

International Standard



7631

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Road vehicles — Elastomeric cups and seals for cylinders for hydraulic braking systems using a petroleum base hydraulic brake fluid (service temperature 120 °C max.)

Véhicules routiers — Coupelles et joints en caoutchouc pour cylindres de dispositifs de freinage hydrauliques utilisant un liquide de frein à base pétrolière (température maximale d'utilisation 120 °C)

First edition — 1985-05-01

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UDC 629.113-592.2 : 678.06 : 621-762

Ref. No. ISO 7631-1985 (E)

Descriptors : road vehicles, braking systems, hydraulic brakes, hydraulic cylinders, rubber products, seals (stoppers), cups, specifications, tests, marking, test equipment.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7631 was prepared by Technical Committee ISO/TC 22, *Road vehicles*.

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Road vehicles — Elastomeric cups and seals for cylinders for hydraulic braking systems using a petroleum base hydraulic brake fluid (service temperature 120 °C max.)

1 Scope

This International Standard specifies performance tests of brake cups and seals for hydraulic braking systems for road vehicles used with a petroleum base hydraulic brake fluid; it does not include requirements relating to chemical composition, tensile strength and elongation of the rubber compound; disc brake seals and O-rings for hydraulic drum brake wheel cylinders are not covered by this International Standard.

2 Field of application

This International Standard applies to moulded seals (cups or double-lipped type gland seals), 60 mm in diameter and under, compounded from high temperature-resistant rubber, for use in hydraulic cylinders employing a petroleum base brake fluid conforming to the requirements of ISO 7308.

3 References

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

ISO 7308, *Road vehicles — Petroleum base hydraulic brake fluid for hydraulic braking device with stored energy*.¹⁾

ISO 7309, *Road vehicles — Hydraulic braking systems — ISO reference petroleum base fluid*.

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

ASTM E 145, *Specifications for gravity convection and forced ventilation ovens*.

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

4 Definitions

For the purpose of this International Standard, the following definitions apply.

4.1 sloughing : The release of carbon black on the surface of the rubber.

4.2 scoring : The formation of grooves in the rubber parallel to the direction of travel of the piston or seal.

4.3 souffing : Visible erosion of the outer surface of the rubber.

5 General requirements

5.1 Workmanship and finish

Seals shall be free from blisters, pin-holes, cracks, protuberances, embedded foreign material or other physical defects which can be detected by thorough inspection, and shall conform to the dimensions specified on the drawings.

5.2 Marking and identifying

5.2.1 Marking

The identification mark of the manufacturer and other details as specified on drawings shall be moulded into each seal. Each seal in conformity with this International Standard may also have the following mark : ISO 7631.

5.2.2 Identifying

5.2.2.1 Each seal shall bear a green-coloured identification specifying that it refers to a category of seals for use with a petroleum base brake fluid.

1) At present at the stage of draft.

5.2.2.2 The green-coloured identification can be ink or tinted elastomer.

5.2.2.3 The place and type of green identification shall be the subject of an agreement between buyer and supplier.

5.2.2.4 The green identification shall entail neither extra thickness nor alteration of material characteristics; it shall remain during all handling before bringing the seal into use.

5.3 Packaging

Seals shall be packaged to meet requirements specified by the purchaser.

5.4 Sampling

The minimum lot on which complete specification tests shall be conducted for quality control testing, or the frequency of any specific type test used to check production, shall be agreed upon by the manufacturer and the purchaser.

6 Test requirements

6.1 Resistance to fluid at elevated temperature

After being subjected to the test for resistance to compatibility fluid at elevated temperature as described in 7.1, the seals shall conform to the requirements specified in table 1.

Table 1 — Requirements for fluid resistance at elevated temperature (120 °C)

Characteristic	Permitted change
Volume	0 to + 15 %
Outside diameter, lip	0 to + 5,75 %
Outside diameter, base	0 to + 5,75 %
Hardness	-7 to + 8 IRHD

The seals shall show no excessive disintegration as evidenced by blisters or sloughing.

6.2 Precipitation

Not more than 0,3 % sediment by volume shall be formed in the centrifuge tube after the seals have been tested as specified in 7.2.

6.3 Wheel cylinder seals heat pressure stroking

Wheel cylinder seals, when tested by the procedure specified in 7.3, shall meet the following performance requirements.

6.3.1 Lip diameter change

The minimum lip diameter of wheel cylinder seals after the stroking test shall be greater than the wheel cylinder bore by the minimum dimensions specified in table 2.

