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MILITARY SPECIFICATION

# CUP, HYDRAULIC BRAKE ACTUATING CYLINDER: SYNTHETIC RUBBER

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers molded cups, 2 inches in diameter and under, compounded from high temperature resistant rubber for use in hydraulic actuating cylinders employing hydraulic-brake fluid of nonmineral-oil type.

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified (see 6.2), the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

| | |
|---|---|
| QQ-T-425 | - Tinplate (Electrolytic). |
| PPP-B-566 | - Boxes, Folding Paperboard. |
| PPP-B-601 | - Boxes, Wood, Cleated-Plywood. |
| PPP-B-636 | - Boxes, Shipping, Fiberboard. |
| PPP-B-676 | - Boxes, Setup. |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Mobility Equipment Research and Development Command, ATTN: DRDME-DS, Fort Belvoir, VA 22060 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 2530

MILITARY

| | |
|---|---|
| MIL-P-116 | - Preservation, Methods of. |
| MIL-B-46176 | - Brake Fluid, Silicone, Automotive, All Weather, Operational and Preservative. |

STANDARDS

FEDERAL

| | |
|---|---|
| FED-STD-791 | - Lubricants, Liquid Fuels, and related Products; Methods of Testing. |

MILITARY

| | |
|---|---|
| MIL-STD-105 | - Sampling Procedures and Tables for Inspection by Attributes. |
| MIL-STD-129 | - Marking for Shipment and Storage. |
| MIL-STD-1188 | - Commercial Packaging of Supplies and Equipment. |

(Copies of specifications and standards, required by contractors in connection with specific acquistion functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| D91 | - Oil, Lubricating, Precipitation Number of. |
| D573 | - Accelerated Aging of Vulcanized Rubber by the Oven Method. |
| D2240 | - Indentation Hardness of Rubber and Plastics by Means of a Durometer. |
| A366 | - Steel, Carbon, Cold-Rolled Sheet, Commercial. |
| B36 | - Brass Plate, Sheet, Strip and Rolled Bar. |
| B152 | - Copper, Sheet, Strip and Rolled Bar. |
| B209 | - Aluminum and Aluminum-Alloy Sheet and Plate |

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103).

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

| | |
|---|---|
| SAE J527 | - Brazed Double Wall Low Carbon Steel Tubing |
| SAE J1703 | - Motor Vehicle Brake Fluid. |

(Application for copies should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15086.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the reference cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Qualification. Cylinder cups furnished under this specification shall be manufactured from a compound which has been tested and passed the qualification tests specified herein (see 4.5) and has been listed on or approved for listing on the applicable Qualified Products List (see 6.3 and 6.4). Separate qualification shall be conducted for each compound. The formula of an approved cylinder cup may not be changed or altered without prior approval. The quality of the ingredients used in an approved compound shall be so controlled as to insure uniformity of performance of the cylinder cup.

3.2 Materials. The materials used in the cylinder cups shall be a compound using a copolymer product of butadiene and styrene (SBR) or ethylene propylene rubber(EPDM) as the basic material. The quality of the ingredients used in an approved compound shall be so controlled as to insure uniformity of performance of the cylinder cups.

3.3 Design and construction. For procurement purposes cylinder cups shall be molded to the dimensions shown on the applicable drawings (see 6.2). For qualification purposes cups may be molded in accordance with Appendix B of SAE J1703.

3.4 Physical Properties.

3.4.1 Hardness, Durometer (Shore A).

3.4.1.1 For qualification. When tested as specified in 4.5.1 for qualification, the durometer hardness of the cups shall be within the limits of 55 to 75 points.

3.4.1.2 For lot acceptance. When tested as specified in 4.5.1 for lot acceptance, the durometer hardness of the cups shall be equal to the qualified value ± 5 points, providing it is within the limits of 55 to 75 points. The qualified value is the durometer hardness value obtained on a particular size and compound of cup at time of qualification testing. The same value is thereby established for the other sizes of cups of that same compound for which qualification has been established (see 6.4).

3.4.2 Accelerated aging. After cylinder cups have been subjected to the accelerated aging test specified in 4.5.2, the change in durometer hardness shall be within the limits of -5 to +5 points.

3.4.3 Low temperature.

3.4.3.1 Bendability. When subjected to the bend test specified in 4.5.3.1, the cup shall not crack and shall return to its approximate original shape within 1 minute.

3.4.3.2 Fluid leakage. When cups are tested as specified in 4.5.3.2, there shall be no leakage of fluid during the test.

3.4.4 Resistance to fluids at elevated temperature. After cylinder cups have been tested as specified in 4.5.4, changes in physical properties shall be within the limits shown in Table I.

TABLE I. Change in physical properties.

| Physical Properties | Change |
|---|---|
| Volume | +5 to +20 percent |
| Outside diameter (lip) | 0 to +5.75 percent |
| Outside diameter (base) | 0 to +5.75 percent |
| Durometer hardness | 0 to -15 points |

3.4.4.1 Sedimentation. Not more than 0.2 percent sediment by volume shall be formed in the centrifuge tube and after the cylinder cups have been tested as specified in 4.5.4.3.2. The sedimentation shall show no crystalline particles.

