ± 50 psi). Place the leak trap under each wheel cylinder boot and lower the temperature of the chamber to -40 °C ± 3 °C (–40 °F ± 5 °F) within 18 h. Commence stroking after a minimum of 4 h soak at the test temperature.

3.7.1.2 Observe the wheel cylinder action during stroking.

3.7.1.3 Discontinue stroking at the end of 20 cycles and allow the load fixture(s) to come to room temperature. Inspect the wheel cylinder for external leakage. Measure and record the fluid in each leak trap.

3.7.1.4 Perform pressure test per 3.3.

3.7.1.5 Open the valve to the master cylinder and remove the connecting link lock(s), and remove the load fixture from the cold chamber.

3.7.2 Requirements

3.7.2.1 There shall be no visible leakage at the wheel cylinder bleed screw or hydraulic connector(s), and leakage at each boot of the wheel cylinder shall not exceed five drops.

3.7.2.2 Also see requirement for 3.3.

3.8 Storage Corrosion Resistance

3.8.1 Procedure

3.8.1.1 Remove the wheel cylinder connector at its juncture with the line to the master cylinder, and then, taking care not to empty fluid from the wheel cylinder or its connecting tubing/hose, install a vented plug in the open end of connecting tubing/hose. With the wheel cylinder on its load fixture or a like device that holds the piston(s) in release position, place empty leak trap(s) under the cylinder boot(s) and store the cylinder for seven days at room temperature.

At the end of seven days, examine the cylinder for visible leakage. Measure the amount of fluid in the leakage trap(s).

3.8.1.2 Remove the piston clamps, if used, and remount the cylinder on the load fixture or like device allowing equivalent piston stroke. Reattach the cylinder to the test apparatus or equivalent and build up hydraulic pressure gradually until the piston(s) starts to move, measure and record this pressure.

Continue the pressure buildup until 3.5 MPa ± 0.3 MPa (500 psi ± 50 psi) is achieved and release it, meanwhile observing the wheel cylinder action.

Perform pressure test per 3.3.

3.8.1.3 Open the valve to the master cylinder and remove the connecting link lock(s).

3.8.2 Requirements

3.8.2.1 There shall be no visible leakage at the wheel cylinder bleed screw or hydraulic connector(s), and leakage at each boot shall not exceed five drops.

3.8.2.2 Piston(s) must start to move by 300 kPa (40 psi) maximum pressure.

3.8.2.3 The wheel cylinder piston(s) must fully apply the load fixture to its bottom or stop and return it to full release stop.

3.8.2.4 Also see requirements for 3.3.

3.9 Under Water Operation

3.9.1 Procedure

3.9.1.1 Confirm that water temperature is equal to room temperature to within ± 3 °C (± 5 °F). Set the pressure actuating mechanism for cyclic operation at 1000 cycles/h ± 100 cycles/h (3.3 to 4.0 s/cycle of apply and release stroke) and adjust it to build up a master cylinder output pressure of 3.5 MPa ± 0.35 MPa (500 psi ± 50 psi). Place the load fixture(s) with the wheel cylinder(s) in the water bath at 300 mm ± 30 mm (12 in ± 1 in) under the surface and commence stroking within 2 minutes.

DO NOT DISTURB WHEEL CYLINDER BOOT(S).

Periodically observe the wheel cylinder action during stroking.

Discontinue stroking at the end of 500 cycles. Take out the load fixture(s) with the wheel cylinder(s) from the water bath at the end of the cycling.

3.9.1.2 Wipe the exterior water off prior to removal of the boot.

3.9.1.3 Inspect water in the boot(s).

3.9.1.4 Perform Pressure Test per 3.3.

3.9.2 Requirements

3.9.2.1 There shall be no water intrusion in boot except boot groove.

3.9.2.2 Also see requirement for 3.3.

3.10 Static Leakage

3.10.1 Procedure:

3.10.1.1 Remove the wheel cylinder boot(s) and drain any fluid that might be present. Shut off the valve to the master cylinder and open the valve from the wheel cylinder to the standpipe. Fill the standpipe with new fluid and let the system stand idle for 12 to 18 h with leak traps under each open end of the cylinder.

