BRITISH STANDARD

BS 4161-5: 1990

Incorporating Amendments Nos. 1, 2 and 3

Gas meters —

Part 5: Specification for diaphragm meters for working pressures up to 7 bar

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been prepared under the direction of the Gas Standards Policy Committee it is a revision of BS 4161-5:1977, which is withdrawn.

BS 4161-5 was first published in 1977 as the fifth in a series relating to meters for gaseous fuels used for registering the volume of gas passed. This revision updates Part 5, 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 or 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.

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.

These meters may be fitted with a volume corrector; such devices for the type of meter specified in this standard are generally interchangeable with, or additional to, the index.

All pressures quoted in this standard are gauge pressures.

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

— *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 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 these meters is the subject of BS 6400 and of "*Recommendations on gas measurement practice IGE/GM/1 Gas meter installations for pressures not exceeding 100 bar*", published by the institution of Gas Engineers.

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 40, 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.

Section 1. General

1 Scope

This Part of BS 4161 specifies requirements for the construction, performance and marking of positive displacement diaphragm meters for use with 1st and 2nd family gases and for all specified gas working pressures up to 7.0 bar[1)]. It also includes certain requirements for fire resistance.

NOTE 1 For use with gases other than 1st and 2nd family gases see the foreword.
Meters covered by this standard are all suitable for pressures up to 75 mbar.

NOTE 2 The information to be supplied by the purchaser when ordering or enquiring about meters is given in Appendix A.

NOTE 3 Requirements specific to meters rated at 6 m^3/h (212 ft^3/h) and for working pressures up to 50 mbar, are given in BS 4161-3.

NOTE 4 The titles of the publications referred to in this standard are listed on pages 40 and 41.

2 Definitions

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

3 Meter designation and rating

3.1 Meter designation

A meter shall be designated by the letter "U" followed by its rating in cubic metres per hour (see Table 1).

3.2 Meter rating

A meter shall be rated according to one of the Q_{max} (maximum flow) values given in Table 1.

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

Table 1 — Meter designations and ratings

Meter designation	Q_{max}	
	m^3/h	ft^3/h
U2.5	2.5	88
U4	4	141
U6	6	212
U10	10	353
U16	16	565
U25	25	883
U40	40	1 413
U65	65	2 296
U100	100	3 530
U160	160	5 650

3.3 Pressure rating

The pressure rating is the maximum working pressure specified by the manufacturer (see **8.1**).

The minimum rated pressure shall be 75 mbar.

NOTE Other rated pressures may be specified with preferred ratings of 2 bar and 7 bar.

The operating temperature range shall be – 5 °C to + 35 °C.

[1)] 1 bar = 10^5 N/m^2 = 10^5 Pa.

Section 2. General requirements

4 Materials and finish

4.1 Materials

The meter shall be constructed of materials complying with the 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. This thickness of any coating and the method of measurement shall be declared by the meter manufacturer to the test authorities.

4.2 Decorative finish

If meters have a decorative finish it shall be of a colour complying 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, shall not be fully penetrated. The spring force shall be 9.8 N. 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 item 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 shall be tested in accordance with Appendix B, shall be examined and shall resist penetration in accordance with item 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 be used in place of a component only 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 items a), b) and c) of **4.2**.

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*. When tested in accordance with **E.1.2**, all coatings providing corrosion protection shall show no signs of cracking or loss of adhesion.

If the corrosion protection of the surface is provided solely by means of an organic coating, when tested in accordance with **E.1.1**, the coating shall show no signs of cracking or loss of adhesion, and when tested in accordance with **E.1.3**, the classification of the test results shall be 0, i.e. there shall be no detachment of the coating.

NOTE In the test described in **E.1.1**, an area 3 mm from the edges of the sample may be ignored.

4.3.2.3 *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 then shall be ignored. Attack on the edge or up to 2 mm from it shall be ignored only 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 *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.

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

b) *Chemical resistance*. The requirements given in item c) of **4.3.2.1** shall apply, except that item g) of **E.2.2** 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 either from a synthetic material or from leather.

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, 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 extracted material shall not exceed 12 % by mass of the original mass of the test piece, 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 allowed 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 extracted material shall not exceed 12 % by mass of the original mass of the test piece 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, when remeasured at 20 ± 5 °C, 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 when measured at – 5 ± 1 °C shall not have increased by more than 25 % after the test piece has been subjected to this temperature in an environmental chamber for 20 min.

4.4.3.3.4 *Porosity*. When tested in accordance with Appendix G, no detectable movement shall be seen in the manometer tube.

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

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 for 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 0.5 × Q_{max} in an ambient temperature of – 5 ± 1 °C;

b) 400 h on air at 0.5 × Q_{max} 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 comply with **4.5.2**, **4.5.3** and **4.5.4**. The accelerated ageing tests shall be performed on samples that have not previously been 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 normal 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 ethanol 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.

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

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 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.

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 mercury are enclosed in glass that has a low-transmission below 280 mm. 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 corrosion, wear resistance and shock tests specified in **4.4.3.4.1**, **10.1**, **10.4**, and Appendix M.

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 resistance and dimensional stability shall comply with the requirements given in **4.4.3.4.1**, **10.1**, **10.4** and Appendix M.

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 for the appropriate temperature range and gas family.

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 are satisfied.

When tested in accordance with **J.1.2.1**, the meter shall comply with the internal leakage requirements specified in **8.2**. It shall also withstand a static internal air pressure equal to the maximum working pressure or 345 mbar, whichever is the greater, without permanent distortion or external leakage.

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

a) the internal leakage 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*. When tested in accordance with **J.2**, the internal and external sealing glands shall show no sign of deterioration or permanent deformation. In addition, the turning resistance, measured using a torque meter, shall not exceed 0.015 N·m or vary by more than 80 % of the initial value.

4.11 Motion wires and components

Where fitted, motion wires and their guides shall comply with the corrosion, wear resistance and shock tests specified in **4.4.3.4.1**, **10.1**, **10.4** and Appendix M.

4.12 Meter connections

The meter connections shall be made and finished in accordance with BS 746 or BS 4504, as appropriate.

4.13 Adhesive

The performance of adhesives used for fixing components shall comply with the tests described in this standard. 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 comply 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, withstand the impact test in accordance with **10.3.1.2**.

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

5.2 Clearances

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

5.3 Pressure test point

5.3.1 *General*. All meters up to and including U40 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 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 connection 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 meter body test nipple shall be sited to indicate outlet gas pressure, positioned to minimize the risk of accidental damage and be easily accessible.

The strength of the securing joint of the nipple fitted in either position shall be such that it complies with the appropriate requirements of **8.1** after:

a) applying a torque of 4 N·m and;

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

NOTE Both tests need not be applied to the same sample.

5.3.2 *Working pressures up to 75 mbar*

5.3.2.1 *Test nipples*. Test nipples for use in meters having working pressures up to 75 mbar shall be in the form shown in Figure 2. They shall be manufactured from brass complying with alloy CZ 121 of BS 2874.

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

5.3.2.3 *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.

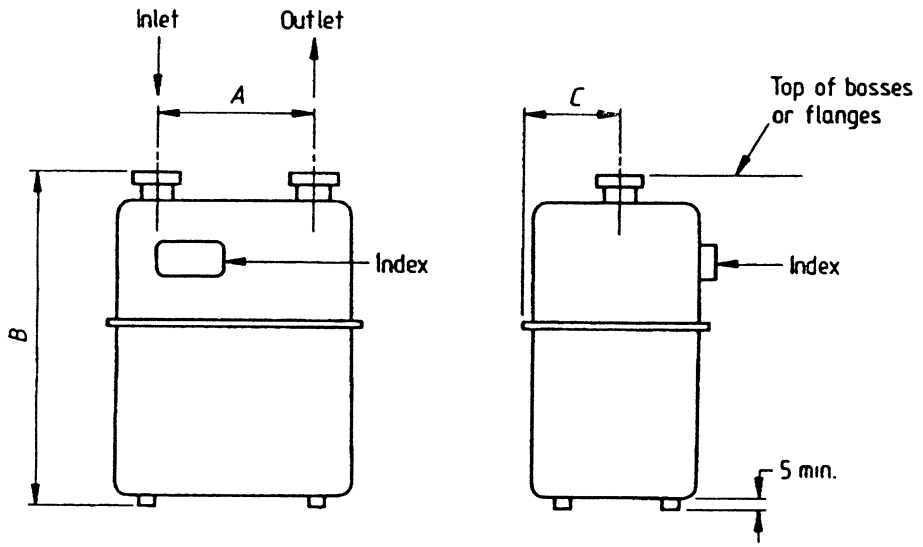
To ensure a sound seating of the coned faces the screw shall not bottom and the cones and mating threads shall all be coaxial. The pressure test nipple shall be free from burrs, sharp edges, swarf or other foreign matter.

5.3.2.4 *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.

5.3.3 *Working pressures above* 75 mbar. For meters having working pressures above 75 mbar an appropriate proprietary high pressure test nipple shall be used.

NOTE For meters with flanged connections (U65 and above) it is customary to fit appropriate pressure test nipples in the installation pipe work.

