SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

# SURFACE VEHICLE STANDARD

SAE J1605 | REV. MAR92

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Submitted for recognition as an American National Standard

## (R) BRAKE MASTER CYLINDER RESERVOIR DIAPHRAGM GASKET

***1.*** ***Scope—***This SAE Standard covers performance requirements and methods of test for master cylinder reservoir diaphragm gaskets that will provide a functional seal and protection from outside dirt and water.

***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.

SAE J1601—Rubber Cups for Hydraulic Actuating Cylinders
SAE J1703—Motor Vehicle Brake Fluid

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

ASTM D 395—Test Methods for Rubber Property—Compression Set
ASTM D 412—Test Methods for Rubber Properties in Tension
ASTM D 471—Test Method for Rubber Property—Effect of Liquids
ASTM D 573—Test Method for Rubber—Deterioration in an Air Oven
ASTM D 1149—Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber (Flat Specimens)
ASTM D 1415—Test Method for Rubber Property—International Hardness

***3.*** ***General Material Requirements***

**3.1** **Composition—**The materials used in the diaphragm gaskets shall be a rubber elastomer or combinations of elastomers and moisture barrier materials suitable for use with motor vehicle brake fluids of the nonpetroleum type conforming to SAE J1703.

**3.2** **Workmanship and Finish—**The diaphragm gaskets 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.

**3.3** **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 diaphragm gasket.





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## *4. Inspection and Rejection*

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

**4.2** The purchaser may make tests and inspections to govern the acceptance or rejection of the diaphragm gaskets at a laboratory of choice. Such tests and inspections shall be made not later than 60 days after receipt of the material.

**4.3** 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.

**4.4** All rejected diaphragm gaskets shall be destroyed by the manufacturer to insure that no substandard diaphragms will be used.

## *5. Classification of Tests*

**5.1 Qualification Tests—**The qualification tests shall include all tests specified herein.

**5.2 Lot Acceptance Tests—**Quality control tests for production lot acceptance shall include tests specified in 6.1.2, 6.3, and 6.4.1.

**5.3 Sampling and Test Frequency—**The quantity of parts and the frequency of qualification tests and lot acceptance tests used to control production shall be agreed upon by the supplier and purchaser.

## *6. Physical Properties Requirements*

### 6.1 Rubber Hardness

6.1.1 QUALIFICATION—When tested as specified in 7.1, the rubber hardness shall be within the limits of 45 to 67 points. Hardness determinations from any one lot shall not vary more than ±5 points.

6.1.2 LOT ACCEPTANCE—When tested as specified in 7.1, the rubber hardness shall be equal to the qualifying value within ±5 points providing it is within the limits of 45 to 67 points.

### 6.2 Rubber Tension and Tear

6.2.1 QUALIFICATION—ORIGINAL PROPERTIES—When tested per ASTM D 412 and ASTM D 624, the rubber materials shall meet the following requirements:

a. Tensile Strength: 6.9 MPa (1000 psi) min
b. Ultimate Elongation: 250% min
c. Tear, Die C: 21.9 kN/m (125 lb) min

6.2.2 QUALIFICATION—ACCELERATED AGING AT 100 °C (212 °F)—The change from the original properties and compression set after dry heat aging per 7.2 shall conform to the following requirements:

a. Change in Hardness (IRHD or Durometer): 0 to +10 points
b. Change in Tensile Strength: –20% max
c. Change in Ultimate Elongation: –30% max
d. Compression Set: 25% max

**6.3 Low Temperature Bendability at –40 °C (–40 °F)—**After the low temperature test as described in 7.3, the diaphragm shall not crack and shall return to its approximate original shape within 1 min.

NOTE—Residual kinking of some convolutions shall not be cause for rejection.

**6.4 Resistance to Fluids at Elevated Temperature 120 °C (248 °F)—**After being subjected to the test for resistance to fluids at elevated temperature per 7.4, the diaphragm materials shall conform to the following requirements:

6.4.1 LOT ACCEPTANCE

a. Change in Hardness (IRHD or Durometer): –10 to +5 points
b. Change in Volume: –10 to +20%
c. Precipitation: Not more than light

6.4.2 QUALIFICATION

a. Change in Tensile Strength: –30% max
b. Change in Ultimate Elongation: –55% max

**6.5 Ozone Resistance—**After being tested per 7.5, the surface of the diaphragm shall evidence no cracking, rupture, or other deterioration when examined under 2X magnification.

