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INTERNATIONAL
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SURFACE VEHICLE STANDARD

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Submitted for recognition as an American National Standard

RUBBER SEALS FOR HYDRAULIC DISC BRAKE CYLINDERS

1. ***Scope—***This SAE Standard describes the performance and part requirements for elastomeric seals used in highway vehicle disc brake calipers. Seals covered by this specification may be the solid section type (square, rectangular, O-ring, etc.) mounted stationary in the cylinder bore or on the movable piston. The specification contains the following major sections:

a. Resistance to Fluid at Elevated Temperature—Physical Stability [loose parts in 120 °C ± 2 °C (248 °F ± 3.6 °F) brake fluid for 70 h]
b. Resistance to Fluid at Elevated Temperature—Precipitation Characteristics [loose parts in 120 °C ± 2 °C (248 °F ± 3.6 °F) brake fluid for 70 h]
c. Resistance to Elevated Temperatures in Dry Air [loose parts in 175 °C ± 2 °C (347 °F ± 3.6 °F) air for 22 h]
d. Ambient Temperature Stroking Test [tested in brake assembly for 500 000 cycles to 7 MPa ± 0.3 MPa (1000 psi ± 50 psi)]
e. High Temperature Stroking Test [tested in brake assembly for 70 h (70 000 strokes) at 120 °C ± 2 °C (248 °F ± 3.6 °F) to 7 MPa ± 0.3 MPa (1000 psi ± 50 psi)]
f. Low Temperature Leakage Test [tested in brake assembly for 120 h at –40 to –43 °C (–40 to –45.4 °F)]
g. Cycling Humidity Storage Corrosion Test [tested in brake assembly for 14 days at 95% humidity cycling between 21 to 46 °C (69.8 to 114.8 °F)]

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

SAE J1703—Motor Vehicle Brake Fluid

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

ASTM D 573—Standard Test for Rubber—Deterioration in an Air Oven

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3. Parts Requirements

3.1 Parts shall conform to the pertinent drawing in all respects.

3.2 Manufacturer's identification, when used, shall be that on record at the Rubber Manufacturers Association.

3.3 All parts to be tested shall be cleaned prior to testing by rinsing in isopropyl alcohol and blown dry or wiped dry with a lint-free cloth. Seals shall not remain in alcohol for more than 30 s.

4. ***Brake Test Fluid—***Fluid for all test phases except 7 (see 7.7) shall be SAE compatibility fluid, or a mutually agreed upon commercial fluid which subscribes to SAE J1703. Fluid used in test 7 shall be SAE compatibility fluid or a mutually agreed upon commercial preservative type fluid.

NOTE—RM-66-03 is obtainable from SAE.

5. ***Test Equipment—***Equipment used for testing shall be as shown in Figures 1 and 2.

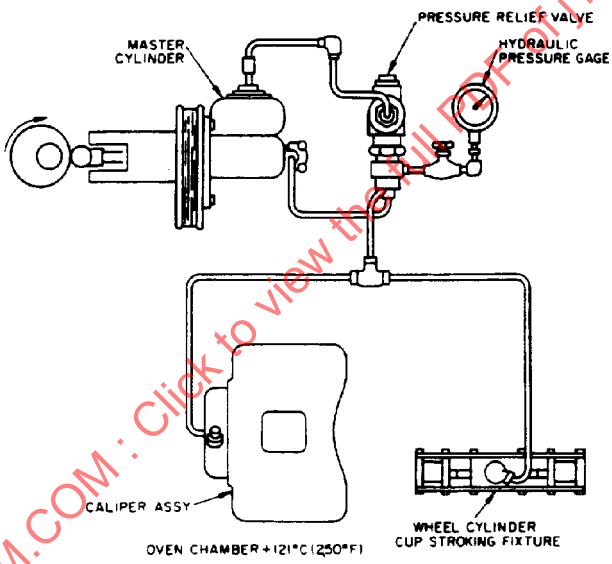

FIGURE 1—HIGH TEMPERATURE STROKING TEST

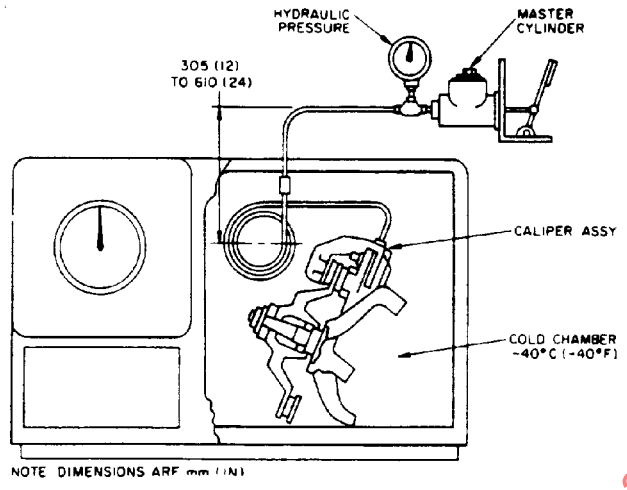

FIGURE 2—LOW TEMPERATURE LEAKAGE TEST

6. Test Requirements

6.1 After test 1, Resistance to Fluid at Elevated Temperature—Physical Stability, the parts must subscribe to the following:

6.1.1 Volume change must be within 0 and +15%.

6.1.2 IRHD hardness change must be within 0 and −15 points.

6.2 After test 2, Resistance to Fluid at Elevated Temperature—Precipitation Characteristics, the parts must subscribe to the following:

6.2.1 Not more than 0.05% vol sediment shall be formed.

6.3 After test 3, Resistance to Elevated Temperature in Dry Air, the parts must subscribe to the following:

6.3.1 Change in IRHD hardness must be within 0 and +15 points.

6.3.2 SEAL CONDITION—Test parts shall show no evidence of tackiness, blistering, cracking, or change in shape from original appearance.

6.4 After test 4, Ambient Temperature Stroking Test, parts and assembly must subscribe to the following:

6.4.1 No leakage beyond normal wetting of the bore(s) is allowed during the stroking test.

6.4.2 No leakage beyond normal wetting of the bore(s) is allowed during static leak test (see 7.4.8).

6.5 After test 5, High Temperature Stroking Test, the parts must subscribe to the following:

6.5.1 No leakage beyond normal wetting of the bore(s) is allowed during the stroking test.

6.5.2 No leakage beyond normal wetting of the bore(s) is allowed during static leak test (see7.5.11).

6.6 After test 6, Low Temperature Leakage Test, the parts and assemblies must subscribe to:

6.6.1 No leakage beyond normal wetting of the bore(s) is allowed during the test period or pressure applications.

6.6.2 The seal shall not crack and shall show evidence of rubber-like qualities during the flexibility bend test (see 7.6.10).

6.7 After test 7, Cycling Humidity Storage Corrosion Test, the parts and assembly must subscribe to the following:

6.7.1 No evidence of rubber adhesion of the test seal(s) is allowed during disassembly of the test brake.

6.7.2 No surfaces of the sealing systems shall show evidence of corrosion or deterioration which would interfere with proper sealing action. Normal staining or discoloration of metal parts is acceptable if surface finish is unaffected.

7. Test Procedures

7.1 Resistance to Fluid at Elevated Temperatures—Physical Stability

7.1.1 TEST SPECIMENS—From three or more seals to be tested, obtain a sample of 3 to 5 g.

7.1.2 Determine and record the initial volume of each seal in accordance with Section 9.1 of ASTM D 471.

7.1.3 Determine and record the initial IRHD hardness of the test seals. Measure hardness as prescribed in ASTM D 1415 using a microtester (or per a procedure previously agreed upon between vendor and purchaser).

7.1.4 Test specimens shall be placed in a suitable glass container and completely immersed in 75 mL of test brake fluid; the container shall be sealed to prevent vapor loss and placed in an oven at 120 °C ± 2 °C (248 °F ± 3.6 °F) for 70 h.

7.1.5 After 70 h, remove the test specimens from the oven and allow to cool in the container at 23 °C ± 5 °C (73.4 °F ± 9 °F) for 60 to 90 min. At the end of the cooling period, remove the seals from the container and rinse in isopropyl or ethyl alcohol and wipe dry with a clean, lint-free cloth. Seals shall not remain in the alcohol for more than 30 s.

7.1.6 Determine and record within 60 min the final volume and IRHD hardness of each seal per 7.1.2 and 7.1.3.

NOTE—The change in volume shall be reported at a percentage of the original volume. The calculations shall be made as follows:

$$\text{Increase in volume, \%} = \frac{(M_3 - M_4) - (M_1 - M_2)}{(M_1 - M_2)} \times 100 \qquad \text{(Eq. 1)}$$

where:

M_1 = Initial weight in air
M_2 = Initial weight in water
M_3 = Weight in air after test
M_4 = Weight in water after test

7.2 Resistance to Fluid at Elevated Temperature—Precipitation Characteristics

7.2.1 TEST SPECIMENS—From three or more seals to be tested, obtain a sample of 3 to 5 g.

7.2.2 Place the test seals in a suitable glass container, together with 75 mL of the test fluid. The container shall be sealed to prevent vapor loss and placed in an oven at 120 °C ± 2 °C (248 °F ± 3.6 °F).

7.2.3 After 70 h, remove the container from the oven. The seals shall remain in the fluid at room temperature for 24 h, after which the test fluid is agitated and poured into a cone-shaped centrifuge tube.