Table 2 — Lip diameter change, wheel cylinder seals

Diameter mm	Excess over bore mm min.
≤ 25,4	0,51
> 25,4 and ≤ 38,1	0,64
> 38,1 and ≤ 60	0,76

6.3.2 Leakage

Constant dampness past the seals or fluid discoloration of the filter paper on two or more inspections shall be cause for rejection.

6.3.3 Corrosion

Pistons and cylinder bore shall not show corrosion as evidenced by pitting to an extent discernible to the naked eye; but staining or discoloration shall be permitted.

6.3.4 Change in hardness

Rubber seals shall not change in hardness by more than the values shown in table 1 when tested in accordance with the procedure in 7.7.

6.3.5 Condition of test seals

Wheel cylinder seals shall not show excessive deterioration such as scoring, scuffing, blistering, cracking, chipping (heel abrasion) or change from original shape.

6.4 Master cylinder seals heat pressure stroking

Master cylinder seals, when tested as specified in 7.4, shall meet the following performance requirements.

6.4.1 Lip diameter change

The minimum lip diameter of master cylinder seals after the stroking test shall be greater than the master cylinder bore by the minimum dimensions specified in table 3.

Table 3 — Lip diameter change, master cylinder seals

Diameter mm	Excess over bore mm min.
≤ 25,4	0,38
> 25,4 and ≤ 38,1	0,51
> 38,1 and ≤ 60	0,64

6.4.2 Leakage

As for wheel cylinder seals (see 6.3.2).

6.4.3 Corrosion

As for wheel cylinder seals (see 6.3.3).

6.4.4 Change in hardness

As for wheel cylinder seals (see 6.3.4).

6.4.5 Condition of test seals

As for wheel cylinder seals (see 6.3.5).

6.5 Low temperature performance

6.5.1 Leakage

No leakage of fluid shall occur when seals are tested according to the procedure specified in 7.5.1.

6.5.2 Bend test

The seal shall not crack and shall return to its approximate original shape within 1 min when tested as specified in 7.5.2.

6.6 Oven ageing

Seals when tested according to the procedure specified in 7.6 shall meet the following requirements.

6.6.1 Change in hardness

The change in hardness shall be within the limits of 0 to + 10 IRHD.

6.6.2 Condition of test seals

The seals shall show no evidence of deterioration, or change from original shape.

6.7 Storage corrosion test

After 12 cycles in the humidity cabinet according to the procedure specified in 7.8, there shall be no evidence of corrosion adhering to or penetrating the wall of the cylinder bore which was in contact with the test seal.

Slight discoloration (staining) or any corrosion or spots away from the contact surface of the test seals shall not be cause for rejection.

7 Test procedures

7.1 Resistance to fluid at elevated temperature — Dimensional test

7.1.1 Apparatus

7.1.1.1 Micrometer, shadowgraph, or other suitable apparatus, to measure accurately to 0,02 mm.

7.1.1.2 Glass containers, of capacity approximately 250 ml and diameter 50 mm, which can be tightly sealed.¹⁾

7.1.1.3 Oven, dry air type, uniformly heated, conforming to the requirements for type II A of ASTM E 145.

7.1.2 Test specimens

Two seals shall be used for testing at 120 °C.

7.1.3 Procedure

Rinse the cups in hexane and wipe dry with a clean, lint-free cloth to remove dirt and packing debris. Do not leave the seals in the hexane for more than 10 s.

Measure the lip and base diameters to the nearest 0,02 mm, taking the average of two readings at right angles to one another. Take care when measuring the diameters before and after ageing that the measurements are made in the same manner and at the same locations.

Determine and record the initial hardness of the test seals (see 7.7 and figure 5).

Determine the volume of each seal in the following manner : weigh the seals in air (m_1) to the nearest 0,001 g and then weigh the seals immersed in distilled water at room temperature (m_2). Quickly dip each specimen in hexane and then blot dry with filter paper free of lint and foreign material.

Immerse two seals completely in 75 ml of petroleum base compatibility reference fluid as defined in ISO 7309 in a suitable glass container (7.1.1.2) and seal the container to prevent vapour loss. Place the container in the oven (7.1.1.3) maintained at 120 ± 2 °C for a period of 70 h. At the end of the heating period, remove the container from the oven and allow the seals to cool in the container at 23 ± 5 °C for 60 to 90 min. At the end of the cooling period, remove the seals from the container and rinse in hexane and wipe dry with a clean, lint-free cloth. Do not allow the seals to remain in the hexane for more than 10 s.