**6.6 Heat Pressure Stroking—**After being subjected to the heat pressure stroking test prescribed in 7.6, there shall be no fluid dampness on the top surface of the diaphragm except where there is contact with metal.

**6.7 Functional Design Test—**After being subjected to the functional design test prescribed in 7.7, the convolutions of the diaphragm shall be fully extended, or the brake fluid level in the master cylinder reservoir shall not be greater than 3.2 mm (1/8 in) above the master cylinder porting.

## *7. Test Procedures*

**7.1 Rubber Hardness—**The referee method of determining rubber hardness shall be as described in ASTM D 1415. An alternate procedure, as agreed upon between vendor and purchaser, may be used. Test each specimen submitted for test; record the range of IRHD (degrees).

Sample diaphragms, segments thereof, or specimens mutually acceptable to supplier and purchaser shall be plied together as necessary to provide the test thickness. The same operator shall make all hardness determinations for any one test.

**7.2 Accelerated Aging at 100 °C (212 °F)**

7.2.1 TEST METHOD—Rubber Hardness, Tensile Strength, and Elongation Charge

*7.2.1.1* *Apparatus*—Circulating air oven as specified by ASTM D 573.

*7.2.1.2* *Procedure*—Sample diaphragms, specimen sections thereof, or accepted specimens shall be rinsed in isopropyl alcohol or equivalent and wiped dry with a lint-free cloth to remove dirt and packing debris. The specimen shall not remain in the alcohol for more than 30 s.

The rubber hardness of unaged test specimens shall be determined as specified in 7.1 and recorded. The unaged tensile strength and ultimate elongation shall be determined and recorded in accordance with ASTM D 412.

New test specimens shall be placed in a circulating air oven as described in ASTM D 573 and held for 70 h at 100 °C ± 2 °C (212 °F ± 3.6 °F). The specimen shall then be removed from the oven, placed on a clean dry table top and allowed to cool for 16 to 96 h. The specimens shall then be retested for hardness as specified in 7.1, and tensile strength and ultimate elongation as specified in ASTM D 412. The tensile strength and ultimate elongation change shall be calculated per ASTM D 573.

7.2.2 TEST METHOD—Compression Set—Sample diaphragms, plied sections thereof, or accepted specimens, mutually agreed upon between supplier and purchaser, shall be rinsed in isopropyl alcohol or equivalent and wiped dry with a lint-free cloth to remove dirt and packing debris. The specimens shall not remain in the alcohol for more than 30 s.

The compression set of the specimens shall then be determined as specified in ASTM D 395, Method B with a heat treatment period of 22 h at 100 °C ± 2 °C (212 °F ± 3.6 °F).

**7.3 Low Temperature Bendability—**Sample diaphragms or accepted specimens shall be rinsed in isopropyl alcohol or its equivalent and wiped dry with a lint-free cloth. The specimen shall not remain in the alcohol for more than 30 s. The specimen shall then be placed in a suitable cold chamber and exposed for 22 h at –40 °C to –43 °C (–40 °F to 45 °F). It shall then be bent 180 degrees around a 6.35 mm (1/4 in) mandrel, conditioned at the test temperature, and released immediately. The time required for the part to return to its approximate original shape shall be noted. (The cold specimen shall be bent while in the cold chamber with cold gloves to prevent heating by the fingers.)

**7.4 Resistance to Fluids at Elevated Temperature**

7.4.1 APPARATUS—Circulating air oven as specified in ASTM D 573.

Use tightly sealed glass containers of suitable size.

7.4.2 SPECIMEN—Sample diaphragms or acceptable specimens providing a suitable sample size weighing approximately 3 to 5 g shall be used for the rubber hardness, volume change, and precipitation test. Suitably prepared specimens per ASTM D 412 shall be used for the tensile strength and elongation change tests.

The specimens shall be stabilized at room temperature and then rinsed in isopropyl alcohol or its equivalent and wiped dry with a lint-free cloth to remove dirt and packing debris. The specimens shall not remain in the alcohol for more than 30 s.