3.4.5 Heat-pressure stroking. When tested as specified in 4.5.5, the cylinder cups shall conform to the following requirements.

3.4.5.1 Volume loss. The volume loss of brake fluid due to leakage past either the secondary cup of the master cylinder or past the wheel cylinder cups during any 24,000-stroke period in the test, shall not exceed 3.5 milliliters or a total of 10 milliliters for the 70,000-stroke period.

3.4.5.2 Pressure change. The pressure in the simulated brake system shall not vary more than ± 50 psi from the initial stroking pressure throughout the 70-hour test period.

3.4.5.3 Leakage. After the 24-hour cooling period specified in the test, constant dampness past the cups or fluid discoloration of the filter paper due to leakage, on two or more inspections, shall be cause for rejection.

3.4.5.4 Lip diameter interference. After test, the minimum lip diameter of the cups shall be greater than the cylinder bore by the minimum dimensions shown in Table II. This dimensional quality of a cup is known as its lip diameter interference.

TABLE II. LIP diameter interference.

| Cup Size (diameter) | Wheel Cyl. Cup | Master and Slave Cyl. Cups |
|---|---|---|
| To 1 inch (incl.) | 0.030 inch min. | 0.020 inch min. |
| Over 1 to 1-1/2 inches (incl.) | 0.035 inch min. | 0.025 inch min. |
| Over 1-1/2 to 2 inches (incl.) | 0.040 inch min. | 0.030 inch min. |

3.4.5.5 Appearance of rubber cups. At the completion of the test, the cylinder cups shall show no more than a moderate amount of shipping, scuffing, blistering, cracking, tackiness, or change in shape from original appearance.

3.4.5.6 Hardness. Rubber cups shall not decrease in hardness by more than 15 points.

3.4.5.7 Corrosion. Pistons and cylinder bore shall not show corrosion as evidenced by pitting to an extent discernible to the naked eye.

3.4.5.8 Sedimentation. Not more then 1.50 percent sediment by volume shall be formed in the centrifuge tube after the fluid from the stroking test has been tested as specified in 4.5.5.7.1 and 4.5.5.8.2

3.4.6 Corrosiveness. When the cylinder cups have been tested for corrosiveness as specified in 4.5.6, the test results shall be as follows.

3.4.6.1 Metal strips. The metal strips shall not be pitted nor etched. The permissible loss in weight of the strips shall be as follows:

| Metal | Loss in Weight mg./sq. c., Max. |
|---|---|
| Tinned iron | 0.2 |
| Steel | 0.2 |
| Aluminum alloy | 0.1 |
| Cast iron | 0.2 |
| Brass | 0.4 |
| Copper | 0.4 |

3.4.6.2 Disintegration of rubber cup. The rubber cup exposed to the brake fluid-water mixture shall show no sloughing, tackiness, blisters, nor any other form of disintegration. (Sloughing is indicated by the presence of carbon black on the surface of the rubber cup.) The base diameter of the cup shall not increase more than 0.050 inch (1.3 mm). The hardness of the rubber shall not decrease more than 15 points.

3.4.6.3 Fluid. Following the corrosiveness test, the test fluid shall show no jelling or crystalline deposit, and shall contain not more than 0.05 percent (by volume) precipitated matter.

3.4.7 Storage corrosion. When cylinder cups are tested as specified in 4.5.6 there shall be no evidence of corrosion adhering to or penetrating the wall of the test cylinder bore which was in contact with the test cup. Slight discoloration (staining) or corrosion away from the contact surface of the test cups shall not be cause for rejection.

3.5 Marking. The identification mark of the manufacturer and other marking as specified on applicable drawings (see 6.2) shall be molded into each cylinder cup.

3.6 Workmanship. Workmanship shall be such as to produce cylinder cups free from blisters, pin holes, cracks, protuberances, embedded foreign matter or other physical defects which can be detected through visual examination. The cylinder cups shall conform to the dimension specified on the drawings (see 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Qualification samples. Qualification samples (see 3.1, 6.3, and 6.4) shall consist of not less than the following:

(a) 64 Each 1-1/8" Wheel Cylinder Cups
(b) 10 Each 1-1/8" Master Cylinder Primary Cups
(c) 10 Each 1-1/8" Master Cylinder Secondary Cups
(d) 10 Each 1-1/8" Master Cylinder Check Valve Assemblies
(e) 1 Platen Press Sheet 6 by 6 by 0.075 inch, of the same formulation and cure as all cylinder cups.

4.3 Sampling and inspection.

4.3.1 Sampling for cups.

4.3.1.1 Lot formation. A lot shall consist of all cylinder cups of one shape and size from one manufacturer from an identifiable production period, submitted at one time for acceptance.

4.3.1.2 Sampling for acceptance examination. Sampling for quality conformance examination shall be in accordance with standard sampling of MIL-STD-105.