7.2.4 Rotate the tube for 30 min at 1500 rpm. Note the volume of sediment as observed in tube. Repeat the previous rotation for an additional 30 min and record any difference in volume of sediment.

7.2.5 Record amount of sediment per 6.2.1.

7.3 Resistance to Elevated Temperatures in Dry Air

7.3.1 TEST SPECIMENS—Two or more seals shall be used.

7.3.2 Measure and record the IRHD hardness of each seal per 7.1.3.

7.3.3 The test seals shall be placed in a circulating air oven, as prescribed in ASTM D 573 and held for 22 h at 175 °C ± 2 °C (347 °F ± 3.6 °F).

7.3.4 At the termination of the heating period, the seals shall be removed from the oven and allowed to cool for 30 min to room temperature.

7.3.5 After cooling, measure and record the IRHD hardness per 7.1.3 and note any visual change such as cracking, blistering, distortion, etc.

7.4 Ambient Temperature Stroking Test

7.4.1 TEST SPECIMENS—Adequate test seals for at least one complete caliper shall be prepared.

7.4.2 Measure and record the IRHD hardness of the seal per 7.1.3.

7.4.3 Wet seals and caliper bores with the test brake fluid. Install test seals in caliper.

7.4.4 Complete the test caliper assembly, placing the piston to simulate half-worn lining position.

7.4.5 Assemble the test caliper assembly to a production spindle and disc assembly or equivalent simulating fixture.

7.4.6 Connect the test fixture to the pressure source. It may be necessary or desirable to include a fluid accumulator (such as the standard SAE J60 fixture).

7.4.7 TEST PARAMETERS

7.4.7.1 *Temperature*—18.3 to 32.2 °C (65 to 90 °F).

7.4.7.2 *Pressure*—Pressure will be applied to external means at a maximum rate-of-pressure rise of 21 MPa/s ± 1.4 MPa/s (3000 psi/s ± 200 psi/s) from 0 to 7 MPa ± 0.3 MPa (0 to 1000 psi ± 40 psi).

7.4.7.3 *Cycles Required*—500 000 total.

7.4.7.4 *Cycle Rate*—3600/h maximum.

7.4.8 LEAKAGE TEST—Observe leakage during and after the stroking test. After completion of the stroking test, run high and low pressure leak tests.

7.4.8.1 *High Pressure Leak Test*—Apply 0.7 MPa (100 psi) hydraulic pressure for 5 min and observe and record leakage, if any.

7.4.8.2 *Low Pressure Leak Test*—Remove the caliper from the test stand and connect the test caliper to a pressure source of 10 kPa ± 1.75 kPa (1.5 psi ± 0.25 psi) for 24 h. Observe leakage, if any.

NOTE—The low pressure source may be a static column of fluid. A 1200 mm (48 in) column will provide 10 kPa (1.5 psi).

7.4.9 Disassemble caliper and inspect seal. Record visual condition of seal, bore, and piston.

7.4.10 Wash seal per 3.3.

7.4.11 Measure and record IRHD hardness of the seal per 7.1.3.

7.5 High Temperature Stroking Test

7.5.1 Adequate test seals for at least one complete caliper shall be prepared.

7.5.2 Measure and record the IRHD hardness of seal per 7.1.3.

7.5.3 Wet seals and caliper bores with the test brake fluid. Install test seals in caliper.

7.5.4 Complete the test caliper assembly, placing the piston to simulate half-worn lining position.

7.5.5 Assemble the test caliper assembly to a production spindle and disc assembly or equivalent simulating fixture.

7.5.6 Place complete test fixture in an oven conforming to Section 4 of ASTM D 573. (Also, See Figure 1.)

7.5.7 Connect to the actuating pressure device. Device may be composed of a mechanically, pneumatically, or hydraulically actuated automotive type master cylinder whose rate of operation shall be controlled at 1000 strokes/h ± 100 strokes/h. The test mixture shall be connected to the actuating pressure device in conjunction with a suitable pressure relief valve (if mechanically actuated) and arranged in such a manner as to yield a maximum rate-of-pressure rise of 7 MPa/s (1000 psi/s) and a minimum dwell period below 0.18 MPa (25 psi) of 0.25 s. (It may be found necessary to install a fluid accumulator, such as a standard wheel cylinder in an SAE 60R2 fixture, to meet the prescribed curve.)

7.5.8 TEST PARAMETERS

7.5.8.1 *Temperature*—120 °C ± 2 °C (248 °F ± 3.6 °F).

7.5.8.2 *Pressure*—7 MPa ± 0.3 MPa (1000 psi ± 50 psi) at a rate-of-pressure rise of 7 MPa/s (1000 psi/s) maximum.