7.4.3 TEST METHODS—Rubber Hardness and Volume Change—Select two test specimens for test. Establish the initial rubber hardness per 7.1 and record.

Establish the volume of the same two specimens per ASTM D 471, using the water displacement method and record. The specimens shall then be quickly dipped in alcohol to remove the water and dried with a lint-free cloth. Immediately after drying, each specimen shall be placed in a container and completely immersed in 75 mL of the specified test fluid RM-66-03[1]. Containers shall be sealed to prevent vapor loss, placed in the oven, and held at 120 °C ± 2 °C (248 °F ± 3.6 °F) for 70 h. At the end of the heating period, remove the specimen and container from the oven and allow to cool at 23 °C ± 5 °C (73 °F ± 3.6 °F) for 60 to 90 min. The specimens shall then be removed from their containers, rinsed in isopropyl alcohol, and wiped dry with a lint-free cloth. The final volume and hardness shall be determined within 60 min after rinsing in alcohol.

The weighings shall be the last operation before and the first operation after the immersion in the brake fluid and followed by a rubber hardness determination.

1. SAE RM-66-03 is obtainable from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

The volume change shall be calculated per ASTM D 471 as follows in Equation 1 to determine conformance to 6.4.1.

$$\text{Change in volume, \%} = \frac{(m_3 - m_4) - (m_1 - m_2) \times 100}{(m_1 - m_2)} \qquad \text{(Eq. 1)}$$

where:

$m_1$ = initial mass in air
$m_2$ = initial mass in water
$m_3$ = final mass in air
$m_4$ = final mass in water

7.4.4 TEST METHOD—PRECIPITATION—Two specimens approximately 3 to 5 g each shall be placed in a suitable glass container and completely immersed in 75 mL of the specified test fluid RM-66-03[2]. The container shall be sealed to prevent vapor loss and placed in the oven at 120 °C ± 2 °C (248 °F ± 3.6 °F) for 70 h. At the end of the heating period, remove the container from the oven and with the diaphragm specimens still in the fluid, allow it to stand at room temperature for 22 h. The resulting precipitate shall be classified as none, trace, light, medium, or heavy. (It is recommended that a blank be run on the fluid with each series of tests.)

a. A trace precipitate shall be flocculent and remain in suspension.
b. A light precipitate shall be flocculent, may settle, but possess no crystalline formations.
c. A medium precipitate shall be primarily flocculent material with a few small crystals.
d. A heavy precipitate shall be large in volume and contain both flocculent and crystalline material.

7.4.5 TEST METHOD—TENSILE STRENGTH AND ELONGATION—Sample diaphragms, sections thereof, or accepted specimens as specified in ASTM D 412 for tensile strength and ultimate elongation shall be immersed in the specified test fluid RM-66-03[2] for 70 h at 120 °C ± 2 °C (248 °F ± 3.6 °F). At the end of the heating period, remove the specimens and container from the oven and allow to cool at 23 °C ± 5 °C (73 °F ± 9 °F) for 60 to 90 min. The specimens shall then be removed from their container, rinsed in isopropyl alcohol, wiped dry with a lint-free cloth, and the tensile strength and ultimate elongation determined within 30 min after removal from the test fluid container.

The change in tensile strength and elongation shall be expressed as a percentage of change from the original value as determined in 6.2.1.

## 7.5 Ozone Resistance

7.5.1 APPARATUS—The apparatus shall consist of an ozone test chamber as described in ASTM D 1149 and capable of maintaining an ozone concentration of 50 mPa by volume.

7.5.2 SPECIMEN—The diaphragm test specimens shall be segments cut from the gasket area of the diaphragm or any substantially flat area.

7.5.3 TEST METHOD—The specimens shall be mounted flat and clamped at each end to provide a 15% stretch. They shall be allowed to rest in this position for 22 h at room temperature and then exposed in the test chamber to an ozone concentration of 50 mPa ± 5 mPa by volume at 40 °C ± 2 °C (104 °F ± 3.6 °F) for a period of 70 h.



2. SAE RM-66-03 is obtainable from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.