INTERNATIONAL STANDARD ISO 4925

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Road vehicles — Non-petroleum base brake fluid

Véhicules routiers — Liquide de frein à base non pétrolière

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ISO 4925-1978 (E)

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4925 was developed by Technical Committee ISO/TC 22, *Road vehicles*, and was circulated to the member bodies in June 1976.

It has been approved by the member bodies of the following countries :

Australia	Germany	Netherlands
Austria	Hungary	New Zealand
Belgium	Iran	Poland
Brazil	Italy	Sweden
Chile	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	United Kingdom
France	Mexico	Yugoslavia

The member bodies of the following countries expressed disapproval of the document on technical grounds :

South Africa, Rep. of
U.S.A.

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Annexes

Road vehicles – Non-petroleum base brake fluid

1 SCOPE

This International Standard lays down the characteristics and the test methods for the non-petroleum base brake fluid used in the hydraulic brake systems of road vehicles.

2 FIELD OF APPLICATION

The brake fluid described is for use in road vehicle hydraulic brake systems equipped with seals, cups or double-lipped type gland seals made from natural rubber (NR), styrene-butadiene rubber (SBR) and ethylene-propylene elastomer (EP); this brake fluid is not intended for use under arctic conditions.

3 REFERENCES

ISO 37, *Rubber, vulcanized – Determination of tensile stress-strain properties.*

ISO 48, *Vulcanized rubbers – Determination of hardness (hardness between 30 and 85 IRHD).*

ISO/R 301, *Zinc alloy ingots.*

ISO/R 812, *Method of test for temperature limit of brittleness for vulcanized rubbers.*

ISO 815, *Vulcanized rubbers – Determination of compression set under constant deflection at normal and high temperatures.*

ISO 1250, *Mineral solvents for paints – White spirits and related hydrocarbon solvents.*

ISO 1817, *Vulcanized rubbers – Resistance to liquids – Methods of test.*

ISO 3104, *Petroleum products – Transparent and opaque liquids – Determination of kinematic viscosity and calculation of dynamic viscosity.*

ISO 4926, *Road vehicles – Hydraulic brake systems – Non-petroleum base reference fluids.*

ASTM D 91, *Test for precipitation number of lubricating oils.*

ASTM D 664, *Test for neutralization number by potentiometric titration.*

ASTM D 865, *Test for rubber deterioration by heating in a test tube.*

ASTM D 1120, *Test for boiling point of engine antifreezes.*

ASTM D 1123, *Test for water in engine coolant concentrate by the iodine reagent method.*

ASTM D 3182, *Recommended practice for rubber – Materials, equipment and procedures for mixing standard compounds and preparing standard vulcanized sheets.*

ASTM D 3185, *Rubber – Evaluation of SBR (styrene-butadiene copolymers) including mixtures with oil.*

ASTM E 298, *Assay of organic peroxides.*

NOTE – The ASTM references will be replaced by ISO references when the latter become available.

4 MATERIALS

The quality of the materials used shall be such that the resulting product will conform to the requirements of this International Standard and ensure uniformity of performance. Colouring agents, if used, shall be such that the resulting colour will not be red or green. On visual inspection, the fluid shall be clear and free of suspended matter, dirt and sediment.

5 REQUIREMENTS

5.1 Equilibrium reflux boiling point (ERBP)[2)]

5.1.1 Brake fluid when tested by the procedure specified in 6.1.1 shall have an equilibrium reflux boiling point not less than 205 °C. (See also 6.1.4 and 6.1.5.)

5.1.2 *Wet equilibrium reflux boiling point*[1)]

Brake fluid when tested by the procedure specified in 6.1.6 shall have a wet equilibrium reflux boiling point not less than 140 °C.

1) Equilibrium reflux boiling point will be replaced by vapour lock measurements as soon as a suitable test method becomes available.

5.2 Viscosity

Brake fluid when tested by the procedure specified in 6.2 shall have the following kinematic viscosities :

5.2.1 *At* – 40 °C

Not more than 1 500 mm^2/s (1 500 cSt).

5.2.2 *At* 100 °C

Not less than 1,5 mm^2/s (1,5 cSt).

5.3 pH value

Brake fluid when tested by the procedure specified in 6.3 shall have a pH value not less than 7,0 and not more than 11,5.

5.4 Fluid stability

5.4.1 *High-temperature stability*

When tested by the procedure specified in 6.4, the equilibrium reflux boiling point of the brake fluid shall not change by more than 3,0 °C plus 0,05 °C for each degree that the boiling point exceeds 225 °C.

5.4.2 *Chemical stability*

When tested by the procedure specified in 6.4.2, the test fluid mixture shall show no chemical reversion as evidenced by a decrease in recorded temperature of more than 2,0 °C.

5.5 Corrosion

Brake fluid when tested by the procedure specified in 6.5 shall not cause corrosion exceeding the limits shown in the table. The metal strips outside of the area where the strips are in contact shall be neither pitted nor roughened to an extent discernible to the naked eye, but staining or discoloration is permitted.

TABLE – **Corrosion test strips and mass changes**

Test strips*	Maximum permissible mass change mg/cm^2 of surface area
Tinned iron	0,2
Steel	0,2
Aluminium	0,1
Cast iron	0,2
Brass	0,4
Copper	0,4
Zinc	0,4

* See annex B.

The fluid/water mixture at the end of the test shall show no jelling at 23 ± 5 °C. No crystalline-type deposit shall form and adhere to either the glass jar walls or the surface of the metal strips. The fluid/water mixture shall not contain more than 0,10 % sediment by volume. The fluid/water mixture shall have a pH of not less than 7,0 and not more than 11,5.

The rubber cups at the end of the test shall show no disintegration, as evidenced by blisters or sloughing indicated by carbon black separation on the surface of the rubber cup. The hardness of the rubber cup shall not decrease by more than 15 IRHD, the base diameter shall not increase by more than 1,4 mm and volume increase shall not be greater than 16 %.

5.6 Fluidity and appearance at low temperatures

5.6.1 *At* – 40 °C

When brake fluid is tested by the procedure specified in 6.6.1, the black contrast lines on a hiding power chart shall be clearly discernible when viewed through the fluid in the sample bottle. The fluid shall show no stratification or sedimentation and upon inversion of the sample bottle, the air bubble shall travel to the top of the fluid in not more than 10 s.

5.6.2 *At* – 50 °C

When brake fluid is tested by the procedure specified in 6.6.2, the black contrast lines on a hiding power chart shall be clearly discernible when viewed through the fluid in the sample bottle. The fluid shall show no stratification or sedimentation and upon inversion of the sample bottle, the air bubble shall travel to the top of the fluid in not more than 35 s.

5.7 Evaporation

When brake fluid is tested by the procedure specified in 6.7, loss by evaporation shall not exceed 80 % by mass. Residue from the brake fluid after evaporation shall contain no precipitate that remains gritty or abrasive when rubbed with the fingertip. Residue shall have a pour point below – 5 °C.

5.8 Water tolerance

5.8.1 *At* – 40 °C

When brake fluid is tested by the procedure specified in 6.8.1, the black contrast lines on a hiding power chart shall be clearly discernible when viewed through the fluid in the centrifuge tube. The fluid shall show no stratification or sedimentation. Upon inversion of the centrifuge tube, the air bubble shall travel to the top of the fluid in not more than 10 s.

5.8.2 *At* 60 °C

When brake fluid is tested by the procedure specified in 6.8.2, the fluid shall show no stratification, and sedimentation shall not exceed 0,05 % by volume after centrifuging when fluid is tested for qualification, or shall not exceed 0,15 % by volume for a commercial packaged fluid.

5.9 Compatibility

5.9.1 *At* −40 °C

When brake fluid is tested by the procedure specified in 6.9.1, the black contrast lines on a hiding power chart shall be clearly discernible when viewed through the fluid in the centrifuge tube. The fluid shall show no stratification or sedimentation.

5.9.2 *At* 60 °C

When brake fluid is tested by the procedure specified in 6.9.2, the fluid shall show no stratification, and sedimentation shall not exceed 0,05 % by volume after centrifuging.

5.10 Resistance to oxidation

Brake fluid when tested by the procedure specified in 6.10 shall not cause the metal strips outside the areas in contact with the tinfoil to be pitted or roughened to an extent discernible to the naked eye, but staining or discoloration is permitted. No more than a trace of gum shall be deposited on the test strips outside of the areas in contact with the tinfoil. The aluminium strips shall not change in mass by more than 0,05 mg/cm^2 and the cast iron strips shall not change in mass by more than 0,3 mg/cm^2.

5.11 Effect on rubber

5.11.1 Styrene-butadiene rubber brake cups subjected to brake fluid as specified in 6.11.1 shall show no increase in hardness, shall not decrease in hardness by more than 10 IRHD, and shall show no disintegration as evidenced by blisters or sloughing indicated by carbon black separation on the surface of the rubber cup. The increase in the diameter of the base of the cups shall not be less than 0,15 mm, or more than 1,4 mm. Volume increase shall not be less than 1 % or greater than 16 %.

5.11.2 Styrene-butadiene rubber brake cups subjected to brake fluid as specified in 6.11.2 shall show no increase in hardness, shall not decrease in hardness by more than 15 IRHD and shall show no disintegration as evidenced by blisters or sloughing indicated by carbon black separation on the surface of the rubber cup. The increase in the diameter of the base of the cups shall not be less than 0,15 mm, or more than 1,4 mm. Volume increase shall not be less than 1 % or greater than 16 %.