4.3.2 Examination inspection.

4.3.2.1 Visual, dimensional, and primary functional examination.

4.3.2.1.1 Acceptable quality levels. Each sample selected in accordance with 4.3.1.2 shall be examined for conformance to the following Acceptable Quality levels (AQL) on the basis of percent defective:

| CLASSIFICATION | AQL |
|---|---|
| Major | 1.0 |
| Minor | 2.5 |

4.3.2.1.2 Classification of defects. For examination inspection purposes, defects shall be classified as follows:

TABLE III. Classification of defects-examination inspection.

| Categories | Defects | Gage or other method of inspection |
|---|---|---|
| Critical | Non defined | |
| Major | AQL 1.0 percent | |
| 101 | Dimensional nonconformance (see 3.3). | Scale |
| 102 | Blisters (see 3.6) | Visual |
| 103 | Pin holes (see 3.6) | Visual |
| 104 | Cracks (see 3.6) | Visual |
| 105 | Protuberances (see 3.6) | Visual |
| 106 | Embedded foreign matter (see 3.6) | Visual |
| 107 | Sealing lips dirty and rough (see 3.6) | Visual |
| Minor | AQL 2.5 | |
| 201 | Improper or illegible identification (see 3.5) | Visual |

4.3.2.1.3 Workmanship deficiencies. Workmanship deficiencies, other than those listed in 3.6, recurring in five consecutive lots, or in 10 or more lots within a 30-day period, will be added to the minor classification of defects.

4.4 Classification of tests.

4.4.1 Qualification tests. The qualification tests shall consist of all the tests specified herein.

4.4.2 Quality conformance tests. Inspection tests for quality conformance shall consist of the tests specified in 4.5.1, 4.5.3.1, 4.5.4 and 4.5.6 and shall meet the requirements specified in 3.4.1.2, 3.4.3.1, 3.4.4 and 3.4.6.

4.4.3 Failure. Failure of a quality conformance test sample to pass any specified test may be cause for the Government to refuse to accept subsequent lots until it has been proved to the satisfaction of the Government that the faults revealed by the test have been corrected.

4.5 Test procedures.

4.5.1 Durometer hardness. To determine conformance to 3.4.1, the durometer hardness shall be determined in accordance with ASTM D2240 or Method 361 of FED-STD-791, and using a Type A Shore durometer. The same operator shall make all hardness determinations for any one test.

4.5.1.1 Apparatus. Apparatus shall incorporate the use of a rubber anvil having a durometer hardness in the same range as the cup being tested and of such shape as to mate with the inner contour of the cup, and a metal fixture to hold the anvil firmly and provide a level seat for the instrument.

4.5.2 Accelerated aging. The cups shall be subjected to the accelerated aging test specified in ASTM D 573 with the following exceptions:

(a) Two cups shall be rinsed in isopropyl alcohol or ethyl alcohol and wiped dry with a lint-free cloth to remove dirt and packing debris. The cups shall not remain in the alcohol for more than 30 seconds.
(b) The cups shall be tested for durometer hardness as specified in 4.5.1.
(c) The cups shall be aged at a temperature of 212° ± 2°F (100° ± 1.5° C) for 70 hours.
(d) At the end of the 70-hour period, the cups shall be removed from the oven, placed on a table with a wooden top and allowed to cool for 30 minutes to room temperature. The cups shall then be retested for durometer hardness to determine their conformance to 3.4.2.

4.5.3 Low temperature test.

4.5.3.1 Bendability.

4.5.3.1.1 Test specimens. One cylinder cup shall be used as a test specimen.

4.5.3.1.2 Procedure. The specimen shall be rinsed in isopropyl alcohol or ethyl alcohol, and wiped dry with a lint-free cloth. The cylinder cup shall not remain in the alcohol for more than 30 seconds. The test cup after being subjected to 22 hours at -40 to 43°C (-40 to -45.4°F) shall be bent through an angle of approximately 90 degrees and immediately released. The cold cup shall be handled to prevent warming. Within 1 minute examine test cup for cracking and change in shape from original appearance to determine conformance to 3.4.3.1.

4.5.3.2 Leakage.

4.5.3.2.1 Apparatus. The apparatus shall include the following:

(a) A cold chamber large enough to permit arrangement of the apparatus within, for checking and operation without removal from the chamber.
(b) A master cylinder and four wheel cylinders so connected that their operation closely approximates the brake system in actual service.
(c) A pressure gage.

The brake cylinder containing the specimens under test shall meet the dimensional limitations of a new cylinder. The retractor spring shall be such as to require not more than 50 pounds line pressure to make a complete stroke at room temperature. An alternative apparatus such as specified in 4.5.5.1.3 may be used.

4.5.3.2.2 Specimens. The specimens for test shall consist of one primary and one secondary master cylinder cup and eight wheel cylinder cups.