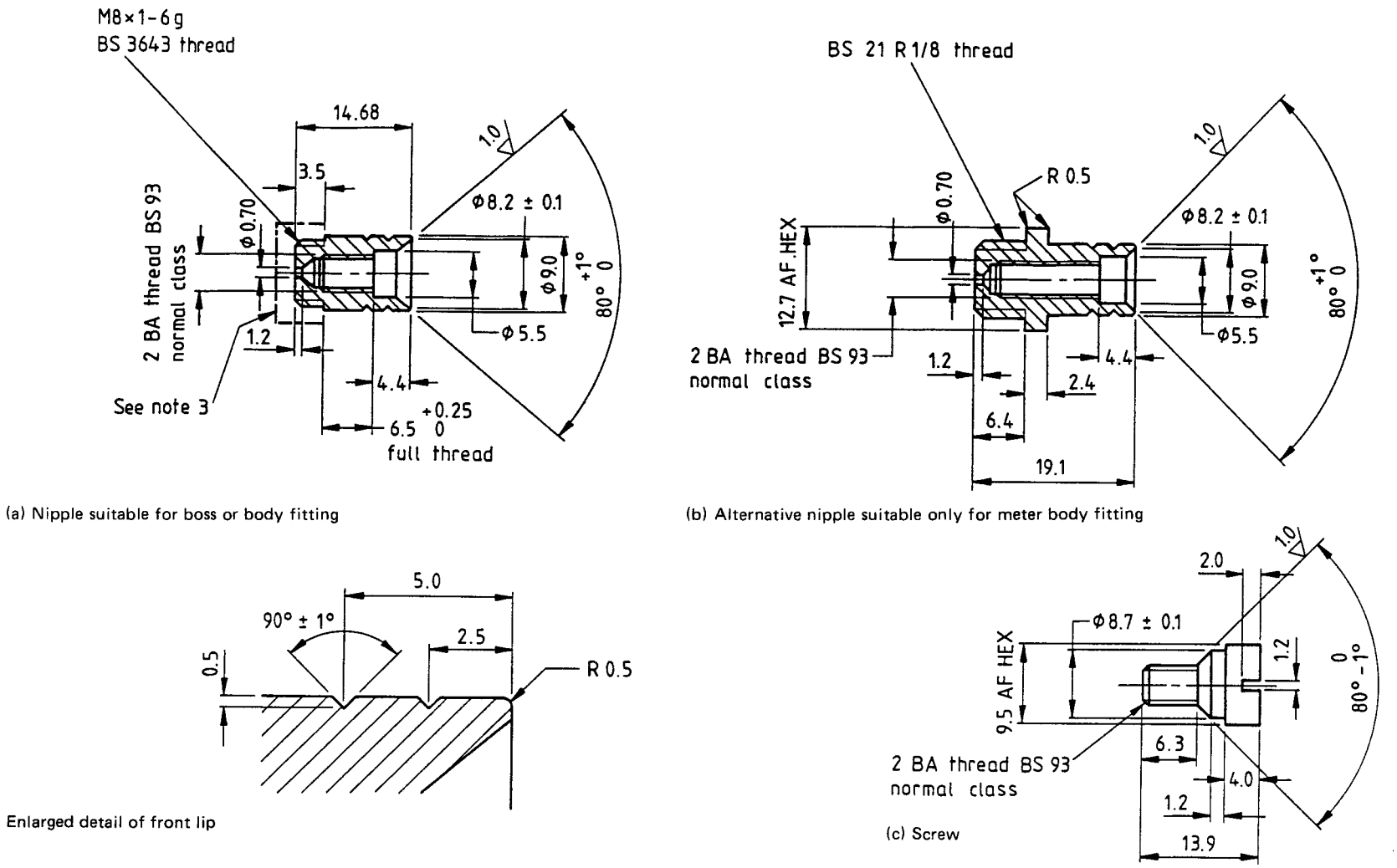


Dimension is in millimetres.

Meter designation	Connection: nominal size		Connection centres *A* (nominal)	Overall height *B* (maximum)	Rear of meter casing to connection centre *C* (maximum)
	mm	in	mm	mm	mm
	Threaded BS 746				
U2.5		½	—	—	—
U4		1	110	—	—
U6		1	152.4	282	85
U10		1	152.4	415	110
U16		1¼	152.4	415	160
U25		2	250	415	160
U40		2	280	500	180
	Flanged BS 4504				
U65	*65		335	550	200
U100	80		430	630	275
U160	100		430	670	290

*Non-preferred size of pipe, but adaptors if used should be upwards to 3 in and not downwards to 2 in.
A 3 in flange complying with Table D of BS 10:1962 matches exactly the 65 mm PN10 or PN16 meter flanges complying with BS 4504.

Figure 1 — Diagrammatic illustration of meters showing connections and index with tabulated connection end case dimensions



(a) Nipple suitable for boss or body fitting

(b) Alternative nipple suitable only for meter body fitting

Enlarged detail of front lip

(c) Screw

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

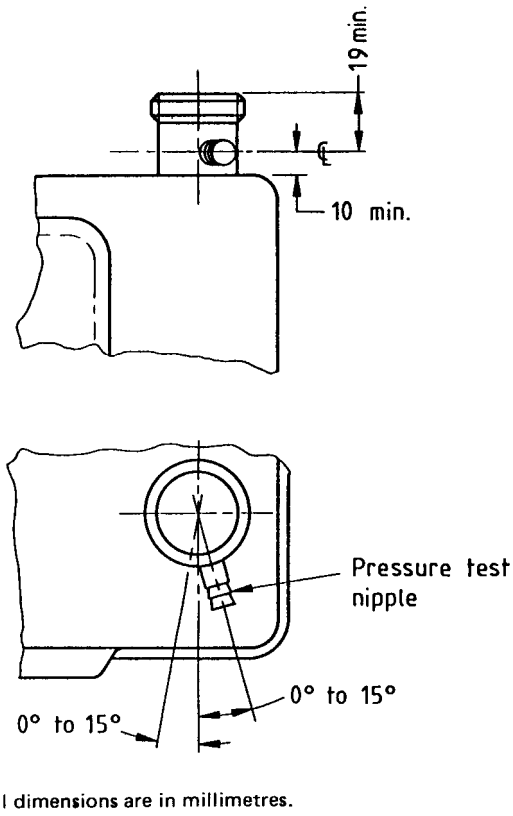


Figure 3 — Pressure test point positions

5.4 Feet

The meter shall be supported on four firmly attached feet and the method of attachment shall comply with the corrosion test as specified in items b) and c) of **4.3.2.1**. 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.

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 be clearly visible at an angle of 15° to the normal.

A complete revolution of a drum shall, during the last one-tenth 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 this volume specified on the meter shall not exceed 5 % of the latter.

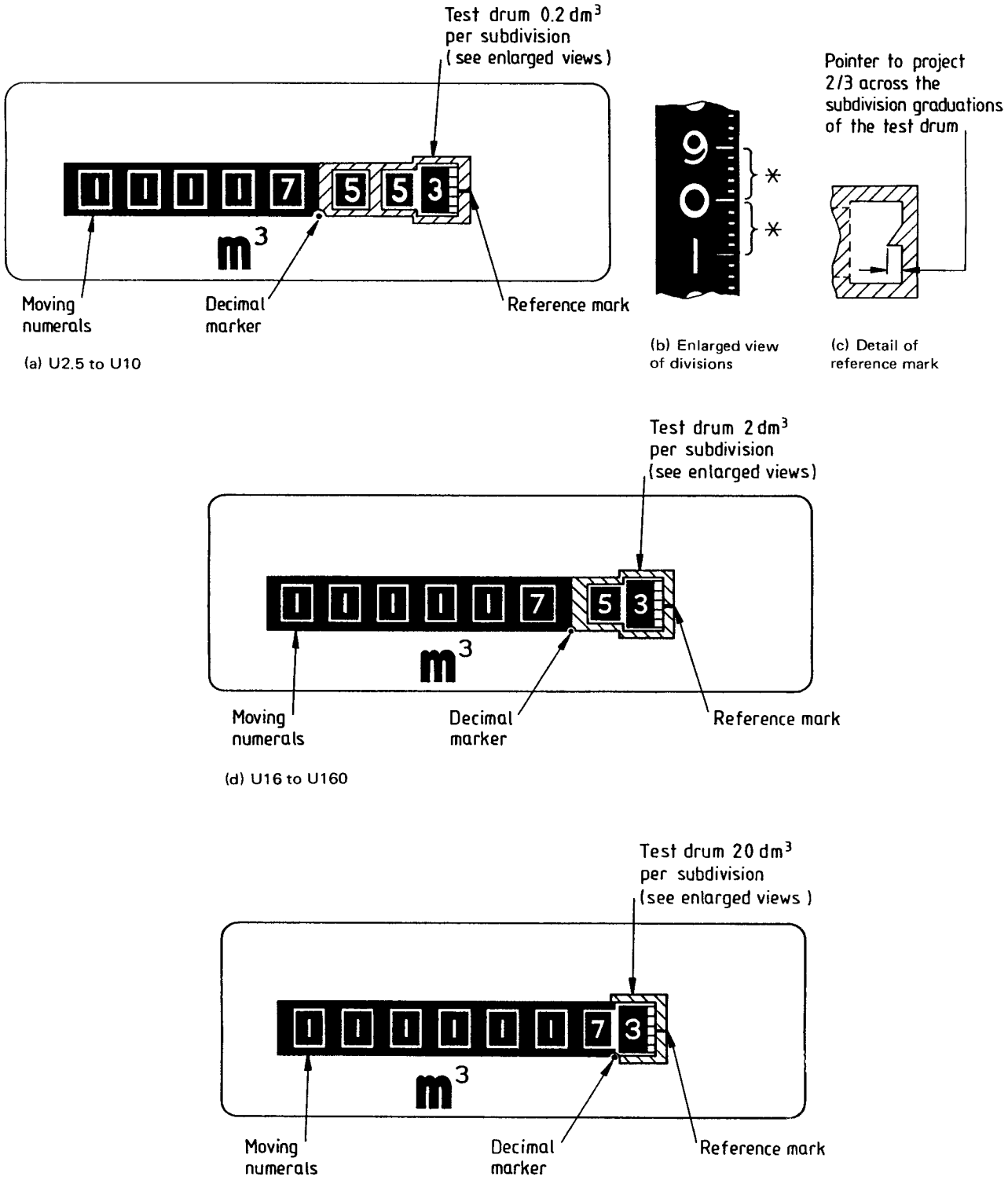
5.5.3 *Cubic metre index*. The index for a meter with a badged rating in cubic metres shall comply with Figure 4 and shall have a test drum. This drum shall move continuously while the meter is recording. It shall have a minimum diameter of 16 mm and the interval between scale divisions shall be constant 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.