5.11.3 Natural rubber brake cups subjected to brake fluid as specified in 6.11.3 shall show no increase in hardness, shall not decrease in hardness by more than 10 IRHD and shall show no disintegration as evidenced by excessive blisters, or sloughing indicated by carbon black separation on the surface of the rubber cup. The increase in the diameter of the base of the cups shall not be less than 0,15 mm, or more than 1,4 mm. Volume increase shall not be less than 1 % or greater than 16 %.

5.12 Simulated service performance

Brake fluid when tested by the procedure specified in 6.12 shall meet the following performance requirements :

5.12.1 Metal parts shall not show corrosion as evidenced by pitting to an extent discernible to the naked eye, but staining or discoloration is permitted.

5.12.2 The initial diameter of any cylinder or piston shall not change by more than 0,13 mm during test.

5.12.3 Rubber cups shall not decrease in hardness by more than 15 IHRD and shall not be in an unsatisfactory operating condition as evidenced by excessive amounts of scoring, scuffing, blistering, cracking, chipping (heel abrasion), or change in shape from original appearance.

5.12.4 The base diameter of the rubber cups shall not increase by more than 0,9 mm.

5.12.5 The average lip diameter interference set of all the rubber cups in the test shall not be greater than 65 %.

5.12.6 During any period of 24 000 strokes the volume loss of fluid shall be not more than 36 ml.

5.12.7 The cylinder pistons shall not seize or function improperly throughout the test.

5.12.8 During the last 100 strokes at the end of the test, the volume loss of fluid shall not be more than 36 ml.

5.12.9 The fluid at the end of the test shall not be in an unsatisfactory operating condition as evidenced by sludging, jelling, or abrasive grittiness, and sedimentation shall not exceed 1,5 % by volume after centrifuging.

5.12.10 No more than a trace of gum shall be deposited on brake cylinder walls or other metal parts during test. The brake cylinders shall be free of deposits which are abrasive or which cannot be removed when rubbed with a cloth wetted with ethanol.

6 TEST METHODS

6.1 Equilibrium reflux boiling point (see figures 1 and 2)

6.1.1 Determine the equilibrium reflux boiling point of the fluid by ASTM D 1120, with the following exceptions in the apparatus used :

– thermometer, 76 mm immersion, calibrated;

– heat source : Use either a suitable variac-controlled heating mantle designed to fit the flask, or an electric heater with rheostat heat control. The heat source shall be capable of supplying the heat required to conform to the specified heating and reflux rates.

Dimensions in millimetres

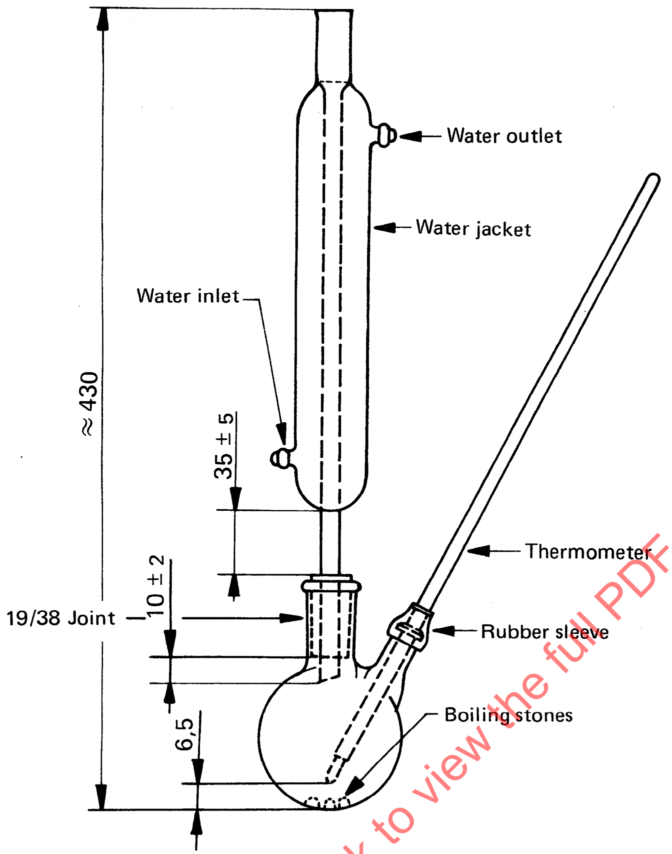


FIGURE 1 — **Boiling point test apparatus**

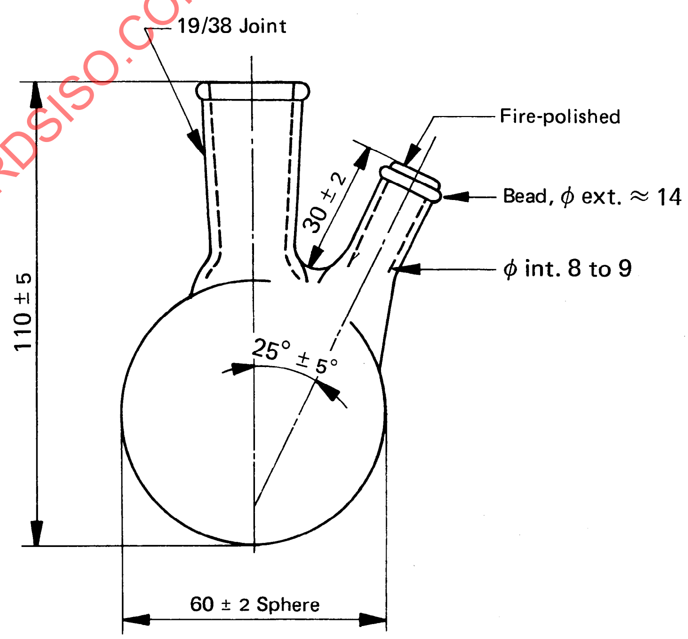


FIGURE 2 — **Detail of 100 ml short-neck flask**

6.1.2 *Preparation of apparatus*

Thoroughly clean and dry all glassware before use. Attach the flask to the condenser. When using a heating mantle, place the mantle under the flask and support it with a suitable ring clamp and laboratory-type stand, holding the whole assembly in place by a clamp. When using a rheostat-controlled heater, centre a standard porcelain or hard asbestos refractory, having a suitable diameter opening (32 to 38 mm), over the heating element of the electric heater and mount the flask on the refractory so that direct heat is applied to the flask only through the opening in the refractory.

NOTE — Place the whole assembly in an area free from draughts or other causes of sudden temperature changes.

6.1.3 *Procedure*

When everything is in readiness, turn on the condenser water and apply heat to the flask at such a rate that the fluid is refluxing in 10 ± 2 min at a rate in excess of 1 drop/s. The reflux rate shall not exceed 5 drops/s. Immediately adjust the heat input to obtain a specified equilibrium reflux rate of 1 to 2 drops/s over the next 5 ± 2 min period. Maintain a timed and constant equilibrium reflux rate of 1 to 2 drops/s for an additional 2 min; record the average value of four temperature readings taken at 30 s intervals as the equilibrium reflux boiling point.

6.1.4 205 *and* 232 °C *fluids*

Report the boiling point to the nearest degree Celsius. Duplicate runs which agree within 1 °C are acceptable for averaging (95 % confidence level).

6.1.4.1 REPEATABILITY (single analyst)

The standard deviation of results (each the average of duplicates), obtained by the same analyst on different days, has been estimated to be 0,4 °C at 72 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 1,5 °C.

6.1.4.2 REPRODUCIBILITY (multilaboratory)

The standard deviation of results (each the average of duplicates), obtained by analysts in different laboratories, has been estimated to be 1,8 °C at 17 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 5 °C.

6.1.5 288 °C *fluid*

Report the boiling point to the nearest degree Celsius. Duplicate runs which agree within 3 °C are acceptable for averaging (95 % confidence level).

6.1.5.1 REPEATABILITY (single analyst)

The standard deviation of results (each the average of duplicates), obtained by the same analyst on different days, has been estimated to be 1,3 °C at 34 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 4 °C.

6.1.5.2 REPRODUCIBILITY (multilaboratory)

The standard deviation of results (each the average of duplicates), obtained by analysts in different laboratories, has been estimated to be 3,5 °C at 15 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 10,5 °C.

6.1.6 *Wet equilibrium reflux boiling point*

6.1.6.1 APPARATUS

6.1.6.1.1 Corrosion test jars[1]. Four corrosion test jars or equivalent screw-top, straight-sided, round glass jars each having a capacity of about 475 ml and approximate inner dimensions of 100 mm height by 75 mm diameter, with matching lids having new, clean inserts providing water-vapour-proof seals.

6.1.6.1.2 Desiccator and cover. Four bowl-form glass desiccators, 250 mm inside diameter, having matching tubulated covers fitted with No. 8 rubber stoppers (see figure 3).

6.1.6.1.3 Desiccator plate. Four 230 mm diameter, perforated porcelain desiccator plates, without feet, glazed on one side.

6.1.6.2 Determine the wet ERBP of a brake fluid by running duplicate samples according to the following procedure (see figure 3).

A 100 ml sample of the brake fluid is humidified under controlled conditions; 100 ml of compatibility fluid (see ISO 4926) is used to establish the end point for humidification. After humidification, the water content and ERBP of the brake fluid are determined.

Lubricate the ground glass joint of the desiccator. Load each desiccator with 450 ± 25 g of ammonium sulphate and add 125 ± 10 ml of distilled water. The surface of the salt slurry shall lie within 45 ± 7 mm of the top surface of the desiccator plate. Place the desiccators in an area with temperature controlled at 23 ± 2 °C throughout the humidification procedure. Leave the desiccators with the slurry and allow to condition with the covers on and stoppers in place at least 12 h before use. Use a fresh charge of salt slurry for each test.