After removal from the hexane and drying, place each seal in a separate, tared, stoppered weighing bottle and weigh (m_3). Remove each seal from its weighing bottle and weigh immersed in distilled water (m_4) to determine water displacement after hot fluid immersion. Make all weighings to the nearest 0,001 g.

Determine the final volume, dimensions and hardness of each seal within 60 min after rinsing in hexane.

1) Suitable glass containers and tinned steel lids are available commercially. Details may be obtained from the Secretariat of ISO/TC 22 or from the ISO Central Secretariat.

7.1.4 Expression of results

7.1.4.1 Calculation

The volume change is given, as a percentage of the original volume, by the formula

$$\frac{(m_3 - m_4) - (m_1 - m_2)}{(m_1 - m_2)} \times 100$$

where

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

m_2 is the initial apparent 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 immersion in test fluid.

7.1.4.2 Dimensional changes

The original measurements of the lip and base diameters shall be subtracted from measurements taken after the test and the difference reported in millimetres and as a percentage of the original diameters.

7.1.4.3 Hardness

Change in hardness shall be determined and recorded.

7.1.4.4 Disintegration

The seals shall be examined for disintegration as evidenced by blisters or sloughing.

7.2 Precipitation test

7.2.1 Apparatus

7.2.1.1 Glass containers, of capacity approximately 250 ml and diameter 50 mm which can be tightly sealed.¹⁾

7.2.1.2 Cone-shaped centrifuge tube, of capacity 100 ml.

7.2.1.3 Oven, uniformly heated dry air type, conforming to the requirements for type II A of ASTM E 145.

7.2.2 Test specimens

From two or more seals to be tested, obtain a sample of mass $4 \pm 0,5$ g. Since sizes of seals vary, small pieces may be cut from the seals to reach the mass. Use the minimum number of pieces to obtain a mass of $4 \pm 0,5$ g.

7.2.3 Procedure

To determine the precipitation compatibility characteristics of the test seals, place the sample (7.2.2) in one of the specified glass containers (7.2.1.1) containing 75 ml of petroleum base compatibility fluid of ISO 7309. Seal the container to prevent vapour loss and place in the oven (7.2.1.3), maintained at 120 ± 2 °C for 70 h. (Optional test — A blank test may be run on the brake fluid prior to the test and any sediment from the blank test may be subtracted from the sediment amount obtained from the test.)

At the end of the heating period, remove the container from the oven and allow to cool at room temperature for 24 h, after which remove the seals.

Thoroughly shake the contents of the jar and transfer to a cone-shaped centrifuge tube (7.2.1.2) and determine the sediment as described in paragraphs 5 and 6 of ASTM D 91.

7.3 Wheel cylinder seals heat pressure stroking

7.3.1 Apparatus

7.3.1.1 Oven, uniformly heated dry air type conforming to the requirements for type II B of ASTM E 145.

7.3.1.2 Actuating stroking fixture for wheel cylinder seals, designed to provide a $3,8 \pm 1,7$ mm movement of each piston. During the total movement of the piston, the pressure shall increase to $7 \pm 0,3$ MPa. The rate of operation shall be held to a uniform reciprocating motion of $1\,000 \pm 100$ strokes/h.

Figure 1 illustrates recommended mounting for the wheel and master cylinder stroking test. Figure 2 illustrates a recommended pressure (in megapascals) versus wheel cylinder piston movement curve for wheel cylinders having diameters of 12,7 to 60 mm.

NOTE — A new wheel cylinder assembly must be used for each test.

7.3.2 Test specimens

Two wheel cylinder seals shall be used as test specimens.

7.3.3 Procedure

Rinse the seals in hexane and wipe dry with a clean, lint-free cloth to remove dirt and packing debris. Do not allow the seals to remain in the hexane for more than 10 s.

Determine the lip diameter to the nearest 0,02 mm, taking the average of two readings at right angles to one another. In the case of double-lip seals, take these measurements after the cup has been assembled on the piston. Determine and record the initial hardness of the test seals.

1) Suitable glass containers and tinned steel lids are available commercially. Details may be obtained from the Secretariat of ISO/TC 22 or from the ISO Central Secretariat.

Install the internal parts, which may include among other things seals, piston springs, expanders, etc., in a wheel cylinder of known diameter using petroleum base compatibility fluid of ISO 7309 as a lubricant. (Boots shall not be used.) Mount the wheel cylinder assembly on the stroking fixture (7.3.1.2). Fill the system with petroleum base compatibility fluid conforming to ISO 7309. Bleed all air from the system. Place a sheet of filter paper under each end of the wheel cylinder to catch and determine leakage.

