BRITISH STANDARD

BS 4161-3: 1989

Incorporating Amendments Nos. 1 and 2

Gas meters

Part 3: Specification for diaphragm meters of 6 cubic metres (or 212 cubic feet) per hour rating for working pressures up to 50 mbar

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Gas Standards Policy Committee (GSE/-) to Technical Committee GSE/25, upon which the following bodies were represented:

British Gas plc
British Non-ferrous Metals Federation
Chief and Assistant Chief Fire Officers' Association
Department of Energy (Gas and Oil Measurement Branch)
Institution of Gas Engineers
Society of British Gas Industries

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Contents

Foreword

This Part of BS 4161 has been prepared under the direction of the Gas Standards Policy Committee. It is a revision of BS 4161-3:1977, which is withdrawn.

BS 4161-3 was first published in 1968 as the third in a series relating to meters for gaseous fuels used for registering the volume of gas passed. It was revised in 1977 due to advent of both synthetic diaphragms and legislative changes. This revision updates Part 3, widens its scope and takes account of further legislative changes.

In the preparation of this standard account has been taken both of commercial factors associated with export and of European harmonization by incorporating relevant requirements of the following.

Statutory Instrument 1983: No. 684: The Gas (Meters) Regulations 1983.

Statutory Instrument 1988: No. 186: The Measuring Instruments (EEC Requirements) Regulations 1988.

Statutory Instrument 1988: No. 296: The Measuring Instruments (EEC Requirements) (Gas Volume Meters) Regulations 1988, which implement EEC Council Directive 71/318/EEC and its subsequent technical progress amendments.

Although primarily intended for 1st and 2nd family gases, the meters may be used for other gases, but the suitability of a meter for such a purpose should be verified with the manufacturer.

This standard contains requirements for prepayment meter mechanisms intended for use with 50p and £1 coins.

Meters may be fitted with electrical instrumentation; such devices for the type of meter specified in this standard are generally additional to the mechanical index.

NOTE A meter used for the sale of gas has to comply with statutory requirements. The addition of electrical instrumentation to such a meter may mean that the system no longer complies with statutory requirements.

Information that should be supplied by the purchaser is listed in Appendix A.

The other Parts of BS 4161 covering temperature and pressure compensating devices and other types of gas meter are as follows.

— *Part 1: Meters of plate construction up to 1 000 cubic feet per hour rating (obsolescent)*;

— *Part 2: Meters of plate construction above 1 000 cubic feet (28 cubic metres) per hour rating (obsolescent)*;

— *Part 4: Plate constructed positive displacement diaphragm meters for a pressure of 350 mbar (5 lbf/in^2) and up to 170 cubic metres (6 000 cubic feet) per hour rating (obsolescent)*;

— *Part 5: Positive displacement diaphragm meters for pressures up to 7 bar*;

— *Part 6: Specification for rotary displacement and turbine meters for gas pressures up to 100 bar*;

— *Part 7: Mechanical volume correctors (obsolescent)*;

— *Part 8: Specification for electronic volume correctors*;

Installation of meters covered by this Part of BS 4161 are the subject of BS 6400.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 36, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Section 1. General

1 Scope

This Part of BS 4161 specifies requirements for the construction, performance and marking of credit and prepayment diaphragm meters with a badged rating of 6 m^3/h or 212 ft^3/h, for use with 1st or 2nd family gases at working pressures up to 50 mbar [1)]. It refers to top connections complying with BS 746 and includes requirements for fire and heat resistance.

The prepayment meter requirements relate to mechanisms suitable for use with 50p and £1 coins.

NOTE 1 The information to be supplied by the purchaser when ordering or enquiring about meters is given in Appendix A.
NOTE 2 The requirements for diaphragm meters for working pressures above 50 mbar are specified in BS 4161-5.
NOTE 3 All pressures quoted in this standard are gauge pressures.
NOTE 4 The titles of the publications referred to in this Part of BS 4161 are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 4161, the definitions given in BS 746 and BS 1179 apply, together with the following.

2.1
coin ejection

the ejection of the coin from the coin carrier into the cash box

2.2
quantity wheel

a toothed wheel that is attached to, and operates, the prepayment mechanism when it is engaged by the coin carrier. There may be one or two quantity wheels, according to the prepayment attachment design

3 Meter designation and rating

3.1 Meter designation

The meter shall be designated U6.

3.2 Meter rating

The meter rating shall be 6 m^3/h or 212 ft^3/h as ordered.

NOTE The badged rating as defined in BS 1179 is determined using air.

The maximum working pressure shall be 50 mbar. The operating temperature range shall be – 5 °C to + 35 °C.

[1)] 1 mbar = 10^2 N/m^2 = 0.1 kPa.

Section 2. General requirements for credit and prepayment diaphragm meters

4 Materials and finish

4.1 Materials

The meter shall be constructed of materials complying with appropriate British Standards. Materials shall be such that they satisfy this Part of BS 4161.

Sample plaques shall be made from the same grade and thickness of material, pretreated and coated in the same way as the component. The thickness of any coating and the method of measurement shall be declared by the meter manufacturer to the test authority.

4.2 Decorative finish

If meters have a decorative finish it shall be of a colour in accordance with BS 4800 or BS 381C and shall comply with the following requirements.

a) After 7 days from the time of application of the external finish, the external finish layer of the meter or sample plaque thereof when tested in accordance with Appendix B using a spring force of 9.8 N, shall not be fully penetrated. The external finish shall be visually examined for penetration. Jagged edges shall not extend by more than 1 mm from any scratch mark.

b) After testing in accordance with **4.2** a), the external surface finish of the meter or sample plaques thereof when tested in accordance with Appendix C, shall not show evidence of lifting, blistering or deterioration, although blooming of the surface finish is acceptable.

NOTE Test b) may be carried out on a separate sample or on the original sample with the original scratch protected.

c) Immediately after testing in accordance with Appendix C, the external finish of the same test piece when tested in accordance with Appendix B and examined shall resist penetration in accordance with **4.2** a).

4.3 Corrosion resistance of meter components

NOTE Appendix D is a guide to the relationship between the requirements and associated tests for corrosion resistance.

4.3.1 *Test pieces.* The tests shall be carried out either on sample plaques or on the components themselves. A sample plaque shall only be used in place of a component if no forming operations are carried out on the component after the protection is applied. If a sample plaque is used, its minimum area shall be as defined in BS 3900-E1 or BS 3900-E2 as appropriate. Attack at the edges of a sample plaque shall be ignored if the component under consideration has no exposed edges when installed.

Items submitted for test shall have been fully dried and aged.

4.3.2 ***External surfaces of the meter***

4.3.2.1 *General.* External surfaces of the meter other than those of any components made from austenitic stainless steel, shall comply with the following requirements.

a) *Finish.* Any external finish shall comply with **4.2** a), b) and c).

b) *Humidity.* When tested in accordance with Appendix C there shall be no signs of significant corrosion to the base material. Attack on the edge or up to 2 mm from it shall be ignored if the component under consideration has no exposed edges when installed.

c) *Chemical resistance*. When tested in accordance with **E.2** there shall be no signs of blistering, lifting, loss of adhesion or significant corrosion. Attack on the edge or up to 2 mm from it shall be ignored if the component under consideration has no exposed edges when installed.

4.3.2.2 *Protective coatings.* All coatings providing corrosion protection shall not show signs of cracking or loss of adhesion when tested in accordance with **E.1.2**.

If the corrosion protection of the surface is provided solely by means of an organic coating, the coating shall not show signs of cracking or loss of adhesion when tested in accordance with **E.1.1** and shall show no detachment when tested in accordance with **E.1.3**.

4.3.2.3 *Requirements for gas containing components, meter band and index cover.* All external surfaces of gas-containing components, meter band and the index cover shall comply with the following requirements.

a) *Salt spray*. When tested in accordance with **E.2.4** there shall be no signs of significant corrosion. Attack on the cross cuts and up to 2 mm from them shall be ignored. Attack on the edge or up to 2 mm from it shall only be ignored if the component under consideration has no exposed edges when installed.

Where a formed component is too small for the cross cuts to be applied, the component shall be tested without cross cuts and an additional test shall be carried out on a sample plaque to which cross cuts have been applied.

b) *Scratch resistance*. When tested using either the method given in Appendix B with a spring force of 29.4 N or the method given in BS 3900-E2 with the same load there shall be no penetration of the surface resulting in the exposure of corrodible base material.

If, during the test, exposure of corrodible base material is established by visual inspection or electrical contact, the scratched surface shall then be subjected to a salt spray test in accordance with BS 3900-F4 for 24 h. After this test there shall be no sign of significant corrosion.

4.3.2.4 *Requirements in addition to* **4.3.2.3** *for gas-containing components made of austenitic stainless steel.* Gas-containing components made of austenitic stainless steel shall either be stress free, no cracks being visible when they are tested in accordance with **E.3**, or be protected on their external surface by a coating complying with **4.2**.

4.3.3 ***Internal surfaces of the meter***

4.3.3.1 *Internal surfaces in contact with gas.* Surfaces in contact with gas during normal use shall comply with the following requirements.

a) *Humidity*. The requirements given in **4.3.2.1** b) shall apply.

b) *Chemical resistance*. The requirements given in **4.3.2.1** c) shall apply, except that **E.2** g) shall not be used.

4.3.3.2 *Internal surfaces exposed to atmosphere.* Surfaces exposed to atmosphere and normally concealed shall comply with **4.3.2** as if they were external surfaces.

4.3.3.3 *Protective coatings.* The requirements given in **4.3.2.2** shall apply.

4.4 Diaphragms

4.4.1 *General.* Diaphragms shall be manufactured from either leather or from a synthetic material.

4.4.2 *Leather diaphragms.* Leather diaphragms shall comply with type 1 of BS 2797. The dressing shall be non-acid, covering the surface and filling the pores and shall be suitable for the gas for which the meter is to be used. The dressed leather shall be impermeable to air at a differential pressure of 5 mbar.

NOTE Leather diaphragms are not suitable for 3rd family gases.

4.4.3 ***Synthetic diaphragms***

4.4.3.1 *Identification.* The manufacturer, composition and date of manufacture shall be indicated on the diaphragm.

4.4.3.2 *Test pieces.* Test pieces shall be taken from a diaphragm or from the diaphragm material; if from the latter, they shall be of the same thickness and cured under the same conditions as the diaphragm.

Unless otherwise stated in the test method, the test pieces shall be either square or circular and shall have a minimum length or diameter of 40 mm.

4.4.3.3 *Tests on diaphragm material*

4.4.3.3.1 *Liquid phase immersion tests*

4.4.3.3.1.1 *Hydrocarbon mixture.* When a test piece is immersed and allowed to swell freely in a mixture of toluene and heptane in the proportion 1 : 1 by volume at 20 ± 5 °C for 7 days, the change in area shall not be greater than 5 % of the original area.

After immersion and drying to constant mass at room temperature, the mass of the test piece shall not have reduced by more than 12 % of the original mass and the area shall not differ from the original area by more than 5 %.

The material shall not show any sign of delamination or blistering.

NOTE 1 The volume ratio of liquid to test piece should be not less than 50 : 1.

NOTE 2 To measure the change in area, it is recommended that the liquid-soaked test piece be placed quickly between two microscope slides.

4.4.3.3.1.2 *Water.* When the test piece is immersed in distilled or deionized water and allow to swell freely at 20 ± 5 °C for 7 days, the change in area of the material shall not be greater than 5 % of the original area of the test piece.

After immersion and drying to constant mass in air at room temperature, the mass of the test piece shall not have reduced by more than 12 % of the original mass and the area shall not differ from the original area by more than 5 %. The difference in relative humidity between taking the original and final mass and area measurements shall not exceed ± 10 %.

The material shall not show any sign of delamination or blistering.

4.4.3.3.2 *Accelerated ageing.* The stiffness of the test piece shall be measured at 20 ± 5 °C in accordance with Appendix F, using the Williamson torsion apparatus. The stiffness shall not have increased by more than 25 % after the test piece has been subjected to a temperature of 70 ± 2 °C in an air-circulating oven for 4 weeks. In addition, the test piece shall not show any sign of delamination, blistering or significant deterioration.

4.4.3.3.3 *Low temperature flexibility.* The stiffness of the test piece shall be measured at 20 ± 5 °C in accordance with Appendix F, using the Williamson torsion apparatus. The stiffness shall not have increased by more than 25 % after the test piece has been subjected to a temperature of – 5 ± 1 °C in an air-circulating oven for 20 minutes.

4.4.3.3.4 *Porosity.* No detectable movement shall be seen in the manometer tube when test pieces are tested in accordance with Appendix G.

NOTE With a thin soap film applied to the top surface of the test piece no bubbles should occur after 1 minute.

4.4.3.4 *Tests on components assembled in the meter*

NOTE **Important**. A new sample is recommended for each test.

4.4.3.4.1 *Vapour phase test.* For the purposes of this test, one method of which is given in Appendix H, the meter registration shall be determined at 6 m^3/h (or 212 ft^3/h) on test gas NGA[2)], nitrogen or air.

After determining the meter registration with a particular gas, the meter shall be operated at a temperature of 20 ± 5 °C on the same test gas to which has been added 1.0 % *V*/*V* of toluene and sufficient water vapour to give a relative humidity of 65 ± 5 %. The gas flow rate shall be not less than 30 dm^3/h (1 ft^3/h). Immediately following a test period of 264 h, the meter registration shall be determined, on the same untreated test gas that was used at the beginning of the test, and shall not have changed by more than 2 units of percentage from the previously determined value. The meter shall then continue to be operated on the untreated test gas for a further period of at least 168 h at 1.5 m^3/h (50 ft^3/h) in an ambient temperature of 20 ± 5 °C. The meter shall then comply with **9.1**.

NOTE 1 When air is used as the carrier gas, the mixture of air and toluene vapour should be exhausted externally to atmosphere (not burnt) via a flame trap.

NOTE 2 The concentration of toluene vapour is equivalent to a 34.7 % saturation level at 20 °C.

4.4.3.4.2 *Ambient temperature tests.* The meter shall comply with clauses **8** and **9** when tested in an ambient temperature of 20 ± 2 °C after each of the following periods of operation:

a) 400 h on air at 3 m^3/h (100 ft^3/h) in an ambient temperature of – 5 ± 1 °C;

b) 400 h on air at 3 m^3/h (100 ft^3/h) in an ambient temperature of + 35 ± 1 °C.

NOTE Care should be taken to prevent condensation in the meter.

4.5 Index windows

4.5.1 *General.* The index window shall be made of any material which satisfies the following requirements.

Both as supplied, and after being subjected to the accelerated ageing tests specified in **4.5.6**, samples of window panes or moulding shall meet the requirements of **4.5.2**, **4.5.3** and **4.5.4**. The accelerated ageing tests shall be performed on samples that have not been previously subjected to the flammability test.

4.5.2 *Visual inspection.* The window pane or moulding shall show no crazing or blisters. The portion through which the index is viewed shall be transparent, and shall not cause visual distortion of the matter to be viewed within an angle of 15° from the normal to the window.

4.5.3 *Rigidity.* With the window fitted on the meter as in operation, and at a temperature of 30 ± 2 °C, a 10 mm diameter timber rod applied normal to any external part of the window or moulding with a force of 200 N shall not cause it to touch any moving part of the mechanism.

4.5.4 *Impact.* The window, fitted in the meter as in operation and at a temperature of – 5 ± 1 °C, shall withstand the impact of a 25 mm diameter solid steel ball dropped three times from a height of 350 mm and striking the centre of the window normally to its plane.

4.5.5 *Flammability.* The window shall be tested in accordance with BS 2782:Method 140E:1982. For this test, the test piece shall be positioned centrally with its external face downwards on the centre of the wire grid.

The material shall comply with the following requirements.

a) The period of time for which the test piece glows or flames from the instant the alcohol burns out shall not exceed 5 s.

b) Any material that may have dropped from the specimen shall not continue to burn.

c) The percentage of the area of the underside of the test piece that is charred or scorched shall not exceed 20 %.

d) The length of that part of any edge of the underside of the test piece that is charred or scorched shall not exceed 50 mm.

