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Copper indirect cylinders for domestic purposes —

Part 2: Specification for single feed indirect cylinders

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Building Services Standards Committee (SEB/-) to Technical Committee SEB/9 upon which the following bodies were represented:

Association of Manufacturers of Domestic Electrical Appliances
British Copper Cylinder Association
British Gas Corporation
British Non-ferrous Metals Federation
Chartered Institute of Building
Copper Cylinder and Boiler Manufacturers
Copper Development Association
Copper Tube Fittings Manufacturers' Association
Department of the Environment (Building Research Establishment)
Department of the Environment (Property Services Agency)
Electricity Supply Industry in England and Wales
Galvanizers' Association
Heating and Ventilating Contractors' Association
Institute of Plumbing
London Boroughs Association
Manufacturers' Association of Radiators and Convectors Ltd.
Royal Institute of British Architects
Royal Institute of Public Health and Hygiene
Solid Fuel Advisory Service
STC Water Regulations and Fittings Scheme
Thames Water Authority Metropolitan Water Division
Water Companies Association
Zinc Development Association
Coopted member

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Contents

Foreword

This revision of this British Standard, which has been prepared under the direction of the Building Services Standards Committee, supersedes BS 1566-2:1972, which is withdrawn. It has been prepared in conjunction with BS 699 "*Specification for copper direct cylinders for domestic purposes*" and is complementary to BS 1566-1 "*Specification for double feed indirect cylinders*".

Whereas double feed indirect cylinders require separate feed cisterns for both primary and secondary circuits, the single feed indirect cylinders specified in this Part of this standard require only one feed cistern, the feed water to the primary circuit being obtained from within the cylinder through the primary heater. The increase in volume of the primary water owing to expansion is accommodated within the primary heater and the primary water is prevented from coming into contact with the secondary water.

A new size 9E has been added to provide an additional size of cylinder suitable for off-peak electric water heating systems. The dimensions and positioning of connections are unaltered. The original cylinder grades 2 and 3 are included. A new grade 4 covers cylinders specifically designed for installations which are subject to a lower maximum working head than the maximum permitted in the previous grade 3, thus enabling a reduction to be made in the thickness of copper sheet used.

Primary heaters of the coil or annular type are used in single feed indirect cylinders. Whereas double feed indirect cylinders in accordance with BS 1566-1 with coil primary heaters are preferred for higher primary water operating pressures and higher primary water circulation rates, this is not the case with single feed indirect cylinders, which should not be used in sealed systems and which have limited application on direct pump circulation.

This Part of this standard does not include every detail of the primary heater design, and the manufacturer will continue to decide on the construction of his own particular unit to ensure that it complies with all relevant requirements and particularly with **12.3**.

Metal thicknesses are now specified both before and after forming.

Attention is drawn to the preferred sizes of cylinders in Table 1.

This standard now specifies material and heat loss performance requirements for thermal insulation where this is applied to cylinders by the manufacturer at the factory. In the interest of energy saving, it is recommended that all cylinders are either insulated at the factory or are provided with an insulating jacket complying with BS 5615.

A specification for aluminium protector rods is now included. It is recommended that these be fitted to copper cylinders during manufacture to help to ensure long service in those supply waters that have been known to cause or are expected to cause premature failure by pin hole corrosion. When required it is important that they be specified at the time of ordering. It is rarely possible and never satisfactory to install aluminium protector rods after the cylinder has been put into service. Leaflet MP.538 published by BNF Metals Technology Centre, Grove Laboratories, Denchworth Road, Wantage, Oxon, OX12 9BJ gives further information.

Copper cylinders require careful handling during transit and installation to avoid damage. Factory insulation is recommended to help prevent such damage (see **11.5**).

Parts 1 and 2 of this standard and BS 417, BS 699, BS 1565, BS 2777, BS 3198 and BS 4213 cover water storage vessels mainly for domestic use and now form a series to which others may be added when such a course is considered necessary.

Certification. It is strongly recommended that in view of the nature of this specification, manufacturers and purchasers should make use of the certification facilities described on the inside back cover of this standard.

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 14, an inside back cover and a back cover.

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

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1 Scope

This Part of this British Standard specifies requirements for copper cylinders, with or without the optional features listed in clause **11**, for the storage of hot water, where the water is heated indirectly by the water circulating in an integral primary heater of annular or coil type and for which only one feed cistern is required, the feed water to the primary circuit being obtained from within the cylinder through the primary heater. Three grades and seven sizes are specified. The minimum storage capacities are from 86 L to 196 L. The cylinders are intended for fixing in the vertical position and are all of the type in which the bottom is domed inwards.