1) Suitable corrosion test jars and tinned steel lids may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096 U.S.A.

6.1.6.3 Pour 100 ± 1 ml of the brake fluid into a corrosion test jar. Promptly place the jar into a desiccator. Prepare duplicate test samples, and two duplicate specimens of the compatibility fluid. Adjust the water content of the compatibility fluid to 0,50 ± 0,05 % by mass at the start of the test. At intervals remove the rubber stopper in the top of each desiccator containing compatibility fluid. Using a long-needled hypodermic syringe, take a sample of not more than 2 ml from each jar and determine its water content. Remove no more than 10 ml of fluid from each reference sample during the humidification procedure. When the water content of the reference fluid reaches 3,50 ± 0,05 % by mass (average of the duplicates), remove the two test fluid specimens from their desiccators and promptly cap each jar tightly. Determine their ERBP's in accordance with 6.1.1 to 6.1.3. If the two ERBP's agree within 4 °C, average them to determine the wet ERBP; otherwise, repeat and average the four individual ERBP's as the wet ERBP of the brake fluid. Make all water content measurements according to ASTM D 1123-73.

6.2 Viscosity

6.2.1 Determine the kinematic viscosity of the fluid by ISO 3104.

6.2.2 Report the viscosity to the nearest 1 mm²/s at −40 °C and to the nearest 0,01 mm²/s at + 100 °C. Duplicate runs which agree within 1,2 % relative are acceptable for averaging (95 % confidence level).

6.2.2.1 REPEATABILITY (single analyst)

The coefficient of variation of results (each the average of duplicates) obtained by the same analyst on different days has been estimated to be 0,4 % at 47 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 1,2 %.

6.2.2.2 REPRODUCIBILITY (multilaboratory)

The coefficient of variation of results (each the average of duplicates) obtained by analysts in different laboratories has been estimated to be 1,0 % at 15 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 3,0 %.

6.3 pH value

Mix the fluid with an equal volume of an 80 %/20 % (*V/V*) ethanol/distilled water mixture neutralized to a pH of 7,0. Determine the pH of the resulting solution electrometrically at 23 ± 5 °C, using a pH meter equipped with a calibrated full range (0 to 14) glass electrode and a calomel reference electrode, as specified in ASTM D 664.

Prior to its use, adjust the pH of the ethanol/water mixture to 7,0 at 23 ± 5 °C using 0,1 N sodium hydroxide solution. If more than 4,0 ml of sodium hydroxide solution is required for neutralization, discard the mixture. All reagents used should be of a recognized analytical grade.

Dimensions in millimetres

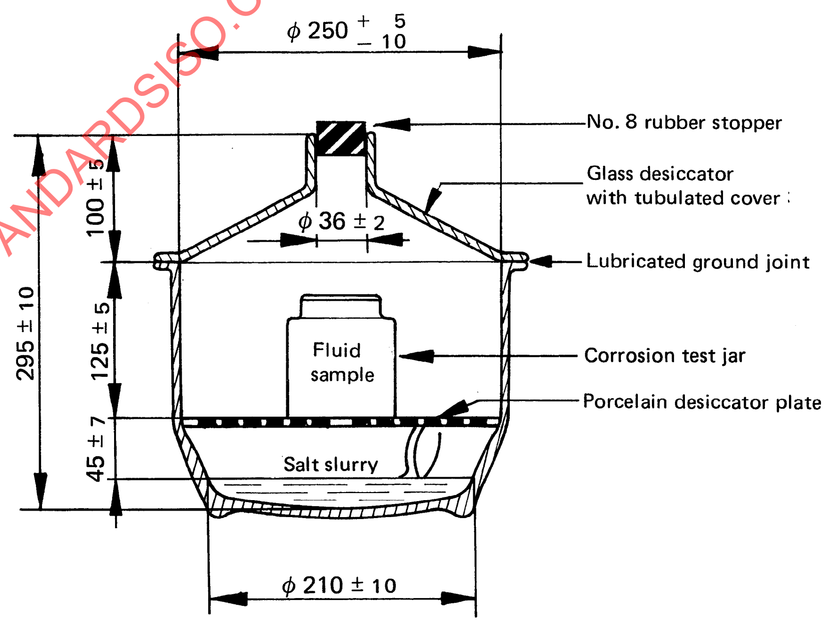


FIGURE 3 — **Humidification apparatus**

6.4 Fluid stability

6.4.1 *High-temperature stability*

Heat a new sample of the original test brake fluid to a temperature of 185 ± 2 °C by the procedure specified in 6.1 and maintain at that temperature for 2 h. Then determine the boiling point of this brake fluid as specified in 6.1. The difference between this observed boiling point and that previously determined in 6.1 shall be considered as the change in boiling point of the brake fluid.

6.4.2 *Chemical stability*

Mix 30 ml of brake fluid with 30 ml of compatibility fluid (see ISO 4926).

Determine the equilibrium reflux boiling point of this fluid mixture by use of the test apparatus specified in 6.1, applying heat to the flask at such a rate that the fluid is refluxing in 10 ± 2 min at a rate in excess of 1 drop/s. The reflux rate shall not exceed 5 drops/s. Record the maximum fluid temperature observed during the first minute after the fluid begins refluxing at a rate in excess of 1 drop/s. Over the next 15 ± 1 min, adjust and maintain the rate of reflux to 1 to 2 drops/s. Maintain a timed and constant equilibrium reflux rate of 1 to 2 drops/s for an additional 2 min; record the average value of four temperature readings taken at 30 s intervals as the final equilibrium reflux boiling point. Chemical reversion is evidenced by the decrease in temperature between the maximum fluid temperature recorded and the final equilibrium reflux boiling point.

6.5 Corrosion

Prepare two sets of strips from each of the metals listed in the table in 5.5, each strip having a surface area of 25 ± 5 cm² (approximately 8 cm long, 1,3 cm wide, and not more than 0,6 cm thick). Drill a hole between 4 and 5 mm in diameter and about 6 mm from one end of each strip. With the exception of the tinned iron strips, clean the strips by abrading them on all surfaces with 320 A silicon carbide paper and ISO 1250 white spirit until all surface scratches, cuts and pits are removed from the strips, using a new piece of silicon carbide paper for each different type of metal. With the exception of the tinned iron strips, polish the strips with 00 grade (very fine) steel wool, using a new piece of steel wool for each strip. Wash the strips, including the tinned iron, with 95 % ethanol, dry them with a clean, lint-free cloth and place them in a desiccator containing desiccant maintained at 23 ± 5 °C for at least 1 h. Handle the strips with clean forceps after polishing, to avoid fingerprint contamination.

Determine the mass of each strip to the nearest 0,1 mg and assemble each set of strips on an uncoated steel cotter pin or bolt in the order tinned iron, steel, aluminium, cast iron, brass, copper and zinc, so that the strips are in electrical contact. Bend the strips, except the cast iron, so that there is a separation of approximately 10 mm between two adjacent strips at their free ends. Immerse the strip assemblies in 95 % ethanol containing 5 % by volume of distilled water to eliminate fingerprints and then handle only with clean forceps. (See Annex E.)

Measure the base diameter of two standard SBR cups, described in annex A (figure 7), using an optical comparator or micrometer, to the nearest 0,02 mm along the centreline of the ISO and rubber type identifications and at right angles to this centreline. Take the measurements at least 0,4 mm and not more than 2,4 mm above the bottom edge and parallel to the base of the cup. Discard any cup if the two measured diameters differ by more than 0,08 mm. Take the average of the measurements on each cup. Determine the hardness of each cup thus supported by the procedure specified in ISO 48. If this International Standard cannot be used, another procedure may be selected, possibly using a rubber anvil (see figure 9a). Determine the volume change by the method given in 6.11.1

Place one rubber cup, with lip edge facing up, in each of two straight-sided round glass jars having a capacity of approximately 475 ml and inner dimensions of approximately 100 mm height and 75 mm diameter. Use only tinned steel lids vented with a hole 0,8 ± 0,1 mm in diameter.

Insert a metal strip assembly inside each cup with the pinned end in contact with the concavity of the cup and the free end extending upward in the jar. Mix 760 ml of brake fluid with 40 ml of distilled water.

Add a sufficient amount of the mixture to cover the metal strip assembly in each jar to a depth of approximately 10 mm above the tops of the strips. Tighten the lids and place the jars in a gravity convection oven maintained at 100 ± 2 °C for 120 ± 2 h. Allow the jars to cool at 23 ± 5 °C for 60 to 90 min. Immediately following the cooling period, remove the metal strips from the jars by use of forceps, removing loose adhering sediment by agitation of the metal strip assembly in the fluid in the jar. Examine the test strips and test jars for adhering crystalline deposit, disassemble the metal strips, remove adhering fluid by flushing with water and clean individual strips by wiping with a cloth wetted with 95 % ethanol. Examine the strips for evidence of corrosion and pitting. Place the strips in a desiccator containing a desiccant maintained at 23 ± 5 °C for at least 1 h. Determine the mass of each strip to the nearest 0,1 mg. Determine the difference in mass of each metal strip and divide the difference by the total surface area of the metal strip measured in square centimetres. Average the measured values of the duplicates. In the event of a marginal pass on inspection, or of a failure in only one of the duplicates, another set of duplicate test samples shall be run. Both repeat samples must meet all the requirements of 5.5.