4.5.6 ***Accelerated ageing tests***

4.5.6.1 *General.* Subject one sample window pane or moulding to the ageing tests specified in **4.5.6.2**. Subject another sample window pane or moulding to the tests specified in **4.5.6.3**. After these ageing tests, and before being given the flammability test, the samples shall still fit the meter.

[2)] Full details of test gases are given in BS 4947.

4.5.6.2 *Effects of ultraviolet light and loss of volatile plasticizer*

4.5.6.2.1 *Radiation test.* The window pane or moulding shall be exposed for five periods each of 8 h duration to the radiation of a suspended sun lamp that has been in use for not less than 50 h and not more than 400 h. The light source shall be a combination tungsten filament nercury arc enclosed in glass that has a low-transmission below 280 nm. The glass envelope shall be conical and silvered internally to form a reflector. The lamp shall be rated at 275 W to 300 W. The window pane or moulding shall be positioned, as designed, on its index with its outer face towards the lamp and 400 mm from the bottom and on the axis of the lamp. The surrounding air shall not be confined and shall be free to circulate.

After each exposure except the last, the sample shall be immersed completely in distilled water for 16 h. It shall be cleaned and carefully dried with cotton wool after each immersion period.

4.5.6.2.2 *Loss of volatile plasticizer.* The sample shall be heated in air at 100 ± 3 °C for 24 h. In this test the window pane or moulding shall be reasonably supported so as not to encourage deformation.

4.5.6.3 *Resistance to chemical substances.* The sample shall be constrained as it will be in the meter and then totally immersed, in turn and in the order listed, in the following technically pure substances at 20 ± 3 °C:

a) sodium carbonate (20 % *m*/*m*) for 2 h;

b) paint thinners (approximately 50 % aromatic and 50 % aliphatic hydrocarbons, e.g. 50 % o-xylene and 50 % n-heptane) for 1 h.

The sample shall be cleaned with distilled water and carefully dried with cotton wool after each immersion.

4.6 Bearings

All linkage, pivot and other bearings shall comply with the requirement for corrosion and wear and shock resistance specified in **4.4.3.4.1**, **5.14**, **10.1** and **10.4**.

4.7 Valves

The valve grids shall be made of material that is compatible with that of the valve covers, i.e. either the valve cover or the grids shall be made of material with self-lubricating properties, e.g. made of, or faced with, phenolformaldehyde with an inert filler and graphite impregnated, or of a material having equivalent properties, such as wear resistance, strength, impact resistance and low coefficient of friction.

4.8 Gearing

The gearing shall be made of materials that are compatible, i.e. wear and shock resistance and dimensional stability shall comply with the requirements given in **4.4.3.4.1**, **5.14**, **10.1** and **10.4**.

4.9 Grease

Where grease is used for lubricating bearings and gears it shall not contain solids unless the solids have lubricating properties. Metallic soap-base greases shall not be used.

4.10 Seals and sealing glands

4.10.1 *General.* Seals and sealing glands shall be made of materials complying with **4.10.2**. Internal and external sealing glands shall comply with **4.10.3**. Seals and sealing glands shall comply with the requirements of BS 6505 as appropriate.

4.10.2 *Chemical resistance.* The material of construction of the seal or sealing gland shall be deemed to be suitable if the following series of requirements is satisfied.

When tested in accordance with **J.1.2.1**, the meter shall comply with **8.2**. It shall also withstand a static internal air pressure of 345 mbar, without permanent distortion or external leakage.

When subsequently tested in accordance with **J.1.2.2**, the same meter shall comply with the following requirements in the given order.

a) The requirements specified in **8.2**.

b) It shall withstand a static internal air pressure of 345 mbar without external leakage, when tested using one of the methods given in Appendix N.

c) The total mean pressure loss requirement specified in **9.2**.

d) The mechanical pressure loss requirement specified in **9.3**.

4.10.3 *Wear resistance.* The wear resistance shall be deemed to be satisfactory if the meter used for the endurance test (see **10.1**) subsequently complies with clauses **8** and **9**.

Seals and sealing glands which are not in operation during the endurance test, e.g. prepayment valve sealing glands, shall be subjected to 10 000 cycles of operation at a speed of rotation or other cyclic movement equivalent to that experienced during normal operation. They shall then be checked for soundness using one of the methods given in Appendix N at pressures of 75 mbar and 5 mbar.

4.11 Motion wires and components

Where fitted, motion wires, and their guides shall comply with the requirements for corrosion, wear and shock resistance specified in **4.4.3.4.1**, **5.14**, **10.1** and **10.4**.

4.12 Meter bosses

The meter bosses shall be made and finished in accordance with BS 746.

4.13 Adhesive

The adhesive shall be effective throughout the design life of the meter (see **5.11**).

5 Design and dimensions

5.1 Assembled meter

The meter case shall be in accordance with the dimensions given in Figure 1. The inlet connection of the meter shall be on the left-hand side when viewed from the front.

The external surfaces of the gas-containing components of the assembled meter shall, at any point, comply with **8.1** when tested in accordance with Appendix K.

5.2 Clearances

There shall always be clearance between moving components and stationary parts of the meter not intended to make contact.

External holes for screws, pins etc., which are used for the attachment of data badges or for the assembly of parts of the metres, shall not penetrate gas ways. The minimum wall case thickness shall be maintained between these holes and gas ways.

5.3 Pressure test point

5.3.1 *Nipple.* A meter shall be provided with a pressure test point in the form of a nipple as shown in Figure 2 for the temporary connection of a pressure test gauge. This nipple, manufactured from brass complying with alloy CZ 121 of BS 2874, shall be fitted either in the outlet connection, positioned as shown in Figure 3, or in that face of the meter from which the meter index is read.

A meter boss test nipple shall be either soldered into position, or securely fixed by the use of a suitable adhesive and a visible means of mechanical locking.

A test nipple fitted to the meter body shall be sited to indicate outlet gas pressure, positioned to minimize the risk of accidental damage and be easily accessible.

For either type [see Figure 2(a) or Figure 2(b)] the strength of the securing joint shall be such that it complies with **8.1** after:

a) applying a torque of 4 N·m; and

b) after a mass of 0.5 kg has been dropped from a height of 250 mm through a vertical tube on to the body diameter.

5.3.2 *Sealing screw.* A sealing screw in accordance with Figure 2(c) shall be used to seal off the nipple gas way when not in use.

5.3.3 *Seating and finish.* The machining, particularly that of the cone seating of the screw and body, shall be of a fine finish free from scores and tool marks.

To ensure a sound seating of the coned faces the screw shall not bottom and the cones and mating threads shall all be coaxial.

The pressure test nipple shall be free from burrs, sharp edges, swarf or other foreign matter.

5.3.4 *Soundness of nipple and sealing screw.* The assembled pressure test nipple, with the screw tightened to a torque of 0.5 ± 0.1 N·m, shall be sound when the meter is subjected to the pressure test specified in **8.1** subsequent to the test specified in **10.2**.

NOTE A smear of light oil complying with ISO viscosity grade 10 of BS 4231 may be applied to the cone seating.

5.4 Feet

The meter shall be supported on four firmly attached feet and the method of attachment shall comply with the requirements specified in **4.3.2.1** b) and c). The minimum height of the feet shall be 5 mm. The feet shall be designed either to be insulating or to accept an insulating cap, which shall be fitted (see also **10.6**).

5.5 Index

5.5.1 *General.* The index of the meter shall be sealed from the gas inside the meter and shall be vented to atmosphere.

When the meter is in an upright position the method of venting shall allow any condensate inside the index to drain and minimize the possibility of water ingress. The index cover, window and frame shall prevent unauthorized access to the index and its drive.

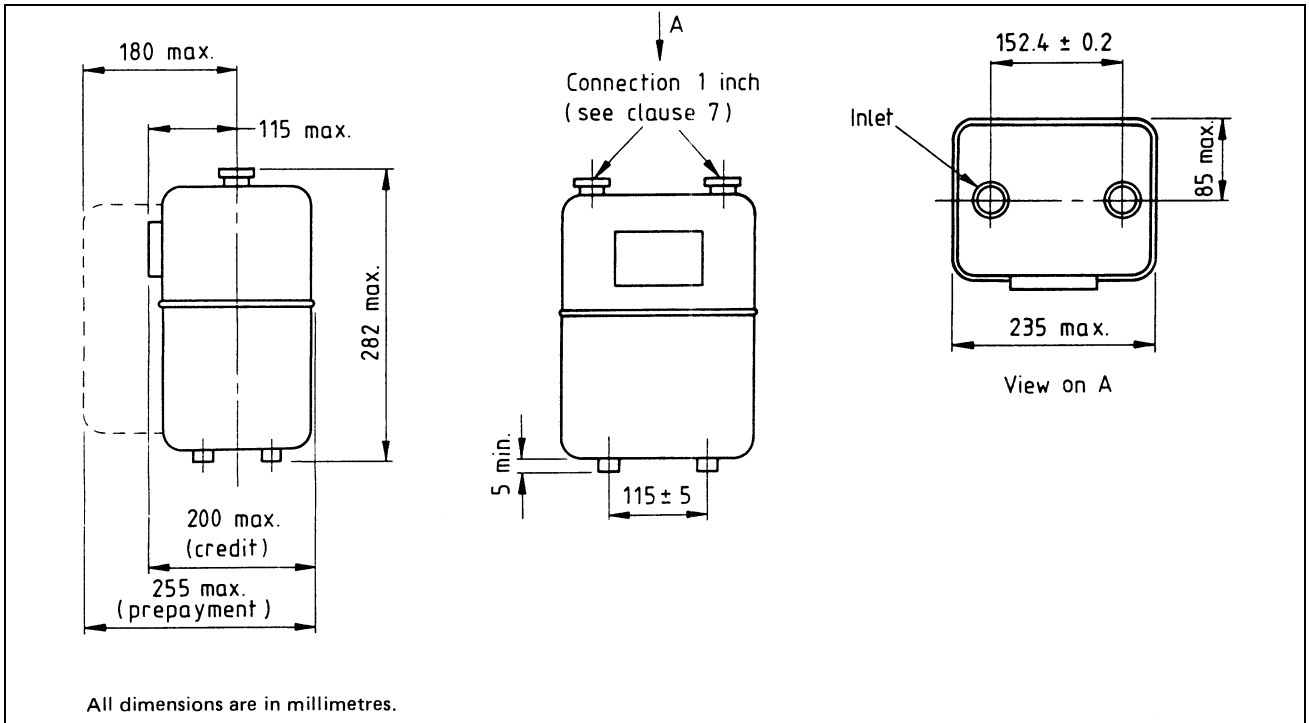


Figure 1 — Credit and prepayment meters

The details on the index face shown in Figure 4 and Figure 5 shall have black printing on a white background, except the red zero or red portion of the visor.

The index face and all markings shall remain legible after the test specified in **4.5.6.2.1**.

The recording numerals shall be arranged as shown in Figure 4 and Figure 5. They shall be of uniform size. Except as specified in **5.5.3**, they shall be white in colour on a black background and surrounded by a black visor as shown in the appropriate figure.

NOTE *Colour code*. The recording numerals shown on Figure 4 and Figure 5 have been chosen as a means of identifying the colours to be used for the index and these are as follows.

1 and 7 black drum, white numerals, black visor
5 black drum, white numerals, red visor
4 black drum, red numerals, no visor
3 black drum, white numerals, white graduations, red visor
0 red on white background

The numerals shall move in an upward direction and shall, with the possible exception referred to in clause **13**, be clearly visible at an angle of 15° to the normal.

A complete revolution of a drum shall, during the last 1/10th of its travel, i.e. from 9 to 0, cause the advance of the next higher drum by one unit.

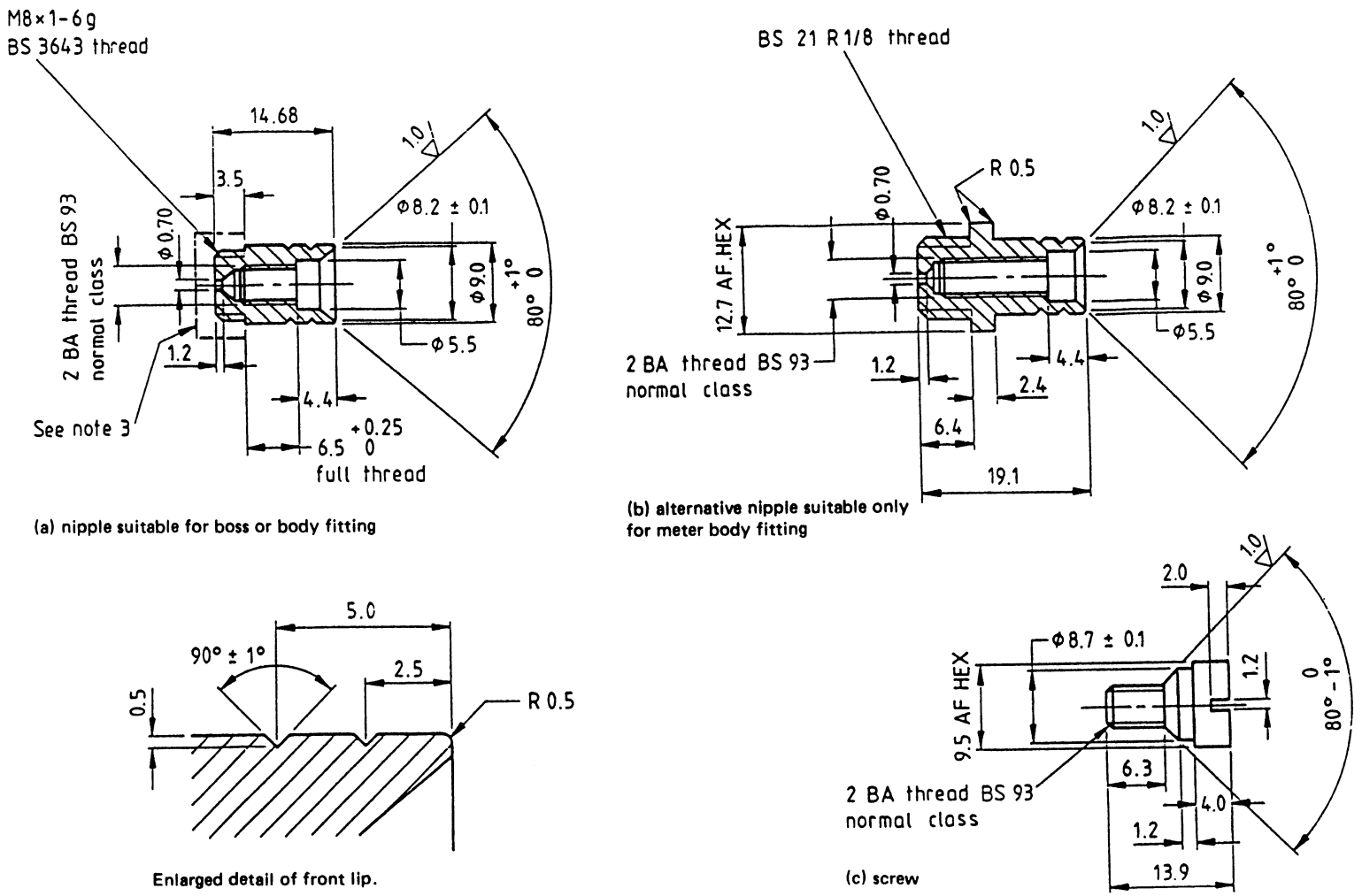
5.5.2 *Cyclic volume.* The difference between the actual value of the cyclic volume of the meter and the value of the cyclic volume specified on the meter shall not exceed 5 % of the latter.

5.5.3 *Cubic metre index.* The index for a meter with a badged rating in cubic metres shall be in accordance with Figure 4 and shall have a test drum. This drum shall move continuously while the meter is recording. It shall have a minimum diameter of 16 mm and the interval between scale divisions shall be constant throughout and not less than 1 mm.

The value chosen for one complete revolution of the test drum shall be a whole number multiple of the cyclic volume given on the meter.

The unit divisions, commencing with the numeral 0, shall be distinguished from the subdivisions by longer lines. These graduation lines shall be fine, uniformly drawn and white in colour [see enlarged view, Figure 4(b)]. For the application of photoelectric meter testing techniques, it is permissible for the test drum to have a clearly distinguishable reference mark that shall not conceal the subdivisions or interfere with the accuracy of reading.