The information to be supplied with any enquiry or order is set out in Appendix A.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of this British Standard, the following definitions apply.

2.1
cylinder

a closed cylindrical vessel with domed ends

2.2
primary heater

an annular type heat exchanger constructed from sheet or a coil type heat exchanger constructed from tube and mounted inside a cylinder for the transfer of heat to the stored water from circulating hot water

2.3
primary water

the water in the primary circuit, including the water in the primary heater, boiler, radiators, pipework, etc.

2.4
primary capacity

the total volume of primary water, the expansion of which is to be accommodated by the primary heater

2.5
secondary water

the water in the cylinder and associated pipework that is heated by the primary heater

2.6
screwed connection

any threaded connection to which pipes or apparatus can be fitted

2.7
length of thread portion (of screwed connection)

the distance measured from the front face of the connection (including any chamfer or radius) to either the leading face of a plug or screw ring gauge which has been screwed as far as possible by hand into or onto the connection or in the case of a fully threaded female connection, to the back face

2.8
metal thickness before forming

the nominal thickness of copper sheet (which is subject to the tolerances specified in BS 2870) from which units are manufactured

2.9
storage capacity

the total volume of water that can be stored in the cylinder, excluding the water content of the primary heater

3 Sizes and grades

The size of cylinder, the grade and the thickness of material appropriate to each grade shall comply with Table 1.

NOTE For thicknesses of materials after forming see clause **8**.

The diameter of a cylinder shall be measured externally, and the height externally from base to top of dome, excluding any seam, screwed connection or other projection.

4 Primary heater

4.1 Classes. The primary heater shall be either:

a) class 110 for systems having a primary capacity of not more than 110 L; or

b) class 180 for systems having a primary capacity of not more than 180 L.

4.2 Dimensions. Primary heaters shall be of the annular or coil type. The minimum surface area and thickness of materials shall be as specified in Table 1.

The tube diameter for coil type heaters shall be as specified in Table 1.

4.3 Feed to primary circuit. The effective cross-sectional area of the waterway from the cylinder to the primary circuit shall be not less than 500 mm^2.

4.4 Vent from primary heater. The effective cross-sectional area of the entry to the internal vent pipe shall be not less than 245 mm^2. Connections between the heat-exchanger and the vent shall at no point be less than 140 mm^2.

Table 1 — Dimensions and details of single feed copper indirect cylinders

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		19	20
British Standard type reference[a]	**External diameter**	**External height (over dome)**	**Minimum storage capacity** (see **2.9**)	**Minimum annular surface area**	**Minimum coil surface area**	**Minimum nominal thickness of copper sheet before forming**										**Coil primary heater: size of tube**	**Height of screwed connections** (see Figure 2 and Figure 3)		**Size of screwed connections: internal threads**[d]	**Size of primary heater connections: external threads**
						Grade 2			**Grade 3**			**Grade 4**			**All grades**					
						Test pressure: 2.20 bar[b]			**Test pressure: 1.45 bar**			**Test pressure: 1.0 bar**			**Annular primary heater**					
	A	*B*				**Maximum working head: 15 m**[c]			**Maximum working head 10 m**[c]			**Maximum working head: 6 m**[c]					J_1	*L*		
						Body	**Top**	**Bottom**	**Body**	**Top**	**Bottom**	**Body**	**Top**	**Bottom**			(see clause **10**)			
	mm	mm	L	m^2	m^2	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		
3[e]	400	1 050	104	0.63	0.42	0.9	0.9	1.6	0.7	0.7	1.2	0.55	0.6	0.9	0.55	28	140	100	G1	G1B
5	450	750	86	0.52	0.35	1.0	1.0	1.6	0.7	0.7	1.2	0.55	0.6	0.9	0.55	28	140	100	G1	G1B
7[e]	450	900	108	0.66	0.44	1.0	1.0	1.6	0.7	0.7	1.2	0.55	0.6	0.9	0.55	28	140	100	G1	G1B
8[e]	450	1 050	130	0.78	0.52	1.0	1.0	1.6	0.7	0.7	1.2	0.55	0.6	0.9	0.55	28	140	100	G1¼	G1B
9[e]	450	1 200	152	0.91	0.61	1.0	1.0	1.6	0.7	0.7	1.2	0.7	0.6	0.9	0.55	28	140	100	G1¼	G1B
9E	450	1 500	196	1.18	0.79	1.0	1.0	1.6	0.7	0.7	1.2	0.7	0.6	0.9	0.55	28	140	100	G1¼	G1B
10	500	1 200	180	1.13	0.75	1.2	1.2	1.8	0.9	0.9	1.6	0.8	0.9	1.4	0.55	35	180	150	G1½	G1¼B

NOTE Type 9 E is the preferred size for off-peak electric water heating.