Immediately following the cooling period, remove the rubber cups from the jars by use of forceps, removing loose adhering sediment by agitation of the cup in the fluid in the jar. Rinse the cups in 95 % ethanol and air-dry them. Examine the cups for evidence of sloughing, blisters, and other forms of disintegration. Measure the base diameter, hardness and volume of each cup within 15 min after removal from the fluid.

Examine the fluid/water mixture in the jars for presence of gel. Agitate the fluid in the jars to suspend and uniformly disperse sediment, transfer a 100 ml portion of this fluid to a cone-shaped centrifuge tube and determine percentage sediment as described in paragraphs 5 and 6 of ASTM D 91. Measure the pH value of the corrosion test fluid by the procedure specified in 6.3.

6.6 Fluidity and appearance at low temperatures

6.6.1 *At* – 40 °C

Place 100 ml of fluid in a glass sample bottle[1)] having a capacity of approximately 125 ml, an outside diameter of 37 ± 0,5 mm and an overall height of 165 ± 2,5 mm. Stopper the bottle with a cork and place in a cold bath maintained at – 40 °C ± 2 °C for 144 ± 4 h. Remove the bottle from the bath, quickly wipe the bottle with a clean, lint-free cloth saturated with ethanol or acetone, and determine the transparency of the fluid by placing the bottle against a hiding power test chart (see annex D) and observing the clarity of the contrast lines on the chart when viewed through the fluid. Examine the fluid for evidence of stratification and sedimentation. Invert the bottle and determine the number of seconds required for the air bubble to travel to the top of the fluid.

6.6.2 *At* – 50 °C

Place 100 ml of fluid in a glass sample bottle[1)] having a capacity of approximately 125 ml, an outside diameter of 37 ± 0,5 mm and an overall height of 165 ± 2,5 mm. Stopper the bottle with a cork and place in a cold bath maintained at – 50 ± 2 °C for 6 ± 0,2 h. Remove the bottle from the bath, quickly wipe the bottle with a clean, lint-free cloth saturated with ethanol or acetone, and determine the transparency of the fluid by placing the bottle against a hiding power test chart and observing the clarity of the contrast lines on the chart when viewed through the fluid. Examine the fluid for evidence of stratification or sedimentation. Invert the bottle and determine the number of seconds required for the air bubble to travel to the top of the fluid.

6.7 Evaporation

Take four covered Petri dishes approximately 100 mm in diameter and 15 mm high, and determine the tare mass with the cover in place to the nearest 0,01 g. Place approximately 25 ml of fluid in each of the four tared Petri dishes, replace the proper covers and redetermine the mass to the rearest 0,01 g. Determine the mass of fluid from the difference in mass of the filled and empty dishes.

Place the dishes inside the inverted covers in a top-vented gravity-convection oven at 100 ± 2 °C and maintain this temperature for 46 ± 2 h. **Do not simultaneously heat more than one fluid in the same oven.**

Remove the dishes from the oven. Allow to cool to 23 ± 5 °C with covers on and determine the mass of each dish. Return all dishes to the oven for an additional 24 ± 2 h. If at the end of 70 ± 4 h the average loss is less than 60 %, discontinue the test and report the average value; otherwise, continue this procedure either until equilibrium is reached, as evidenced by an average incremental mass loss of less than 0,25 g in 22 h on all individual dishes, or for a maximum of 7 days. Calculate the percentage of fluid evaporated from each dish. Average the percentage evaporated from all four dishes to determine the loss by evaporation.

Examine the residue in the dishes at the end of 1 h at 23 ± 5 °C. Rub any sediment with the fingertip to test for grittiness or abrasiveness.

Combine the residue from the four dishes in an oil sample bottle, store in a vertical position at – 5 ± 1 °C for 60 ± 10 min, then remove quickly and turn to the horizontal. The residue must flow at least 5 mm along the tube wall within 5 s.

6.8 Water tolerance

6.8.1 *At* – 40 °C

Mix 3,5 ml of distilled water with 100 ml of fluid and pour the mixture into a cone-shaped centrifuge tube. Stopper the tube with a cork and place in a cold bath maintained at – 40 ± 2 °C for 22 ± 2 h. Remove the centrifuge tube from the bath, quickly wipe the tube with a clean, lint-free cloth saturated with ethanol or acetone, and determine the transparency of the fluid by placing the tube against a hiding power test chart and observing the clarity of the contrast lines on the chart when viewed through the fluid. Examine the fluid for evidence of stratification and sedimentation. Invert the tube and determine the number of seconds required for the air bubble to travel to the top of the fluid. (The air bubble shall be considered to have reached the top of the fluid when the top of the bubble reaches the 2 ml graduation of the centrifuge tube.)

6.8.2 *At* 60 °C

Place the centrifuge tube from 6.8.1 in an oven maintained at 60 ± 2 °C for 22 ± 2 h. Remove the tube from the oven and immediately examine the contents for evidence of stratification. Determine percentage sediment by volume as described in paragraphs 5 and 6 of ASTM D 91.

6.9 Compatibility

6.9.1 *At* – 40 °C

Mix 50 ml of fluid with 50 ml of the compatibility fluid (see ISO 4926), pour this mixture into a cone-shaped centrifuge tube and stopper with a cork. Place the centrifuge tube for 22 ± 2 h in a bath maintained at – 40 ± 2 °C. Remove the centrifuge tube from the bath, quickly wipe the tube with a clean, lint-free cloth saturated with ethanol or acetone, and determine the transparency of the fluid by placing the tube against a hiding power test chart and observing the clarity of the contrast lines on the chart when viewed through the fluid. Examine the fluid for stratification and sedimentation.

1) Sample bottles may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096, U.S.A.

6.9.2 *At* 60 °C

Place the centrifuge tube mentioned in 6.9.1 in an oven maintained at 60 ± 2 °C for 22 ± 2 h. Remove the tube from the oven and immediately examine the contents for evidence of stratification. Determine percentage sediment by volume as described in paragraphs 5 and 6 of ASTM D 91.

6.10 Resistance to oxidation

Prepare two sets of aluminium and cast iron test strips (as listed in the table in 5.5) by the procedure specified in 6.5. Determine the mass of each strip to the nearest 0,1 mg and assemble a strip of each metal on an uncoated steel cotter pin or bolt, separating the strips at each end with a piece of tinfoil[1)] (99,9 % tin 0,025 % lead, max.) approximately 12 mm square and between 0,02 and 0,06 mm in thickness.

Place 30 ± 1 ml of fluid in a small glass bottle approximately 120 ml in capacity. Add 60 ± 2 mg of reagent grade benzoyl peroxide and 1,5 ± 0,05 ml of distilled water to the bottle. (Benzoyl peroxide that is brownish or dusty, or has less than 90 % purity must be discarded. Reagent strength should be evaluated according to ASTM E 298). Stopper the bottle and shake the contents, avoiding contact of the solution with the stopper. Place the bottle in an oven at 70 ± 2 °C for 120 ± 10 min, shaking every 15 min to effect solution of the peroxide. Remove the bottle from the oven, do not disturb the stopper, and cool in air at room temperature (23 ± 5 °C) for 2 h.

Place approximately 1/8 section of a standard SBR cup described in annex A in the bottom of each of two test tubes about 22 mm in diameter and 175 mm in length. Add 10 ml of prepared test fluid to each test tube. Place a metal-strip assembly in each tube with the end of the strips resting on the rubber, the solution covering about one-half the length of the strips, and the end having the cotter pin remaining out of the solution. Stopper the tubes with corks and store upright for 70 ± 2 h at 23 ± 5 °C. Loosen the stoppers and place the tubes for 168 ± 2 h in an oven maintained at 70 ± 2 °C. After the heating period, remove and disassemble the metal strips. Examine the strips for gum deposits. Wipe the strips with a cloth saturated with 95 % ethanol and examine for pitting or roughening of the surface. Place the strips in a desiccator containing a desiccant maintained at 23 ± 5 °C for at least 1 h. Determine the mass of each strip to the nearest 0,1 mg.

Determine the corrosion loss by dividing the difference in mass of each metal strip by the total surface area of each metal strip measured in square centimetres. Average the measured values of the duplicates. In the event of a marginal pass on inspection, or of a failure in only one of the duplicates, another set of duplicate test samples shall be run. Both repeat samples must meet all the requirements of 5.10.

6.11 Effect on rubber

Use standard ISO natural rubber and SBR cups described in annex C and annex A respectively. Measure the base diameter and hardness of all cups as described in 6.5, discarding any cup whose diameters differ by more than 0,08 mm.

Determine the mass of the cups in air (m_1) to the nearest 1 mg and then determine the apparent mass of the cup immersed in distilled water at room temperature (m_2). Quickly dip each specimen in alcohol and then blot dry with filter paper free of lint and foreign material.

6.11.1 *Test at* 70 °C

Place two ISO SBR cups in a straight-sided round glass jar[1)] having a capacity of approximately 250 ml and inner dimensions of approximately 125 mm height and 50 mm diameter, and a tinned steel lid. Add 75 ml of fluid to the jar. Heat the prepared glass jars for 120 ± 2 h at 70 ± 2 °C. Allow the jar to cool at 23 ± 5 °C for 60 to 90 min. Remove the cups from the jar, wash quickly with 95 % ethanol and air-dry the cups. Examine the cups for disintegration as evidenced by blisters or sloughing.

