



SPECIFICATIONS AND METHODS OF TEST FOR RUBBER BOOTS FOR USE ON DRUM TYPE HYDRAULIC BRAKE WHEEL CYLINDERS—SAE J65a

SAE Standard

Report of the Hydraulic Brake Actuating System Committee approved December 1964 and last revised January 1971.

1. Scope—These specifications cover molded rubber boots used as end closures on drum type wheel brake actuating cylinders to prevent the entrance of dirt and moisture which could cause corrosion and otherwise impair wheel brake operation.

The specifications include performance tests of brake cylinder boots of both plain and metal insert types under specified conditions and do not include requirements relating to chemical composition, tensile strength, or elongation of the rubber compound. Further, they do not cover the strength of the adhesion of rubber to metal in the insert type.

The rubber material used in these boots is classified as suitable for operation in a temperature range of -40 to $+120 \pm 2$ C (-40 to $+248 \pm 3.6$ F).

2. General Material Requirements

2.1 Workmanship and Finish—The molded boots shall be free from blisters, pin holes, cracks, embedded foreign material, or other physical defects, and shall conform to the dimensions specified on the drawings.

2.2 Marking—The identification mark of the manufacturer, as designated by the Rubber Manufacturers Association, and other details as specified on the drawing shall be molded into each boot.

2.3 Inspection and Rejection—All tests and inspections shall be made at the place of manufacturer prior to shipment, unless otherwise specified. The manufacturer shall afford the inspector all reasonable facilities for the tests and specimens.

2.4 The purchaser may make tests and inspections to govern the acceptance or rejection of the boots at his laboratory or elsewhere. Such tests and inspections shall be made not later than 60 days after receipt of the material.

2.5 Any lot which fails to conform to one or more of the test requirements on the first sampling may be retested. For this purpose, two additional tests shall be made for the requirement in which failure occurred. Failure of either of the retests shall be cause for final rejection.

2.6 All rejected boots shall be destroyed by the manufacturer to insure that no substandard boots will be used.

3. Test Requirements

3.1 Resistance to Fluids at Elevated Temperature—After being subjected to the test for resistance to fluids at elevated temperatures as prescribed in paragraph 4.4, a boot shall conform to the following requirements:

Change in volume: -10 to $+15\%$

Change in hardness: -10 to $+10$ points

3.2 Heat Stroking Test—After stroking as detailed in paragraph 4.5, a boot shall be free of flex cracks which extend through the wall thickness, and shall fit tightly around the cylinder and push rod.

3.3 Low Temperature Stroking Test—During stroking as detailed in paragraph 4.6, a boot shall not crack or separate from its assembled position on the cylinder or become loose on the push rod.

3.4 Tension Set Test—After being subjected to the tension set test prescribed in paragraph 4.7 the rubber boots shall show no more than 75% tension set.

3.5 Heat Resistance Test (Static)—After the heat resistance test, as detailed in paragraph 4.8, a boot shall conform to the following requirements:

(a) No cracking shall occur when flexed similarly to service conditions.

(b) Change in hardness: -5 to $+10$ points.

(c) No tackiness after removal from the oven.

3.6 Ozone Resistance Test—At the end of the 70 hr exposure period as detailed in paragraph 4.9, test specimens shall be removed from the ozone chamber and examined under 2X magnification. Surface of the test specimens shall show no evidence of cracking, rupture, or other deterioration.

4. Test Procedures

4.1 Test Specimens—Specimens prepared for all testing shall be cut from the same general area of the sample. In addition, hardness test specimens shall be prepared to present a flat molded surface to the indenter.

4.2 Test Fluids—The brake fluid used for the test shall be as outlined in Appendix A.

4.3 Hardness—The referee method of determining rubber hardness shall be as described in ASTM D 1415, International Hardness of Vulcanized Natural and Synthetic Rubbers (Wallace). An alternate procedure, as agreed upon between vendor and purchaser, may be used.

Test each specimen submitted; record the range of IRHD (degrees).

4.4 Resistance to Fluids at Elevated Temperature

4.4.1 APPARATUS—Circulating air oven as specified in Section 4 of ASTM D 573, Method of Test for Accelerated Aging of Vulcanized Rubber by the Oven Method.

Use tightly sealed glass containers of suitable size.