[a] Cylinders should be ordered by the BS type reference.

[b] 1 bar = 10^5 N/m^2 = 100 kPa.

[c] The working head is the vertical distance from the bottom of the cylinder to the water line of the cistern supplying it (1 m water = 0.1 bar approximately).

[d] Class B external threads may be supplied when so ordered and shall be to the requirements of clause **10**.

[e] Preferred sizes for new installations in dwellings.

5 Designation of single feed copper indirect cylinders for ordering purposes

For ordering purposes, single feed copper indirect cylinders shall be designated "BS 1566: SF" followed by "A" to indicate annular type or "C" to indicate coil type, the appropriate BS type reference, the grade from Table 1 and the heater class (see clause **4**), e.g. "BS 1566: SF, C, Ref. 3, grade 2, class 110".

6 Tolerances

The maximum tolerances on the dimensions given in Table 1 shall be as follows:

a) position of screwed connections: 6 mm in any direction;

b) diameter and height of cylinder: ± 6 mm;

c) thickness of material: the tolerances specified in BS 2870 apply.

7 Materials

The cylinders and annular type primary heaters shall be made from copper sheet complying with section eight of BS 2870:1980.

NOTE Where joints are to be welded in copper thicker than 1.2 mm, material designated C106 is preferred.

Screwed connections shall be made of copper, gunmetal or alpha brass (inhibited against dezincification), and shall be attached to the cylinder by either brazing, welding or mechanical means. Filler alloys for brazing shall be types CP1 or CP2 of BS 1845, or other corrosion resistant alloy that does not undergo dezincification and does not produce brittle joints. Filler rods for welding shall be types C7, C8, C9 or C21 of BS 2901-3.

Coil type primary heaters shall be made from copper tube complying with the material and dimensional requirements of BS 2871-1. Before forming, the copper tube shall have been in a suitable temper for forming.

Aluminium protector rods shall be made from alloy 1050A complying with BS 1475.

Any non-metallic materials shall not, under the expected usual conditions of use for which the cylinder is designed, impart to the water with which they will come into contact, unpleasant taste or odour, any cloudiness or discolouration, or any toxic or undesirable substances. For compliance with this requirement see the National Water Council Publication "Requirements for the testing of non-metallic materials for use in contact with potable water"[1)].

8 Manufacture

8.1 After manufacture the copper forming the cylinder shall be in the work-hardened condition except in areas of brazed or welded joints.

All seams shall be jointed by one of the following methods:

a) welting in a manner which gives four times the thickness of metal at the seam and brazing;

b) overlapping, not less than 5 mm wide and brazing;

c) butt welding.

8.2 The minimum thickness of copper after forming for the top and the concave surfaces of the bottom of cylinders shall be not less than 67 %[2)] of the nominal thickness specified in Table 1. The minimum thickness of copper after forming for the upstand portion of the bottom of cylinders shall be not less than 67 %[2)] of the nominal thickness specified for tops in Table 1.

Thickness measurements shall be made using a pointed anvil micrometer or similar instrument.

8.3 The body of the cylinder shall be plain sided with the exception of not more than two circumferential swages. The swages shall be rounded and not sharp edged.

NOTE It is permissible for the top and bottom of a cylinder to have spinning location recesses.

Where the body sheet is swaged and/or manipulated to form a seam, the minimum thickness of the sheet at the swage or seam shall be not less than 67 %[2)] of the nominal thickness before forming specified in Table 1. The thickness of the body other than at a swage or seam shall be not less than the minimum nominal thickness before forming specified in Table 1.

8.4 The coil type primary heater shall be constructed to ensure full flow characteristics and when fitted to the cylinder shall have a continuous fall to prevent the formation of air pockets.

There shall be no more than one joint in any coil other than at end connections used in a cylinder.