3.10.1.2 At the end of 12 to 18 h, measure any fluid leakage. Assemble the wheel cylinder after drying inside the boot(s). Close the valve to the standpipe and open the valve to the master cylinder, and remove the connecting link lock(s).

3.10.2 Requirements

3.10.2.1 There shall be no visible fluid leakage in the trap(s).

3.11 Examination

3.11.1 Procedure

The examination provides the tester with an indication of how far the test wheel cylinder would surpass minimum performance and durability requirements for satisfactory vehicle usage.

3.11.1.1 Tighten the hydraulic connector to the maximum torque specified by the vehicle manufacturer.

3.11.1.2 Remove the wheel cylinder from the load fixture and test apparatus. Carefully disassemble it and measure the smallest diameter of port opening(s).

3.11.1.3 Examine parts and fluid for evidence which would indicate imminent failure of the cylinder on its continued usage in a vehicle.

3.11.2 Requirements

3.11.2.1 Wheel cylinders up to and including 50.8 mm (2 in) bore diameter shall have 2.0 mm (0.08 in) minimum diameter at the smallest opening of the hydraulic inlet(s).

4. TEST APPARATUS

The basic apparatus shall be that shown and as arranged in Figure 1 or equivalent. All hydraulic lines and fittings shall be of sufficient size as to permit unrestricted fluid flow to and from the test wheel cylinder(s). The apparatus shall operate per the following description and as called for in Section 3.

4.1 Master Cylinder Assembly

The master cylinder should be one commercially representative of the brake system(s) in which the test wheel cylinder(s) is (are) used. Its bore size and stroke will depend on the numbers and bore sizes of wheel cylinders to be stroke tested simultaneously.

The referee master cylinder of SAE J1703 is one commercially representative.[1] A shutoff valve shall be provided at the hydraulic outlet of the master cylinder.

4.2 Pressure Actuating Mechanism

The pressure actuating mechanism shall apply an axial force to the master cylinder push rod without side thrust, and it shall allow the pressure in the master cylinder to return to 0 kPa (0 psi) when it is in the released position.

Means must be provided for the actuating mechanism to stroke the master cylinder both singly and cyclically. For single stroke operation, the means must be capable of generating pressures in the master cylinder up to 35 MPa (5000 psi) and it must have adjustment such that pressures of 0.15, 7, and 35 MPa (20, 1000, and 5000 psi) can be held statically after they are achieved. For cyclic operation, the pressure actuating mechanism must be capable of generating pressures in the master cylinder up to 7 MPa (1000 psi) and have adjustments such that pressure can be peaked out at both 3.5 MPa (500 psi) and 7 MPa (1000 psi). Further, it must build up both of these pressures uniformly in 1.6 to 2.0 s, and be capable of doing so at any stroke of the master cylinder up to 90% of its total stroke. The pressure actuating mechanism, when releasing, must permit the full retraction of the master cylinder push rod. The means for cycling the pressure actuating mechanism shall permit adjustment of uniform apply/release strokes at rates of both 500 cycles/h ± 50 cycles/h and 1000 cycles/h ± 100 cycles/h.

[1] Referee master cylinders may be obtained from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