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

Figure 4 — Meter index (cubic metres)

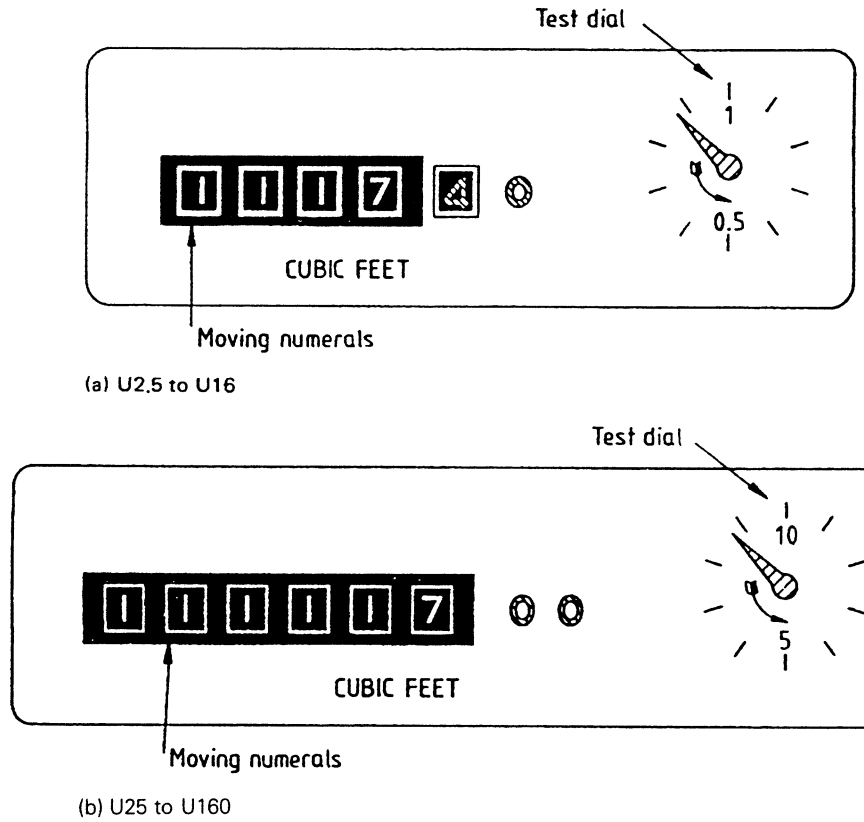


Figure 5 — Meter index (cubic feet)

The recording numerals for submultiples of cubic metres shall be surrounded by a red visor and separated from recording numerals in cubic meteres 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 subdivisions 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 graduation.

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 or two "0"(s) in red on a white background at the end of and in line with the recording numerals as shown in Figure 5(a) and Figure 5(b).

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 equivalent to one revolution of the test drum or pointer.

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 Ω 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 item g) of Appendix A].

5.7 Magnetic index drive

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

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

a) 10 N mm;

b) twice the torque required to drive the index.

The torque shall not be reduced below the minimum specified when a magnet of 4.4 kgf 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.

When the spindle passes through the case the thrust of this spindle shall not be carried by the seal in the gland. A thrust bearing shall be provided to minimize the frictional resistance.

5.9 Gear assembly

The gear assembly shall be designed to ensure correct gear meshing, shall be rigidly secured and shall be of one 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 described in this standard have been performed on them.

When calculated in accordance with Appendix L, the resistance power factor (RPF) 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 if their contact surfaces become contaminated and when tested with light oil complying with ISO viscosity grade 10 of BS 4231.

NOTE 1 To reduce the possibility of tilt, this drive to the valve covers should preferably be placed centrally and low on the covers.

NOTE 2 An RPF 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 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 and 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 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

The connections shall be of a size given in Figure 1 and shall comply with the following.

a) Meters up to and including U40 with working pressures not exceeding 75 mbar shall be fitted with bosses in accordance with BS 746, or a screwed thread BS 21.

b) Meters up to and including U40 with working pressures exceeding 75 mbar shall have screwed threads in accordance with BS 21.

c) All meters of U65 and above shall be flanged in accordance with BS 4504-1, nominal pressure 10 or 16. The bolt holes shall be evenly spaced around the bolt circle and shall be uniformly distributed about, but not on, the centreline between the inlet and outlet connections.

The connections shall be set on a line parallel to the back of the meter (see Figure 1). The face of the connections shall be within 2° of the horizontal plane of the meter.

8 Soundness

8.1 External

8.1.1 *Meters with working pressures not exceeding* 75 mbar. When tested by the method described in Appendix N, the meter shall not leak externally when subjected to an internal air pressure of 115 mbar.

8.1.2 ***Meters with maximum working pressure exceeding 75 mbar but not exceeding 7 bar***

8.1.2.1 The casings shall be designed in accordance with good engineering practice and procedures which shall be recorded and available.

Where the design has been proved by means of calculation, these shall show that the general membrane stress in any part of the vessel during test does not exceed 85 % of the minimum specified yield strength of the material.

Where the casing is of a well established type but no recorded design procedures are available, or of a design where the shape prevents accurate design calculations, one sample of each model size and type of casing shall be subjected to a proof test. The method and result of this proof test shall be recorded and made available for the customer or inspection authority. Following a satisfactory proof test that design shall not be changed without further proof testing.

The proof test, which is a type test, shall be carried out by using strain gauges or a strain indicating coating technique described in BS 5500, or an alternative pressure vessel code, or by performing a hydrostatic test at a pressure five times the maximum working pressure for 30 min without significant yielding.

The intention of such tests is to prove that the design is acceptable without calculation. In such cases, this test pressure shall be the casing design pressure.

Upon completion of manufacture every casing shall be strength tested to 1.5 times the maximum working pressure for a minimum of 15 min.

8.1.2.2 The finished meter shall be pneumatically tested at an internal pressure of 1.1 times the maximum working pressure, during and after which testing there shall be no external leakage.

During this testing in order to prevent damage to the meter, the rate of change of pressure shall be not greater than 350 mbar/s.

The test pressure shall be maintained for 10 min.

NOTE 1 The pressure may be increased by stages up to the test pressure.

NOTE 2 **Important**. Examples of suitable test methods are given in Appendix N.

8.2 Internal

All meters covered by this standard shall register when air is passed through at the rate given in Table 2.

For the purpose of this test the minimum volume of air passed, as indicated by the test drum or test dial pointer, shall be one working cycle of the measuring unit.

For convenience, the test volume should be chosen to correspond to a readily identifiable division or half division of the test drum or dial.

The duration of the test shall not exceed five times the calculated minimum test time for the volume chosen.

Table 2 — Internal leakage test rates

Index units	Meter rating	Air test rate
Cubic metres	m^3/h	dm^3/h
	not exceeding 6	14
	above 6 but not exceeding 25	28
	above 25 but not exceeding 65	56
	above 65	140
Cubic feet	ft^3/h	ft^3/h
	not exceeding 212	0.5
	above 212 but not exceeding 883	1.0
	above 883 but not exceeding 2 296	2.0
	above 2 296	5.0

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}, and one-fifth Q_{max} and the internal leakage complies with **8.2**.

9.2 Total mean pressure loss

For a meter designed to operate at a pressure not greater than 1 bar, the total mean pressure loss when air is passed through it at the meter rating shall not exceed that given in Table 3 when tested in accordance with **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 meter rate shall not exceed that given in Table 3 when tested in accordance with **Q.2.2**.

Table 3 — Total mean pressure loss and mechanical pressure loss

Meter rating		Total mean pressure loss	Mechanical pressure loss
m^3/h	ft^3/h	mbar	mbar
not exceeding 16	566	2.0	0.6
above 16 but not exceeding 65	566 to 2296	3.0	0.6
above 65	2 296	4.0	1.0

10 Type tests

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 tests.

10.2 Pressure cycling test

When subjected to 2 000 cycles at 30 cycles/h at internal pressures varying from 0 mbar to either maximum working pressure plus 200 mbar, or 345 mbar, whichever is the greater, the assembled meter shall suffer no visible permanent distortion and shall comply with **8.1**.

NOTE The meter should attain the test pressure in 20 s to 40 s.

The rate of change of pressure shall not exceed 345 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 in accordance with Table 4 to each boss in turn.

b) With the meter supported by one connection, apply a force of 500 N at right angles to the centreline 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 item b) is carried out with the meter in the horizontal plane, allowance shall be made for its mass.

Table 4 — Strength of connections

Connections nominal size		Torque
mm	in	N.m
Threaded	BS 746	
	½	50
	1	80
	1¼	125
	1½[a]	140
	2	160
Flanged	BS 4504	
65		160
80		160
100		160

[a] Included for special orders.

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 fire-resistant meter 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.

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 placed in an ambient temperature of 120 ± 2 °C for 15 min the meter shall not leak externally while subjected to an internal air pressure equal to the maximum working pressure (see **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 be not 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**.

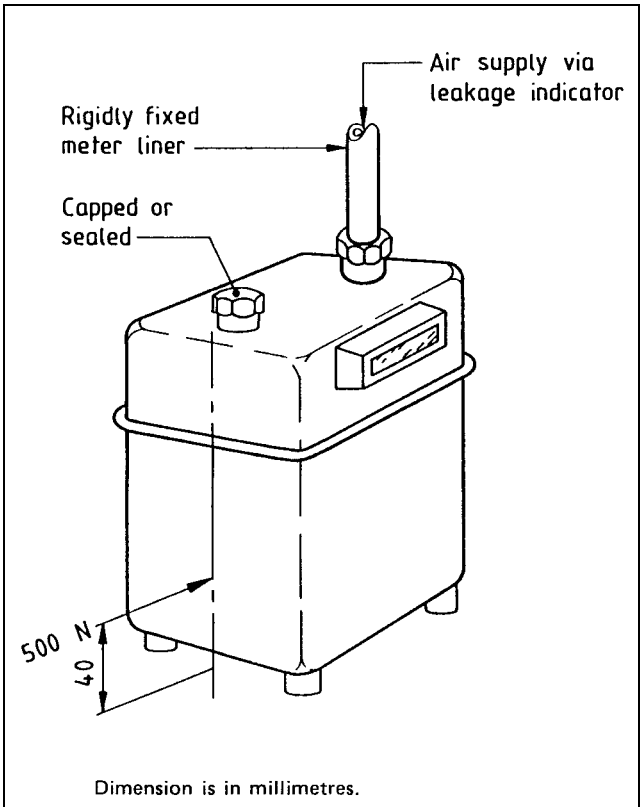


Figure 6 — Method of testing connections

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 connections shall be provided with suitable non-sealing plugs or covers to 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 IN LET 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.