4.4.2 TEST SPECIMEN—A section weighing approximately 3-5 g shall be cut from each of two boots.

4.4.3 PROCEDURE—Rinse the specimens in isopropyl alcohol, or its equivalent, and wipe dry with a lint-free cloth to remove dirt and packing debris. Do not leave test specimens in the alcohol for more than 30 s.

4.4.4 Determine the percent volume increase of each test specimen by the water displacement method in Section 9.1 of ASTM D 471, Tentative Methods of Test for Changes in Properties of Rubber and Rubber-like Materials in Liquid.

4.4.5 Determine the hardness of the test specimens in accordance with paragraph 4.3. Then place two test specimens in the glass container and completely immerse in 75 ml of the specified test fluid. Seal the container to prevent loss of vapor during the test, and place in the oven at 120 ± 2 C (248 ± 3.6 F) for 70 hr. At the end of the heating period, remove the test specimens immediately, rinse in isopropyl alcohol, and wipe dry with an alcohol saturated lint-free cloth. Determine the final volume and hardness of each test specimen as described above within 30 min after removal from the test fluid.

4.4.6 CALCULATION—VOLUME CHANGE—Report the change in volume as a percentage of the original volume, calculated as follows:

$$\text{Increase in volume, \%} = \frac{(W_3 - W_4) - (W_1 - W_2)}{(W_1 - W_2)} \times 100$$

where:

W_1 = initial weight in air

W_2 = initial weight in water

W_3 = weight in air after immersion in the test fluid

W_4 = weight in water after immersion in the test fluid

4.4.7 HARDNESS—Report the original hardness reading and the change in hardness after test. Also report any observable changes in the condition of the test specimens.

4.5 Heat Stroking Test

4.5.1 APPARATUS—Circulating air oven as specified in Section 4 of ASTM D 573. Stroking fixtures as shown in Figs. 1 and 2 of SAE J60.

4.5.2 TEST SPECIMENS—Two boots shall be used as test specimens.

4.5.3 PROCEDURE—Install two sample wheel cylinder boots on the cylinder for which they are designed, or equivalent. Then mount the cylinder into the actuator assembly, operating at 1000 strokes/hr with a stroke length of 4.78 mm ($\frac{3}{16}$ in.).

Then place the cylinder assembly in the oven and actuate for 22 hr at 120 ± 2 C (248 ± 3.6 F). After the actuation of the assembly, it shall be removed from the oven, allowed to cool to room temperature, and the boots examined for flex cracks and general appearance.

4.6 Low Temperature Stroking Test

4.6.1 APPARATUS—The cold chamber in which the test specimens are exposed to the low temperature shall be of sufficient size to contain the apparatus assembled with test specimens and so arranged to permit the operator to check and operate it without removal from the chamber. It shall be capable of maintaining a uniform atmosphere of cold dry air within the specified temperature range of -40 to -42.8 C (-40 to -45 F).

4.6.2 TEST SPECIMENS—Two boots shall be used as test specimens.

4.6.3 STROKING FIXTURE—As shown in Fig. 4 of SAE J60.

4.6.4 PROCEDURE—Install the sample wheel cylinder boots on the cylinder for which they are designed, or equivalent. Place the test boots and test apparatus in a cold chamber and expose to a temperature of -40 to -42.8 C (-40 to -45 F) for 70 hr. After 70 hr of low-temperature exposure, stroke the boots with the stroking apparatus for six strokes, 30 sec apart, without removal from the cold chamber.

4.7 Tension Set Test

4.7.1 APPARATUS—Circular stretching mandrel having a diameter which will expand by 15% one or the other of the sealing ends attached to the wheel cylinder or to the actuating rod. The mandrel diameter is calculated as 115% of the molded diameter of the chosen boot end. The molded diameter shall be calculated from the average of two measurements made at right angles to each other on a contour projector. The mandrel shall be provided with a smooth lead-in chamfer to prevent cutting of the rubber and shall itself have a polished machine finish.

Circulating air oven as specified in Section 4 of ASTM D 573.

4.7.2 PROCEDURE

(a) Measure accurately the inside diameters of the ends of three specimen boots and record. Assemble on stretching mandrels. Place assemblies in the oven and age for 70 hr at 120 ± 2 C (248 ± 3.6 F). Remove the assemblies and cool at room temperature for 1 hr. Remove the boots. Allow to recover between $\frac{1}{2}$ and 1 hr. Again measure the

diameter and record.