Joints shall be made by socketting and brazing with an overlap of not less than one-third the nominal tube size. Where smaller sizes of primary connection are specified by the purchaser in accordance with Appendix A, the test shall be carried out on the coil without the end connections.

The method used for forming the coil shall be such that deformation, crimping and/or flattening of the surface and reduction in internal diameter is minimized.

[1)] Obtainable from the Water Research Centre, Fittings Testing Station, 660 Ajax Avenue, Slough, Berks SL1 4BG.
[2)] In these calculations the figures given in Table 1 are not subject to the tolerances specified in BS 2870.

The completed coil, including end connections, shall be capable of accommodating the passage of a rigid ball, of the diameter given in Table 2, throughout its length.

Table 2 — Ball diameter

Size of tube (see Table 1)	**Ball diameter**
mm	mm
28	$22^{+0.5}_{-0}$
35	$28^{+0.5}_{-0}$

9 Design of cylinder top and bottom

9.1 The top of the cylinder [see Figure 1(a)] shall have a radius of curvature not exceeding three-quarters of the nominal diameter of its body. The height of the top, excluding any spinning location recess, shall comply with the dimensions given in Table 3. The top curve shall be blended, by means of a radius between 25 mm and 50 mm, to form a straight portion to meet the body.

Table 3 — Maximum height of cylinder top

External diameter *A* (see Table 1)	**Maximum height dimension *X*** [see Figure 1(a)]
mm	mm
400	125
450	140
500	150

9.2 The bottom of the cylinder shall have a radius of curvature not exceeding three-quarters of the nominal diameter of its body.

The radius at, and adjacent to, the flange connecting the curved end to the body shall be between 25 mm and 50 mm [see Figure 1(b)].

NOTE It is permissible to join the two radii at the bottom of the cylinder with a straight section.

Where the flange is extended to remove the brazed seam from the curved portion, the minimum diameter of the curved portion and the maximum upstand of the flange shall be as shown in Figure 1(c).

10 Screwed connections for pipes

Cylinders shall be fitted with four screwed connections for pipes which shall be in the positions and of the type shown in Figure 2. The sizes of these connections shall be as shown in Table 1.

NOTE The height of primary flow connection *M* is not specified as it is dependent on the design of the primary heater. [See also Appendix A, item j).]

Threads shall comply with the following requirements.

a) *External threads*. Class B in accordance with Table 3M of BS 2779:1973 with a length of threaded portion of not less than 13 mm.

b) *Internal threads*. In accordance with Table 4M of BS 2779:1973 with a length of threaded portion of not less than 11 mm.

The minimum thickness of metal below the root of any thread with the exclusion of one pitch from the free end shall be not less than 0.7 mm.

These connections shall be parallel threaded for use with fittings complying with BS 864-2. Taper thread attachments shall not be used.

Connections which are attached by mechanical means shall be capable of withstanding an applied torque of 50 N m in both directions without rotating or distorting.

The connection in the top of a cylinder shall be housed in a projection in such a way as to prevent the formation of an air pocket.

11 Optional features

11.1 General. The cylinder shall be supplied without any of the permissible optional features specified in **11.2** to **11.6**, unless otherwise specified by the purchaser in accordance with Appendix A.

11.2 Screwed bosses for draining taps. The connection shall be threaded internally with a G½ internal thread complying with Table 4M of BS 2779:1973. The length of threaded portion shall be not less than 11 mm and the thickness of metal below the root of the thread, with the exclusion of one pitch from the free end, shall be not less than 0.7 mm. The connection shall be located as shown in Figure 3.

11.3 Fixing provision for combined immersion heaters and thermostats. Connections shall be threaded internally with a G2¼ thread, complying with Table 4M of BS 2779:1973, and the length of threaded portion shall be between 13 mm and 15 mm. The thickness of metal below the root of the thread, with the exclusion of one pitch from the free end, shall be not less than 0.7 mm.

The connection for an immersion heater shall be fitted at a minimum distance of 25 mm from the centre connection as shown in Figure 2 or Figure 3 in such a way as to minimize the formation of an air pocket. It shall be possible to fit an immersion heater complying with BS 3456-2.21 and of length $B - 200$ mm, where B is the external height over the dome, without it touching any part of the cylinder wall, cylinder bottom or primary heater.

NOTE 1 It is recommended that any connections for immersion heaters should be fitted during manufacture of the cylinders and not subsequently. If not required immediately they may be temporarily blanked off.
NOTE 2 Attention is directed to the fact that, with the top entry method of mounting, the quantity of water heated is dependent upon the length of the immersion heater and integral thermostat.