The window for the test drum shall have a projection or a reference mark as shown in Figure 4 to permit certain and easy reading.



NOTE 1 The grooves are to facilitate the gripping of the tube.

NOTE 2 Unlimited dimensions to be correct to within ± 0.254. Concentricity on threads to cones to have total indicator reading (TIR) of 0.127.

NOTE 3 External dimensions and configuration shown by the area marked thus —.— may be altered to suit the application, except for the 0.7 ϕ × 1.2 deep hole.

All dimensions are in millimetres.

Figure 2 — Pressure test nipple

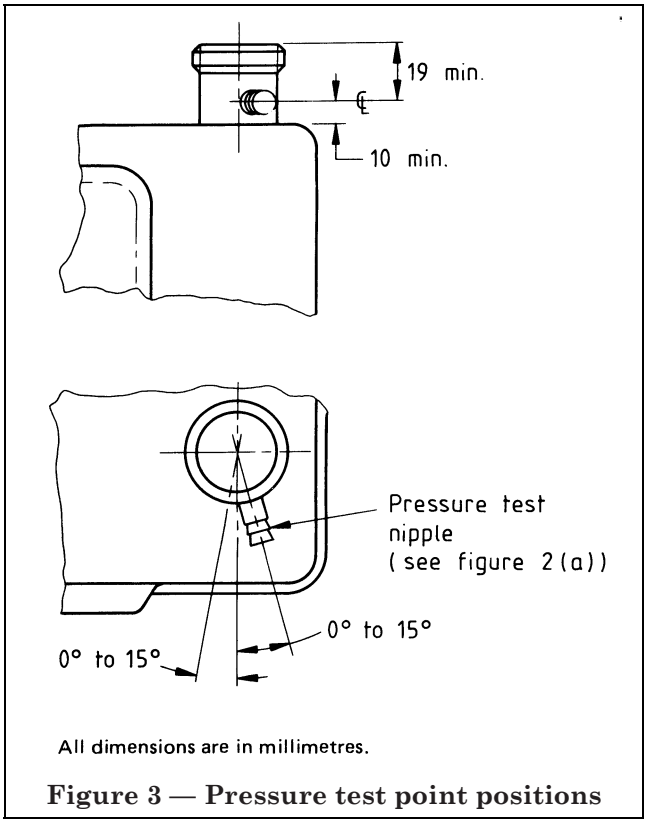


Figure 3 — Pressure test point positions

The recording numerals for submultiples of m^3 shall be surrounded by a red visor and separated from recording numerals in m^3 by a clear decimal marker.

5.5.4 *Cubic feet index.* The index for a meter with a badged rating in cubic feet shall be in accordance with Figure 5 and shall have a test dial, the diameter and sub-divisions of which shall permit certain and easy readings to be made when the meter is working at the badged rating. The enclosing diameter of the radial graduations shall be such that the tip of the test dial pointer moves a minimum of 4.5 mm per 0.1 ft^3 of gas passed.

The value chosen for one complete revolution of the test dial pointer shall be a whole number multiple of the cyclic volume given on the meter.

NOTE 1 The test dial as shown in Figure 5 indicates the principle.

The direction of rotation of the test dial pointer shall be indicated.

NOTE 2 The direction of rotation may be either clockwise or anticlockwise.

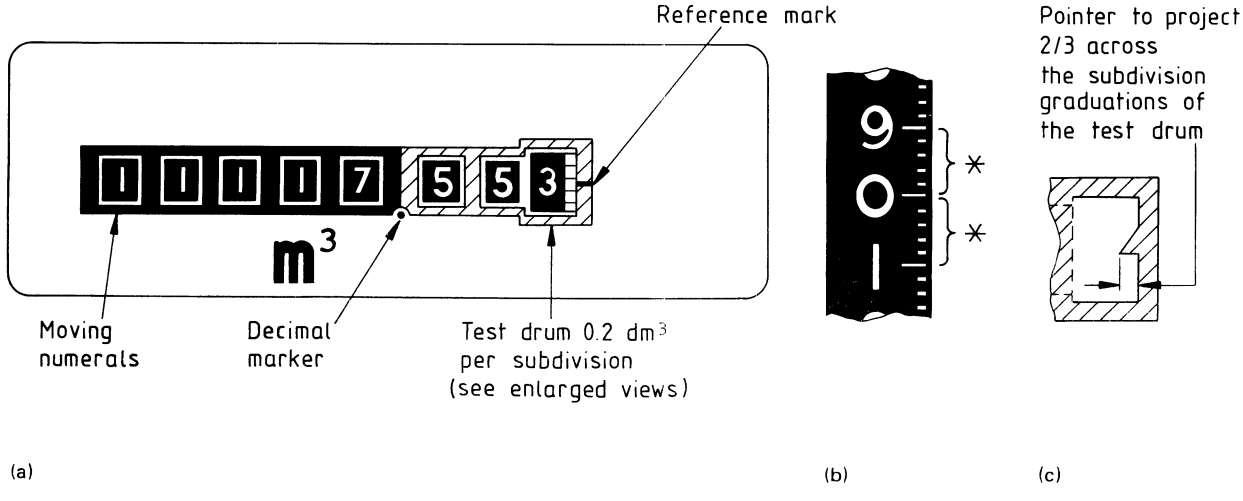
The test dial pointer shall be red, sharply pointed and lie as close to the dial as practicable.

The index face shall have one "0" in red on the white background at the end of, and in line with the recording numerals as shown in Figure 5.

5.6 Electrical output signal

Where the meter provides an electrical output signal, the meter shall bear a separate label (see **12.3**).

Where the output signal is derived from the operation of a switch type transmitter, e.g. a reed switch, the value of 1 pulse shall be 10 dm^3 (or 1 ft^3 on a cubic foot index).



* Four subdivision graduations; spaced at 1 mm (minimum) intervals between each pair of unit division graduations.

Figure 4 — Meter index (cubic metres)

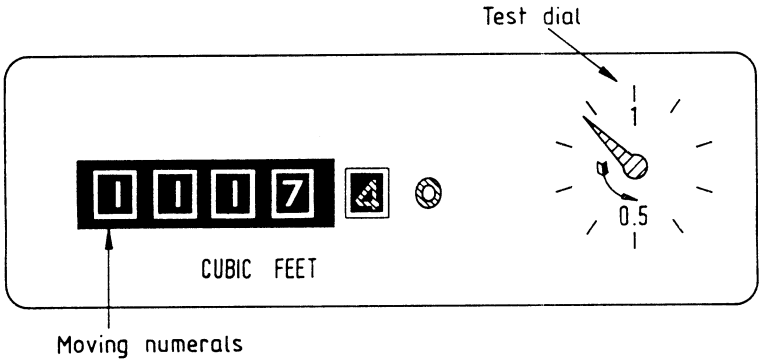


Figure 5 — Meter index (cubic feet)

The minimum closed or open time of the switch type transmitter shall be 200 ms and the maximum switch bounce time shall be 10 ms. The switch shall be regarded as closed if the resistance at the meter output is less than 50 ohms and shall be regarded as open if the resistance at the meter output is greater than 100 kΩ.

A connection of a type agreed between the meter manufacturer and the purchaser shall be used [see Appendix A g)].

5.7 Magnetic index drive

Where the drive for the index incorporates magnetic coupling this shall be of a straight-through line drive of a two-face or a cup-and-socket type.

The minimum torque transmission shall be whichever is the greatest of the following:

a) 0.01 N m;

b) twice the torque required to drive the index;

c) where applicable on prepayment meters, twice the torque required to drive the prepayment mechanism whilst the clutch specified in **14.4.3** is slipping.

The torque shall not be reduced below the minimum specified when a magnet of 4.4 kg pulling strength is positioned as close as possible to any point on the external surface of the meter.

5.8 Sealing gland assemblies

Any threaded device securing an external sealing gland shall tighten in the direction of rotation of the spindle passing through it.

5.9 Gear assembly

The gear assembly shall be designed to ensure correct gear meshing, shall be rigidly secured and shall be of either one or the other of the following types.

a) *Non-lubricated type*. The gears shall be either enclosed or provided with a dust cover.

b) *Lubricated type*. The gears shall be enclosed within a housing and lubricated with a grease that complies with **4.9**. It shall be possible to apply the grease with the housing fitted.

5.10 Diaphragm assembly

Flexing parts of synthetic meter diaphragms shall not touch moving parts or the diaphragm pans in normal operation.

5.11 Bonding

For additional safety where failure of any adhesive can cause mechanical failure or leakage, additional mechanical means shall be provided to secure components.

5.12 Valves

Valves shall be of the radial or straight-line action type. Where valves of the straight-line action type are used, they shall be driven indirectly from the crank through a link arm so that the valve movement will be effectively in a straight line.

Where sliding guide members are used to control the position of the valve covers on the grids, the design shall be such that the mechanical pressure loss does not increase after the tests for wear and corrosion included in this standard.

When calculated in accordance with Appendix L, the resistance power factor (R.P.F.) shall not exceed 1.2, i.e. the size of the valves shall not be excessive in relation to the capacity per revolution of the meter mechanism.

The ribs of the valve grids in contact with the valve covers shall have a minimum sealing width of 0.5 mm and shall allow for regrinding without an increase in the resistance power factor which would cause it to exceed the value of 1.2.

The drive to the valves shall be such that the valve covers do not tilt when tested with their contact surfaces contaminated with light oil complying with ISO viscosity grade 10 of BS 4231.

NOTE 1 To reduce the possibility of tilt, the drive for the valve covers should preferably be placed centrally and low on the covers.
NOTE 2 An R.P.F. of 1.2 has been chosen for this standard to ensure that there will not be excessive pressure absorption should the valve covers and grids become contaminated.

5.13 Adjustment

Any means of adjusting the performance characteristics of the meter shall be effectively secured and protected against interference.

5.14 Transit shocks

When tested in accordance with Appendix M the complete meter, in the upright position, without any packaging, shall withstand the vibration tests. Before and after this test, the meter shall comply with clauses **8** and **9**.

6 Assembly and workmanship

6.1 General

The interior of the meter shall be free from loose solder, swarf, grinding material and other foreign matter. Any corrosive soldering flux or spirit shall be removed.

6.2 Diaphragm assembly

6.2.1 Additional sealant or grease shall not be applied to the diaphragm or pan assembly to form a seal that is not permanent.

6.2.2 When assembled, there shall be no undue resistance to the movement of the mechanism at the end of each stroke.

6.3 Valves

Oil or other liquid shall not be applied to valve covers or grids.

6.4 Internal security

Any assembled parts, where manufactured as separate components, shall be securely fitted together and locked. After completion of the endurance test (see **10.1**) there shall be no evidence of significant deterioration of these components or joints.

6.5 Gearing and index drive

The gearing and all index drive shafts shall be aligned and coupled to minimize cyclic errors. The test drum or test dial pointer shall rotate smoothly.

6.6 Lubrication

Linkage pivot bearings which require lubrication shall be lubricated with grease which complies with **4.9**.

7 Connections

7.1 General

A meter shall have two one inch connecting bosses on top which comply with the relevant requirements of BS 746.

The bosses shall be set on a line parallel to the back of the meter (see Figure 1).

The face of the bosses shall be within **2**° of the horizontal plane of the meter.

8 Soundness

8.1 External

Meters shall be tested by one of the methods described in Appendix N and shall be sound externally when subjected to an internal air pressure of 75 mbar.

On a prepayment meter the prepayment valve shall be set in the open position whilst the meter is tested for external soundness.

8.2 Internal

The meter shall register when air is passed through it at 14 dm^3/h (or 0.5 ft^3/h) for a minimum of one working cycle of the measuring unit. During this test the test drum shall move 3 dm^3 or the test pointer 1 division (0.1 ft^3) in under 1 h.

9 Performance

9.1 Accuracy of registration

The meter, having been tested to comply with **8.1**, shall be tested in accordance with Appendix P using air. It shall be accurate within the limits ± 2 % at any rate of flow between the badged rating and any rate of flow not less than one-fiftieth of the badged rating.

For other than type testing, a meter is considered to satisfy these requirements if the requirements are met at Q_{max}, (6 m^3/h) and one fifth Q_{max} (1.2 m^3/h) and the internal leakage complies with **8.2**.

9.2 Total mean pressure loss

The total mean pressure loss of the meter when air is passed through it at the badged rating shall not exceed 2 mbar when measured using the method given in **Q.2.1**.

9.3 Mechanical pressure loss

The mechanical pressure loss of the meter when air is passed through it at 1 % of the badged rating shall not exceed 0.6 mbar when determined in accordance with **Q.2.2**.

10 Type tests

NOTE A different sample meter may be used for each test.

10.1 Endurance test

An endurance test shall be carried out on a sample meter in accordance with Appendix R. At interim times specified by the manufacturer and after 135 days, the meter shall comply with **8.1**, **8.2**, **9.1**, **9.2** and **9.3**. The interim times shall be specified before the commencement of the test.

10.2 Pressure cycling test

An assembled sample meter shall be subjected to 2 000 cycles at 30 cycles/h at internal pressures varying from 0 mbar to 345 mbar without visible permanent distortion and shall comply with **8.1**.

The rate of change of pressure shall not exceed 20 mbar/s.

10.3 Mechanical strength

10.3.1 ***Case***

10.3.1.1 *Load test.* The meter shall withstand an 80 kg load having a flat bottom surface area of 100 mm square, applied vertically, without shock, to any point on the top of the case. When the load is removed the meter shall not be visibly deformed; and shall comply with **8.1**.

10.3.1.2 *Impact test.* When tested in accordance with Appendix K the meter shall comply with **8.1**.

10.3.2 *Connections.* The meter shall not leak when subjected to the test specified in **8.1** during and after the following tests, and the connection shall not have a permanent deflection of more than **2°** in any plane.

a) With the meter held firmly, apply a torque of 80 N·m to each boss in turn.

b) With the meter supported by one connection, apply a force of 500 N at right angles to the centre line of the meter at 40 mm up from the base on the side of the meter remote from the connection (see Figure 6). Repeat the test on the other connection.

If, for convenience, the test specified in b) is carried out with the meter in the horizontal plane, allowance shall be made for its mass.

10.4 Ambient and extreme temperatures

10.4.1 *Ambient temperatures* (– 5 °C to + 35 °C). After testing in accordance with **S.1**, the meter shall comply with clauses **8** and **9**.

10.4.2 *Extreme temperatures* (– 15 °C, + 40 °C). The meter shall start up and register a volume of gas at least equal to one cyclic volume after being tested in accordance with **S.2**.

10.5 Fire and heat resistance

10.5.1 *Fire resistance.* A sample fire resistant meter or meter case shall be fire tested in accordance with the method described in Appendix T.

NOTE This method is based on the time/temperature curve, given in Figure 1 of BS 476-8:1982.

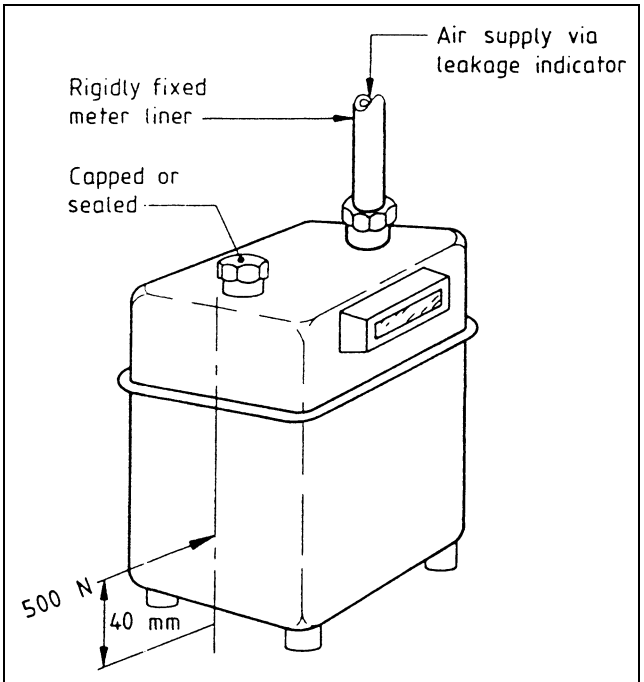


Figure 6 — Method of testing connections

Throughout the test, the leakage rate of the meter shall not exceed 140 dm^3/h (or 5 ft^3/h), whilst a constant test pressure of 50 mbar is maintained.