After removal from the alcohol and drying, place each cup in a separate, tared, stoppered weighing bottle and determine the mass (m_3). Remove each cup from its weighing bottle and determine the apparent mass immersed in distilled water (m_4) to determine water displacement after hot fluid immersion. Measure the base diameter and hardness of each cup within 15 min after removal from the fluid.

Volume change shall be reported as a percentage of the original volume. The calculation shall be made using the formula :

$$\%\ \text{change in volume} = \frac{(m_3 - m_4) - (m_1 - m_2)}{(m_1 - m_2)} \times 100$$

where

m_1 is the initial mass, in grams, in air;

m_2 is the apparent initial mass, in grams, in water;

m_3 is the mass, in grams, in air after immersion in test fluid;

m_4 is the apparent mass, in grams, in water after test.

6.11.2 *Test at* 120 °C

Place two standard SBR cups in a straight-sided round glass jar having a capacity of approximately 250 ml and inner dimensions of approximately 125 mm height and 50 mm diameter, and a tinned steel lid. Add 75 ml of fluid to the jar and heat for 70 ± 2 h at 120 ± 2 °C. Allow the jar to cool at 23 ± 5 °C for 60 to 90 min. Remove the cups from the jars, wash quickly with 95 % ethanol and air-dry the cups. Examine the cups for disintegration as evidenced by blisters or sloughing.

1) Tinfoil, and suitable test jars and tinned steel lids may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096, U.S.A.

After removal from the alcohol and drying, place each cup in a separate, tared, stoppered weighing bottle and determine the mass (m_3). Remove each cup from its weighing bottle and determine the mass immersed in distilled water (m_4) to determine water displacement after hot fluid immersion. Measure the base diameter and hardness of each cup within 15 min after removal from the fluid.

Volume change shall be reported as a percentage of the original volume. The calculation shall be made using the formula :

$$\% \text{ change in volume} = \frac{(m_3 - m_4) - (m_1 - m_2)}{(m_1 - m_2)} \times 100$$

6.11.3 Repeat test 6.11.1 using ISO natural rubber cups described in annex C.

6.11.4 Report the rubber swell to the nearest 0,03 mm. Duplicate results which agree within 0,10 mm are acceptable for averaging (95 % confidence level).

6.11.4.1 REPEATABILITY (single analyst)

The standard deviation of results (each the average of duplicate determinations) obtained by the same analyst on different days has been estimated to be 0,05 mm at 46 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 0,13 mm.

6.11.4.2 REPRODUCIBILITY (multilaboratory)

The standard deviation of results (each the average of duplicates) obtained by analysts in different laboratories has been estimated to be 0,08 mm at 7 degrees of freedom. Two such values should be considered suspect (95 % confidence level) if they differ by more than 0,20 mm.

6.12 Simulated service performance

Use the following procedure to evaluate the lubrication quality of the brake fluid.

6.12.1 *Test apparatus and materials*[1)]

Use the stroking fixture type apparatus shown in **figure 5** with the following components arranged as shown in **figure 4**.

6.12.1.1 MASTER CYLINDER ASSEMBLY

One cast iron housing hydraulic brake system cylinder having a diameter of approximately 28 mm and fitted with an uncoated steel standpipe.

6.12.1.2 BRAKE CYLINDER ASSEMBLIES

Four cast iron housing, straight bore hydraulic brake wheel cylinder assemblies having diameters of approximately 28 mm.

With the stroking fixture apparatus, four fixture units are required, including appropriate adapter mounting plates to hold brake wheel cylinder assemblies as shown in figure 5.

6.12.1.3 BRAKING PRESSURE ACTUATING MECHANISM (AIR OR HYDRAULIC)

A suitable actuating mechanism for applying a force to the master cylinder push rod without side thrust.

The amount of force applied by the actuating mechanism shall be adjustable and capable of applying sufficient thrust to the master cylinder to create a pressure of at least 7 MPa in the simulated brake system. A pressure gauge or pressure recorder, having a range of at least 0 to 7 MPa, shall be installed between the master cylinder and the brake assemblies and shall be provided with a shut-off valve and with a bleeding valve for removing air from the connecting tubing.

The actuating mechanism shall be designed to permit adjustable stroking rates of approximately 1 000 strokes/h. A mechanical or electrical counter shall be used to record the total number of strokes.

6.12.1.4 HEATED AIR BATH CABINET

An insulated cabinet or oven having sufficient capacity to house the four fixture assemblies, master cylinder, and necessary connections. A suitable thermostatically controlled heating system is required to maintain a temperature of 120 ± 5 °C. Heaters shall be shielded to prevent direct radiation to wheel or master cylinders.

6.12.2 *Preparation of test apparatus*

6.12.2.1 WHEEL CYLINDER ASSEMBLIES

Use new wheel cylinder assemblies having diameters as specified in 6.12.1.2. Pistons shall be made from unanodized SAE AA 2024 aluminium alloy. Disassemble the cylinders and discard rubber cups. Clean all metal parts with ethanol 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 ethanol. If stains cannot be removed, discard the cylinder.

Measure the internal diameter of each cylinder at locations approximately 19 mm from each end of the cylinder bore, taking measurements in line with the hydraulic inlet opening and at right angles to this centreline. Discard the cylinder if any of these four readings exceeds maximum or minimum limits of 28,55 and 28,52 mm. Select parts to ensure that the clearance between each piston and mating cylinder is within 0,08 and 0,13 mm.

1) Test apparatus components may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096, U.S.A.

Dimensions in millimetres

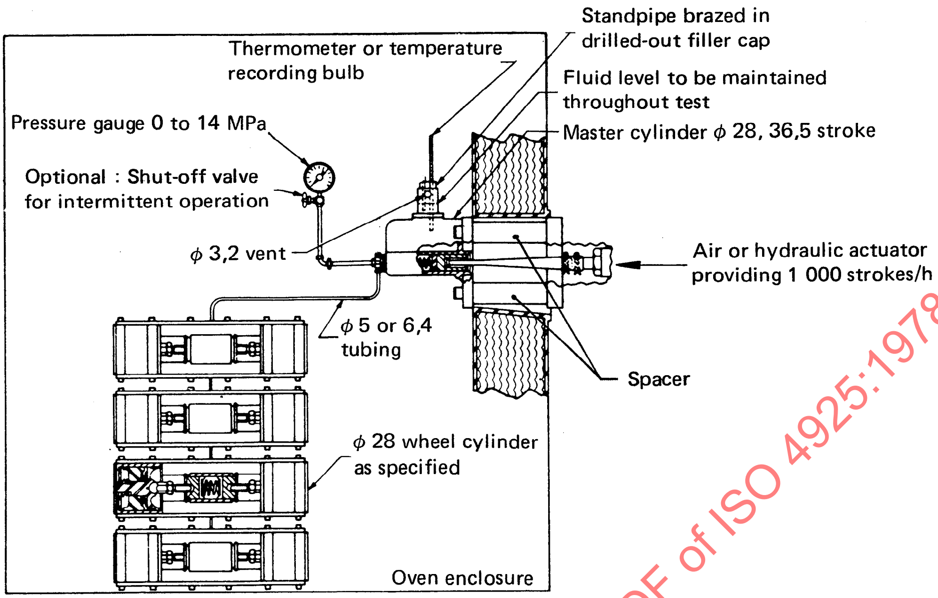
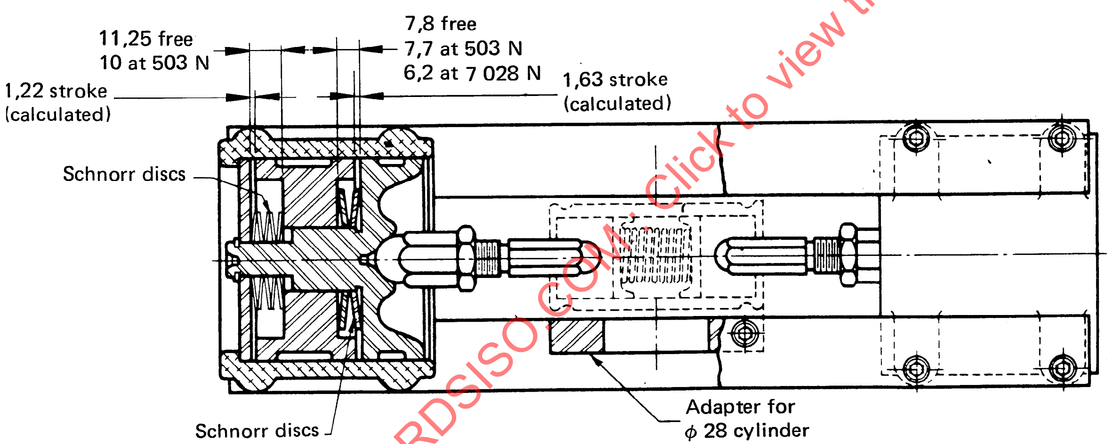


FIGURE 4 — **Stroking test apparatus**



NOTE — Lubricate all moving parts of fixture with multipurpose grease containing min. 3 % MoS_2 or equivalent.