4.5.3.2.3 Procedure. The specimens shall be rinsed in isopropyl alcohol or ethyl alcohol and wiped dry with a lint-free cloth. The specimens shall not remain in the alcohol for more than 30 seconds. The specimens shall be assembled in the test cylinders. During assembly of the cylinder assembly, the cylinder walls shall be coated with and each other part shall be dipped in brake fluid conforming to MIL-B-46176. The cylinder assembly shall be assembled with the master cylinder in the test apparatus in the cold chamber. The system shall be filled with brake fluid conforming to MIL-B-46176 and all air bled from the system. Boots shall not be used. The assembly shall be subjected to a temperature of -67° ± 2°F (-55° ± 1.5°C) for 120 hours. The pistons and cups shall remain in a static position during the first 72 hours of the test and thereafter shall be actuated 6 strokes at 100 psi and 6 strokes at 500 psi each 24 hours, that is, after 72, 96, and 120 hours. The strokes shall be approximately 1 minute apart and the pistons shall return to the stop after each stroke. The pressure in the system shall be noted and the cylinder examined for leakage during the test, to determine conformance to 3.4.3.2.

4.5.4 Resistance to fluids at elevated temperatures.

4.5.4.1 Apparatus. The apparatus shall include a micrometer caliper, shadowgraph, or other device for measuring accurately in thousandths of an inch; screwcap glass jars of approximately 1/2-pint capacity with screwcaps made of tinned steel (no organic coating) and containing no gasket or liner, and an air oven conforming to ASTM D 573 specified in 4.5.2.

4.5.4.2 Specimens. Four wheel cylinder cups shall be subjected to the tests.

4.5.4.3 Procedure. The temperature of the specimens shall be stabilized at room temperature and shall then be rinsed in isopropyl alcohol or ethyl alcohol 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 seconds.

4.5.4.3.1 Change in physical properties. Two of the specimens shall have the durometer hardness determined as specified in 4.5.1 and recorded. The lip and base diameters of the two specimens shall be measured to the nearest 0.001 inch, and the results recorded. The measurements shall be made by taking the average of two readings at right angles to each other. Base diameter measurement shall be taken within 0.015 inch from the back and parallel to the base of the specimen. Volume of the two specimens shall be determined and recorded. Volume determination shall be by weighing the specimen to the nearest milligram in air and in distilled water at room temperature, the difference being the weight of the water displaced by the specimen. Air weight shall be taken with specimen in

a tared bottle. After weighing in water, the specimens shall 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 fluid specified in MIL-B-46176. Containers shall be sealed to prevent vapor loss, placed in the oven and held at 248°F ± 5°F (120° ± 3°C) for 70 hours. At the end of the 70-hour period, the specimens shall be removed from their containers, rinsed in isopropyl alcohol or ethyl alcohol, wiped dry with a lint-free cloth, and the final physical properties determined within 30 minutes after removal from the fluid, to determine conformance to 3.4.4. The method of determining physical properties after testing shall be the same as before testing. The weighings shall be the last operation before and the first operation after the immersion in brake fluid and shall be accomplished without delay. The increase in volume shall be calculated as follows:

$$\text{Percent increase in volume} = \frac{(W_3-W_4) \quad -(W_1-W_2)}{(W_1-W_2)} \times 100$$

Where: $W_1$ = initial weight in air.
$W_2$ = initial weight in water.
$W_3$ = final weight in air.
$W_4$ = final weight in water.

4.5.4.3.2 Sedimentation. Each of the remaining two specimens shall be placed in a container and completely immersed in 75 ml. of the fluid specified in MIL-B-46176. Containers shall be sealed to prevent vapor loss, placed in the oven and held at 248° ± 5°F (120° ± 3°C) for 70 hours. At the end of the 70-hour period, the containers shall be removed from the oven and with the cups still in the fluid, shall be allowed to stand for 24 hours at room temperature. The contents of the jar shall then be thoroughly agitated and transferred to a cone shaped centrifuge tube and the volume of sediment determined in accordance with Method 3101 of FED-STD-791.

4.5.5 Heat-pressure stroking.

4.5.5.1 Test Apparatus and Material. Use the Figure 2 stroking fixture type apparatus of SAE J1703f with the following components arranged as shown in Figure 1. The drum and shoe apparatus as described in SAE J1703c may be used as alternative test system.

4.5.5.1.1 Master cylinder assembly. One cast iron housing hydraulic brake master cylinder having a diameter of approximately 28 mm (1-1/8 in) and fitted with an uncoated steel standpipe. Master cylinder used is SAE RM-15A 28 mm (1-1/8 in) diameter or equivalent.

4.5.5.1.2 Brake assemblies. Three cast iron housing straight bore hydraulic brake wheel cylinder assemblies having a diameter approximately 28 mm (1-1/8 in). Wheel cylinder used is SAE RM-14a or equivalent with stroking fixture apparatus. Three fixture units are required, including appropriate adapter mounting plates to hold the brake wheel cylinder assemblies as shown in Figure 2 of SAE J1703f. The amount of force applied by the actuating mechanism shall be adjustable and capable of supplying sufficient stroke and thrust to the master

cylinder to create a pressure of at least 70 kg/cm$^2$ (1000 psi) in the simulated brake system. A hydraulic gauge and pressure recorder capable of establishing the pressure curve of the system and monitoring the pressure developed shall be installed on a hydraulic line extending from the master cylinder to the outside of the oven. This line shall be provided with a shutoff valve and a bleeding valve for removing air from the connecting tubing. The actuating mechanism shall be designed to provide a stroking rate of approximately 1000 strokes/h. The pressure buildup rate versus cylinder stroke and time shall correspond to Figure 3 of SAE J1703f.