11.4 Fixing provision for a gas circulator. The connection for a gas circulator shall be in accordance with the recommendations given in BS 5546.

NOTE It is advisable that any connections for gas circulators should be fitted during manufacture of the units and not subsequently. If not required immediately they should be blanked off. Any gas circulator should be supported in such a manner that no distortion occurs in the wall of the cylinder to which it is fitted.

11.5 Factory insulated cylinders. Cylinders of type references 7 to 14 supplied with factory applied insulation shall have a heat loss not exceeding 1 W/L of capacity when tested in accordance with one of the methods described in Appendix B, as appropriate.

Cylinders of type references 0 to 6 supplied factory insulated shall have a thickness of insulation not less than that required for a cylinder of type reference 7 insulated with the same material to comply with the requirement specified in the previous paragraph.

The insulating material shall not contain substances which encourage pests or support the growth of fungi and shall be free from objectionable odours and noxious fumes at the temperatures at which it is to be used. It shall not suffer permanent deterioration under conditions of use including temperatures up to 100 °C. It shall not cause corrosion of the surfaces to which it is applied nor to adjacent surfaces, surroundings and fittings under site and usage conditions.

When tested in accordance with BS 4735, a test sample of insulating material that is applied in the form of a homogeneous coating (e.g. a sprayed-on foam), measuring 150 mm × 50 mm × 13 mm, shall have a spread of flame not greater than 125 mm or a test sample of this insulating material shall be designated non-combustible when tested in accordance with BS 476-4.

In the case of insulation in the form of a fill, including foam, enclosed by a rigid or flexible cover (e.g. a factory fitted jacket), the following requirements shall be complied with.

a) The fill shall be designated either non-combustible when tested in accordance with BS 476-4 or of limited combustibility when tested in accordance with BS 476-11.

b) The cover shall have a spread of flame either not greater than 76 mm when tested in accordance with BS 2782:Method 140D or not greater than 125 mm when tested in accordance with BS 4735.

NOTE The test method described in BS 4735 is used in this standard primarily for the purpose of monitoring the consistency of production of insulation material. In no circumstances should the test results thus obtained be considered as an overall indication of the potential fire hazard presented by the insulation under actual conditions of use.

11.6 Aluminium protector rods. Protector rods shall have a minimum surface area of exposed aluminium as given in Table 4.

Table 4 — Minimum surface area of protector rods

Minimum area of exposed aluminium	Diameter of cylinder
m^2	mm
0.018	400
0.021	450
0.025	500

NOTE 0.022 m^2 is the surface area of a 1 m length of 7 mm diameter rod.

Protector rods shall be of a form which provides an exposed surface of aluminium all round the cylinder at a distance of between 50 mm and 100 mm from both the cylinder wall and the lowest part of the bottom. No exposed aluminium shall be within 25 mm of any copper surface. The protector rod shall be attached to the cylinder by means of a copper connecting piece brazed to the bottom of the cylinder. The junction between the aluminium protector rod and the copper connecting piece shall be shielded by a sleeve of electrical insulating material which shall prevent free access of water to the joint. The surface of the aluminium shall be clean and free from grease.

NOTE 1 An example of protector rod construction and fixing is shown in Figure 4.
NOTE 2 Since it is the base and lower part of the cylinder wall that are most susceptible to pitting corrosion it is normally necessary only to fit a protector rod near the base.

12 Tests

NOTE If check tests are made after delivery the appropriate test pressure specified in Table 1 should not be exceeded. It should be applied by means other than through a direct connection to a water main, as the pressure in the latter may not remain constant during the test and may be excessive.

12.1 Primary heaters. Before assembly in the cylinders the primary heaters shall be subjected to a test pressure of 0.1 bar. The pressure shall be applied internally, either hydraulically for a period of not less than 5 min or pneumatically for a period of not less than 2 min.

The primary heater shall not show any leak or any significant distortion as a result of this test.

12.2 Complete cylinders. After complete assembly each cylinder shall be tested by subjecting it to an internal pressure equal to that specified in Table 1 either hydraulically for a period of not less than 5 min or pneumatically for a period of not less than 2 min.

The cylinder shall not show any leak or any significant distortion as a result of this test.

12.3 Test for isolation of primary and secondary water. When tested in accordance with Appendix C, the cylinder shall show no sign of mixing of primary and secondary water.