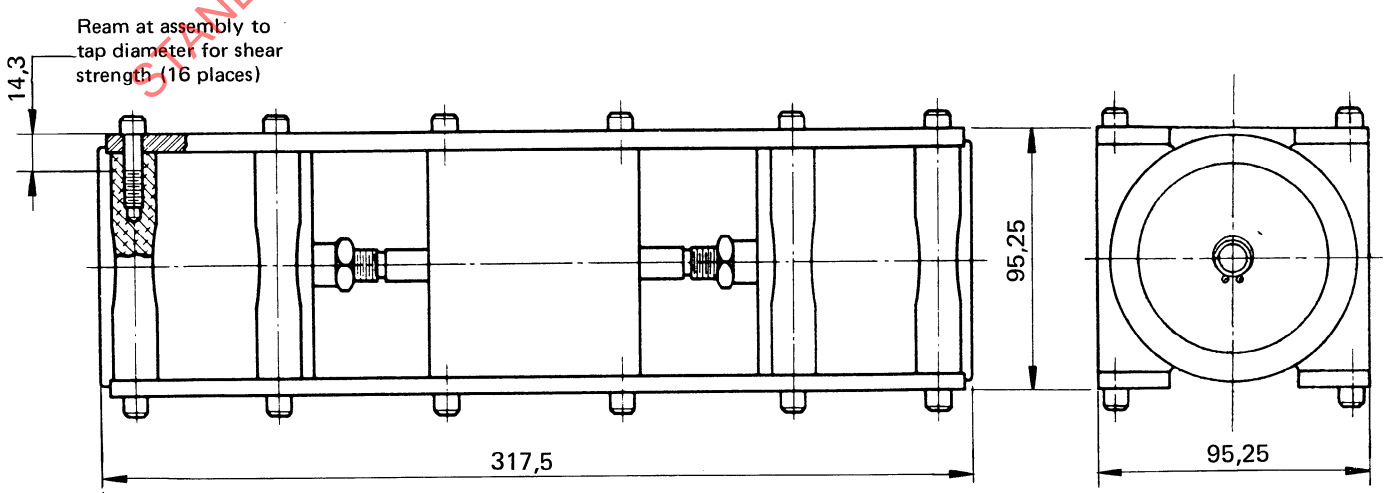


FIGURE 5 — **Detail of figure 4**

Use new ISO SBR cups as specified in figure 7 in annex A, that are free of lint and dirt. Discard any cups showing defects such as cuts, moulding flaws, or blisters. Measure the lip and base diameters of all test cups with an optical comparator or a micrometer to the nearest 0,02 mm along the centreline of ISO and rubber type identifications and at right angles to this centreline. Determine base diameter measurements at least 0,4 mm above the bottom edge and parallel to the base of the cup. Discard any cup where the two measured lip or base diameters differ by more than 0,08 mm. Average the lip and base diameters of each cup. Determine the hardness of all cups by the procedure specified in 6.5. Clean rubber parts with ethanol and lint-free cloth. Dry with clean compressed air. Dip the rubber and metal parts of wheel cylinders, except housings and rubber boots, in the fluid to be tested and install them in accordance with the manufacturer's instructions. Manually stroke the cylinders to ensure that they operate easily. Install cylinders in the simulated brake system.

6.12.2.2 MASTER CYLINDER ASSEMBLY

Use a new master cylinder having a piston made from SAE CA 360 copper-base alloy (half hard) and new standard SBR cups as specified in figures 8 and 9 in annex A, which have been inspected, measured and cleaned in the manner specified in 6.12.2.1. However, prior to determining the lip and base diameters of the secondary cup, dip the cup in test brake fluid, assemble on the piston, and maintain the assembly in a vertical position at 23 ± 5 °C for at least 12 h.

Inspect the relief and supply ports of the master cylinder and discard the cylinder if these ports have burrs or wire edges. Measure the internal diameter of the cylinder at two locations : approximately midway between the relief and supply ports and approximately 19 mm beyond the relief port toward the bottom or discharge end of the bore, taking measurements at each location on the vertical and horizontal centrelines of the bore. Discard the cylinder if any reading exceeds maximum or minimum limits of 28,65 and 28,57 mm. Measure each of the outside diameters of the master cylinder piston at two points approximately 90° apart. Discard the piston if any of these four readings exceeds maximum or minimum limits of 28,55 and 28,52 mm.

Dip the rubber and metal parts of the master cylinder, except housing and push rod-boot assembly, in the fluid to be tested and install them in accordance with manufacturer's instructions. Manually stroke the master cylinder to ensure that it operates easily. Install the master cylinder in the simulated brake system.

6.12.2.3 Use double wall steel tubing. A complete replacement of tubing is essential when visual inspection indicates any corrosion or deposits on the inner surface of the tubing. Tubing from the master cylinder to one wheel cylinder shall be replaced for each test (minimum length 0,9 m).

Uniformity in tubing size is desirable between master cylinder and wheel cylinders.

The standard master cylinder has two outlets for tubing, both of which should be used.

Typical master cylinder cup stroke versus pressure using fixture of figure 4.

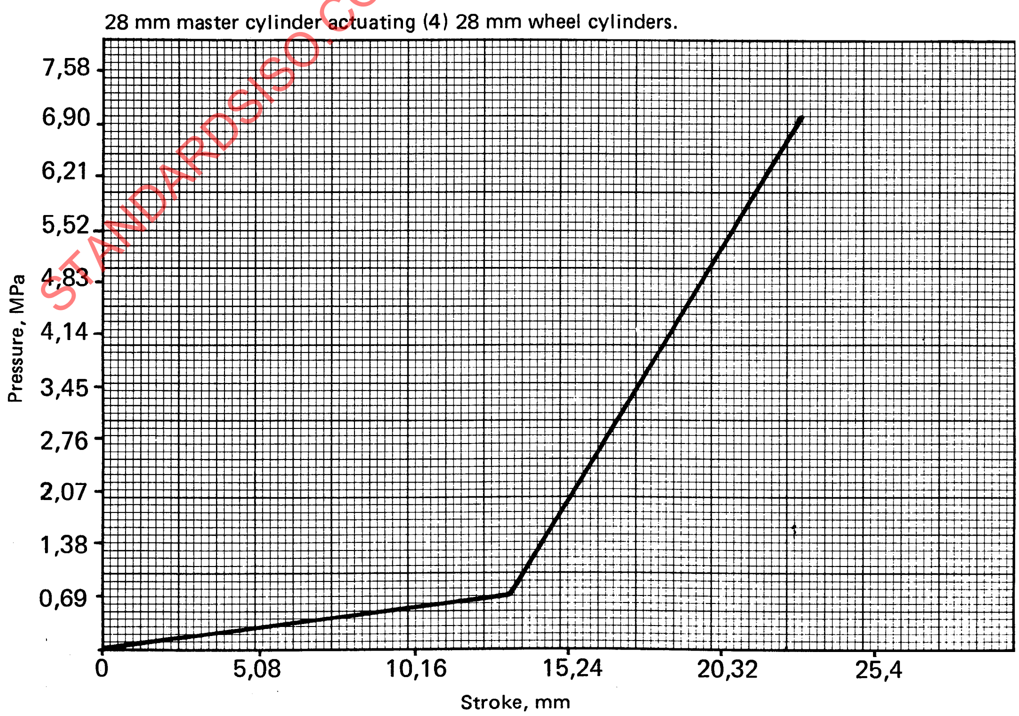


FIGURE 6 — **Master cylinder piston stroke**

6.12.2.4 ASSEMBLY AND ADJUSTMENT OF TEST APPARATUS

Install the wheel and master cylinders. Fill the system with test fluid, bleeding all wheel cylinders and the pressure gauge, 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 to obtain a pressure of 7 ± 0,3 MPa.

Figure 6 illustrates the approximate pressure build-up versus the master cylinder piston movement with the stroking fixture apparatus illustrated in figures 4 and 5. The pressure is relatively low during the first part of the stroke and then builds up to 7 ± 0,3 MPa at the end of the stroke of approximately 23 mm. This permits the primary cup to pass the compensating hole at a relatively low pressure. The wheel cylinder piston travel is about 2,5 ± 0,25 mm when a pressure of 7 ± 0,3 MPa is reached.

Adjust the stroking rate to 1 000 ± 100 strokes/h. Record the fluid level in the master cylinder standpipe.

6.12.3 *Test procedure*

6.12.3.1 Operate the system for 16 000 ± 1 000 cycles at 23 ± 5 °C. Repair any leakage and add fluid to the master cylinder standpipe to bring to the level originally recorded.

Start the test again and raise the temperature of the cabinet within 6 ± 2 h to 120 ± 5 °C. During the test, observe the operation of the wheel cylinders for improper functioning and record the amount of fluid required to replenish any loss at intervals of 24 000 strokes. Stop the test at the end of 85 000 total recorded strokes, which shall include the number of strokes during operation at 23 ± 5 °C and the number of strokes required to bring the system to the operating temperature of 120 ± 5 °C. Allow the equipment to cool to room temperature. Examine the wheel cylinders for excessive leakage. Stroke the assembly an additional 100 strokes, examine the wheel cylinders for leakage and record the volume loss of fluid.

Within 16 h, remove the master and wheel cylinders from the system, retaining the fluid in the cylinders by immediately capping or plugging the parts. Disassemble the cylinders, collecting the fluid from the master cylinder and wheel cylinders in a glass jar. When collecting the stroked fluid, all the residue which has deposited on rubber and metal internal parts should be removed by rinsing and agitating such parts in the stroked fluid and using a soft brush to ensure that all loose adhering sediment is collected. Clean rubber cups in ethanol and dry with compressed air. Examination of the rubber shall not show a decrease in hardness of more than 15 IRHD and shall not reveal an unsatisfactory operating condition as evidenced by excessive amounts of scoring, scuffing, blistering, cracking, chipping (heel abrasion), or change in shape from the original appearance.

Within 1 h after disassembly, measure the lip and base diameters of each cylinder cup by the procedures specified in 6.12.2.1 and 6.12.2.2, with the exception that lip or base diameters of cups may differ by more than 0,08 mm. Determine the hardness of each cup by the procedure specified in 6.5.