(b) Calculate the tension set as a percentage of the original stretch deflection:

$$\text{Tension set} = \frac{D_2 - D_1}{D_3 - D_1} \times 100$$

where:

D_1 = unaged inside diameter of the boot

D_2 = aged inside diameter of the boot

D_3 = diameter of the stretching mandrel

4.7.3 No less than three specimens shall be tested in the above manner.

4.8 Heat Resistance Test—Static

4.8.1 APPARATUS—Circulating air oven as specified in Section 4 of ASTM D 573.

4.8.2 PROCEDURE—Select two sample boots for the heat resistance test. Determine the initial hardness of the boots as detailed in paragraph 4.3.1. Suspend the test specimens in the oven for 22 hr at 120 ± 2 C (248 ± 3.6 F). Remove them from the oven and allow to cool to room temperature; then check for hardness, flexibility, and tackiness.

4.9 Ozone Resistance Test

4.9.1 APPARATUS—The apparatus shall consist of an ozone chamber as described in ASTM D 1149, "Accelerated Ozone Cracking of Vulcanized Rubber," and shall be capable of maintaining an ozone concentration of 50 ppm.

Stretching mandrel (see paragraph 4.7.1).

4.9.2 TEST SPECIMENS—Test specimens shall be two boots.

4.9.3 PROCEDURE—Assemble the boots on the stretching mandrels (which will provide $15 \pm 0.3\%$ stretch in the boot bead section) and allow to rest for 22 hr at room temperature. Then subject the boots installed on the mandrels to an ozone concentration of 50 ± 5 ppm by volume at 75 ± 2 C (103 ± 3.6 F) for 70 hr.

APPENDIX A—COMPOSITION OF SAE COMPATIBILITY FLUID¹—WEIGHT PERCENT

Composition of SAE Compatibility Fluid	% Weight	Composition of SAE Compatibility Fluid	% Weight
1. Monoethyl ether of diethylene glycol	51.70	15. Monobutyl ether 1, 2 oxyethylene, 1, 2 oxypropylene glycols sp gr 1.038 20/20 C, viscosity 260 $\pm$ 15 SUS at 38 C (100 F) [56.5 $\pm$ 3 cs at 38 C (100 F)] ²	8.85
2. Monobutyl ether of diethylene glycol	2.26	16. Borax-ethylene glycol condensate (25% sodium tetraborate, anhydrous)	0.25
3. Methyl ether of tripropylene glycol	5.12	17. Diphenylol propane	0.53
4. Polyalkylene oxide triol viscosity 900 $\pm$ 45 SUS at 38 C (100 F) [200 $\pm$ 10 cs at 38 C (100 F)] sp gr 1.064 20/20 C ³	5.30	18. Sodium nitrate	0.01
5. Ethylene glycol	2.47	19. Sodium tetraborate	0.10
6. Diethylene glycol	1.34	20. Potassium tetraborate	0.18
7. Propylene glycol	2.45	21. Tricresyl phosphate	0.10
8. Methyl isobutyl carbinol	4.30	22. Amino imidazoline salt 33% solution	0.01
9. Polypropylene glycol 2025 MW	2.30	23. Potassium castor oil soap (neutral-anhydrous)	0.18
10. Polypropylene glycol 150 MW	1.30	24. N-phenylmorpholine	0.09
11. Propylene glycol monoricinoleate	3.30		
12. Reacted castor oil—polypropylene glycol	1.90		
13. 2-methyl, 2, 4 pentanediol	2.80		
14. Monobutyl ether 1, 2 oxyethylene, 1, 2 oxypropylene glycols sp gr 1.058 20/20 C, viscosity 2000 $\pm$ 100 SUS at 38 C (100 F) [440 $\pm$ 22 cs at 38 C (100 F)] ²	3.16	Total	100.00

¹ This fluid can be obtained from the Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

² Item 4—Glycerine initiated triol using 50–50 charge ethylene oxide and propylene oxide.

³ Items 14 and 15—Butanol initiated monether using 50–50 charge ethylene oxide and propylene oxide.

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