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 cubic meters per hour (or cubic feet per hour);

e) the capacity per revolution (cyclic volume) in cubic decimetres (or cubic feet);

f) the maximum working pressure (in mbar or bar, as appropriate).

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 markings shall be shown on a separate label adjacent to the output:

1) the value per pulse in cubic metres or cubic feet;

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 diaphragms

A meter provided with a synthetic diaphragm shall carry the letter "S" as a suffix to the serial number. This indication should 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.

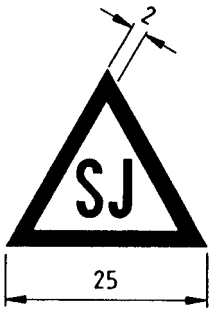
12.6 Badge fixing

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

Appendix A Information to be supplied by the purchaser

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

a) meter designation, i.e.U. . . ;

b) pressure rating (in mbar or bar);

c) whether it is to be fire-resistant (see **10.5** and **12.7**);

d) type and size of connections (in in or mm);

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 4161-5.

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 8.

B.2 Procedure

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

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.

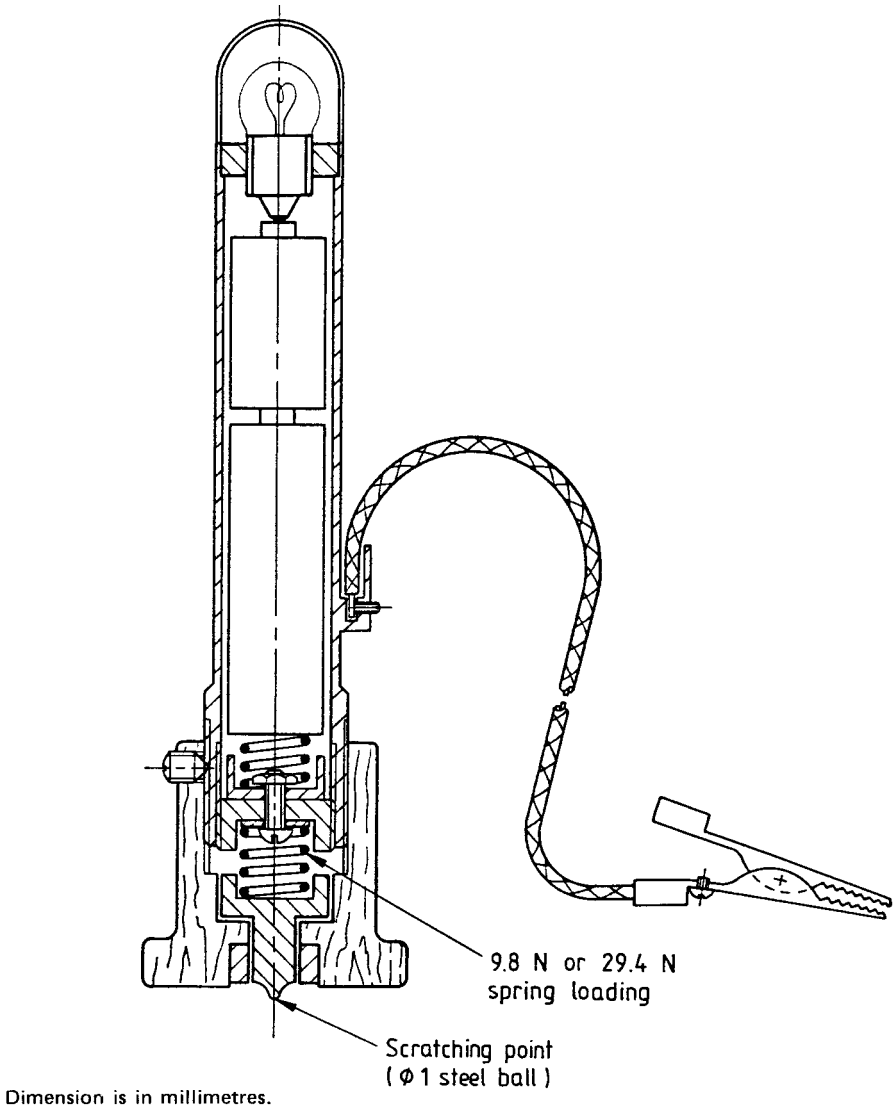


Figure 8 — Paint scratch test apparatus

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 9.

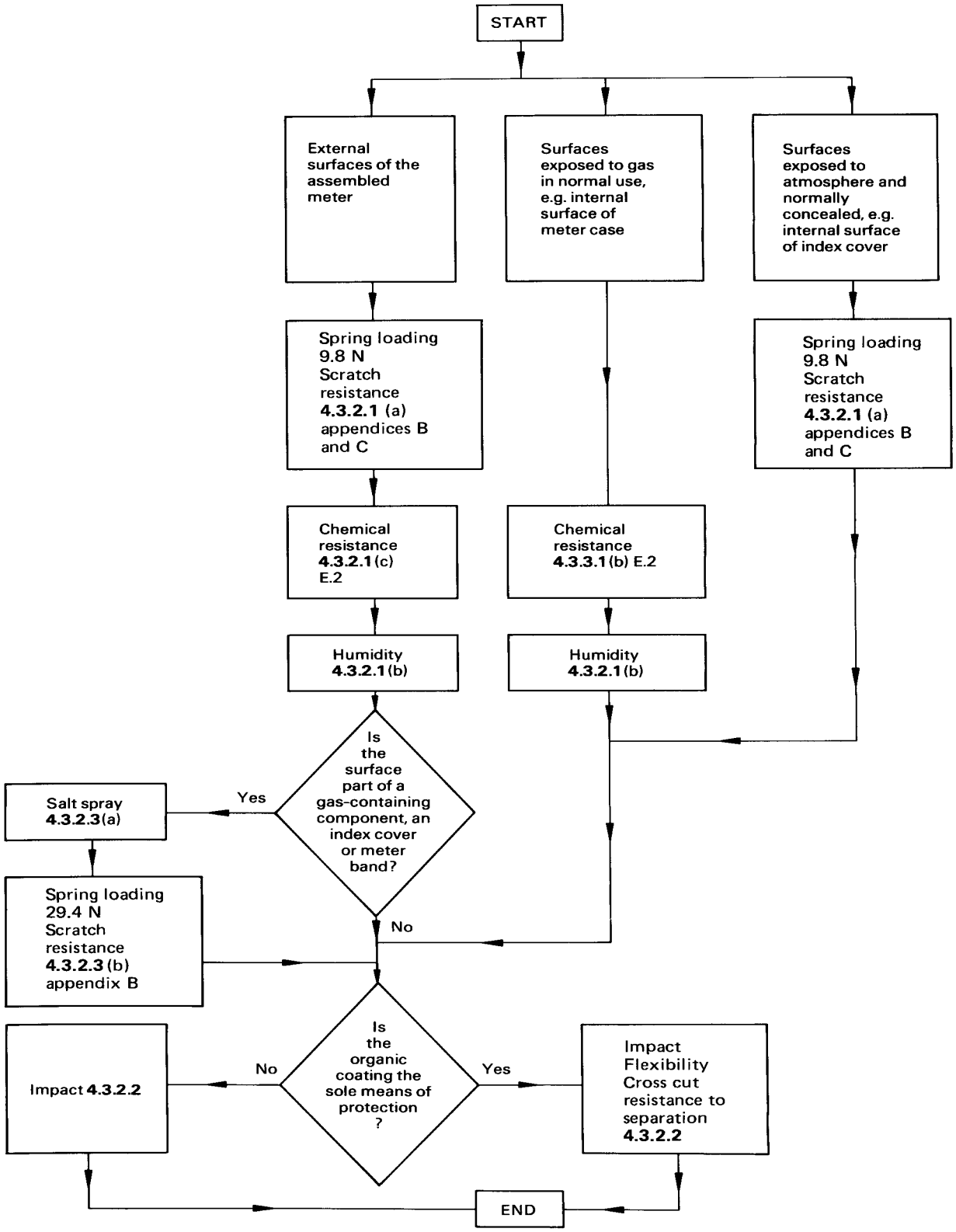


Figure 9 — Scheme of requirements and associated tests for corrosion resistance of materials other than austenitic stainless steel

Appendix E Corrosion resistant 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 specified in BS 3900-E1.

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

E.2.1 *General*

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

E.2.2 *Chemical resistance* [see **4.3.2.1** c) and **4.3.3.1** b)]

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 (previously known as dethylene glycol);

d) methanol;

e) toluene;

f) distilled or dionized water;

g) detergent[3)].

Use a separate test sample for each liquid.

E.2.3 *Humidity test*

The humidity test 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 use 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.

[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, MK 14 6LE enclosing a stamped addressed enveloped for reply.

Appendix F Synthetic diaphragm: Williamson torsion test of stiffness[4)] (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 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 10.

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, restrained from rotating in a horizontal plane but free to move vertically.