10.5.2 *Heat resistance.* When suspended in an ambient temperature of 120 ± 2 °C for 15 min the meter shall comply with **8.1**.

10.6 Insulation test for feet

When the meter is standing on a flat metal plate and a potential of 500 V d.c.is applied between the metal plate and each meter boss separately for 60 s, the electrical resistance shall not be less than 100 kΩ.

When the meter is standing on a flat metal plate and a potential of 650 V a.c. is applied between the metal plate and each meter boss separately for 60 s, there shall be no breakdown of the insulation.

10.7 Labels and badges

10.7.1 *General.* Labels and badges shall remain securely fixed and be legible after being subjected to the tests specified in **10.7.2**, **10.7.3** and **10.7.4**.

10.7.2 *Humidity test.* The meter (or sample plaque thereof) with labels and badges fitted, shall undergo a humidity test for a minimum of 4 days using the apparatus specified in **C.1**.

10.7.3 *Ultraviolet radiation test.* The printing on the labels and badges shall be exposed to the effects of ultraviolet radiation for the same time periods and using the same apparatus as specified in **4.5.6.2.1**.

10.7.4 *Indelibility test.* The printing on the badges, labels and notices shall be tested in accordance with Appendix B of BS 3955:1986.

11 Transit and storage protection

The bosses shall be provided with non-sealing caps to protect the threads and prevent the entry of foreign matter during transit and storage.

12 Marking

12.1 Direction of flow

The meter shall be clearly and permanently marked with the direction of flow either by an arrow between the connections or by the word **INLET** as near as possible to the inlet connection.

12.2 Gas escape notice

If a gas escape notice is fixed to the meter it shall be readable when viewing the index and shall include the following information.

a) It shall specify that the consumer should do the following.

1) Shut off the supply of gas immediately in the event of an escape of gas in the consumer's premises.

2) Immediately give notice of the escape to the supplier if any gas continues to escape after the supply has been shut off.

3) Not reopen the supply until all necessary steps have been taken to prevent the gas from escaping again.

b) It shall include provision for clearly stating the following.

1) The name of the gas supplier.

2) The emergency service telephone number of the gas supplier.

3) The date on which the gas escape notice was first displayed.

The notice shall have black lettering on a yellow background with a black border not less than 2 mm wide.

NOTE It is permissible for the notice to be of a transfer or self- adhesive type (see also **16.1**).

12.3 Identity and data marking

All meters shall bear the following marking, readable from the front of the meter:

a) the meter manufacturer's name;

b) the meter manufacturer's serial number;

c) the year of manufacture;

d) the badged rating in m^3/h (or ft^3/h);

e) the capacity per revolution (cyclic volume) in dm^3 (or ft^3);

f) the maximum working pressure (in mbar).

The above markings shall be shown either on the index or in the form of an embossed metal badge or badges firmly and securely attached to the meter and capable of being sealed against unauthorized interference.

Where the meter provides an electrical output signal, the following additional marking shall be shown on a separate label adjacent to the output:

1) the value per pulse in m^3 or ft^3;

2) the maximum switch rating;

3) a statement that it is imperative that the device be energized only by circuitry suitable for use in at least Zone 2 areas as defined in BS 5345-1.

12.4 Synthetic diagrams

A meter provided with a synthetic diaphragm shall carry the letter "S" as a suffix to the serial number. This indication shall appear in close proximity to the year of manufacture.

12.5 Special conditions

Where a meter is required for use with a gas outside the scope of this specification its suitability shall be verified with the meter manufacturer and the meter shall be appropriately marked in a permanent manner.

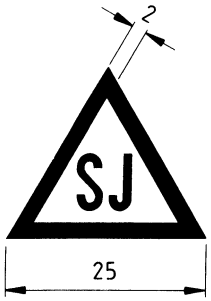
12.6 Badge fixing

Any badge fixed to the meter case shall be sealed around its edges to prevent the ingress of water. Any means used for securing a badge shall not pierce the case.

12.7 Non-fire-resistant meters

Non-fire-resistant meters shall be clearly identified with a badge fixed adjacent to the index (see Figure 7). The lettering shall be in black, the border in red and the background white.

NOTE It is permissible for the badge to be of a transfer or self-adhesive type.



All dimensions are in millimetres.

Figure 7 — Non-fire-resistant meter badge

Section 3. Additional requirements for prepayment meters

13 Visibility

Notwithstanding the requirement of **5.5.1**, where part of a prepayment attachment partially obscures one side of the index, the viewing angle of 15° need not apply to that side.

14 Design and dimensions

14.1 External dimensions

The assembled meter and prepayment attachment shall comply with the dimensions given in Figure 1.

14.2 Prepayment attachment

The prepayment attachment and the cash box shall be on, and operable from, the front of the meter.

The prepayment attachment shall be firmly and securely attached to the meter case but shall be readily removable for repair or exchange purposes.

The prepaid indicator shall be protected by a window and shall be easily readable from the front of the meter.

14.3 Prepayment valve

The prepayment valve shall comply with **15.4** before and after the tests specified in **4.4.3.4.1**.

When the prepayment valve is on the inlet of the meter, means shall be provided to prevent foreign matter falling on to it.

14.4 Mechanism

14.4.1 The prepaid indicator scale shall be marked in divisions of 5 m^3 (or 100 ft^3) and except as stated below, sub-divisions of 1 m^3 (or 25 ft^3) and, when the mechanism is fully prepaid, it shall indicate this by displaying the word FULL. The markings shall remain legible after being subjected to the test specified in **4.5.6.2.1**. The prepaid indicator scale and the mechanism to which it is attached shall be such that it is possible to prepay for at least 15 m^3 (or 500 ft^3).

14.4.2 While a coin is in the coin carrier it shall not be possible to ratchet the mechanism to add to the prepaid volume.

14.4.3 A clutch or other overload device shall be provided to prevent damage to, or malfunctioning of, the mechanism should the meter continue to register when the prepayment valve has closed and the prepaid indicator scale registers zero.

14.4.4 A stop device in the mechanism shall prevent the insertion of further coins when the prepaid indicator shows FULL.

If a coin is contained in the mechanism when the prepaid indicator shows FULL it shall be possible to complete the insertion, and, if the coin is accepted by the mechanism, the full value of gas shall be obtained.

14.4.5 It shall not be possible to operate the mechanism with any current British coins other than by the coin for which it is designed and then only when they are presented in the proper manner.

14.4.6 The overall length of the coining lever, centrally pivoted, shall be between 45 mm and 67 mm and the total maximum torque to turn it (the force being applied to the end of the lever) shall not exceed 0.7 N m. The coin ejection shall not increase this torque beyond 1 N m.

14.5 Coin plate and carrier

14.5.1 Prepayment mechanisms shall accept and be operated satisfactorily by either 50p and/or £1 coins, depending on the design of the mechanism. For test purposes, test pieces made to the limiting coin dimensions given in Table 1 shall be used.

Table 1 — Coin dimensions

Coin	Diameter	Thickness
	mm	mm
50p	29.92[a] 30.08[a]	2.39 2.51
£1	22.075 22.625	2.95 3.25

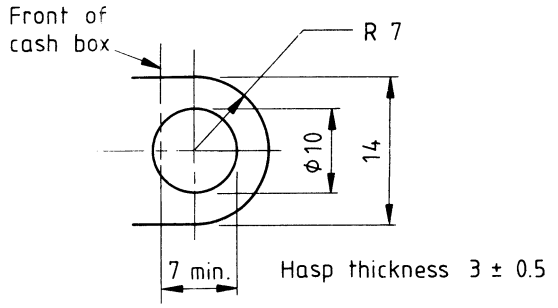
[a] Measured between parallels.

14.5.2 The setting increments and ranges of the coinplates shall be as given in Table 2.

14.6 Cash box

The cash box shall be such as to deter unauthorized entry. It shall be free from sharp edges. The cash box shall be secured by a hasp complying with the dimensions given in Figure 8 and/or an internal lock complying with the dimensions given in Figure 9, a pocket for which shall be provided.

The pocket shall be so placed as to permit the bolt to lock on its parallel section. The lock shall be a slide-in fit in the pocket.

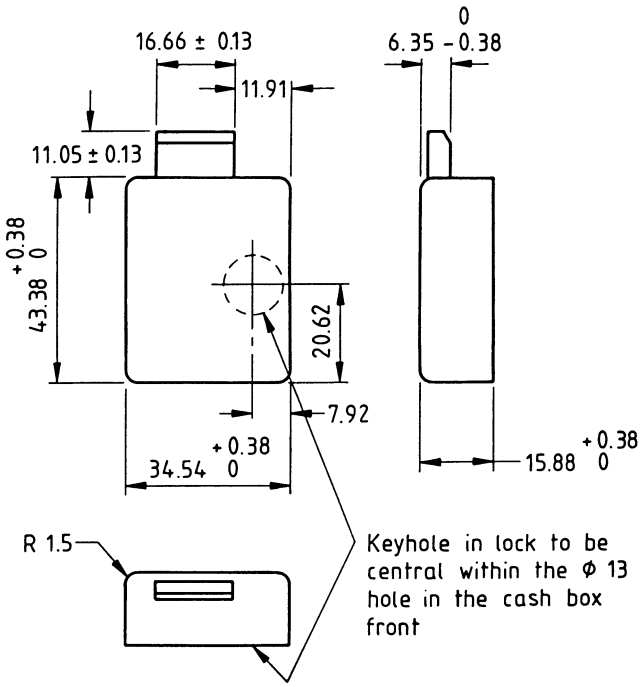


NOTE Tolerances except where stated otherwise are ± 0.25. All dimensions are in millimetres.

Figure 8 — Hasp for external padlock

Table 2 — Coinplate setting increments and ranges

Coinplate	Coinplate colour (see 16.2)	Setting increment per coin		Range			
				From		To	
		m^3	ft^3	m^3	ft^3	m^3	ft^3
50p	Yellow	0.2	6	0.6	18	4.0 min.	150 min.
£1	Dark blue	0.4	12	1.2	36	8.0 min.	300 min.
	Light blue	0.2	6	0.6	18	4.0 min.	150 min.



NOTE This is not intended as a specification for an internal lock but solely as a means of ensuring that all meters requiring this type of lock are capable of accepting one of a standard pattern.

All dimensions are in millimetres.

Figure 9 — Internal lock for prepayment meter

The cash box shall hold, at least once in the course of three attempts, £150 in 50p pieces or a minimum of £300 in £1 pieces, the coins being presented through the coinplate slot. It shall be possible to extract the box containing this value of coins.

A means shall be provided for the withdrawal of the cash box and shall withstand a horizontal pull of 250 N without damage or detachment.

14.7 Attachment cover

The attachment cover shall be securely fitted to the meter and designed to deter unauthorized access to the pre-payment mechanism and to the contents of the cash box.

15 Performance

15.1 General

Tests for compliance with the performance requirements for the prepayment attachment shall be carried out using air. The tests shall be carried out using the appropriate coin or test piece (see **14.5.1**).

15.2 Accuracy of prepaid volume

For one complete revolution of the quantity wheel or wheels, as applicable, the accuracy obtainable shall be within ± 2 % of the volume passed through the meter is indicated by the meter index. The tolerances shall not be cumulative.

15.3 Mean pressure loss

The coinplate setting for this test shall be in accordance with the lowest appropriate setting in Table 2 and the prepayment valve shall be allowed to close by the normal operation of the mechanism. The prepayment valve shall open when the mechanism is operated by a single coin. The mean pressure loss of the meter shall not exceed 1.25 mbar at an air flow rate of 1.5 m^3/h (50 ft^3/h) when measured in accordance with **Q.2.1**.

15.4 Prepayment valve soundness

After the prepayment valve is allowed to close by the normal operation of the mechanism, the rate of leakage past the valve shall not exceed 14 dm^3/h. If the meter continues to register at a rate below 14 dm^3/h (or 0.5 ft^3/h) with an inlet air pressure of 50 mbar, the prepayment valve shall continue to be driven in the closing direction.

15.5 Test of coin insertion force

The force required to insert the coin into the coin mechanism shall not exceed 10 N. The test shall be carried out with the coin mechanism fitted to the prepayment meter and insertion of the coin shall be by thumb. The meter shall be constrained to move only in the forward and backward direction and a spring balance shall be used to measure the coin insertion force.

16 Marking

16.1 Meter badge

The front of either the cash box or attachment cover shall be provided with a transfer or self-adhesive prepayment meter badge having the following wording.

"Insertion of coins

If gas has run out turn off all gas taps on appliances served by this meter before inserting coins

Turn handle left

Insert coin in slot

Turn handle right until coin drops in box

Bent or battered coins must not be used

Relight pilots"

The lettering shall be black on a yellow background; the badge shall incorporate a black border not less than 2 mm wide.

The text of the prepayment meter badge shall form a separate badge or be incorporated with the gas escape notice badge text (see **12.2**).

Whichever option is adopted the text of the prepayment badge shall be readable by a user when in a position to operate the prepayment mechanism.

16.2 Coinplate

The marking on the coinplate shall remain legible after being subjected to the tests specified in **10.7.2**, **10.7.3** and **10.7.4**. The 50p version shall include the words "cubic metres (or cubic feet) per 50p" and the £1 version shall include the words "cubic metres (or cubic feet) per one pound (or £1)".

The 50p coinplate shall be coloured yellow, e.g. in accordance with No. 310 "Primrose" of BS 381C as given in Table 2.

The £1 coinplate or lettering shall be coloured either dark blue, e.g. in accordance with No. 105 "Oxford blue" of BS 381C, or light blue, e.g. in accordance with No. 112 "Arctic blue" of BS 381C, as given in Table 2.

16.3 Setting position

The coinplate setting position shall be clearly indicated.

16.4 Prepaid indicator

The prepaid indicator shall indicate gas prepaid in cubic metres (or cubic feet).

Appendix A Information to be supplied by the purchaser

In any enquiry or order the purchaser should provide the following information:

a) the meter designation, i.e. U6;

b) whether the meter is to be credit or prepayment (in the case of the latter the coinplate (see **14.5.2**) will need to be specified);

c) whether the meter is to be fire resistant (see **10.5** and **12.7**);

d) external finish colour of the meter;

e) type of index in m^3 (or ft^3) (for ft^3 see also note 1 to **5.5.4**);

f) the gas for which the meter is required (see **12.5**);

g) any special requirements, e.g. see **5.6**, **12.2**, **12.3** and **12.4**;

h) the number of this standard, i.e. BS 4161-3.

Appendix B Coated surfaces: test of scratch resistance [see **4.2** a) and **4.3.2.3** b)]

B.1 Apparatus

The apparatus, in which a 1 mm diameter steel ball is mounted by soft soldering in a spring loaded housing, is shown in Figure 10.