13 Marking

13.1 Permanent marking. Every cylinder shall be permanently and clearly marked, by stamping, embossing or etching on the body of the cylinder or on a copper or brass plate soldered to the body of the cylinder, with the following information:

a) the number and date of this British Standard[3)], followed by the type of primary heater, the BS type reference, grade and heater class, e.g. BS 1566:1984, SF, C, Ref. 3, grade 2, class 180;

b) the manufacturer's name or identification mark.

For cylinders supplied with factory applied insulation, marking shall be applied to the body of the cylinder as detailed above. The location of the marking shall be indicated by repeating the marking in indelible ink on the outside of the insulation, by means of a label firmly adhering to the insulation.

13.2 Other marking. The following additional marking in indelible ink shall be applied by means of a label firmly adhering to the insulation or cylinder:

a) the words "single feed indirect cylinder";

b) the words "cylinder to be fixed in vertical position only";

c) the maximum permissible working head of the cylinder in metres;

d) the storage capacity in litres;

e) the maximum permissible quantity of primary water;

f) the water content of the primary heater;

g) the maximum length of immersion heater that the cylinder is designed to accept;

h) the location for an immersion heater connection when not fitted at the time of manufacture (see clause **11**);

i) the area of heating surface of the primary heater;

j) fitted with aluminium protector rod, when so ordered (see Appendix A).

[3)] Marking BS 1566-2:1984 on or in relation to a product is a claim by the manufacturer that the product has been manufactured to the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, Quality Assurance Division, BSI, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ for certification marks administered by BSI or to the appropriate authority for other certification marks.

Appendix A Information to be supplied by the purchaser with any enquiry or order

When enquiring about or ordering cylinders to comply with this British Standard, the purchaser should provide the manufacturer with the following information:

a) the number of this British Standard, i.e. BS 1566-2;

b) British Standard type reference, e.g. Ref. 3, Ref. 5, (see Table 1);

c) grade of cylinder, e.g. grade 2, 3 or 4 (see Table 1);

d) the working head;

e) the class of primary heater required, i.e. class 110 or class 180 (see **4.1**);

f) whether accommodation for an electric immersion heater or a gas circulator is required and, if so, the form and position it should take (see clause **11**);

g) whether accommodation for a draining tap is required (see clause **11**);

h) whether factory applied insulation is required (see clause **11**);

i) whether a protector rod is required (see clause **11**);

j) number, position and size of any screwed connections if not as specified in clause **10**.

Appendix B Performance tests to determine the standing heat losses from factory insulated cylinders

B.1 Test apparatus

B.1.1 Fit the cylinder to be tested with a thermostatically controlled 3 kW immersion heater that complies with BS 3456-2.21. A top entry heater position shall be used and the heater length shall be not less than $B - 215$ mm, where B is the external height over the dome (see Table 1 and Figure 2).

Supply cold water to the cylinder from a cold water storage cistern, situated at least 600 mm above the top of the cylinder, by means of 22 mm copper pipe running vertically between the two vessels and at least 100 mm from the surface of the cylinder. Connect this pipe to a low level screwed connection via a T-piece. Insert a 22 mm copper vent pipe in the highest point of the cylinder so that it travels vertically for at least 100 mm before travelling diagonally to clear the cold water storage cistern and terminating with the outlet directly over this cistern so as to allow venting into the storage tank. Fit blanking-off caps to the primary heater connections. A suitable arrangement is shown in Figure 6.

B.1.2 Support the cylinder on a suitable solid wooden base in a draught free position and protect it from direct radiation or changes in temperature so that the ambient temperature is maintained at 20 ± 2 °C during the period of the test.

B.1.3 Position three thermocouples 700 mm to 1 000 mm from the cylinder at heights approximately level with the top, middle and 150 mm from the base and not closer than 500 mm to any wall and connect to a temperature recorder.

B.1.4 Attach a thermocouple to the copper surface of the cylinder at a height of 2/3 B from the cylinder base and connect to a temperature recorder.

Measure all temperatures to an accuracy of 0.5 °C.

B.2 Test procedure

B.2.1 Fill the test apparatus with water, switch on the immersion heater and adjust the thermostat to give a water temperature of 70 ± 2 °C, at the thermocouple position.

B.2.2 Determine the standing heat losses over successive 24 h test periods as follows. After a stabilization period of at least 24 h, confirmed by consistent water temperature readings, record an initial kilowatt hour meter reading to the nearest 0.01 kW·h.