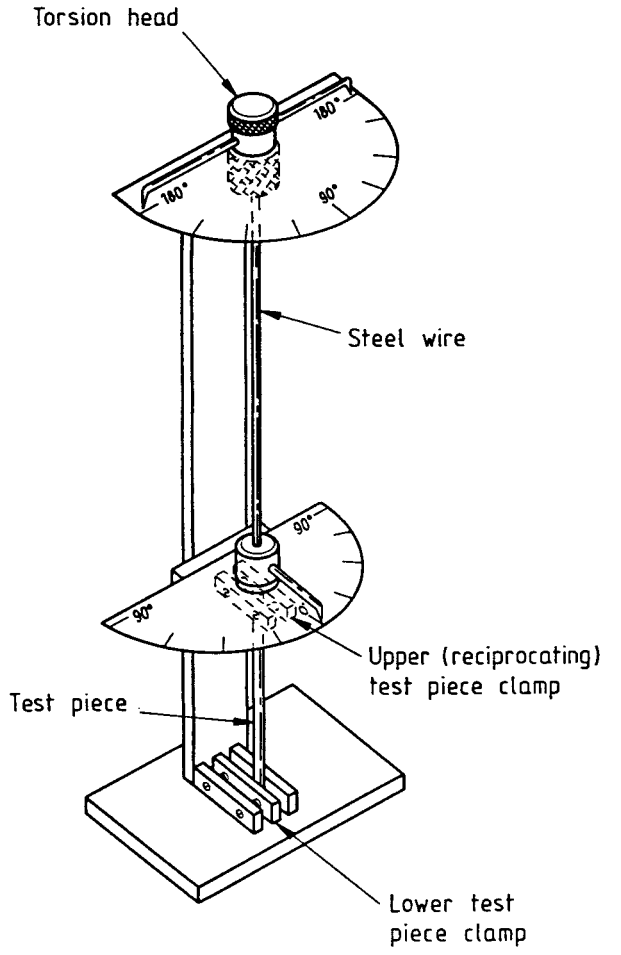


Figure 10 — Torsion apparatus

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.

[4)] For further details see Williamson "An improved instrument for the evaluation of the physical properties of high polymer compositions", British Plastics, Volume 53, September 1950, pp 87 to 90, 102.

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

NOTE 1 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 6).

e) Return the torsion head to zero, i.e. to the starting position, and repeat the procedure given in item 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 items d) and e) minus 90°.

NOTE 2 It is essential that the lower test piece clamp can move in a vertical direction with the least possible friction.
NOTE 3 The test piece has to be vertical and the lower test piece clamp has to be evenly balanced and horizontal.
NOTE 4 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 5 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 an environmental chamber.
NOTE 6 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 the test rig and clamp securely (a suitable rig is shown in Figure 11).

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 diaphragms: preparation and use of treated gas for vapour phase test (see 4.4.3.4.1)

H.1 Apparatus

NOTE See Figure 12 for key references.

H.1.1 *Modified gas meter*, a U6 gas meter, or a P1 or P2 as in BS 4161-1 can be conveniently 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 item 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 the toluene from the micrometering pump (see **H.1.2**). Each pulse[5)] 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). The head sizes available are:

No. 1 capacity 0 cm^3/h to 100 cm^3/h
No. 2 capacity 0 cm^3/h to 300 cm^3/h
No. 3 capacity 0 cm^3/h to 1 000 cm^3/h
No. 4 capacity 0 cm^3/h to 1 500 cm^3/h

[5)] Electrical pulses from the modified gas meter trigger the mircrometering pump.

Each head has a micrometer thimble calibrated in one-hundredths and the maximum pulse rate is 100/h. One electrical pulse causes one stroke of the pump. Up to six separate heads can be fixed to the pump.

H.1.3 *Heater for toluene tower* (9).

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 and controlled by a thermostat sensor (11).

H.1.4 *Gas humidifier*, in which 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 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.

NOTE This should ensure that the reference meter or other proving equipment is not affected by the treated test gas.

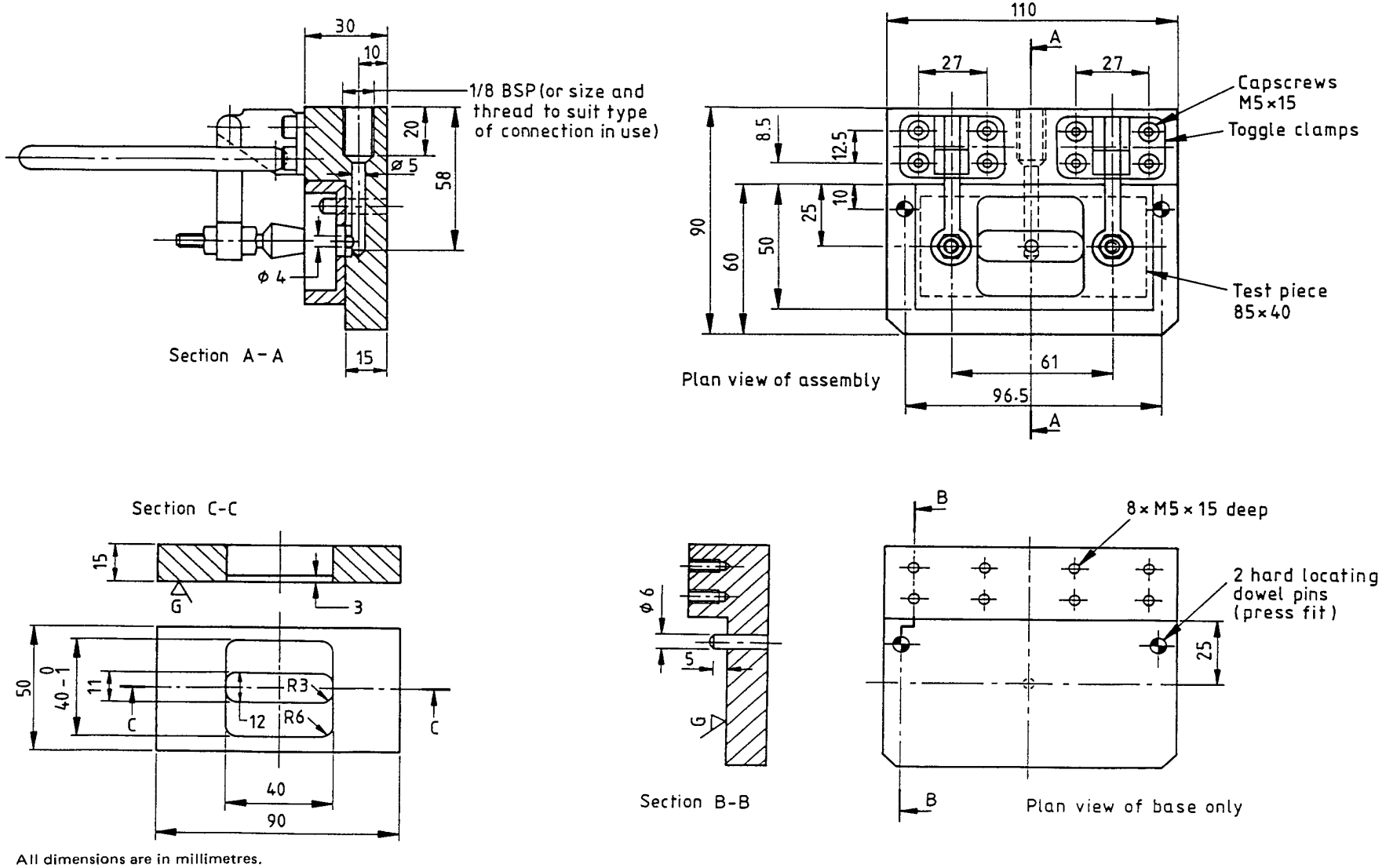


Figure 11 — Porosity test rig

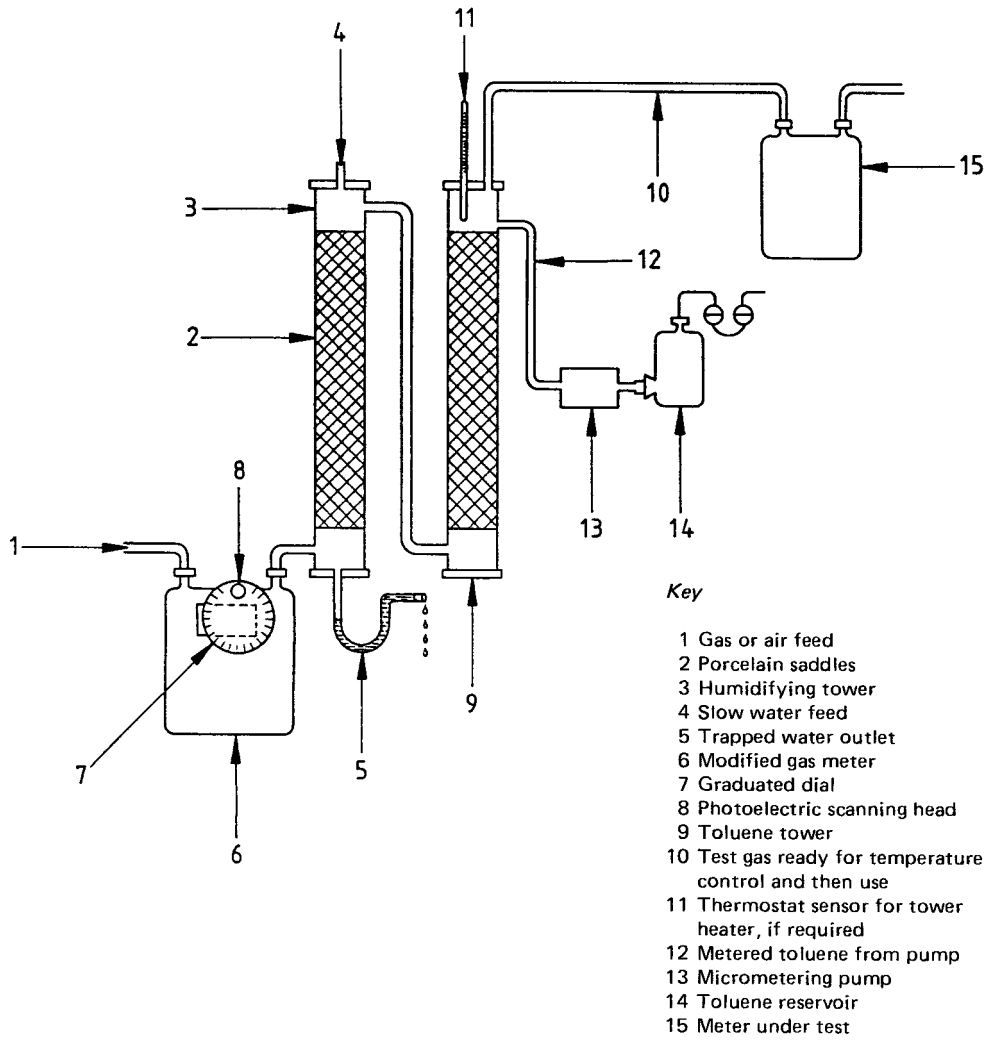


Figure 12 — Diagram of a typical test gas mixer apparatus

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.