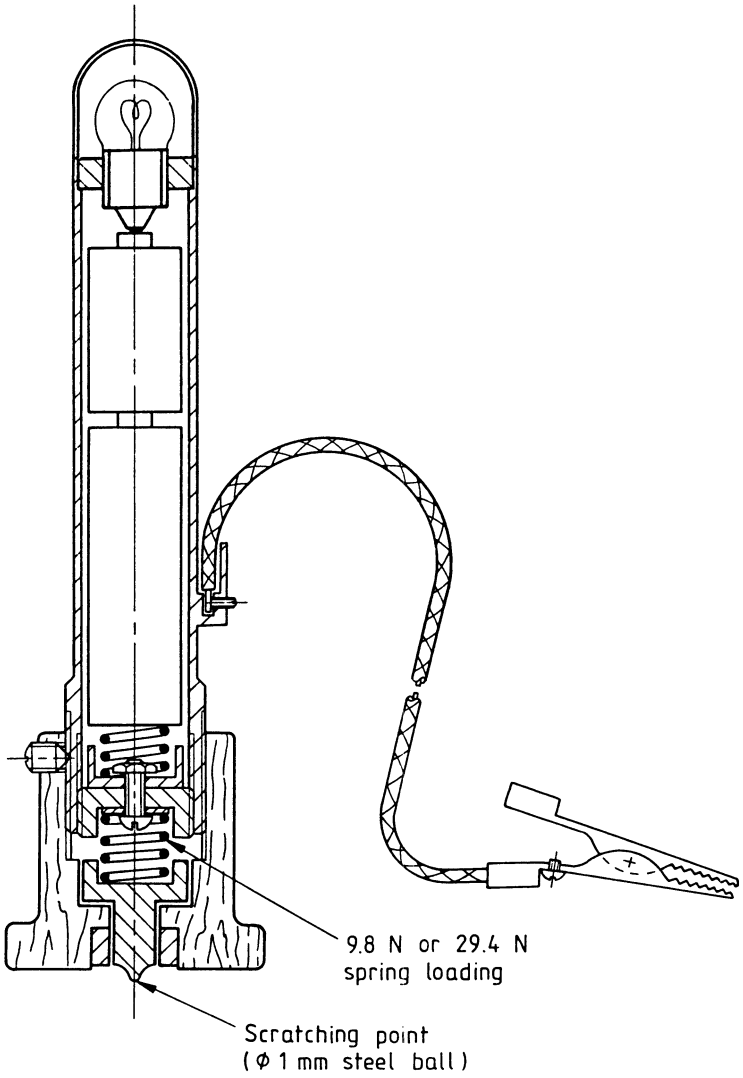


Figure 10 — Paint scratch test apparatus

B.2 Procedure

When determining the scratch resistance as required by **4.2** a), use a spring loading of 9.8 N. When determining the scratch resistance as required by **4.3.2.3** b), use a spring loading of 29.4 N.

Attach the crocodile clip to the meter connection or substrate of sample meter plaque. Draw the apparatus evenly over the surface under test at a speed of 30 mm/s to 40 mm/s, keeping it upright and pressed to the surface throughout the movement.

Clean the ball after each test and inspect it frequently to verify that it remains a 1 mm sphere.

Check that the force exerted by the spring is 9.8 N or 29.4 N.

B.3 Penetration criteria

When the apparatus is drawn across the test surface, if the indicator bulb lights, the surface finish shall be deemed to have been penetrated.

A conductive finish applied directly to a metal surface shows a light without penetration and in this case, the surface should be examined for penetration, e.g. visually or by micro-porous examination or by salt spray tests.

Appendix C Decorative finish: test for resistance to humidity [see **4.2** b)]

C.1 Apparatus

The apparatus consists of a closed cabinet, in which the relative humidity is maintained at approximately 100 % by cycling the temperature of a water bath continuously over a range from 42 °C to 48 °C, thereby ensuring that copious condensation occurs on the samples under test.

Details of the cabinet and the temperature requirements are given in BS 3900-F2.

C.2 Procedure

Paint the unprotected edges of any test sample that are not normally exposed in practice. Vertically position the painted sample within the cabinet for 4 days. Remove the sample and examine for evidence of corrosion beneath the paint film or deterioration of this film.

Leave the sample to stand for a further 24 h at room temperature, then subject it to a further visual examination for evidence of corrosion beneath the paint film or deterioration of this film.

Appendix D Scheme of requirements and associated tests for corrosion resistance of materials other than austenitic stainless steel

A scheme of requirements and associated tests for corrosion resistance of materials other than austenitic stainless steel is given in Figure 11.

Appendix E Corrosion resistance surfaces: tests (see **4.3**)

E.1 Mechanical tests

E.1.1 ***Flexibility***

Flexibility shall be measured at a temperature of 20 ± 5 °C, using a 6 mm diameter cylindrical mandrel for the bending test, as specified in BS 3900-E1.

The flexibility shall be such that there is no cracking or loss of adhesion after the bending test.

NOTE An area 3 mm from the edges of the test sample may be ignored.

E.1.2 ***Impact resistance***

Impact resistance shall be measured in both directions in accordance with BS 3900-E3 using a washer of 2.5 mm thickness after which there shall be no cracking or loss of adhesion.

E.1.3 ***Cross cut resistance to separation***

Cross cut resistance to separation shall be measured in accordance with BS 3900-E6, using a 1 mm grid pattern made with a multiple tool, after which the classification of the results shall be 0, i.e. no detachment.

E.2 Chemical tests [see **4.3.2.1** c) and **4.3.3.1** b)]

E.2.1 ***General***

The tests specified in **E.2.2** to **E.2.4** shall each be for a duration of 1 000 h.

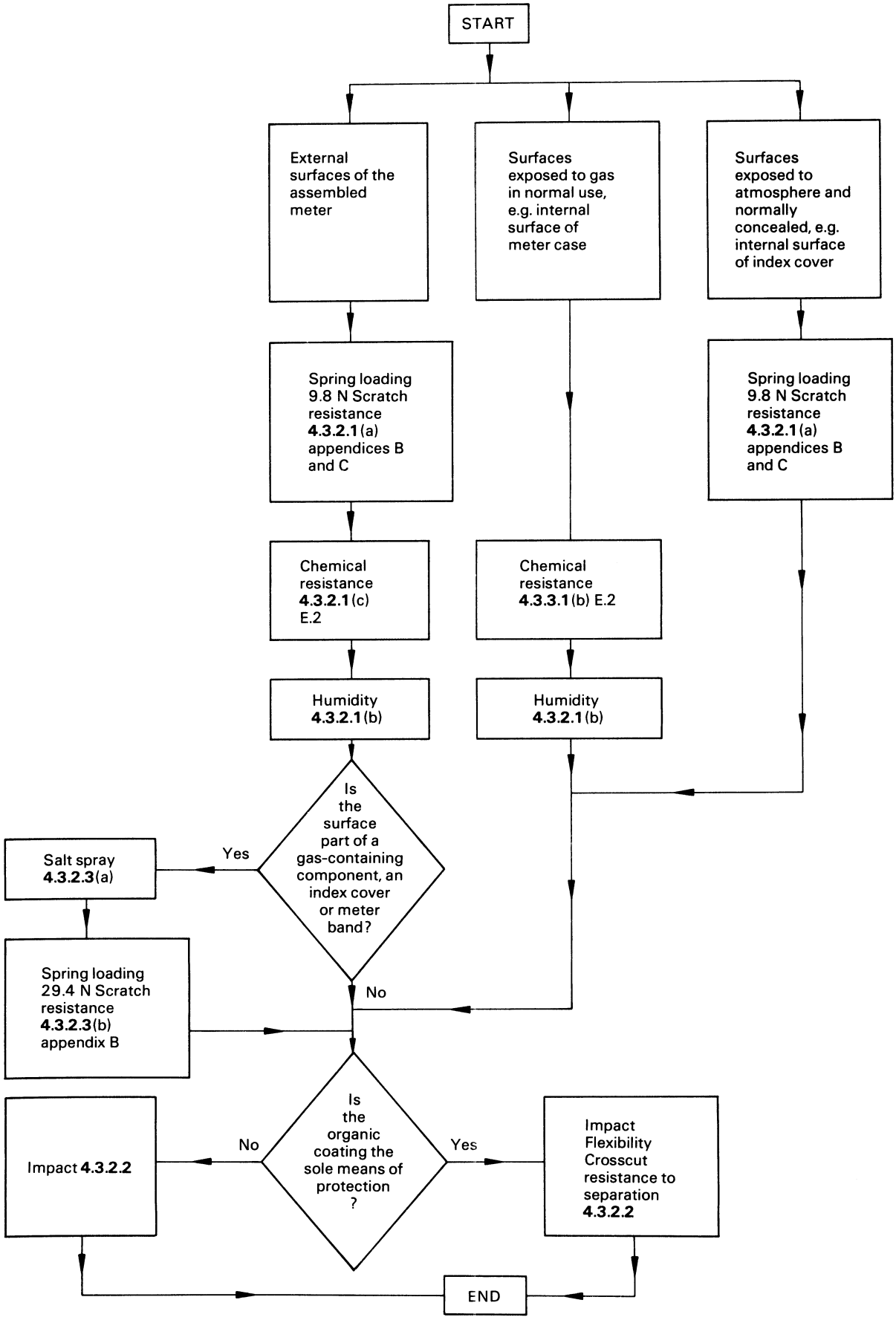


Figure 11 — Scheme of requirements and associated tests for corrosion resistance of materials other than austenitic stainless steel

E.2.2 ***Chemical resistance***

Partially immerse the test samples in each of the following liquids at 20 ± 2 °C, with at least 30 % of the sample below the liquid surface:

a) lubricating oil[3)];

b) heptane;

c) digol;

NOTE Digol was previously known as diethylene glycol.

d) methanol;

e) toluene;

f) distilled or deionized water;

g) detergent[5)].

Use a separate test sample for each liquid.

E.2.3 ***Humidity test***

The humidity test shall be carried out in accordance with BS 3900-F2 with a relative humidity of 100 % and a temperature cycle of 42 °C to 48 °C and back to 42 °C in 1 h.

E.2.4 ***Salt spray test***

The salt spray test shall be carried out in accordance with BS 3900-F4. Before exposure in the apparatus, the sample shall be scribed with a 60° cross score to bare metal with the lines at least 100 mm long and not nearer than 15 mm to any edge.

E.3 Austenitic stainless steel: test (see **4.3.2.4**)

E.3.1 ***Test solution***

Dissolve hydrated magnesium chloride ($MgCl_2.6H_2O$) in a minimum of distilled water. Bring the solution to the boil and add small quantities of distilled water or magnesium chloride as required to obtain a boiling point of 130 ± 2 °C.

E.3.2 ***Procedure***

Using a stainless steel wire suspend the component, or a part of it cut from the most severely deformed region, in a test vessel. Add sufficient test solution to cover the sample, but a minimum of 15 mL of solution per 100 mm^2 exposed surface of the test sample. Using a vapour condenser to maintain a solution of the correct boiling point, heat the solution uniformly to 130 ± 2 °C. Maintain the solution at this temperature for 96 h then at 70 ± 2 °C for a further 72 h. Remove the sample and examine it for signs of cracks using a × 10 magnifying glass.

Appendix F Synthetic diaphragm: Williamson torsion test of stiffness (see **4.4.3.3.2** and **4.4.3.3.3**)

F.1 Principle

The percentage change in stiffness is measured as the percentage change in the force necessary to impart a 90° twist to a strip of synthetic diaphragm material.

F.2 Apparatus

F.2.1 *Bright steel wire,* about 300 mm in length and 0.18 mm in diameter, suspended from a torsion head, as shown in Figure 12.

F.2.2 *Upper (reciprocating) test piece clamp,* carried by the bright steel wire.

F.2.3 *Pointer,* upper and lower pointers which move over their respective scales.

F.2.4 *Lower test piece clamp,* of mass 8 g and restrained from rotating in a horizontal plane but free to move vertically.

F.3 Procedure

Proceed as follows.

a) Prepare test pieces 120 mm long by 10 mm wide from the diaphragm or diaphragm material.

b) Fix one end of the test piece in the upper (reciprocating) test piece clamp and, by means of a gauge or by prior marking of the test piece, attach the lower test piece clamp so that exactly 100 mm of the test piece is exposed between the two clamps.

[3)] For information on the availability of a suitable lubricating oil and detergent, apply to the Enquiry Section, British Standards Institution, Linford Wood, Milton Keynes MK14 6LE, enclosing a stamped addressed envelope for reply.

c) Set the torsion head to read zero and adjust the (lower) pointer to read 0°.

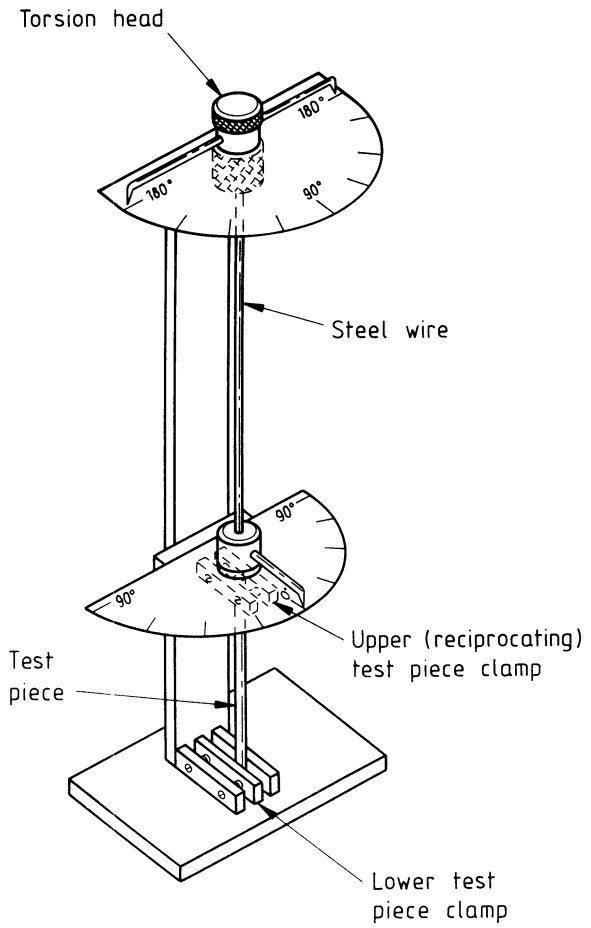


Figure 12 — Torsion apparatus

NOTE At this stage both the wire and the test piece are approximately torsion free.

d) Rotate the torsion head clockwise until the lower pointer indicates that the top end of the test piece has been twisted through 90°. Note the reading of the torsion head (see note 5).

e) Return the torsion head to zero, i.e. to the starting position, and repeat the procedure given in d), but in the anticlockwise direction.

f) Calculate the angle of twist in the wire, which is proportional to the stiffness of the test piece, from the mean of the deflections measured in d) and e) minus 90°.

NOTE 1 It is essential that the lower test piece clamp can move in a vertical direction with the least possible friction.
NOTE 2 The test piece has to be vertical and the lower test piece clamp has to be evenly balanced and horizontal.
NOTE 3 The same test piece can be used for the determination of stiffness at room temperature before and after ageing and for flexibility measurements at – 5 °C.
NOTE 4 A liquid environment is not to be used to maintain the experimental temperature. For low temperature flexibility measurements at – 5 °C, see **4.4.3.3.3**. The apparatus is to be placed in a cold room.
NOTE 5 When measuring materials subject to creep, the time between the first application of force and the reading of the torsion head has to be constant. A period of 10 s is suggested.

F.4 Calculation of the percentage change in stiffness

The percentage change in stiffness is calculated as follows:

$$\frac{\text{angle of twist after ageing (or at } -5\ ^{\circ}\text{C}) - \text{initial angle of twist}}{\text{initial angle of twist}} \times 100$$

Appendix G Synthetic diaphragm porosity test (see 4.4.3.3.4)

G.1 Locate the test piece centrally between the two halves of a test rig and clamp securely (a suitable rig is shown in Figure 13).

G.2 Supply air at a pressure of 25 mbar to the underside of the test piece. Lock off inlet pressure and monitor system pressure via a manometer.

Appendix H Synthetic diaphragm: preparation and use of treated gas for the vapour phase test (see 4.4.3.4.1)

H.1 Apparatus

NOTE See Figure 14 for key references.

H.1.1 *Modified gas meter* (6), a U6 gas meter (6), or a P1 or P2 as in BS 4161-1 modified in either of the following ways.

a) By extending the test dial shaft of the index, and attaching a plain white disc of 75 mm to 100 mm diameter (7) on which have been drawn thin black radial lines dividing the periphery into not more than 30 equal divisions. These divisions are scanned by a photoelectric scanning head (8) so arranged as to give an electrical pulse on each line.

NOTE 1 Stronger signals may be obtained by using a black disc with narrow slits in place of the lines, the slits being lit from the back by a small electric lamp.

b) By taking a gas-tight drive direct from the tangent of the meter through the top of the case. To this shaft a disc is attached, but with only one line or slit which is scanned as in a).

NOTE 2 It is not convenient to use method b) if change-wheels are used within the index.

NOTE 3 The purpose of the modified gas meter is to measure the flow of gas through the apparatus, and if the apparatus is not manually operated, to control the input rate of toluene from the micrometering pump (see **H.1.2**). Each pulse[4)] causes the pump to deliver a predetermined volume of toluene to the top of the tower (9), which is filled with porcelain saddles. The previously humidified gas passes up the tower.