Place the stroking fixture assembly in the oven (7.3.1.1) and actuate for 70 h at 120 ± 2 °C. Shut off the actuating means and the oven heater at the termination of the 70 h stroking period with the master cylinder piston in the "off" position to relieve retained pressure in the system.

After a cooling period of 1 h with the oven door open and a ventilation fan on, disconnect the fluid line at the wheel cylinder inlet. Remove the entire stroking test fixture containing the test wheel cylinder from the oven and allow to cool for 22 ± 2 h at room temperature. Immediately after completion of the cooling period, make a careful inspection to check for fluid leaks past the seals and record the results.

Drain the fluid from the system, and remove the seals from the wheel cylinder. Measure double-lip seals before removal from the pistons. Rinse the seals in hexane and dry with compressed air. Do not allow the seals to remain in the hexane for more than 10 s.

Inspect seals for scoring, scuffing, blistering, cracking, chipping (heel abrasion) and change from original shape. Inspect cylinder parts, recording any pitting on pistons and cylinder walls. Determine and record the change in hardness.

Measure the lip diameter of each seal within 30 to 60 min after removal from the wheel cylinder and report the difference between the cylinder bore and the lip diameter after the test (see table 2 for allowable lip diameter change).

7.4 Master cylinder seals heat pressure stroking

7.4.1 Apparatus

7.4.1.1 Oven, uniformly heated, dry air type conforming to the requirements for type II A of ASTM E 145.

NOTE — When strip heaters are used, they shall be placed not less than 150 mm from the cylinder on test, but shall be shielded to prevent direct radiation to any cylinder.

7.4.1.2 Actuating stroking machine for master cylinder seals, consisting of a suitable means for actuating the master cylinder containing the test specimens at the rate of $0,28 \pm 0,03$ stroke/s ($1\,000 \pm 100$ strokes/h). The total piston movement shall be sufficient to cover approximately 90 % of the total available stroke.

All master cylinders having a total stroke of 63 mm or more shall be heat and pressure stroke-tested at 90 % of the 63 mm stroke, i.e. 57 mm. The rate of stroking shall be $0,22 \pm 0,02$ stroke/s (800 ± 80 strokes/h). Full pressure (7 MPa) shall be attained and maintained for 3 mm of the stroke or 1 s maximum.

Figure 1 illustrates a recommended master cylinder seal stroking apparatus. Figure 3 illustrates a recommended pressure (in megapascals) versus master cylinder piston movement curve obtained with three wheel cylinders of approximately 22 mm diameter mounted in the stroking fixtures shown in figure 1 actuated by a 25 mm diameter master cylinder. The total stroke of such a master cylinder shall be 25 mm. The initial movement of approximately 14 to 15 mm shall be at a rate providing a gradual buildup of pressure, not exceeding 1 MPa. This shall permit the primary seal to pass over the compensating port at a low pressure. The balance of the stroke shall provide a gradual buildup of pressure to $7,0 \pm 0,3$ MPa during the last 1,6 to 3,2 mm of the stroke.

The master cylinder shall be located in the oven (7.4.1.1) and the fluid temperature in the master cylinder reservoir shall be maintained at 120 ± 2 °C.

NOTE — A new master cylinder shall be used for each test. It is recommended that at least 0,05 to 0,13 mm clearance be allowed between the master cylinder piston and the master cylinder bore when conducting a master cylinder stroking test.

7.4.2 Test specimens

One primary and one secondary seal shall be used for test specimens.

7.4.3 Procedure

Rinse the seals in hexane and wipe dry with a clean, lint-free cloth to remove dirt and packing debris. Do not allow the seals to remain in the hexane for more than 10 s.

Determine and record the initial hardness of the test seals. Measure the lip diameter of the primary and secondary seals and record to the nearest 0,02 mm, taking the average of two readings at right angles to one another. Measure the lip diameter of the secondary seal after the seal has been assembled on the piston.

Dip the seals and master cylinder internal parts in petroleum base compatibility fluid to ISO 7309 and coat the cylinder walls with the same fluid before assembly. Fill the system with petroleum base compatibility fluid conforming to ISO 7309. Bleed all air from the system.

Operate the master cylinder assembly after installation in the oven (7.4.1.1) for 70 h at the rate specified in 7.4.1.2 and at a temperature of 120 ± 2 °C. After allowing excess fluid to evaporate, place a sheet of filter paper under the secondary seal of the master cylinder to catch and determine leakage past the secondary seal. Shut off the heat and actuating means at the termination of the 70 h stroking period with the master cylinder in the "off" position to relieve retained pressure in the master cylinder.