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 tests, 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 0.25 Q_{max}.

J.2 Wear resistance of sealing glands

House and test the gland as it is used in the meter.

Test the internal or external sealing gland for 100 days, at a speed of rotation or other cyclic movement equivalent to that experienced at 1.5 times the meter badged rating.

Alternate between natural gas and air every 7 days.

Check the sealing glands for soundness in accordance with Appendix N, at the beginning of the test, after each 7 day period and at the end of the test.

Test internal sealing glands at 5 mbar. Test external sealing glands from the pressure side at 5 mbar and at the maximum working pressure.

Determine the turning resistance using a torque meter before beginning the test after each 7 day period and at the end of the test.

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 13).

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 14). Each size of striker tip is used during the test, but no test area on any one meter sample shall be 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 to be 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 onto 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 (in joules) = mass of striker (in kg) × acceleration due to gravity (in m/s^2) × height of fall (in m)

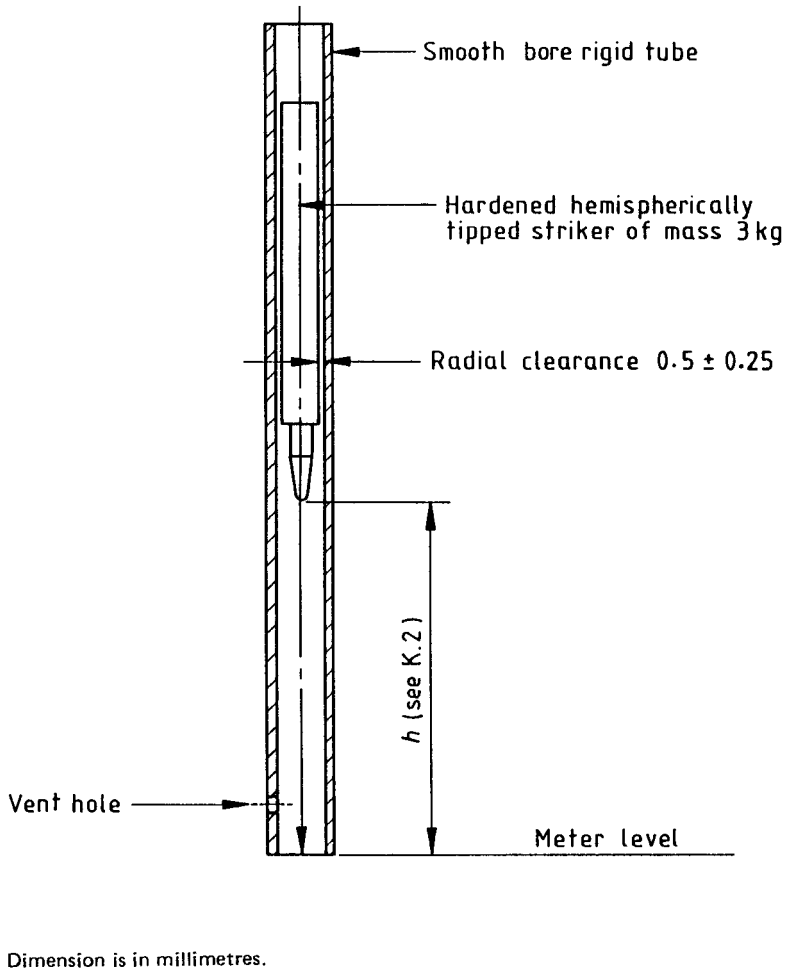


Figure 13 — Impact test apparatus

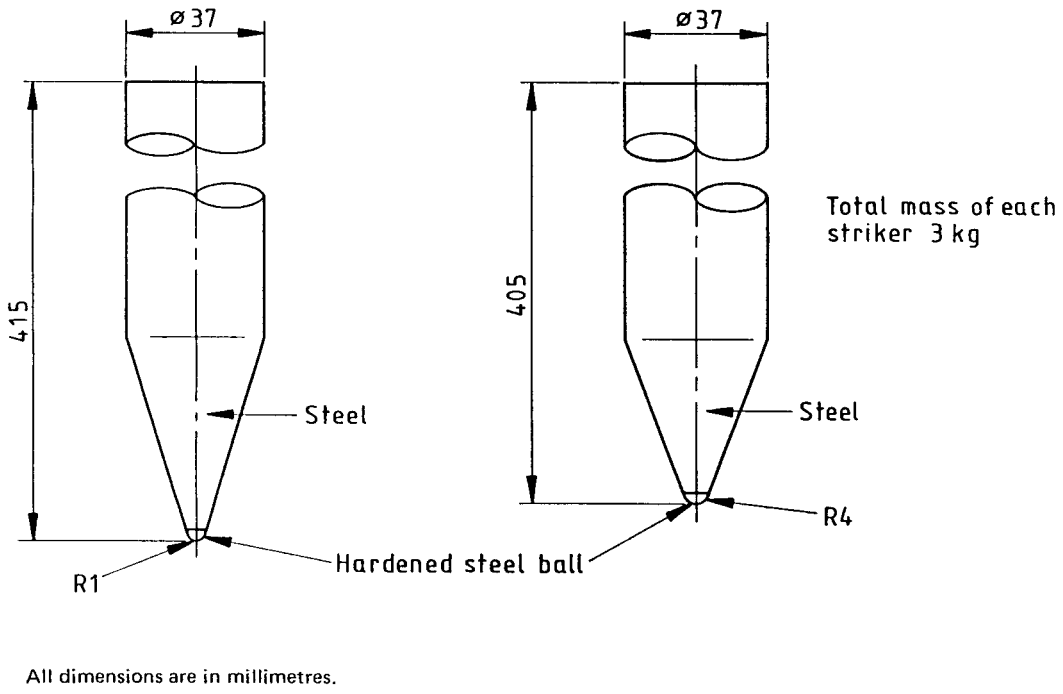


Figure 14 — Typical hemispherically-tipped strikers used in impact test

Appendix L Method of calculating the resistance power factor (see **5.12**)

L.1 Formula (see Figure 15)

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;

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;

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 (RPF) is given by the formula:

$$\frac{T}{V} \times 1\,000$$

where

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

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.

L.2 Assumptions

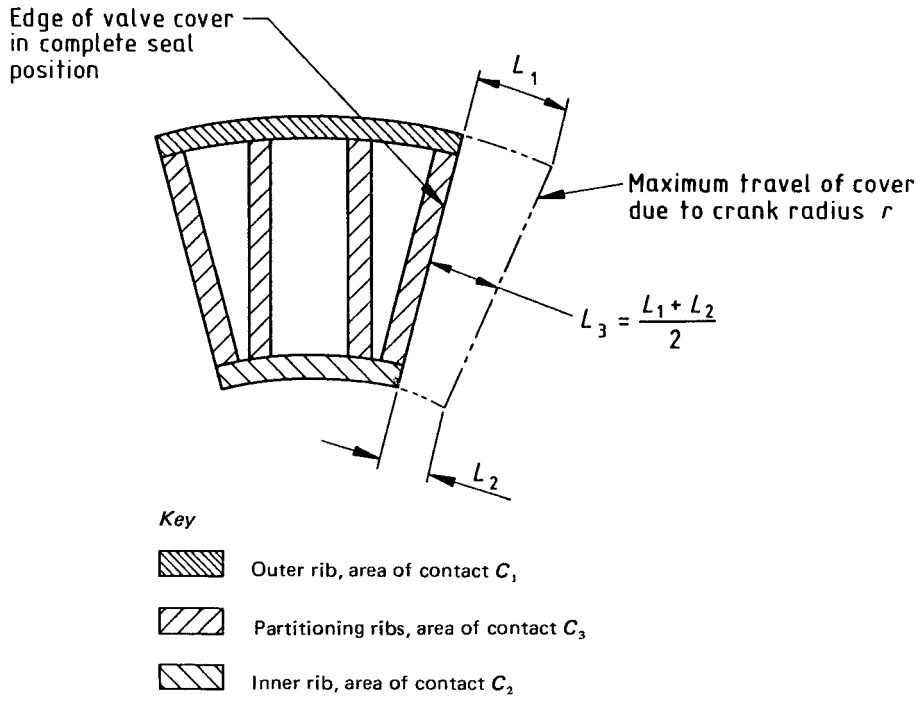
It has been assumed:

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.



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 15 — Valve grid (diagrammatic only)

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:

$$\text{RPF} \propto \frac{T}{V}$$

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

Therefore

$$\begin{aligned} C \times R &= \Sigma c \times r \\ &= \Sigma c \times L \\ &= (C_1 L_1 + C_2 L_2 + C_3 L_3) \end{aligned}$$

The figure 1 000 is an arbitrary constant selected to provide a suitable working value for the RPF.

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

M.1 Apparatus

The vibration test rig and associated electronic equipment are shown diagrammatically in Figure 16. 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 cycled between a pair of selected frequencies, alternately increasing and decreasing.