4.5.5.1.3 Heated air bath cabinet. An insulated cabinet or oven having sufficient capacity to house the three wheel cylinder fixture assemblies, master cylinder and necessary connections. A suitable thermostatically-controlled heating system is required to maintain a motor vehicle brake fluid temperature of 120° + 5°C (248 + 9°F). Heaters shall be shielded to prevent direct radiation of wheel or master cylinders. Fluid temperature shall be monitored at random intervals during the test at the master cylinder reservoir, using a temperature recording device.

4.5.5.2 Preparation of test apparatus.

4.5.5.2.1 Wheel cylinder assemblies. Use new wheel cylinder assemblies SAE RM-14a or equivalent having diameters as specified in 4.5.5.1.2. Pistons (SAE RM-12 or equivalent) shall be made from unanodized ASTM B 209, aluminum alloy 2024-0. Disassemble cylinders and discard rubber cups. Clean all metal parts with Isopropanol and dry with clean compressed air. Inspect the working surfaces of all metal parts for scoring, galling or pitting and cylinder bore roughness and discard all defective parts. Remove any stains on cylinder walls with crocus cloth and Isopropanol. If stains cannot be removed, discard the cylinder. Measure the internal diameter of each cylinder at locations approximately 19 mm (0.75 in) from each of the cylinder bores, taking measurements in line with the hydraulic inlet opening and at right angles to the center line. Discard the cylinder if any of these four readings exceeds maximum or minimum limits of 28.66 - 28.60 mm (1.1285 - 1.126 in). Measure the outside diameter of each piston at two points approximately 90 deg apart. Discard any piston if either reading exceeds maximum or minimum limits or 28.55 - 28.52mm (1.124 - 1.123 in). Select parts to insure that the clearance between each piston and mating cylinder is within 0.08 - 0.13 mm (0.003 - 0.005 in). Use new test cups that are free of lint and dirt. Discard any cups showing imperfections such as cuts, tooling marks, molding flaws or blisters. Measure the lip and base diameters of all test cups with an optical comparator or a micrometer to the nearest 0.025 mm (0.001 in) along the center line of cups and at right angles to this center line. Determine base diameter measurements within 0.8 mm (0.032 in) of the bottom edge and parallel to the base of the cup. Discard any cups if the two measured lip or base diameters differ by more than 0.08 mm (0.003 in). Average the lip and base diameters of each cup. Determine the hardness of all cups by the procedure specified in Section 4.5.1. Clean rubber parts with Isopropanol and a lint-free cloth. Dry with clean compressed air. Dip the rubber and metal parts of the wheel cylinders, except housings, in the fluid specified in MIL-B-46176 and install them in accordance

with manufacturer's instructions. Rubber boots shall not be used. Manually stroke the cylinders to insure that they operate easily. Install cylinders in the simulated brake system.

4.5.5.2.2 Master cylinder assembly. Use a new SAE RM-15a master cylinder or equivalent having an SAE RM-13 piston or equivalent made from ASTM B36 copper alloy UNS No. C26800, temper HO2 and new standard SAE RM-4 and RM-5 SBR cups as specified in Figures 5 and 6 and in Appendix B of SAE J1703f. Inspect and clean all parts as specified in 4.5.5.2.1. Measure each land of the master cylinder piston at two points approximately 90 deg apart. Discard the piston if any of these readings exceed maximum or minimum limits of 28.55 - 28.52 mm (1.124 - 1.123 in). Dip the secondary cup in the test brake fluid, assemble on the piston, and maintain the assembly in a vertical position at 23 ± 5°C (73.4 ± 9°F) for at least two hours. Determine the lip and base diameter of the secondary cup as installed on the piston and the primary cup at locations shown in Figure 5 of SAE J1703. Inspect the relief and supply ports of the master cylinder and discard the cylinder if their ports have burrs or wire edges. Measure the internal diameter of the cylinder at two locations: approximately mid-way between the relief and supply ports and approximately 19 mm (0.75 in) beyond the relief port toward the bottom or discharge end of the bore, taking measurements at each location on the vertical and horizontal center lines of the bore. Discard the cylinder if any readings exceeds maximum or minimum limits of 28.65 - 28.58 mm (1.128 - 1.125 inch). Dip the rubber and metal parts of the master cylinder, except the housing, in the fluid specified in MIL-B-46176 and install them in accordance with manufacturer's instructions. Discard boot and push rod assembly. Manually stroke the master cylinder to insure that it operates easily. Install the master cylinder in the simulated brake system.

4.5.5.2.3 Tubing. Use double wall steel tubing (SAE RM-57 or -58) or equivalent meeting SAE J527. Tubing from one outlet of master cylinder to the pair of wheel cylinders or to the single wheel cylinder shall alternately be replaced with new tubing for each test (minimum length 915 mm (3 feet). Uniformity in tubing size is desirable between master cylinder and wheel cylinder; 6.3 mm (1/4 in) tubing is more adaptable with available tube connectors. The standard SAE RM-15a master cylinder has two outlets for tubing, both of which should be used.