Record any sludge, gel or abrasive grit present in the test fluid. Within 1 h after draining the cylinders, agitate the fluid in the glass jar to suspend and uniformly disperse sediment and transfer a 100 ml portion of this fluid to a cone-shaped centrifuge tube and determine the percentage sediment as described in paragraphs 5 and 6 of ASTM D 91. Inspect the cylinder parts, recording any gumming or any pitting on pistons and cylinder walls. Rub any deposits adhering to cylinder walls with a cloth wetted with ethanol to determine abrasiveness and removability. Clean the cylinder parts in ethanol and dry with compressed air. Measure and record the diameters of the pistons and cylinders by the procedures specified in 6.12.2.1 and 6.12.2.2. Calculate lip diameter interference set by the following formula :

$$\text{\% Lip diameter interference set} = \frac{d_1 - d_2}{d_1 - d_3} \times 100$$

where

d_1 is the original lip diameter;

d_2 is the final lip diameter;

d_3 is the original cylinder bore diameter.

Repeat the test if mechanical failure occurs that may affect the evaluation of the test fluid.

ANNEX A

ISO STYRENE-BUTADIENE RUBBER (SBR) BRAKE CUPS FOR TESTING BRAKE FLUID COMPLYING WITH ISO 4925

A.1 COMPOSITION

Ingredient	Parts by mass
SBR type 1503*	100
Oil furnace black (NBS 378)	40
Zinc oxide (NBS 370)	5
Sulphur (NBS 371)	0,25
Stearic acid (NBS 372)	1
n-tertiary butyl-2-benzothiazole sulphenamide (NBS 384)	1
Symmetrical-dibetanaphthyl-*p*-phenylenediamine	1,5
Dicumyl peroxide (40 % on precipitated $CaCO_3$)**	4,5
TOTAL	153,25

* Philprene 1503 has been found suitable.

** Use only within 90 days of manufacture and store at a temperature below 27 °C.

NOTE — Ingredients labelled (NBS . . .) must have properties technically equivalent to those supplied by the National Bureau of Standards (U.S.A.).

A.2 PROCEDURE FOR MIXING RUBBER COMPOUND

The rubber compound shall be mixed in accordance with the procedure given in ASTM D 3185 for formula 2B.

A.3 PROPERTIES OF THE RUBBER COMPOUND

Vulcanizates cured for 12 min at 180 °C by the procedure described in ASTM D 3185 shall meet the following requirements :

Property	Requirement	Method
Hardness	63 ± 3	ISO 48
Tensile strength	17,5 MPa, min.	ISO 37
Ultimate elongation	350 %, min.	ISO 37
Tensile strength after 70 h at 125 °C	30 % decrease, max.	ASTM D 865
Ultimate elongation after 70 h at 125 °C	50 % decrease, max.	ASTM D 865
Hardness after 70 h at 125 °C	0 to 10 increase	ISO 48
Compression set after 22 h at 125 °C	15 to 20 %	ISO 815
Brittleness temperature	– 40 °C, max.	ISO/R 812

A.4 BRAKE CUPS PREPARED FROM RUBBER COMPOUND

Standard brake cups conforming to figures 7, 8 and 9 may be obtained from

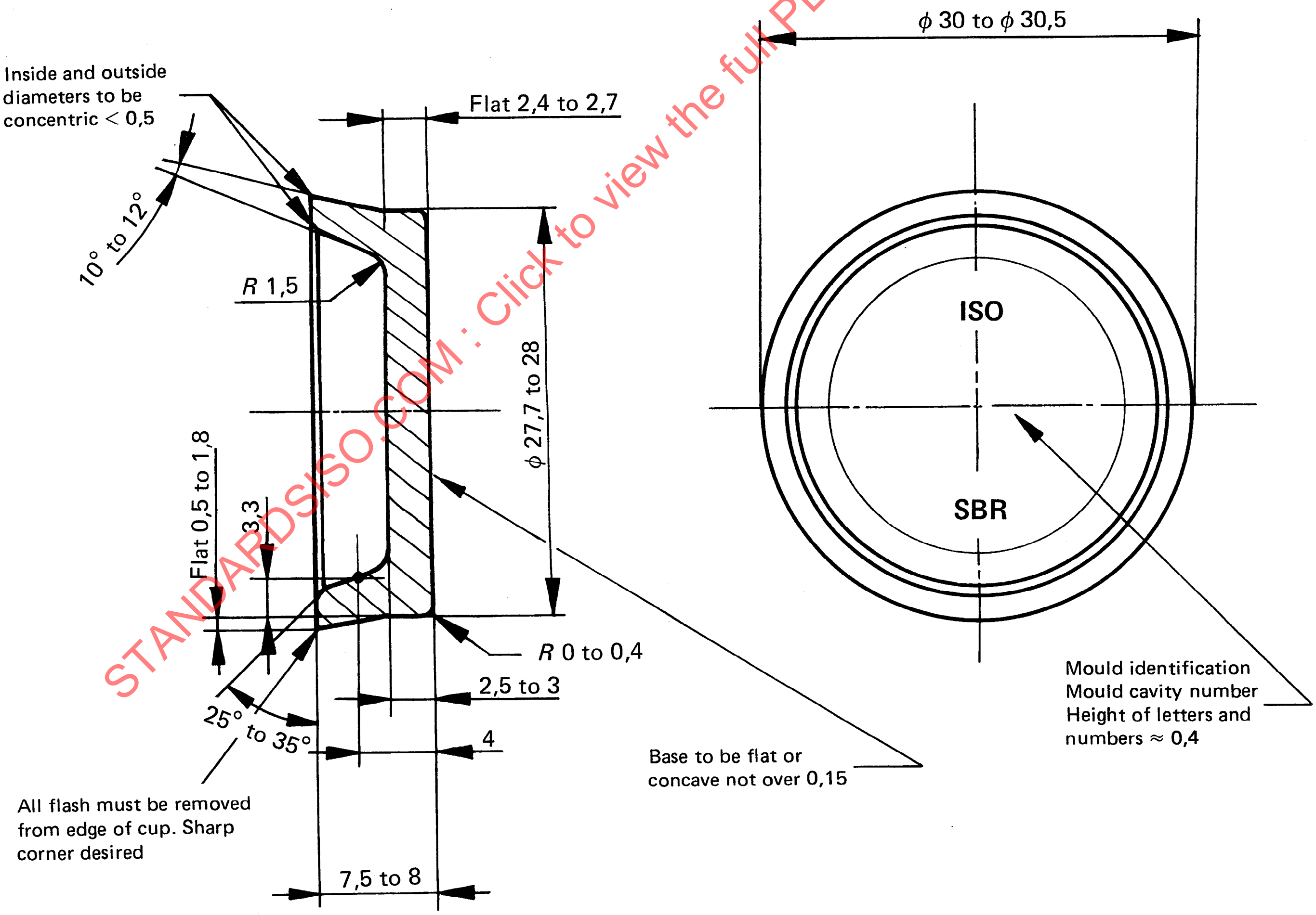
Society of Automotive Engineers, Inc.,
400 Commonwealth Drive,
Warrendale, Pa. 15096, U.S.A.

or

Laboratoire de recherches et de contrôle du caoutchouc
12, rue Carvès
92120 Montrouge, France

Brake cups shall be prepared from the rubber compound by vulcanization under the conditions required to obtain the properties given in clause A.3. The dimensions of the cups shall be suitable for the brake cylinders used to determine simulated service performance. The cups shall be used in testing brake fluids either within 6 months from date of manufacture when stored at room temperature below 30 °C or within 36 months from date of manufacture when stored at temperatures below – 15 °C. After removal of cups from storage they shall be conditioned base down on a flat surface for at least 12 h at room temperature in order to allow them to reach their true configuration before measurement.