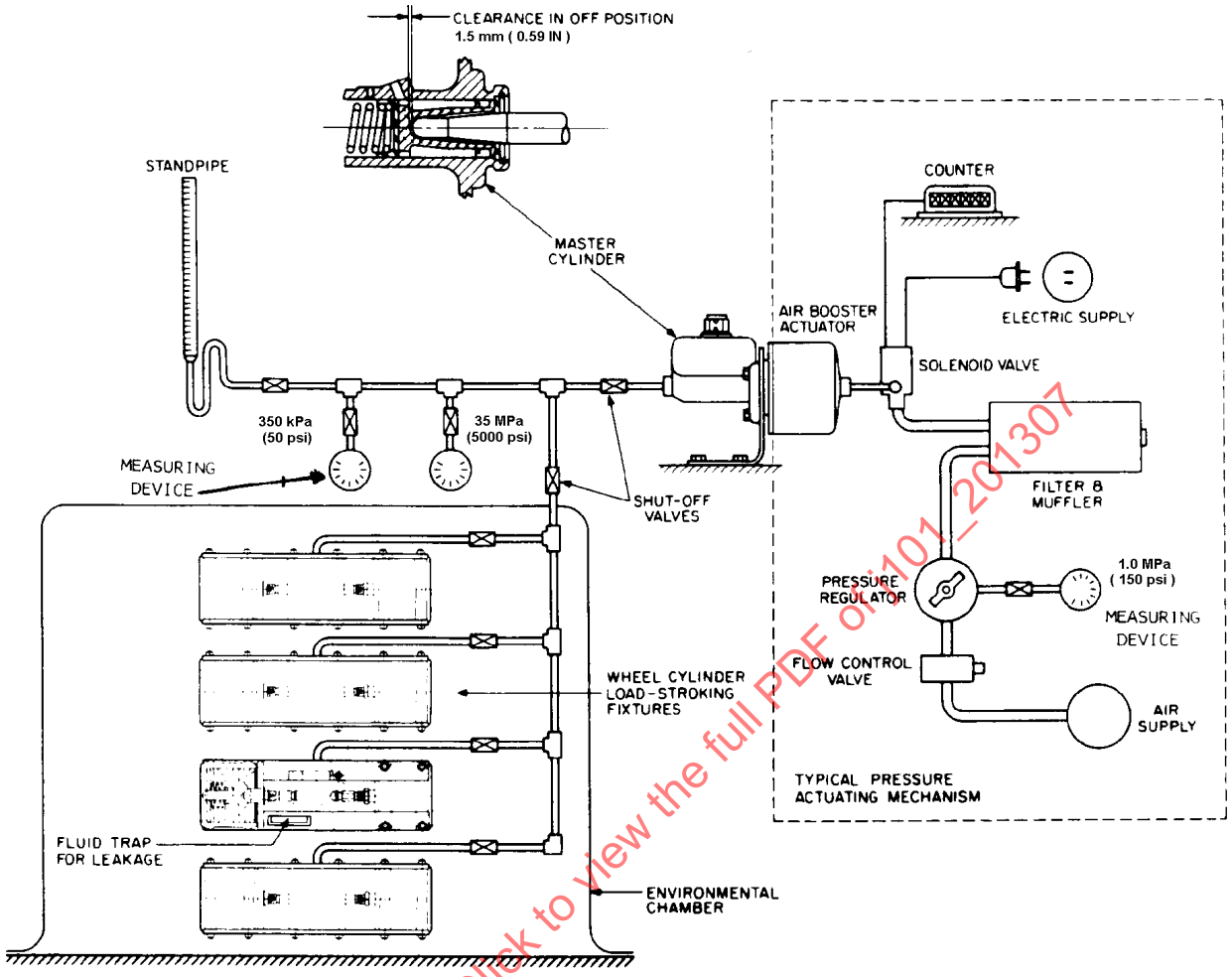

FIGURE 1 - TEST APPARATUS

4.3 Load Fixture

The load fixture, such as that shown in Figure 2, must stroke 3 mm ± 0.5 mm (0.12 in ± 0.02 in) in each load cell at a hydraulic pressure buildup in the wheel cylinder within the limits shown by the curves of Figure 3. It must accommodate both single- and double-ended wheel cylinders and mount them as they would be mounted on their brakes; it must accommodate both insert and socket-type wheel cylinder pistons; it must be capable of placing 4 deg ± 0.5 deg angularity on connecting link(s) with respect to the wheel cylinder bore longitudinal axis; and it must accommodate wheel cylinders of 15.9 to 50.8 mm (5/8 to 2 in) diameter. (This is a composite description of load fixture requirements. At least two load fixtures with appropriate differences in design would be necessary for testing all types and sizes of wheel cylinders.)