After a cooling period of 1 h with the oven door open and the ventilation fan on, disconnect the fluid line at the master cylinder outlet. Remove the master cylinder from the oven and allow to cool for 22 ± 2 h at room temperature. Immediately after completion of the 22 h cooling period, make a careful inspection to check fluid leakage past the master cylinder secondary seal.

Drain the fluid from the master cylinder. Remove the primary seal from the cylinder, rinse with hexane and dry with compressed air. Rinse the secondary seal on the piston in hexane, dry with compressed air and measure the lip diameter before removal from the piston. Do not allow the seals to remain in the hexane for more than 10 s.

Inspect seals for deterioration such as scoring, scuffing, blistering, cracking, chipping (heel abrasion) and change from original shape. Inspect cylinder parts, recording any pitting on piston or cylinder walls. Measure the lip diameter of the primary seal within 30 to 60 min after removal from the cylinder and determine the difference between the cylinder bore and the lip diameter after the test; record the difference for both primary and secondary seals.

Determine and record the change in hardness.

7.5 Low temperature performance

7.5.1 Leakage

7.5.1.1 Apparatus

7.5.1.1.1 Cold chamber, large enough to permit arrangement of the test apparatus within and to permit the operator to check and operate the apparatus without removal from the chamber.

7.5.1.1.2 Master cylinder and wheel cylinder, so connected that their operation closely approximates to the brake system in actual service. The apparatus shown in figure 4 has been found to be satisfactory. The cylinder bore containing the test seals shall meet the dimensional limitations and bore finish requirements specified by the manufacturer.

7.5.1.1.3 Retractor spring, such as to require a line pressure of not more than 0,35 MPa to make a complete stroke at room temperature.

7.5.1.2 Test specimens

Two wheel cylinder seals and one primary and one secondary master cylinder seal shall be used for test seals.

7.5.1.3 Procedure

Rinse the test seals in hexane and wipe dry with a clean, lint-free cloth. Do not allow the seals to remain in the hexane for more than 10 s. Assemble the test seals in the test cylinder. During the assembly of the cylinder, coat the cylinder walls with petroleum base compatibility fluid conforming to ISO 7309 as well as other parts intended to be immersed in the fluid.

Install the wheel and master cylinder assembly containing the test seals (7.5.1.1.2) in the cold chamber (7.5.1.1.1). Fill the system with test fluid and bleed all air from the system. Do not use boots.

Enclose the complete actuating system in the cold chamber and subject to a temperature of -40 to -43 °C for 120 h. Maintain the piston and seals in a static position during the first 72 h of

the test and thereafter actuate the cylinders for 6 strokes at 0,7 MPa and 6 strokes at 3,5 MPa each 24 h (after 72, 96, 120 h). The strokes shall be approximately 1 min apart and the piston shall return to the stop after each stroke. No leakage shall occur during the 120 h test period.

7.5.2 Bend test

7.5.2.1 Test specimen

One seal shall be used.

7.5.2.2 Procedure

Bend the test seal, after it has been maintained for 22 h at -40 to -43 °C, between the thumb and finger through an angle of approximately 90° and release immediately. (Bend the cold seal while in the cold chamber and handle it with gloved hands to prevent warming from body heat.)

Within 1 min, examine the test seal for cracking and change from original shape.

7.6 Oven ageing

7.6.1 Apparatus

Oven, conforming to the requirements of type II B of ASTM E 145.

7.6.2 Test specimens

Two seals shall be used.

7.6.3 Procedure

Rinse two test seals in hexane and wipe dry with a clean, lint-free cloth to remove dirt and packing debris. Do not allow the seals to remain in the hexane for more than 10 s.

Determine and record the hardness of the seals.

Place the two test seals in the oven (7.6.1), and subject to hot air heating at 100 ± 2 °C for 70 h. At the termination of the 70 h heating period, remove the seals from the oven and allow to cool for 16 to 96 h at room temperature.

Inspect the seals for blistering, or change in shape from original form. Determine and record the hardness after ageing.

7.7 Hardness determination

As specified in ISO 48. If ISO 48 cannot be used, another procedure may be selected, possibly using a rubber anvil (see figure 5).

7.8 Storage corrosion test

7.8.1 Apparatus

7.8.1.1 Humidity cabinet, capable of maintaining temperatures of 21 ± 2 °C and 46 ± 2 °C, at 95 ± 2 % humidity.

7.8.1.2 Three wheel cylinder assemblies, of correct size for the seals being tested.

7.8.2 Test specimens

Six seals shall be used.

7.8.3 Procedure

Disassemble the three cylinder assemblies and using a clean, lint-free cloth, wipe all fluids from the cylinders, pistons, boots and springs.