4.5.5.2.4 Assembly and adjustment of test apparatus. Install wheel and master cylinders. Fill the system with fluid specified in Appendix A of SAE J1703f, bleeding all wheel cylinders and the pressure equipment and gauges to remove entrapped air from the system. Operate the actuator manually to apply a pressure of more than the required operating pressure and inspect the system for leaks. Adjust the actuator and pressure relief valve to obtain a pressure of 70 ± 3.5 $kg/cm^2$ (1000 ± 50 psi) at the end of the stroke of approximately 25 mm (1 in). The pressure buildup rate versus cylinder stroke and time shall correspond to Figure 3 of SAE J1703f. The wheel cylinder piston travel is approximately 4.8 ± 0.25 mm (0.19 ± 0.01 in) when a pressure of 70 ± 3.5 $kg/cm^2$ (1000 ± 50 psi) is reached. Adjust the stroking rate to 1000 ± 100 strokes/h. Record the fluid level in the master cylinder standpipe at 23 ± 5°C (73.4 ± 9°F) with the master cylinder piston in the fully returned position.

4.5.5.3 Test procedure.

4.5.5.3.1 Stroking procedure. Run a pressure versus stroke curve utilizing the pressure recorder at room temperature before stroking, after the fluid is at the test temperature, before shutdown at the test temperature and at room temperature after stroking. Operate the system at 16,000 ± 1,000 cycles at 23 ± 5°C (73.4 ± 9°F). Repair any leaks and add fluid to the master cylinder standpipe to bring the fluid level to the level originally recorded at room temperature with the piston fully returned. Start test again and raise the temperature of the fluid in the master cylinder within 6 ± 2 hours to 120 ± 5°C (248 ± 9°F). During test, observe operation of the master cylinder for complete piston return and wheel cylinders for proper operation. Observe fluid level in relation to the room temperature level at random intervals. Continue the test to 94,000 total recorded strokes which shall include the number of strokes during operation at 23 ± 5°C (73.4 ± 9°F), the number of strokes required to bring the system to the operating temperature of 120 ± 5°C (248 ± 9°F), plus the number of strokes at this operating temperature. Stop the test, and with the master cylinder piston in the fully returned position to relieve retained pressure in the system, allow the equipment to cool to room temperature. Record the amount of fluid required to replenish any loss of fluid to the 23 ± 5°C (73.4 ± 9°F) and 70 ± 3.5 kg/cm$^2$ (1000 ± 50 psi), examine wheel cylinders for leakage and add and record volume of fluid required to bring the fluid level to the 23 ± 5°C (73.4 ± 9°F) original level. Within 16 hours remove the master and wheel cylinders from the system, retaining the fluid in the cylinders by immediatly capping or plugging the ports. Disassemble the cylinders, collecting the fluid from the master cylinder and wheel cylinders in a glass jar. Record any sludge, jell or abrasive grit present in the test fluid. When collecting the stroked fluid, all the residue which has deposited on the rubber and metal internal parts should be removed by rinsing and agitating such parts in the stroked fluid and using a soft brush to assure that all loose adhering sediment is collected. Clean rubber cups in Isopropanol and dry with clean, compressed air. Inspect cups for tackiness, scoring, scuffing, blistering, cracking, chipping, (heel abrasions), and change in shape from original appearance. Within 1 hour after disassembly, measure the lip and base diameter of each cylinder cup by the procedure specified in 4.5.5.2.2) with the exception that the lip or base diameters of cups may differ by more than 0.08 mm (0.003 in). Determine the hardness of each cup by the procedure specified in 4.5.1. Within 1 hour after draining cylinders, agitate fluid in glass jar to suspend and uniformly disperse sediment and transfer a 100 ml portion of this fluid to an ASTM cone-shaped centrifuge tube and determine percent sediment as described in paragraph 5(b) of ASTM D91. Inspect cylinder parts, recording any gum deposits. Rub any deposits adhering to cylinder walls with a cloth wetted with Isopropanol to determine abrasiveness and removability. Clean cylinder parts in Isopropanol and dry with compressed air, and inspect for pitting and scoring on pistons and cylinder walls. Measure and record diameters of pistons and cylinders by the procedures specified in 4.5.5.2.1 and 4.5.5.2.2.

4.5.5.3.2 Alternative method. When using the alternative method described in SAE J1703c, a complete hydraulic brake system including a master cylinder, four brake assemblies with drums, and necessary tubes and fittings shall be assembled and provided with a pressure gauge suitable for operation at 70 kg/cm$^2$ (1000

psi). Mechanical application of pressure to the master cylinder push rod shall be employed in such a manner as to duplicate, as nearly as possible, operation on a vehicle. At the start of the test, the brake shoes shall be adjusted concentric with the brake assembly axis to provide a diametrical clearance of 0.080 inch between the shoes and drums (0.040 inch clearance on each side).