7.5.8.3 *Elapsed Time*—70 h.

7.5.8.4 *Cycles Required*—70 000 ± 5000.

7.5.9 After 70 h, discontinue stroking, shut off heat, open oven door, release hydraulic pressures in system, and alow oven to cool for 60 min. The circulating fan may be left on to aid in cooling.

7.5.10 After the 60 min cooling period, remove the test assembly and allow to complete cooling in open air for 25 h ± 5 h.

7.5.11 LEAKAGE TEST—Observe leakage during and after the 70 h stroking test. After completion of the 25 h cooling period, run high and low pressure leak test.

7.5.11.1 *High Pressure Leak Test*—Apply 0.7 MPa (100 psi) hydraulic pressure for 5 min and observe and record leakage, if any.

7.5.11.2 *Low Pressure Leak Test*—Remove the caliper from the test stand and connect the test caliper to a pressure source of 10 kPa ± 3.3 kPa (1.5 psi ± 0.5 psi) for 24 h. Observe leakage, if any.

NOTE—The low pressure source may be a static column of fluid. A 1200 mm (48 in) column will provide 10 kPa (1.5 psi).

7.5.12 Wash seals per 3.3.

7.5.13 Measure and record IRHD hardness of the seal per 7.1.3.

7.6 Low Temperature Leakage Test

7.6.1 Adequate test seals for at least one complete caliper shall be prepared.

7.6.2 Wet the seals and caliper bores with the test brake fluid. Install test seals in caliper.

7.6.3 Complete the test caliper assembly, placing the piston to simulate new lining position. Accommodations must be made to change piston position during the cold test to simulate new, half, two-thirds, and full-worn lining positions.

7.6.4 Assemble the test caliper assembly to a production spindle and disc assembly or equivalent simulating fixture.

7.6.5 Place the test fixture in a –40 to –43 °C (–40 to –45.4 °F) cold chamber and connect to a pressure source as shown in Figure 2. Pressure source shall be located to provide a static reservoir head of 300 to 600 mm (12 to 24 in).

7.6.6 Allow the caliper to soak for 72 h with the piston at new lining position.

7.6.7 After 72 h, stroke the actuating mechanism 6 times at 1 MPa ± 0.07 MPa (150 psi ± 10 psi) followed by 6 times at 4.2 MPa ± 0.35 MPa (600 psi ± 50 psi). Stroke shall be held for approximately 5 s and applied approximately 60 s apart. Immediately after stroking, remove the first shims and by means of the stroking mechanism, move the pistons into the half-worn lining position using minimum line pressure to establish the new location for all pistons. Observe and record leakage, if any, 30 min after new position is established. Allow the test caliper to continue to soak for 24 h.

7.6.8 After 96 h, repeat 7.6.7, except progress to two-thirds worn lining piston position.

7.6.9 After 120 h, repeat 7.6.7, except progress to full-worn lining piston position and discontinue test 30 min after establishing final piston position.

7.6.10 BEND TEST PROCEDURE

7.6.10.1 Place one seal in a test chamber at –40 to –43 °C (–40 to –45.4 °F).

7.6.10.2 After 22 h, the seal shall be folded back upon itself between the thumb and finger and released within 2 to 5 s. The cold seal shall be folded while in the cold chamber and shall be handled with cold gloves to prevent heating by fingers.

7.7 Cycling Humidity Storage Corrosion Test

7.7.1 Adequate test seals for at least one complete caliper shall be prepared.

7.7.2 Wet seals and caliper with test brake fluid. Install test seals in caliper.

7.7.3 Complete the test caliper assembly, placing the piston to simulate half-worn lining position. Caliper assembly need not be assembled to spindle or test fixture as long as provisions are made to hold the pistons in their proper positions and the boots are properly installed.

7.7.4 Place the test caliper in a humidity chamber capable of 95% relative humidity and a temperature range of 21 to 46 °C (70 to 115 °F). Caliper should be placed with inlet port open and facing down.

7.7.5 Hold the caliper at 43 to 46 °C (110 to 115 °F) and 95% humidity for 16 h.

7.7.6 Change temperature to 18 to 21 °C (65 to 70 °F) while maintaining 95% relative humidity, and hold for 8 h.

7.7.7 Continue above 24 h cycle for 12 days. When interrupted during incidence of one or more nonworking days, hold per 7.7.6 until temperature cycling can be resumed.

7.7.8 At the conclusion of the 12 day test, remove the test caliper for disassembly and inspection. Do not rotate caliper, and where possible, disassemble while holding in the test position.

7.7.9 Inspect and note all components for corrosion, pitting, adhesion, and other deleterious factors resulting from corrosion and/or interaction between the materials involved.

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 HYDRAULIC BRAKE ACTUATING ELASTOMERS COMMITTEE