Discard cylinders or parts showing light stains or corrosion. Assemble the six test seals into the wheel cylinders (7.8.1.2) after completely coating the cylinder walls, seals, springs and pistons with a light film of the reference petroleum base fluid specified in ISO 7309. Install the clean boots into the cylinders to hold the pistons in position. Leave one inlet hole open and close the remaining holes with suitable rubber or metal plugs.

Adjust the humidity cabinet (7.8.1.1) to 46 °C and 95 % humidity. Place the cylinders in the cabinet with the unplugged inlet holes facing down.

Maintain the specified temperature and humidity conditions for 16 h. Readjust the cabinet controls to 21 °C and 95 % humidity

and maintain these new conditions for 8 h to complete the first cycle.

Repeat the above 24 h cycle for 12 days. When interrupted due to incidence of one or more non-working days, keep the cylinder assemblies in the humidity cabinet with the cabinet controls set to maintain 21 °C at 95 % humidity until cycling can be resumed.

At the conclusion of 12 complete cycles, remove the cylinder assemblies from the humidity cabinet for inspection. In case of a non-working day, make the inspection on the following working day.

Inspect the cylinder assemblies in accordance with the following procedure :

- During the removal from the humidity cabinet and subsequent disassembly, maintain the cylinders in the same position as they were in the cabinet to avoid fluid contamination of the inside of the cylinder.
- Remove the pistons and seals from the cylinders, after removal of the boots, 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 seals and pistons.
- Wipe the cylinder bore free of fluid with a clean, lint-free cloth. Inspect the condition of the cylinder bore under or adjacent to the seal lip under a strong light for corrosion, discoloration, or spots, noting particularly the area of the ring left by the lip of the seal during its exposure in the humidity cabinet.

Disregard any corrosion or spots away from the contact surface of the seals.