Dimensions in millimetres

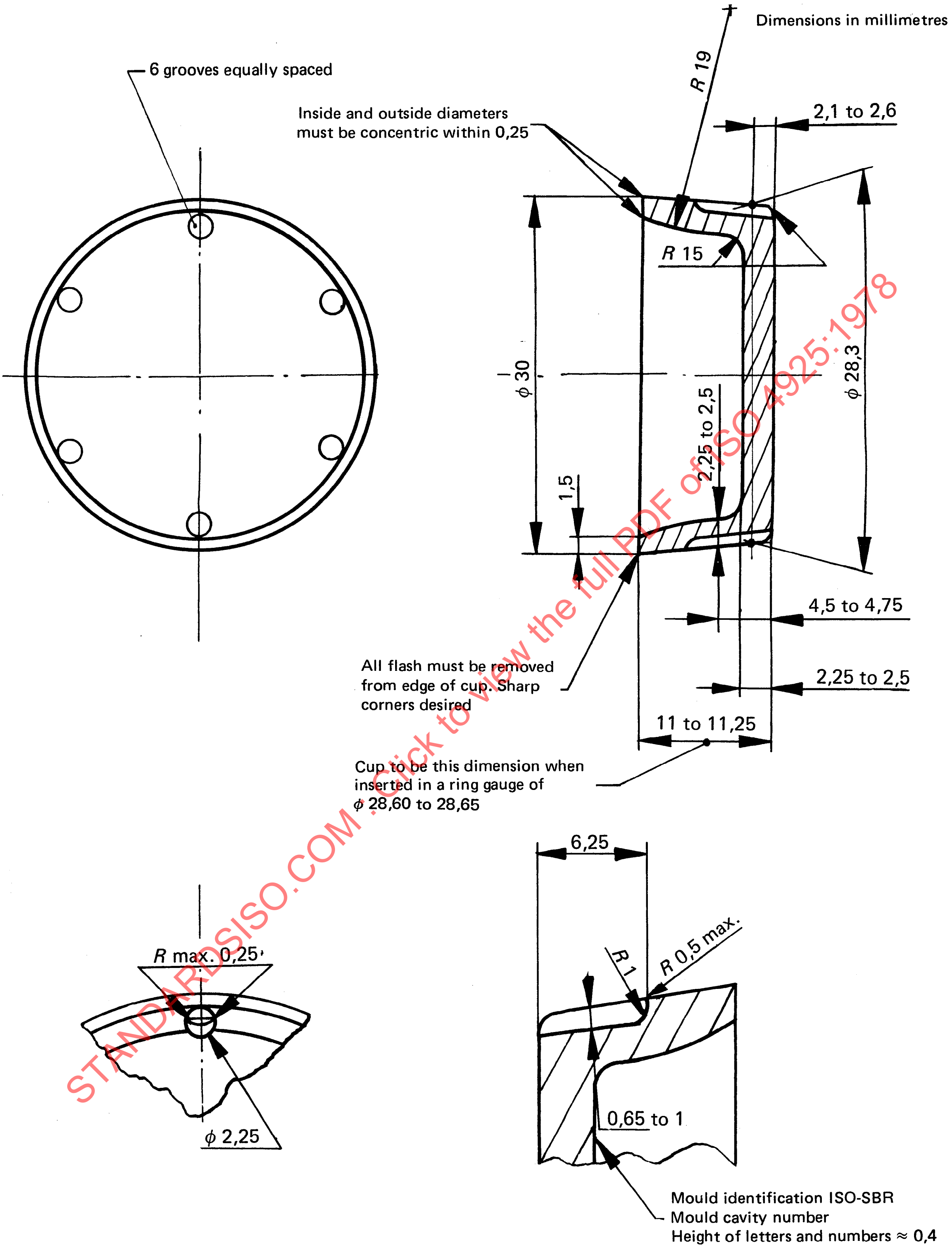


Unless otherwise specified, tolerances on dimensions are :

linear : ± 0,25;
angular : ± 30′.

Smooth finish all over cup, to be free of foreign substances and moulding imperfections.

FIGURE 7 — **ISO test brake cup for wheel cylinder**



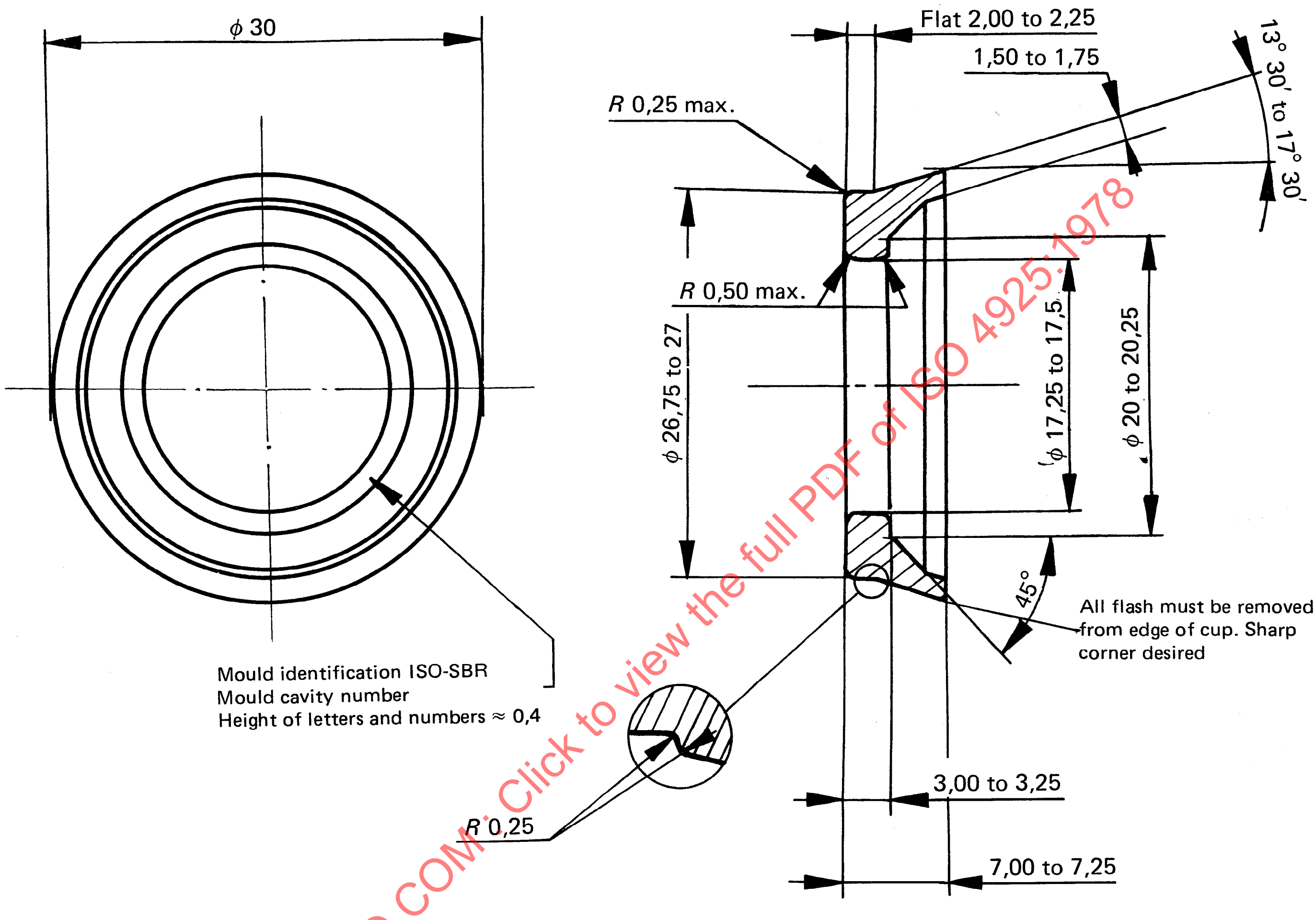
Unless otherwise specified, tolerances on dimensions are :

linear : ± 0,25;
angular : ± 30′.

Smooth finish all over cup, to be free of foreign substances and moulding imperfections.

FIGURE 8 — **ISO test brake cup for primary master cylinder**

Dimensions in millimetres

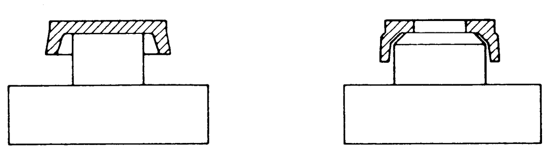


Unless otherwise specified, tolerances on dimensions are :

linear : ± 0,25;
angular : ± 30 ′.

Smooth finish all over cup, to be free of foreign substances and moulding imperfections.

FIGURE 9 — **ISO test brake cup for secondary master-cylinder**



Single lip seal | **Secondary seal**

FIGURE 9a) — **Anvils for measuring hardness**

Material for anvils : Rubber having hardness in same range (± 5 IRHD) as a seal being tested.

ANNEX B

ISO CORROSION TEST STRIPS

Corrosion test strip	Material specification	General material data	Dimensions	Thickness	Surface requirements
Tinned iron	ASTM A – 624 Fed. Spec. QQ – T – 425 A	Tinplate, electrolytic bright sr type Mr. T – 3 No. 25 85 lb	Length ≈ 8 cm Width ≈ 1,3 cm Surface area = 25 ± 5 cm^2	as purchased	As sheared. Clean and uniform tinning
Steel	SAE 1018	Low carbon sheet, cold-rolled, hardness 40 to 72 HB		≈ 0,2 cm	Edges machined to remove shearing marks. Clean uniform surfaces
Aluminium	SAE AA 2024	Wrought aluminium alloy, temper T 3, hardness 75 HB typical		≈ 0,2 cm	Edges machined to remove shearing marks. Clean uniform surfaces
Cast iron	SAE G 3000	Soft automotive cast iron. Must be free from shrinkage cavities, porosity or any other defects detrimental to specification use of the material. Hardness : 86 to 98 HB		≈ 0,4 cm	Surface grind 4 sides to dimension using a well-dressed No. 80 alundum wheel. Clean uniform surfaces
Brass	SAE CA 260	Wrought alloy-yellow brass rolled sheet or strip, half hard temper hardness : 57 to 74 HB		≈ 0,2 cm	Edges machined to remove shearing marks. Clean uniform surfaces
Copper	SAE CA 114	Cold-rolled copper sheet or strip, half hard temper hardness : 35 to 56 HB		≈ 0,2 cm	Edges machined to remove shearing marks. Clean uniform surfaces
Zinc	ZnAl4 Cu1 ISO/R 301	Diecasting alloy strips, hardness 85 to 105 HB		≈ 0,2 cm	Edges machined to remove shearing marks. Clean uniform surfaces

NOTE – Drill hole between 4 and 5 mm in diameter and approximately 6 mm from one end of each strip. Holes to be clean and free from burrs.

Hardness ranges are commercial for the designated metals : hardness is not specified for the tinned iron because it is not considered a practical requirement.

Test strips except zinc strips may be obtained from the Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096, U.S.A., or Laboratoire de Recherches et de Contrôle du Caoutchouc, 12, rue Carvès, 92120 Montrouge, France.