H.1.2 *Micrometering pump*(13), capable of metering the required dosage of toluene as specified in **4.4.3.4.1**.

H.1.3 *Heater for toluene tower*

NOTE It is permissible to manufacture the tower heaters from thin metal piping with copper tubing connecting the apparatus. Should it prove necessary, electrically heated tape may be wound helically round the tower (9) and controlled by a thermostat sensor (11).

H.1.4 *Gas humidifier*

NOTE 1 Humidification of the gas is carried out by passing water from a reservoir down a tower (3) countercurrent to the gas flow. The tower is filled with porcelain saddles or similar inert material to give a large surface area that will allow a high rate of evaporation of the incoming water. Excess water is siphoned off at the base of the tower.

NOTE 2 A mixing tank may be employed, if necessary, before the gas is passed through the meter to be tested.

H.2 Procedure

Meter the gas through a dry gas meter modified as described in **H.1.1** and subsequently condition it by adding water vapour and toluene vapour to the saturation levels specified in **4.4.3.4.1**. Place the meter to be tested at the outlet of the apparatus. Upon completion of the running on the treated gas, remove the meter under test from this test apparatus and return it to the untreated test gas apparatus for immediate determination of the accuracy of registration, thus ensuring that the reference meter or other proving equipment is not affected by the treated test gas.

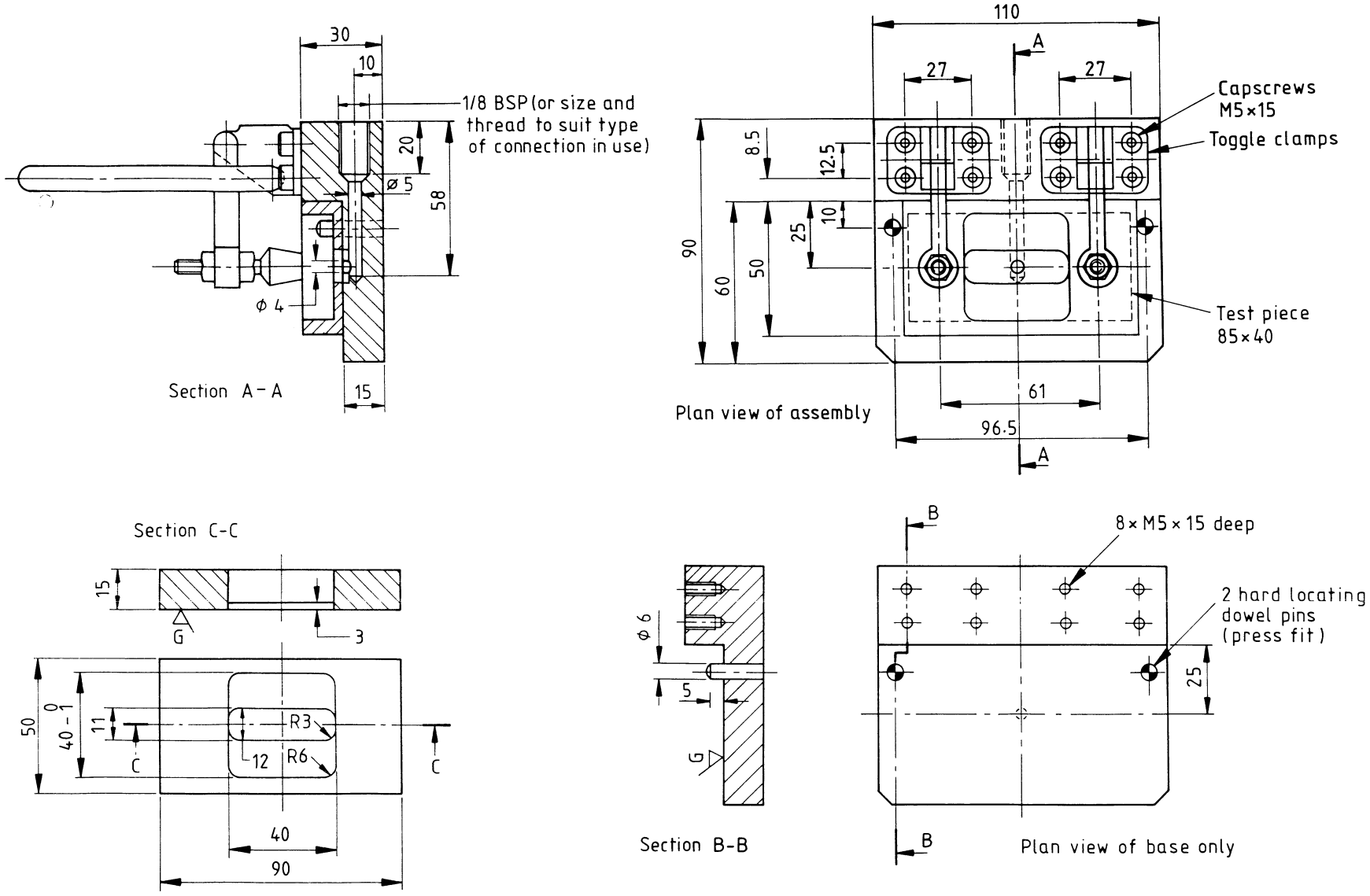
Appendix J Tests on seals and sealing glands (see 4.10)

J.1 Chemical resistance of seals and sealing glands

J.1.1 ***Constituent***

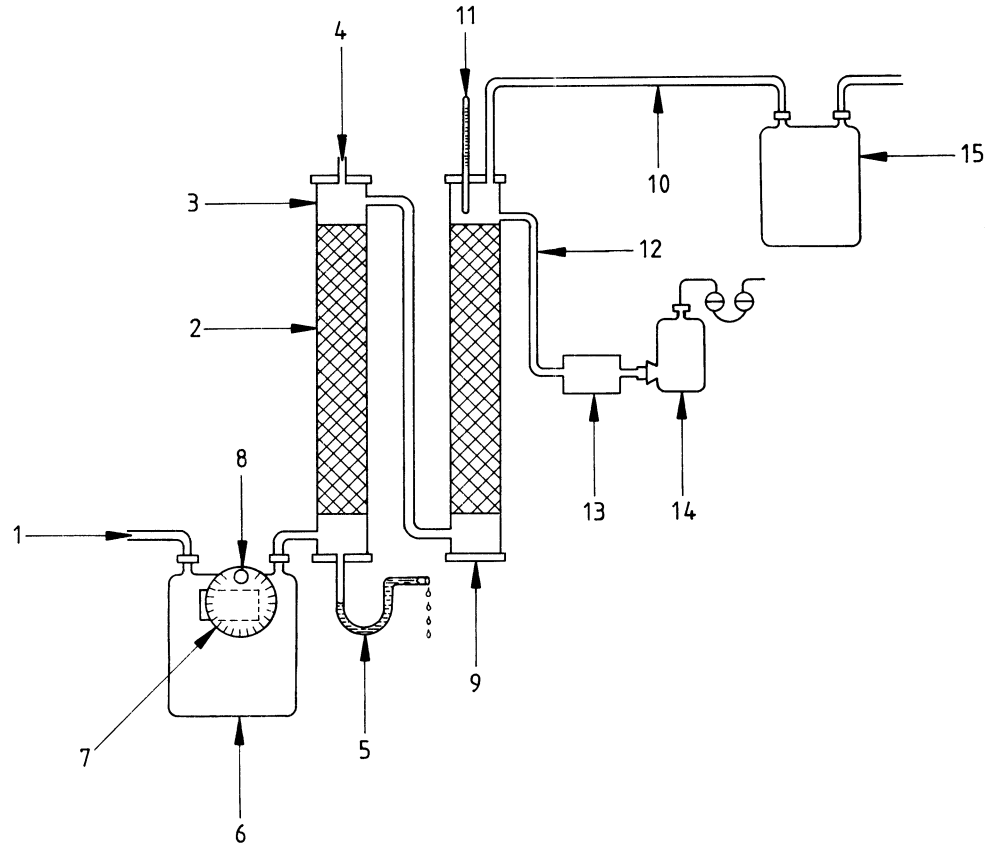
The constituent used in **J.1.2** shall be a toluene/heptane mixture in the proportion 1 : 1 by volume for gas containing aromatic/aliphatic hydrocarbons.

[4)] Electrical pulses from the modified gas meter, trigger the micrometering pump.



All dimensions are in millimetres.

Figure 13 — Porosity test rig



Key

1 Gas or air feed
2 Porcelain saddles
3 Humidifying tower
4 Slow water feed
5 Trapped water outlet
6 Modified gas meter
7 Graduated dial
8 Photoelectric scanning head
9 Toluene tower
10 Test gas ready for temperature control and then use
11 Thermostat sensor for tower heater, if required
12 Metered toluene from pump
13 Micrometering pump
14 Toluene reservoir
15 Meter under test

Figure 14 — Diagram of a typical test gas mixer apparatus

J.1.2 ***Procedure***

J.1.2.1 Subject the gas-containing components of the assembled meter to the appropriate constituent, as follows.

With the meter in the upright position introduce 50 mL of the constituent into each of the connections. Then seal the connections for the duration of the test, which lasts 1 000 h and takes place in an ambient temperature of 20 ± 5 °C.

At the end of the test, remove the constituent.

J.1.2.2 Operate the same meter in an ambient temperature of 20 ± 5 °C for 168 h, using air flowing at 1.5 m^3/h (or 50 ft^3/h).

Appendix K Impact test on assembled meter (see **5.1** and **10.3.1.2**)

K.1 Apparatus

The apparatus consists of a hardened steel hemispherically-tipped striker and a rigid smooth-bore tube in which the striker is capable of sliding freely (see Figure 15).

The total mass of the striker is 3 kg. There are two sizes of striker tip, one having a radius of 1 mm, the other having a radius of 4 mm (see Figure 16).

Each size of striker tip is used during the test, but no test area on any one meter sample is subjected to more than one impact. In the case of the same area being selected for test with each size of striker tip, two meter samples are used.

K.2 Procedure

For each striker, the meter is rigidly supported on a firm base with the intended area of impact, which can be any area of the meter case, horizontal and the end of the guide tube resting on the meter. The striker is allowed to fall freely and vertically on to the test area, through the tube, from a height of h mm:

where

for the 1 mm striker, h is 175 mm,

producing an impact energy of 5 J;

for the 4 mm striker, h is 350 mm,

producing an impact energy of 10 J.

NOTE Impact energy (joules) = mass of striker (kg) × acceleration due to gravity (m/s^2) × height of fall (m)

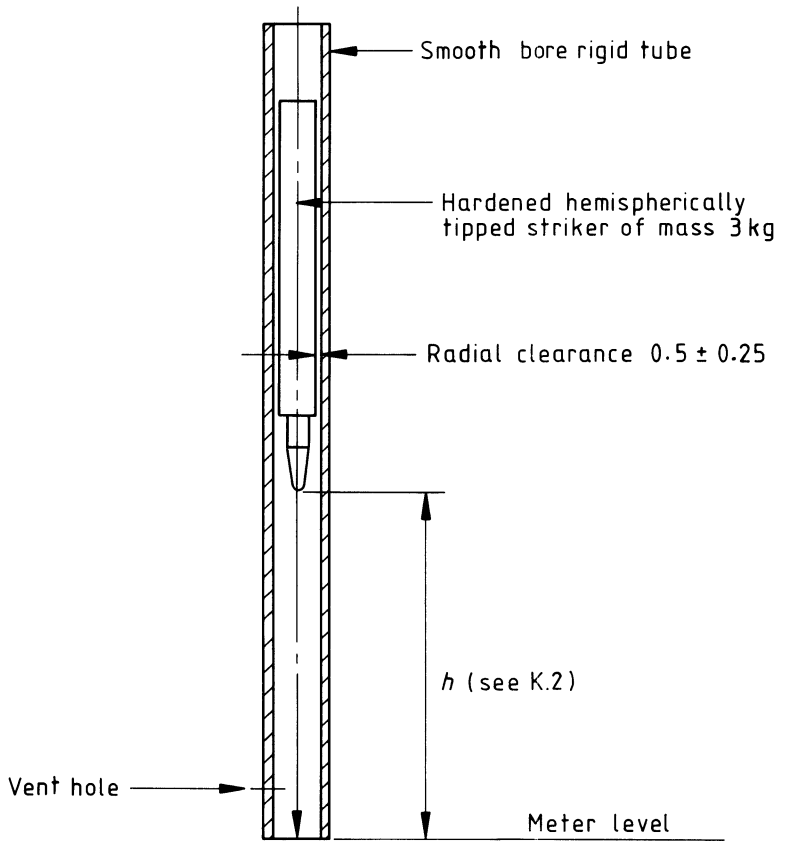


Figure 15 — Impact test apparatus

Appendix L Method of calculating the resistance power factor (see **5.1.2**)

L.1 Formula (see Figure 17)

When the valve cover is at its complete seal position let

a) C_1 be the area of the valve grid outer rib in contact with it;

b) C_2 be the area of the valve grid inner rib in contact with it; and

c) C_3 be the area of the valve grid partitioning ribs in contact with it;

d) L_1 be the maximum travel along the axis of the outer rib due to crank radius r;

e) L_2 be the maximum travel along the axis of the inner rib due to crank radius r; and

f) L_3 be the maximum travel across the middle of the partitioning ribs due to crank radius r, i.e.

$$\frac{L_1 + L_2}{2}$$

Then the resistance power factor (R.P.F.) is given by the formula:

$$\frac{T}{V} \times 1000$$

where

$T = (C_1L_1 + C_2L_2 + C_3L_3)$; and

V is the capacity per revolution of the meter.

Use consistent units in calculation.

NOTE The maximum travel of the cover due to crank radius r will vary with the design of the valves, as also will areas of contact, e.g. on one valve there may be considerable overlap of the valve port at the seal position, whereas another may be designed for hair-line seal only.

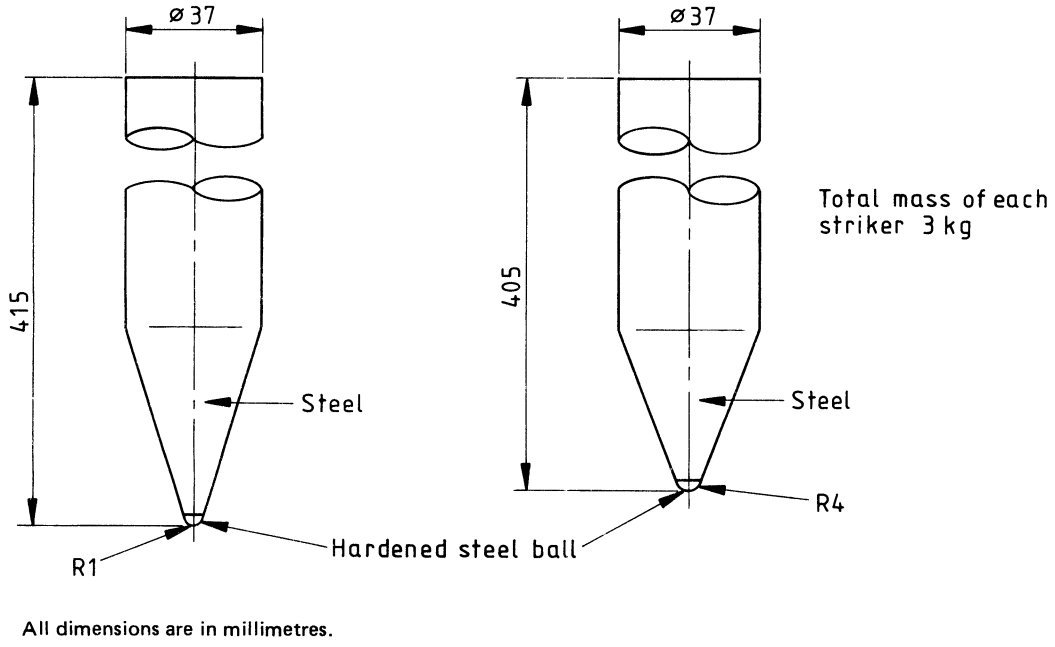
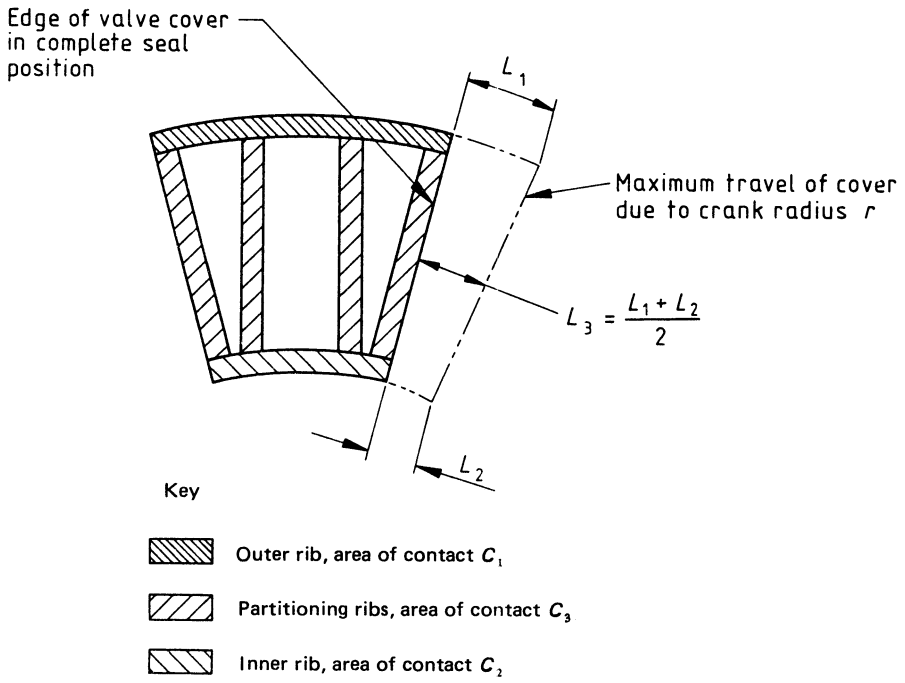


Figure 16 — Typical hemispherically-tipped strikers used in impact test



NOTE If a valve cover in the complete seal position covers only part of these areas, the areas of contact used in the calculation are modified accordingly.