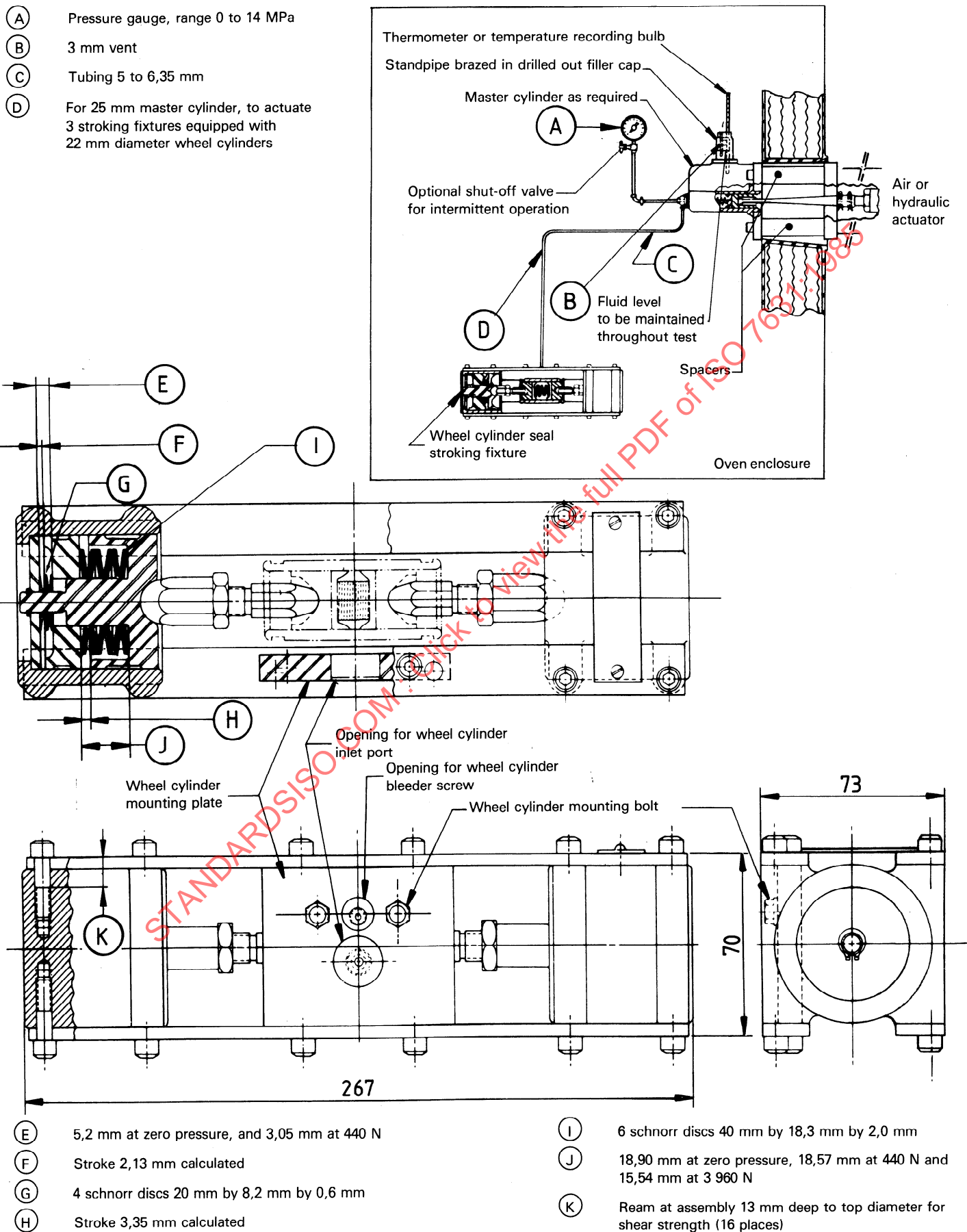


Figure 1 — Recommended wheel and master cylinder stroking test apparatus

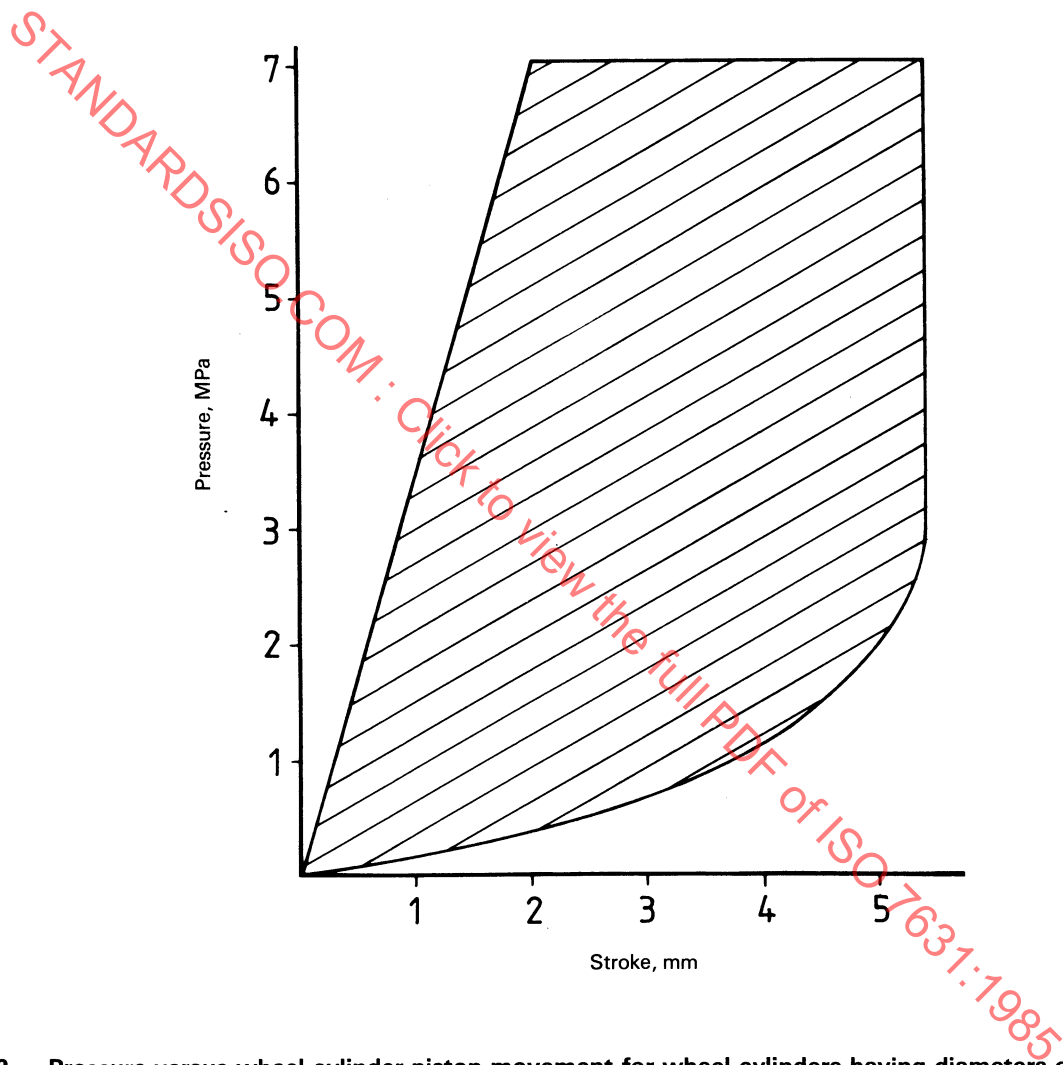


Figure 2 — Pressure versus wheel cylinder piston movement for wheel cylinders having diameters of 12,7 to 60 mm