M.2 Procedure

Secure the complete meter under test to the vibration rig by means of a horizontal clamp across the top of the meter. Subject the whole to a swept frequency of between 10 Hz and 100 Hz (± 5 %) at a sweep rate of 1 octave/min with a peak acceleration of 2*g*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.

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

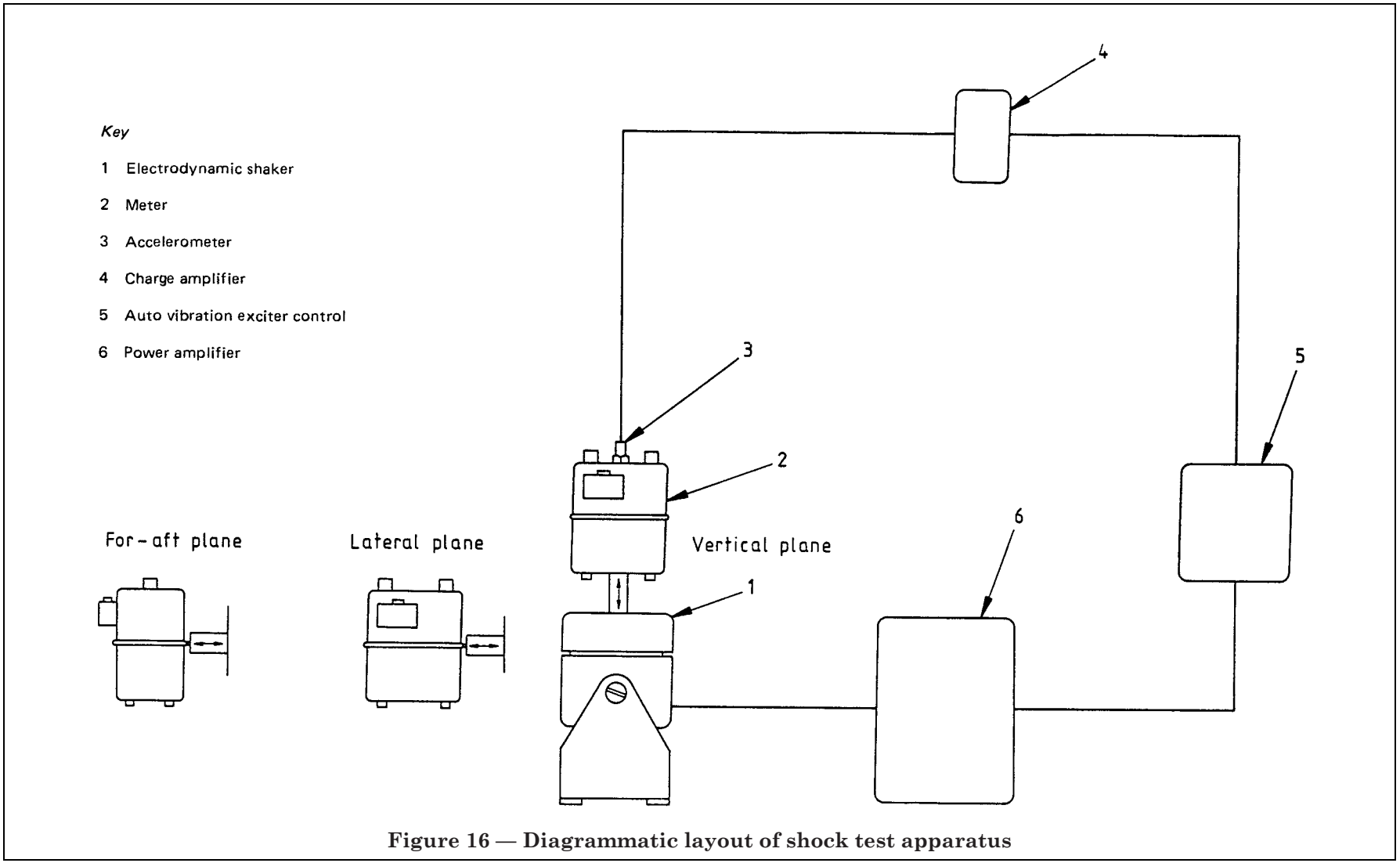


Figure 16 — Diagrammatic layout of shock test apparatus

Appendix N Test for external soundness (see 8.1)

WARNING NOTE 1. 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.

WARNING NOTE 2. Care should be taken in carrying out these tests as high pressures may be involved.

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.

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 with the pressure gauge 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.

NOTE 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 should be employed if these changes are unacceptable.

N.2 Method 2

N.2.1 *Apparatus*

N.2.1.1 *Bubble leak indicator* [see Figure 17(a) or Figure 17(b)], to which is connected a constant pressure air supply at the test pressure.

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 18)

N.3.1.1 *Air supply or pump*, capable of supplying air up to the test pressure.

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

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

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

N.3.1.5 *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.

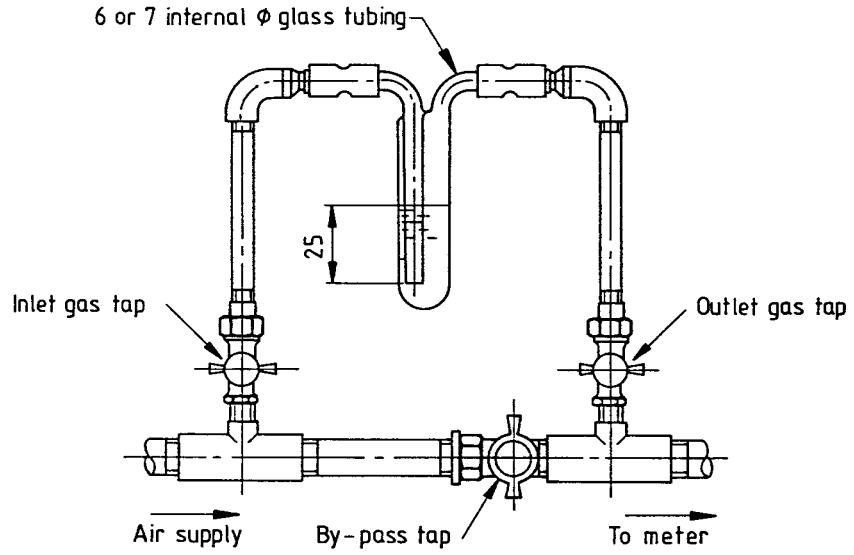
N.3.1.7 *Pressure gauge*, on the downstream side of valve A.

N.3.1.8 *Outlet valve* B.

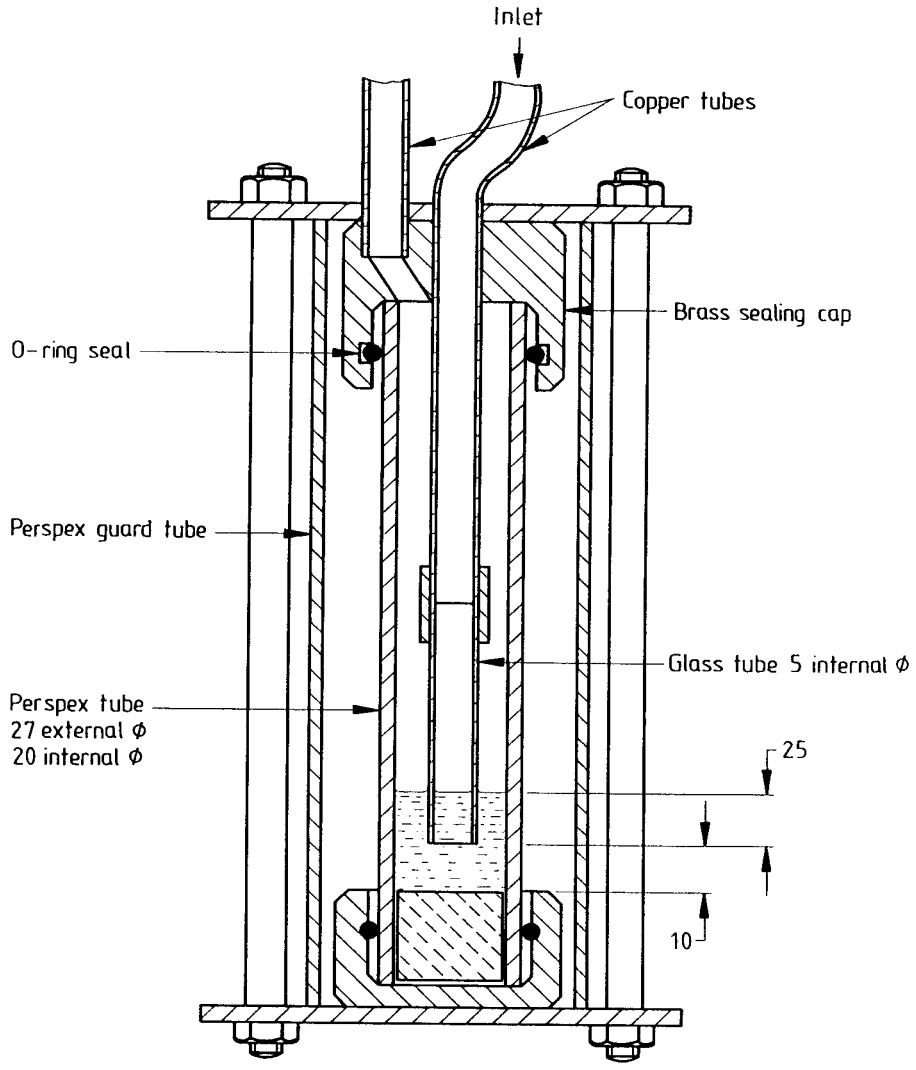
N.3.2 *Procedure*

Remove the index and any attachments. 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 the test pressure.



(a) For pressures up to 250 bar



(b) For pressures up to 8 bar

All dimensions are in millimetres.