4.5.6 Corrosiveness.

4.5.6.1 Rubber cups. Three rubber cups are required. The base diameter and the hardness of the cups shall be determined prior to testing.

4.5.6.2 Metal Strips. Three strips of each of the following metals are required (see 6.6):

| Metal | Description |
|---|---|
| Tin Plate | QQ-T-425 |
| Carbon steel | ASTM A336 |
| Aluminum alloy | ASTM B209 |
| Cast iron | Cut from wheel brake cylinders such as Wagner Electric Corp. F-D-373 cylinders or equivalent (SAE G-3000). |
| Brass | ASTM B36, Copper Alloy UNS No. C26800, temper HO2. |
| Copper | ASTM B152, Copper UNS No. C11000 |

Each strip shall measure 3 inches by 1/2 inch by less than 1/4 inch (76 mm by 12.8 mm by less than 6.4 mm). A hole 3/16-inch (4.8 mm) in diameter, centered 1/4 inch (6.4 mm) from one end, shall be drilled in each strip. All strips, with the exception of the tinned iron strips, shall be cleaned by abrading with 320A water proof carborundum paper and Stoddard solvent, until all surface scratches, cuts and pits are removed from the strips. The strips shall then be polished with 00 grade steel wool. All strips, including the tinned iron, shall then be rinsed with isopropyl alcohol or 95 percent ethyl alcohol and dried with a clean lint-free cloth and brought to constant weight in a desiccator.

4.5.6.2.1 Procedure. When the strips are ready for testing, weigh them to the nearest 0.1 mg. Fasten one strip of each of the metals together through the holes in the strips, using an uncoated cotter pin or a Size No. 6 or 8 uncoated mild steel bolt with nut, to ensure electrolytic contact between the strips. The strips shall be arranged on the pin in the same order in which they are listed above (see 4.5.6.2) and shall be bent as required so that there will be a separation of at least 1/8 inch (3 mm) between adjacent strips for a distance of approximately 2-1/4 inches (60 mm) measured from the free end of the strips. The three sets of assembled strips shall then be placed in separate screw cap jars of approximately 1-pint capacity. The screw caps shall be made of tinned steel (no organic coating), containing no gasket or liner, and shall have a 1/32-inch (0.8 mm) hole drilled near the center of the cap. One wheel cylinder cup shall be placed in the container in such a manner that the pinned ends of the strips rest in and are in contact with the concavity of the cup. A sufficient amount of brake fluid meeting the requirements of 4.6.11.1 of

MIL-B-46176 shall be poured into each jar to a depth of 1/2 inch (12.7 mm) above the tops of the assembled strips. The lids of the jars shall then be secured and the jars placed for 120 ± 2 hours in a gravity convection oven maintained at a temperature of 100° ± 2°C. (212° ± 3.6°F). Following the test period, the metal strips and the rubber cups shall be removed from the jars. The metal strips shall be disassembled, cleaned of all adhering sediment, sludge, and corroded particles, by being first flushed with water and wiped with a cloth wetted with isopropyl alcohol or 95 percent ethyl alcohol. The strips shall then be visually examined for evidence of corrosion, pitting, or etching. The strips shall be brought to constant weight in a desiccator and then weighed to nearest 0.1 milligram. Calculate the weight loss per unit area of each strip by dividing the observed loss in weight of the strip (in milligrams) by its total surface area (in square centimeters). The average of the three determinations made in each type of metal specimen shall be calculated and recorded as the average weight loss in milligrams per square centimeter. The three rubber cups, when removed from the fluid, shall be quickly washed with isopropyl alcohol or 95 percent ethyl alcohol, dried with a clean lint-free cloth, and visually examined for evidence of sloughing, softening, tackiness, and disintegration. The base diameter and hardness of the rubber cups shall be measured to determine compliance with the requirements specified in 3.4.6.2. These measurements shall be made within 10 minutes following removal of the cups from the fluid. One-hundred milliliters of test fluid-water mixture shall be centrifuged in a cone-shaped centrifuge tube and the volume of sediment determined in accordance with Method 3101 of FED-STD-791.

4.5.7 Storage corrosion.

4.5.7.1 Apparatus. Apparatus shall include a humidity cabinet capable of maintaining 70° to 115°F (21° -46° C) at 95 percent humidity; three cylinder assemblies of proper size for the size of cups being tested; containing unanodized aluminum pistons and hydraulic assembly fluid conforming to MIL-B-46176.