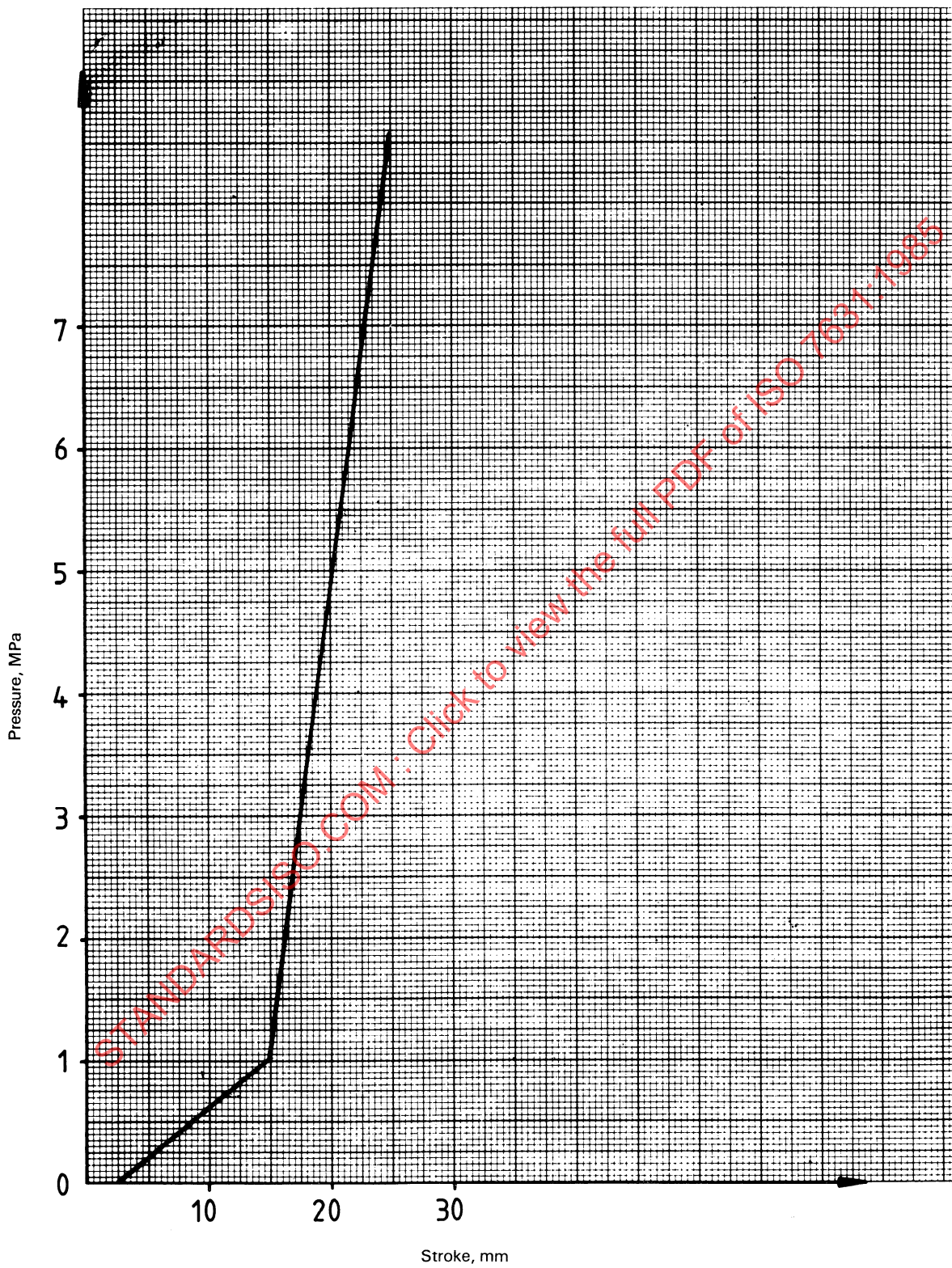


Figure 3 — Typical master cylinder cup stroke versus pressure curve (diameter 25 mm)