Figure 17 — Bubble leak indicator

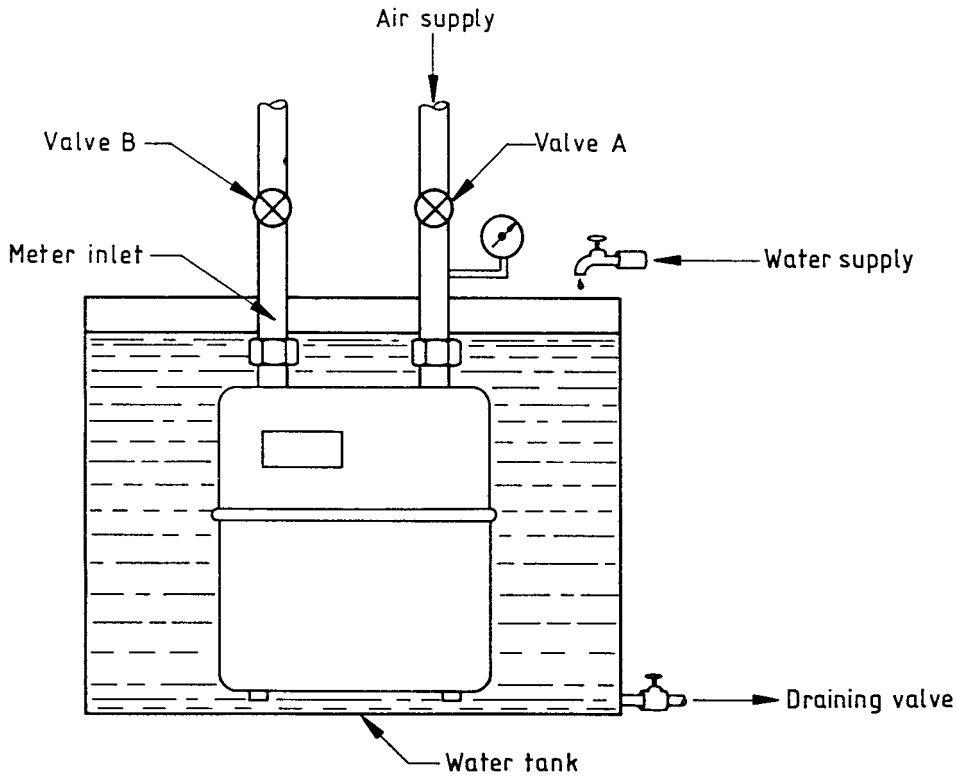


Figure 18 — External leakage test apparatus

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.

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 pointer 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 pointer 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 take 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 100 times the cyclic volume 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 pointer 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 pointer, 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 =

(volume registered in one or more revolutions of test drum or test dial pointer – actual volume of air passed) × 100 /(actual volume of air passed)

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

Appendix Q Tests for total mean pressure loss and mechanical pressure loss (**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 connections. 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**)

Select a meter in a new condition and pass air through it at a flow rate equal to its badged rating for a minimum of 30 min. Check the meter on air for compliance with clause **8** and with **9.1**.

Operate the meter at a flow rate of 115 % of its badged rating, using the gas for which it is intended, 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 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** 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.

NOTE 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 rechecking in accordance with **9.1**.

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

Place the meter at rest for 3 h in a chamber 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 20 ± 5 °C (normal laboratory ambient temperature) at a pressure of 5 mbar and at the flow rate given in Table 2 (see **8.2**).

Take precautions during the test to prevent condensation.

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

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

T.1 Apparatus (see Figure 19)

T.1.1 *Furnace*, producing standard heating conditions as specified in **1.4.2** of BS 476-8:1972, for a temperature rise of 821 °C, and of sufficient size to accept the meter and, if required, its stand.

T.1.2 *Meter*, declared by the manufacturer to be suitable for suspended installation, provided with a suitable stand to support the meter by its connections and permit air to be supplied to the meter.

T.1.3 *Means of recording the flow rates and pressures* of the air supplied.

T.2 Procedure

The meter (or meter case) on its stand, if required, 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 in accordance with clause **8**.

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 19).

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

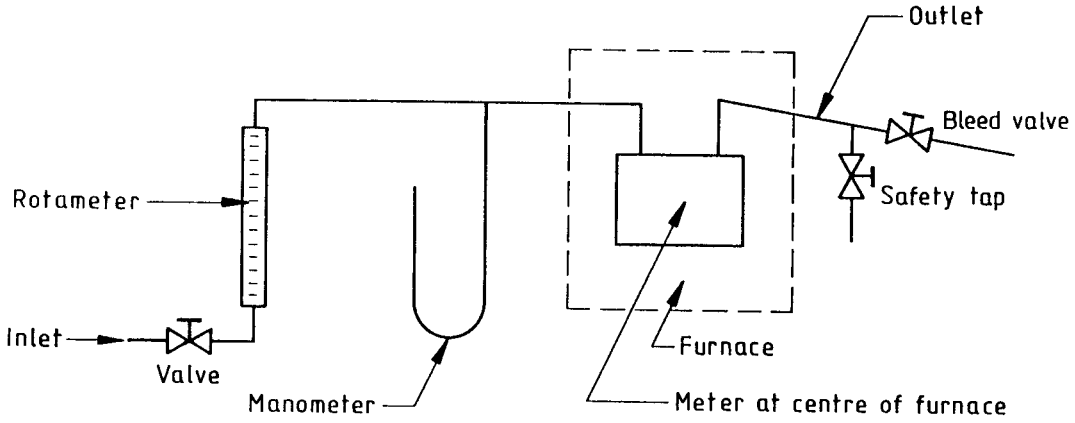


Figure 19 — Schematic diagram of typical fire resistance test apparatus

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 1.0 is used, are shown in Figure 20.

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.

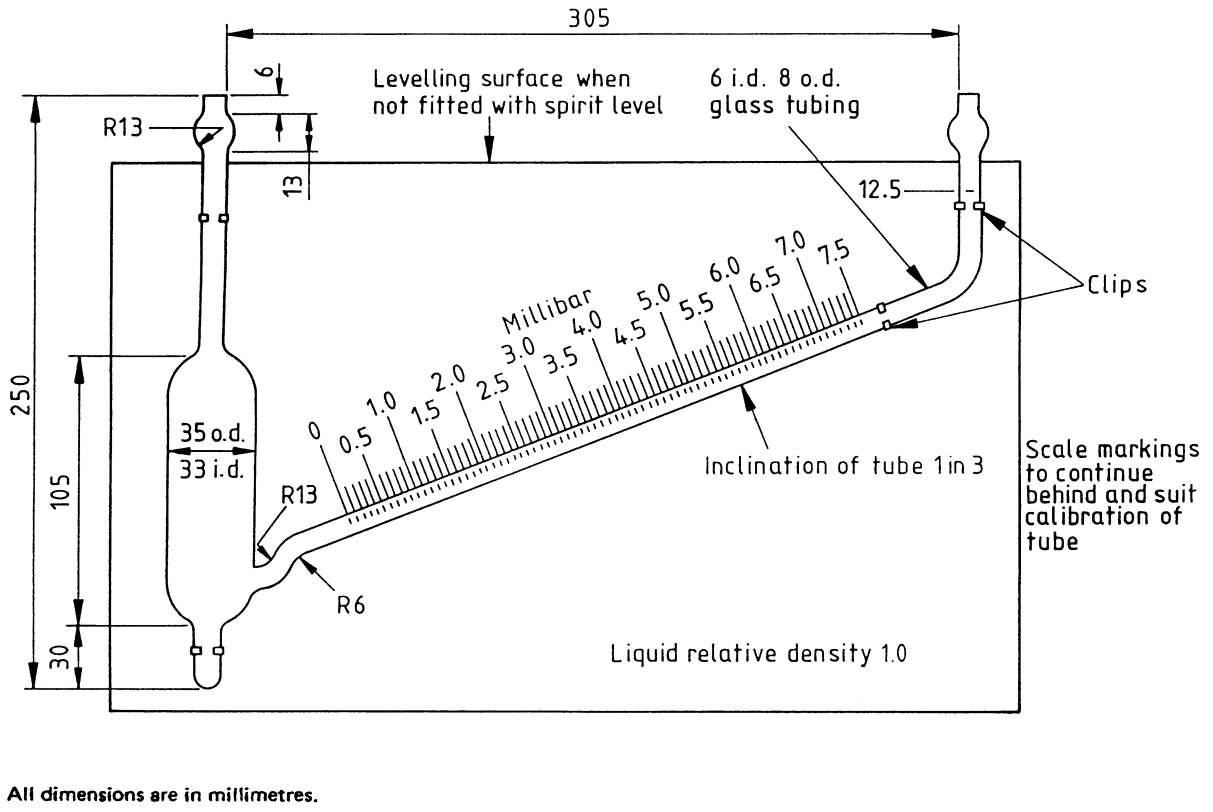


Figure 20 — Inclined pressure gauge: 7.5 mbar range

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Publications referred to

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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-A1, *Sampling.*

BS 3900-A2, *Examination and preparation of samples for testing.*

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*[6)].

BS 4161-3, *Specification for diaphragm meters of 6 cubic metres (or 212 cubic feet) per hour rating for working pressures up to 50 mbar.*

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

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

BS 4161-7, *Mechanical volume correctors*[6)].

BS 4161-8, *Specification for electronic volume correctors*[6)].

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

BS 4504, *Circular flanges for pipes, valves and fittings (PN designated).*

BS 4504-1, *Ferrous.*

BS 4800, *Schedule of paint colours for building purposes.*

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

BS 5345, *Code of practice for the 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, *General recommendations.*

BS 5500, *Specification for unfired fusion welded pressure vessels.*

6) Referred to in the foreword only

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

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

Recommendations on gas measurement practice IGE/GM/I. Installation of high-pressure gas meters[7)].

Williamson "An improved instrument for the evaluation of the physical properties of high polymer compositions", British Plastics, Volume 53, September 1950.

[7)] Published by the Institution of Gas Engineers, 17 Grosvenor Crescent, London, SW1 X 7ES

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