Figure 17 — Valve grid

L.2 Assumptions

It has been assumed:

a) that the valves are contaminated by a thin film of liquid and that the resulting adhesion per unit area between the contacting surfaces is constant;

b) that in a meter having two diaphragms and valve covers, one diaphragm and one valve cover are at rest and that the other diaphragm and valve cover are in their mid-movement position, i.e. the diaphragm at mid-stroke and the valve cover at complete seal position on its grid;

c) that the equivalent crank radius r of a particular section is equal to the maximum cover travel L of the valve cover at that section;

d) that the maximum cover travel L is defined as the maximum distance away from the complete seal position that a cover edge will travel due to the crank radius r, at any considered point along the edge of a cover.

L.3 Theory

The resistance to movement of a radial valve cover, pivoted at one end, over its grid is proportional to the torque T required at the crank spindle to overcome that resistance, i.e. resistance $\propto T$.

The power available to provide this torque is proportional to the capacity per revolution V of the meter, i.e. power $\propto V$. Thus:

$$\text{R.P.F.} \propto \frac{T}{V}$$

The torque is proportional to the product of the areas of contact C between the valve cover and its grid and the effective crank radius R, i.e. $T \propto C \times R$

therefore

$$C \times R = \Sigma\, c \times r$$
$$= \Sigma\, c \times L$$
$$= (C_1L_1 + C_2L_2 + C_3L_3)$$

The Figure 1 000 is an arbitrary constant selected to provide a suitable working value for the R.P.F.

Appendix M Shock test (see **5.14**)

M.1 Apparatus

The vibration test rig and associated electronic equipment are shown diagrammatically in Figure 18. The meter is shown mounted to the spindle of an electrodynamic shaker which is driven by an amplified sine wave from a voltage generator. The head of the shaker can be rotated through 90° for the fore-aft and lateral planes.

The acceleration level is sensed using an accelerometer (piezoelectric transducer) whose output is conditioned using a charge amplifier.

An automatic vibration exciter control (which is inserted between the accelerator and the power amplifier) is used in a sweeping mode in which the frequency is cycled between a pair of selected frequencies, alternately increasing and decreasing.

M.2 Procedure

The complete meter under test is secured to the vibration rig by means of a horizontal clamp across the top of the meter. The whole is then subjected to a swept frequency of between 10 Hz and 100 Hz (± 5 %) at a sweep rate of 1 octave per minute with a peak acceleration of $2g_n$ (± 5 %) for 4 h in each of three planes, (vertical, fore-aft and lateral).

NOTE 1 The clamping force should be sufficient to restrain the meter during the test, but should not exceed that specified in **10.3.1.1**.

NOTE 2 An octave is a band of frequency where the upper frequency limit of the band is exactly twice the lower one, e.g. 10 Hz to 20 Hz, 20 Hz to 40 Hz, 40 Hz to 80 Hz and 80 Hz to 160 Hz.

Therefore the time taken to sweep from 10 Hz to 100 Hz at a sweep rate of 1 octave per minute is 3 min 15 s.

Appendix N Test for external soundness (see **8.1**)

WARNING NOTE. To avoid damage to the interior of the meter when applying an internal pressure, the pressure should be applied to the meter gradually without fluctuation, such that the rate of change of pressure is not greater than 350 mbar/s. When the pressure is released it should be released gradually via the meter inlet.

N.1 Method 1

N.1.1 *Apparatus*

N.1.1.1 *T-piece*, with a tap on its inlet, to which is connected a constant air supply at the test pressure of 75 mbar.

N.1.1.2 *Water column pressure gauge*, connected to one of the T-piece outlets.

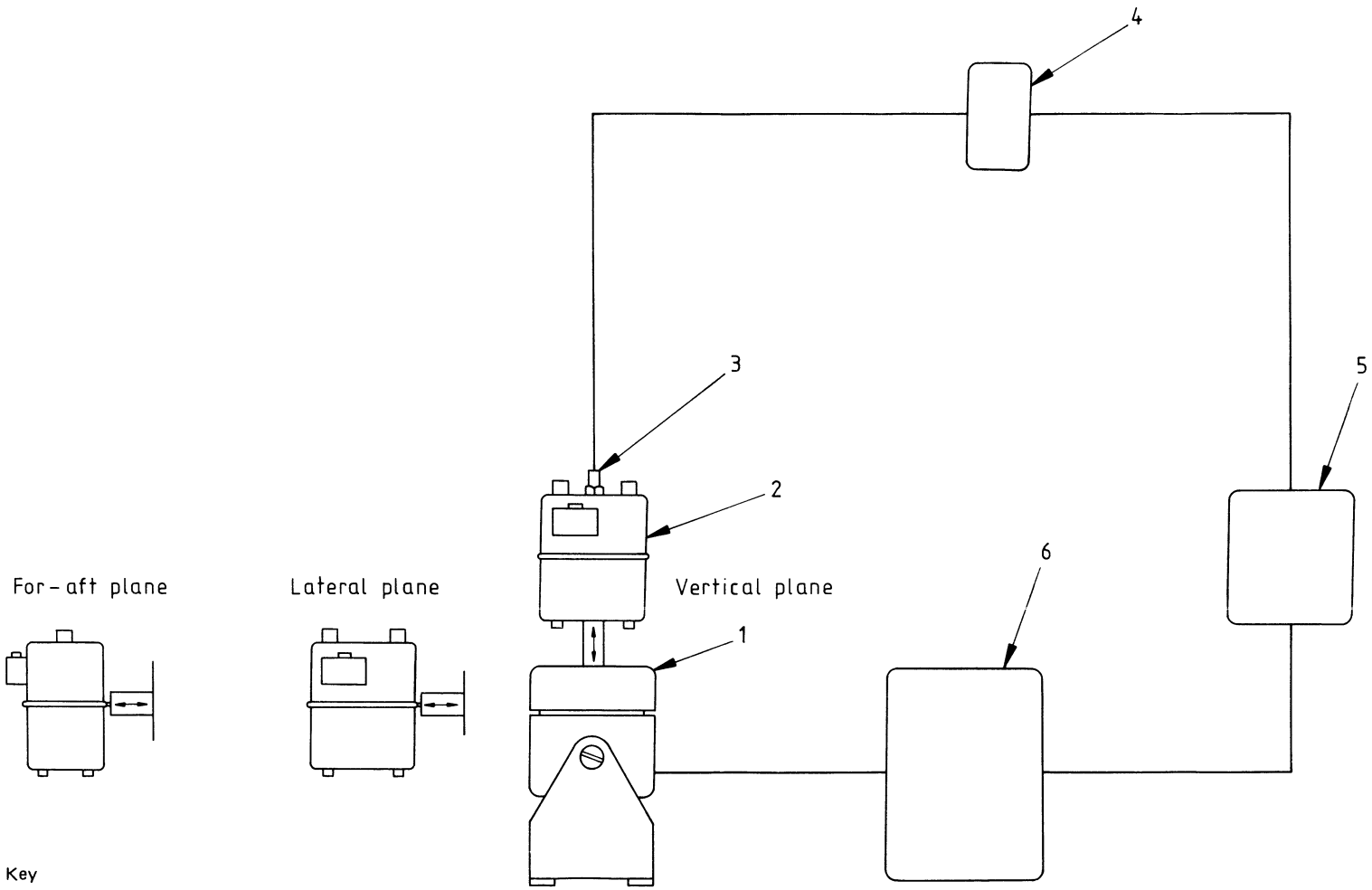
N.1.1.3 *Cap*, suitable for sealing the meter inlet.

N.1.2 *Procedure*

Connect the T-piece (**N.1.1.1**) with the pressure gauge (**N.1.1.2**) attached to the meter outlet boss and seal the meter inlet boss. Supply air to the meter through the tap on the T-piece, until the test pressure is registered on the pressure gauge.

Shut the tap. If, after 1 min from the time of shutting off the tap, no fall in pressure is registered in the following 2 min, the meter shall be deemed to be sound.

The validity of this test depends upon the temperatures and barometric pressure remaining constant throughout the test. By carrying out tests on several meters simultaneously changes in conditions can be indicated by identical movements in all gauges. Method 3 shall be employed if these changes are unacceptable.



Key
1 Electrodynamic shaker
2 Meter
3 Accelerometer
4 Charge amplifier
5 Auto vibration exciter control
6 Power amplifier

Figure 18 — Diagrammatic layout of shock test apparatus

N.2 Method 2

N.2.1 ***Apparatus***

N.2.1.1 *Bubble leak indicator* (see Figure 19), to which is connected a constant pressure air supply at the test pressure of 75 mbar.

N.2.1.2 *Means of connection*, from the outlet of the bubble leak indicator to the meter outlet boss.

N.2.1.3 *Means of sealing the meter inlet*

N.2.2 ***Procedure***

Connect the bubble leak indicator to the meter outlet and seal the meter inlet. Supply air to the meter through the by-pass tap on the indicator and then open the taps to and from the glass tubes.

Shut the by-pass tap. If, after 1 min from the time of shutting off the by-pass tap, no bubble passes through the indicator in the following 2 min, the meter shall be deemed to be sound.

NOTE The validity of this test depends upon the temperatures and barometric pressure remaining constant.

N.3 Method 3

N.3.1 ***Apparatus (see Figure 20)***

N.3.1.1 *An air supply or pump*, capable of supplying air up to 75 mbar.

N.3.1.2 *A means of connecting* the air supply to the meter outlet.

N.3.1.3 *A valve* A, to control the air supply.

N.3.1.4 *A connection,* for the meter inlet to an outlet control valve B.

N.3.1.5 *A water supply and a water tank,* with a drainage system and inspection window as required, capable of containing the meter with sufficient room left to observe any leaks.

N.3.1.6 *Mechanical means for holding the meter underwater,* with a minimum of contacts with the meter.

NOTE The contacts should not be detrimental to the meter or affect the test.

N.3.1.7 *Pressure gauge,* on the downstream side of valve A.

N.3.1.8 *An outlet valve* B

N.3.2 ***Procedure***

Remove the index and any prepayment attachment. Connect the air supply to the meter through valve A and connect the outlet valve B to the meter inlet.

Open valve B. Slowly open valve A. Close valve B and raise the pressure to 75 mbar.

Submerge the meter in the tank. Allow 1 min to elapse whilst dispersing trapped air and then observe for a further 2 min. If no air escapes from the meter during these 2 min the meter shall be deemed to be sound.

When the test is complete, decompress the meter through valve B.

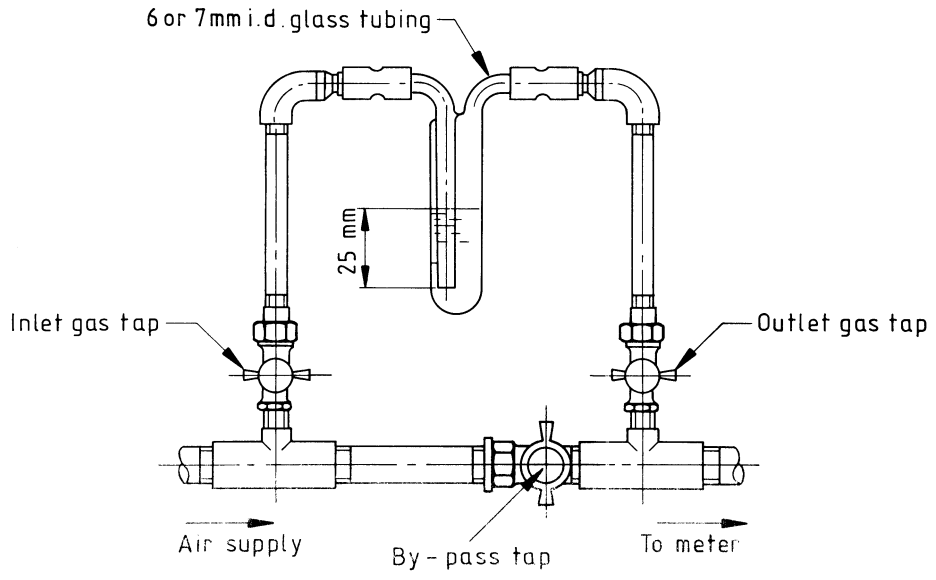


Figure 19 — Bubble leak indicator

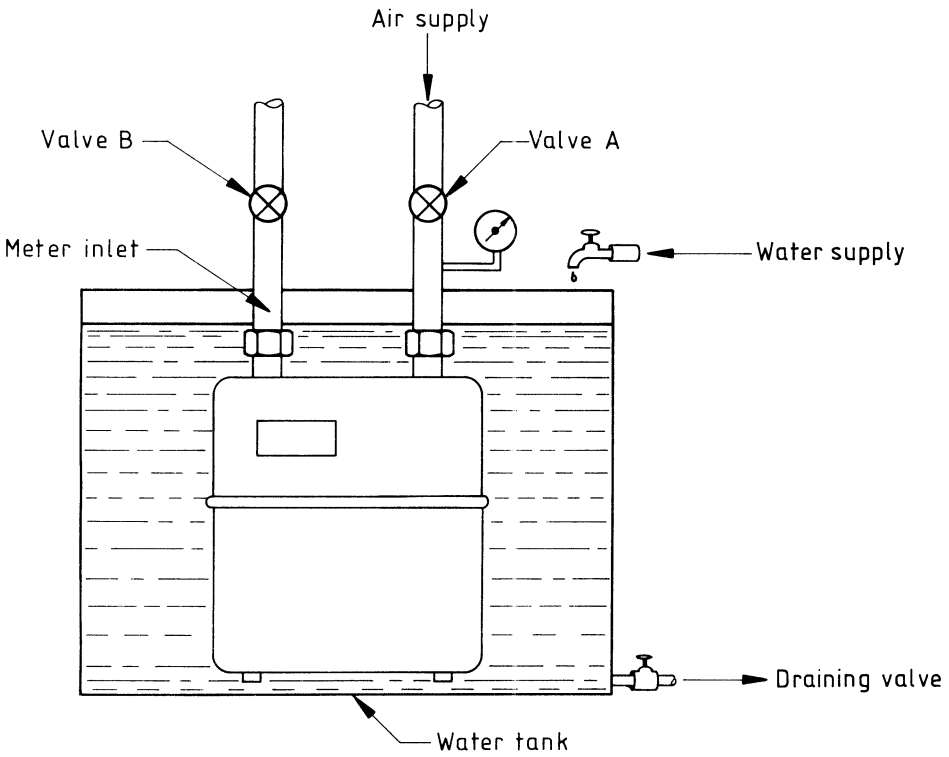


Figure 20 — External soundness test apparatus

Appendix P Test for accuracy of registration (see **9.1**)

P.1 Principle

A meter is tested for accuracy of registration by passing through it a known volume of air at a density of 1.2 kg/m^3 and comparing this volume with the volume as registered by the meter test dial or drum.