4.5.7.2 Procedure. Disassemble the three cylinder assemblies and, using a lint-free cloth, wipe all fluid from the cylinders, pistons, boots, and springs. Cylinders or parts showing light stains or corrosion shall be discarded. Assemble the six test cups into the wheel cylinders using a light film of MIL-B-46176 fluid to completely coat the cylinder walls, cups, springs, and pistons. Assemble the clean boots onto the cylinders to hold the pistons in position. Leave one inlet hole open and close the remaining holes with a suitable rubber or metal plug. Number the cylinders 1 through 3. Adjust the humidity cabinet to 115° F (46°C) and 95 percent humidity. Place the cylinders in the cabinet with open holes facing down. Maintain the temperature and humidity at above levels for 16 hours. Readjust the cabinet controls to 70°F (21°C) and 95 percent humidity and maintain these conditions for 8 hours to complete the first cycle. Repeat this 24-hour cycle for 12 days. When the foregoing cycling is interrupted due to the incidence of one or more nonworking days, the cups shall remain in the humidity cabinet with the cabinet controls set to maintain 70°F (21°C) at 95 percent humidity until cycling is resumed on the following working day. For inspection purposes number 1 cylinder assembly shall be removed from the humidity cabinet at the end of six cycles, number 2

cylinder assembly at the end of the 10 cycles and number 3 cylinder assembly at the end of 12 cycles. In case this inspection would fall on a nonworking day, the inspection shall be made on the following working day. Cylinder assemblies shall be inspected as follows:

(a) During removal from the humidity cabinet and subsequent disassembly, and inspection operations, the cylinders shall be maintained in the same position as they were in the cabinet to avoid fluid contamination of the inside of the cylinder.
(b) The pistons and cups shall be removed from the cylinder by pulling them out from their respective ends. Slight air (dry) pressure may be applied internally in the cylinder, if necessary, to aid in the removal of cups and pistons.
(c) To determine conformance to 3.4.7 inspect the cylinder bore under a strong light for corrosion, discoloration, or spots, particularly noting the area of the fluid ring left by the lip of the cup during its exposure in the humidity cabinet.

4.6 Inspection of packaging

4.6.1 Quality conformance inspection of pack.

4.6.1.1 Unit of product. For the purpose of inspection, a completed pack prepared for shipment shall be considered a unit of product.

4.6.1.2 Sampling. Sampling for examination shall be in accordance with MIL-STD-105.

4.6.1.3 Examination. Samples selected in accordance with 4.6.1.2 shall be examined for the following defects. AQL shall be 2.5 percent defective

102. Method and containers not as specified for level A or B.
103. Size and quantity contained together not as specified for level A.
104. Packing not in accordance with the referenced document for commercial.
105. Marking missing, illegible, incorrect, or incomplete for level A, level B, or commercial.

5. PACKAGING

5.1 Preservation. Preservation shall be level A or commercial as specified (see 6.2).

5.1.1 Level A. Each cup or quantity of cups as required for a specific assembly shall be preserved together in accordance with MIL-P-116, method IC-2, using the supplies container or a close fitting box conforming to PPP-B-676 or PPP-B-566, variety 1, style, type and class optional. The cup size and quantity to be contained together shall be as specified (see 6.2).

5.1.2 Commercial. Cups shall be preserved in accordance with MIL-STD-1188.

5.2 Packing. Packing shall be level A, level B, or commercial as specified (see 6.2).

5.2.1 Level A. Cups, preserved as specified in 5.1, shall be packed together in a close fitting box conforming to PPP-B-601, overseas type, style optional. Box closure and strapping shall be in accordance with the appendix to the box specification.

5.2.2 Level B. Packing shall be as specified in 5.2.1, except the box shall conform to PPP-B-636, V3c, style optional.

5.2.3 Commercial. Cups, preserved as specified in 5.1, shall be packed in accordance with MIL-STD-1188.

5.3 Marking.

5.3.1 Military. Marking for military levels of protection (level A or B) shall be in accordance with MIL-STD-129.

5.3.2 Commercial. Marking for commercial packaging shall be in accordance with MIL-STD-1188.

6. NOTES

6.1 Intended use. Hydraulic brake cylinder cups covered by this specification are intended for use in wheel cylinders, master cylinders, and slave cylinders in hydraulic-brake systems of trucks and other heavy-duty automotive equipment where the cylinder cups are subjected to temperatures ranging from +248° to -67° F (+120° to -55°C).

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Date of issue of DoDISS applicable to this contract and exceptions thereto (see 2.1.1).
c. Title, number, and date of applicable drawings of SAE J1703 (see 3.3 and 3.5).
d. Degree or preservation and degree of packing required (see 5.1 and 5.2).
e. Size and quantity of cups to be contained together (see 5.1.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have been so listed by the date. The attention of contractors is called to this requirement, and manufacturers are urged to arrange to have products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the product covered by this specification.

Information pertaining to qualification products covered by this specification may be obtained from US Army MERADCOM, Energy and Water Resources Laboratory, DRDME-GL, Fort Belvoir, VA 22060.

6.4 Special provisions for establishing qualification. Qualification of one size cup submitted by a manufacturer will be recognized as establishing qualification of all other sizes of cups, of the same compound and having the same durometer hardness, of the same manufacturer.

6.5 Equivalent test methods. The index of test methods in FED-STD-791 lists the corresponding equivalent test methods of the American Society for Testing and Materials where applicable.

6.6 Test materials. Metal strips, the standard compatibility fluid, and suitable test jars can be obtained from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

6.7 Recycled material. Unless otherwise specified herein, all equipment, material and articles used in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jepardizing the intended use. The term "recycled materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw material as opposed to virgin raw material. None of the above shall be interpreted to mean the use of used or rebuilt products are allowed under this specification.

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Army - ME

Review activities:
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