NOTE Room air at 20 °C has approximately this density.

P.2 Apparatus

The following apparatus is required for the test, either a liquid-sealed calibrated bell-type holder maintaining a nominal pressure of 5 mbar and having sufficient capacity to allow at least one complete revolution of the test drum or test dial hand of the meter to be tested, or a calibrated apparatus that will give equivalent results.

The holder or apparatus is provided with tubes to which the inlet and outlet of the meter can be connected. The outlet connection permits the metered air to pass through a rate control valve and an on/off control valve (hereafter referred to as an outlet control) and hence to exhaust.

The inlet connection should be as large as possible to keep its pressure loss to a minimum when a meter is tested at the maximum rate.

P.3 Procedure

P.3.1 *General*

Carry out the test in a room having a controlled temperature of nominally 20 °C, but taking care to ensure that the temperature of the liquid in the test holder or the alternative apparatus, the temperature of the ambient air and the temperature of the meter under test do not differ by more than 1 °C.

P.3.2 *Preliminary tests*

Before testing for accuracy of registration ensure that the meter complies with the requirements of the test specified in **8.1** and pass at least 0.3 m^3 (or 10 ft^3) of room air through it.

P.3.3 ***Accuracy of registration***

Connect the tubes to the meter inlet and outlet connections. Close the outlet control and open the holder outlet valve. Leave the apparatus for 2 min. If the holder bell remains stationary during this period, showing that the connections to and from the meter are sound, continue the test. Alternative means of checking for soundness of connections are permitted.

Open the outlet control and set the rate control valve to pass the required rate. When the test drum or test dial hand is positioned at a convenient point for reading, close the outlet control. Charge the holder with air. Note the scale reading of the holder. Open the outlet control and allow air to pass through the meter for one or more revolutions of the test drum or test dial hand, then close the outlet control and note the new reading on the holder scale. The number of revolutions shall be chosen to ensure that the meter satisfies the registrational accuracy specified in **9.1**.

P.4 Calculations

Determine the volume of air passed by taking the difference between the two scale readings.

Calculate any error in the accuracy of registration and express it as a percentage to the first place of decimals.

Percentage error in the accuracy of registration =

$$\frac{(\text{volume registered in one or more revolutions of test drum or test dial hand} - \text{actual volume of air passed}) \times 100}{\text{actual volume of air passed}}$$

A negative answer indicates a slow meter and a positive answer a fast meter.

Appendix Q Tests for total mean pressure loss and mechanical pressure loss (see **9.2** and **9.3**)

Q.1 Apparatus

The pressure gauge described in Appendix U is used as a differential gauge when determining the total mean pressure loss and the mechanical pressure loss of a meter by connecting the meter to its limbs.

The apparatus described in Appendix P is used to provide the controlled flow rate.

Q.2 Procedure and calculation

Q.2.1 ***Total mean pressure loss***

Connect the differential pressure gauge to the inlet and outlet of the meter. Take the pressure readings at points as close as practicable to the face of the bosses. Pass air through the meter at the badged rating. Note these minimum and maximum readings.

Calculate the total mean pressure loss by deducting any pressure loss caused by the inlet and outlet connections of the test equipment to the meter from the mean of these minimum and maximum readings.

Q.2.2 ***Mechanical pressure loss***

Following the test specified in **Q.2.1** pass air through the meter at 1 % of the badged rating. Measure the mechanical pressure loss by noting the maximum reading indicated by the differential pressure gauge.

NOTE It may be more expedient to test at a higher flow rate (not exceeding 20 % of the badged rating) for the same mechanical pressure loss limit and at 1 % of the badged rating if this limit is exceeded.

Appendix R Endurance test (see **10.1**)

R.1 Procedure

Select a meter in a new condition and pass at least 3 m^3 (or 100 ft^3) of air through it at a flow rate of 6 m^3/h (or 212 ft^3/h). Check the meter on air for compliance with clauses **8** and **9**.

Operate the meter at a flow rate of 7 m^3/h (or 250 ft^3/h), using the gas for which it is intended, with an inlet pressure of 50 mbar, for a period of 135 days in a controlled ambient temperature of 20 ± 5 °C. It is permissible to recirculate the gas but in this case arrangements shall be made to change it continuously by feeding in a proportion of fresh gas to maintain the gas characteristics. The temperature of the gas used in the test shall also be maintained at 20 ± 5 °C.

At the times specified by the meter manufacturer and at the end of the test, purge the meter with at least 3 m^3 (or 100 ft^3) of air. Subject the meter to a soundness test in accordance with clause 8 using test pressures of 75 mbar and 5 mbar and determine the accuracy of its registration and pressure losses in accordance with clause **9**.

Appendix S Ambient temperature tests (see **10.4.1** and **10.4.2**)

S.1 Ambient temperature range (– 5 °C to + 35 °C)

Using air, check the meter for compliance with the registrational accuracy specified in **9.1**.

Subject the meter to three consecutive cycles consisting of the following phases:

a) place the meter at rest, in a chamber maintained at a temperature of – 5 ± 1 °C, for 2 h;

b) operate the meter for 22 h at the ambient temperature of – 5 ± 1 °C using air at a flow rate of 50 % of badged rating measured at – 5 ± 1 °C;

c) stop the operation of the meter and raise the chamber temperature to 35 ± 1 °C;

d) maintain the meter at rest for 2 h at the ambient temperature of 35 ± 1 °C;

e) operate the meter for 22 h at the ambient temperature of 35 ± 1 °C using air at a flow rate of 50 % of badged rating measured at 35 ± 1 °C;

f) stop the operation of the meter and return the chamber temperature to – 5 ± 1 °C.

It is permissible to interrupt the test between each cycle.

Upon completion of the three cycles, allow the meter to return to an ambient temperature of 20 ± 5 °C before re-checking in accordance with **9.1**.

S.2 Extreme temperatures (– 15 °C, + 40 °C)

Place the meter at rest for 3 h in a chamber maintained at a temperature of – 15 ± 1 °C.

At the end of this period supply the meter, whilst maintained at the chamber temperature, with air at a normal laboratory temperature of 20 ± 5 °C at pressure of 5 mbar and at 14 dm^3/h (0.5 ft^3/h). Take precautions during the test to prevent condensation.

Repeat the test but at a temperature of 40 ± 1 °C.

Appendix T Test of fire resistance (see **10.5.1**)

T.1 Apparatus (see Figure 21)

A furnace is required that produces standard heating conditions as specified in clause **1.4.2** of BS 476-8:1972, for a temperature rise of 821 °C, and of sufficient size to accept the meter and its stand. The stand shall support the meter by its connections and permit air to be supplied to the meter.

Arrangements shall be made to record the flow rates and pressures of the air supplied.

T.2 Procedure

The meter (or meter case), on its stand, is connected to the inlet and outlet fittings and the assembly positioned in the centre of the furnace.

With the bleed valve closed the meter is pressurized to 50 mbar and its soundness verified.

With the meter at a pressure of 50 mbar the temperature of the furnace is increased by 821 °C in 30 min in accordance with the temperature rise curve as shown in Figure 1 of BS 476-8:1972.

During the specified temperature rise, the internal pressure is maintained at 50 mbar by means of the bleed valve, and the leakage rate monitored and recorded.

NOTE 1 To avoid blocking of the outlet connections by condensation of materials distilled from the internal components of the meter, it is preferable to carry out the test on an empty meter case supplied as such by the manufacturer. If this is not possible, the outlet pipe of the apparatus should be inclined downwards and a safety tap for the removal of condensation products installed upstream of the bleed valve (see Figure 21).

NOTE 2 It is permissible temporarily to vent a build-up of vapours provided that the test pressure is maintained.

Appendix U Inclined pressure gauge (see Appendix Q)

U.1 General

The design and the main dimensions for the inclined pressure gauge, in which distilled water coloured with methylene blue, of relative density of 1.0 is used, are shown in Figure 22.

Each new gauge shall be calibrated with its glassware. It shall be recalibrated if a new glass is fitted.

It is essential to level the gauge before calibration and use.

NOTE A ruling on the acceptability of alternative pressure gauges is awaited from the Department of Energy. If available an alternative will be included by amendment to this Part of BS 4161.

U.2 Glass cleaning procedure

To clean the glass, drain out the distilled water and wash out the tube with suitable cleansing solvent. Blow air through the tube to remove the solvent. Then wash the tube in strong washing soda solution or caustic soda solution. Flush the tube with tap water, rinse with distilled water and dry by means of an air stream.

NOTE Appropriate precautions should be taken when using dibutyl oxalate.

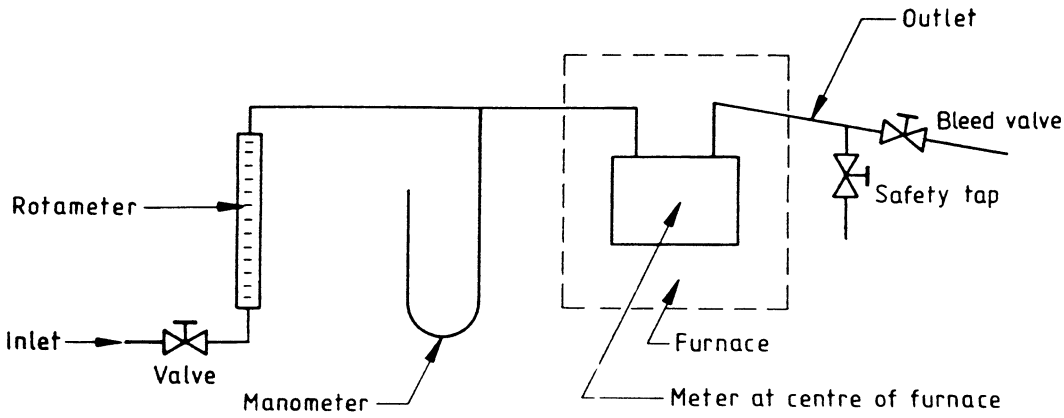


Figure 21 — Schematic diagram of typical fire resistance test apparatus

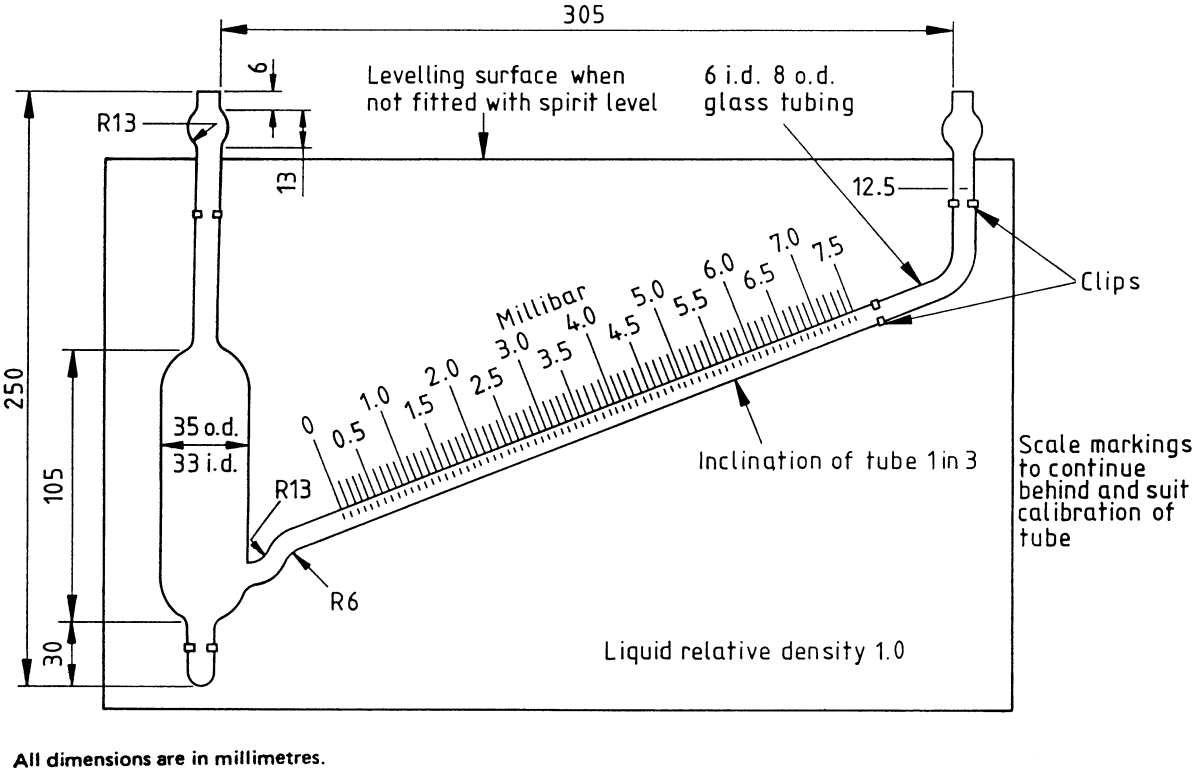


Figure 22 — Inclined pressure gauge: 7.5 mbar range

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Publications referred to

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).*

BS 93, *Specification for British Association (B.A.) screw threads with tolerances for sizes 0 B.A. to 16 B.A.*

BS 381C, *Specification for colours for identification, coding and special purposes.*

BS 476, *Fire tests on building materials and structures.*

BS 476-8, *Test methods and criteria for the fire resistance of elements of building construction.*

BS 746, *Specification for gas meter unions and adaptors.*

BS 1179, *Glossary of terms used in the gas industry.*

BS 2782, *Methods of testing plastics.*

BS 2782, *Method 140E Flammability of a small, inclined test piece exposed to an alcohol flame (laboratory method).*

BS 2797, *Specification for leathers for gas meter diaphragms.*

BS 2874, *Specification for copper and copper alloy rods and sections (other than forging stock).*

BS 3643, *ISO metric screw threads.*

BS 3900, *Methods of test for paints.*

BS 3900-E1, *Bend test (cylindrical mandrel).*

BS 3900-E2, *Scratch test.*

BS 3900-E3, *Impact (falling weight) resistance.*

BS 3900-E6, *Cross-cut test.*

BS 3900-F2, *Determination of resistance to humidity cyclic condensation.*

BS 3900-F4, *Resistance to continuous salt spray.*

BS 3955, *Specification for electrical controls for household and similar general purposes.*

BS 4161, *Gas meters.*

BS 4161-1, *Meters of plate construction up to 1 000 cubic feet per hour rating.*

BS 4161-2, *Meters of plate construction above 1 000 cubic feet (28 cubic metres) per hour rating*[5)].

BS 4161-4, *Plate constructed positive displacement diaphragm meters for a pressure of 350 mbar (5 lbf/in^2) and up to 170 cubic metres (6 000 cubic feet) per hour rating*[5)].

BS 4161-5, *Positive displacement diaphragm meters for pressures up to 7 bar*[5)].

BS 4161-6, *Specification for rotary displacement and turbine meters for gas pressures up to 100 bar*[5)].

BS 4161-7, *Mechanical volume correctors*[5)].

BS 4161-8, *Specification for electronic volume correctors*[5)].

BS 4231, *Classification for viscosity grades of industrial liquid lubricants.*

BS 4800, *Specification for paint colours for building purposes.*

BS 4947, *Specification for test gases for gas appliances.*

BS 5345, *Code of practice for selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture).*

BS 5345-1, *Basic requirements for all Parts of the code.*

BS 6400, *Specification for installation of domestic gas meters (2nd family gases)*[5)].

BS 6505, *Specification for rubber-type materials used for controls components for use with 1st, 2nd and 3rd family gases.*

[5)] Referred to in the foreword only.

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