Record subsequent meter readings, to the nearest 0.01 kW·h, at 24 h intervals and determine the energy consumption (E_1, E_2, etc.) for each 24 h test period by subtraction. Calculate the mean ambient temperature and mean hot water temperature, by taking the arithmetic mean of the continuous temperature readings from the thermocouples described in **B.1.3** and **B.1.4** respectively for each corresponding 24 h test period (T_{W1}, T_{W2}, etc. and T_{A1}, T_{A2}, etc.).

Continue the test until the standing heat loss as calculated in **B.3** is within 2 % for at least two successive 24 h periods. The standing heat loss shall be taken as the mean of these results. If it is not possible to achieve a variation of less than 2 % between results continue the test over a period of at least 168 h and record the mean of the results for the last three 24 h periods.

B.3 Calculation of results. Calculate the heat loss for each test period in watts per litre of cylinder capacity, corrected for a 50 °C differential between hot water and ambient temperatures as follows:

$$\text{Heat loss} = \left(\frac{1000E}{24C}\right)\left(\frac{50}{T_W - T_A}\right)$$

where

C is the cylinder notional capacity (in L) as given in Table 1, column 4 of BS 699:1984 for the appropriate type reference[a];

E is the energy consumed in 24 h test period (in kW·h);

T_W is the mean water temperature over 24 h test period (in °C);

T_A is the mean ambient temperature over 24 h test period (in °C).

[a] To standardize the insulation thickness requirement for cylinders of both direct and indirect types the capacity of all types should be considered to be for direct cylinders shown in Table 1 of BS 699:1984.

B.4 Alternative method of test using a differential thermostatic controller

B.4.1 *Test apparatus*

B.4.1.1 Test apparatus shall be as described in **B.1.1**, except that a thermostatic controller is used to replace the immersion heater thermostat.

B.4.1.2 Support the cylinder on a suitable solid wooden base in a draught free position and protect it from direct radiation or changes in temperature.

B.4.1.3 Measure the ambient air temperature with a thermocouple and locate its hot junction in the geometric centre of a steel block 50 mm × 25 mm × 25 mm. Achieve this by drilling a 2 mm diameter hole, 25 mm in depth, in the centre of one 25 mm × 25 mm face. Position the metal block incorporating the thermocouple 700 mm to 1 000 mm from the cylinder at a level half way up the cylinder.

B.4.1.4 Measure the surface temperature of the cylinder by means of a thermocouple positioned with its hot junction at a height of 2/3 B from the base. Ensure that the thermocouple adheres firmly to the surface of the cylinder so that there is good thermal contact and position it under the insulation so that it indicates the true temperature at that level.

B.4.1.5 Connect the temperature sensors to a controller capable of maintaining a temperature difference of 50 ± 1 °C, between the cylinder and the ambient air. For example, this may be achieved by means of a three term controller and thermocouples.

B.4.2 *Test procedure*

B.4.2.1 Fill the test apparatus with water, set the controller to maintain a temperature differential of 50 ± 1 °C and switch on the heater.

B.4.2.2 Record kilowatt hour meter readings as described in **B.2.2**.

B.4.3 *Calculation of results.* Calculate the standing heat loss for each 24 h test period in watts per litre of cylinder capacity as follows:

$$\text{Heat loss} = \frac{1000E}{24C}$$

where

E is the energy consumed in 24 h test period (in kW·h);

C is the cylinder notional capacity (in L) (see **B.3**).

Appendix C Test for isolation of primary and secondary water

C.1 Apparatus and layout. The apparatus shall be arranged as shown in Figure 6. The single feed test cylinder A shall be connected to a cold water feed cistern and to a cylinder B provided with two 3 kW thermostatically controlled immersion heaters for heating the primary water. Cylinder B shall also be provided with a thermometer to measure the water temperature. The capacity of cylinder B shall provide in the test apparatus a primary capacity appropriate to the class of heater in the test cylinder A. For a class 110 heater, cylinder B shall be a BS 699: Ref. 2, grade 3 cylinder, and for a class 180 heater cylinder B shall be a BS 699: Ref. 9, grade 3 cylinder, in each case with an additional heater boss.

C.2 Adjustment of thermostats. Before the test is carried out, adjust the thermostats on the heaters in cylinder B so that the temperature of the primary water is maintained at 82 ± 3 °C.

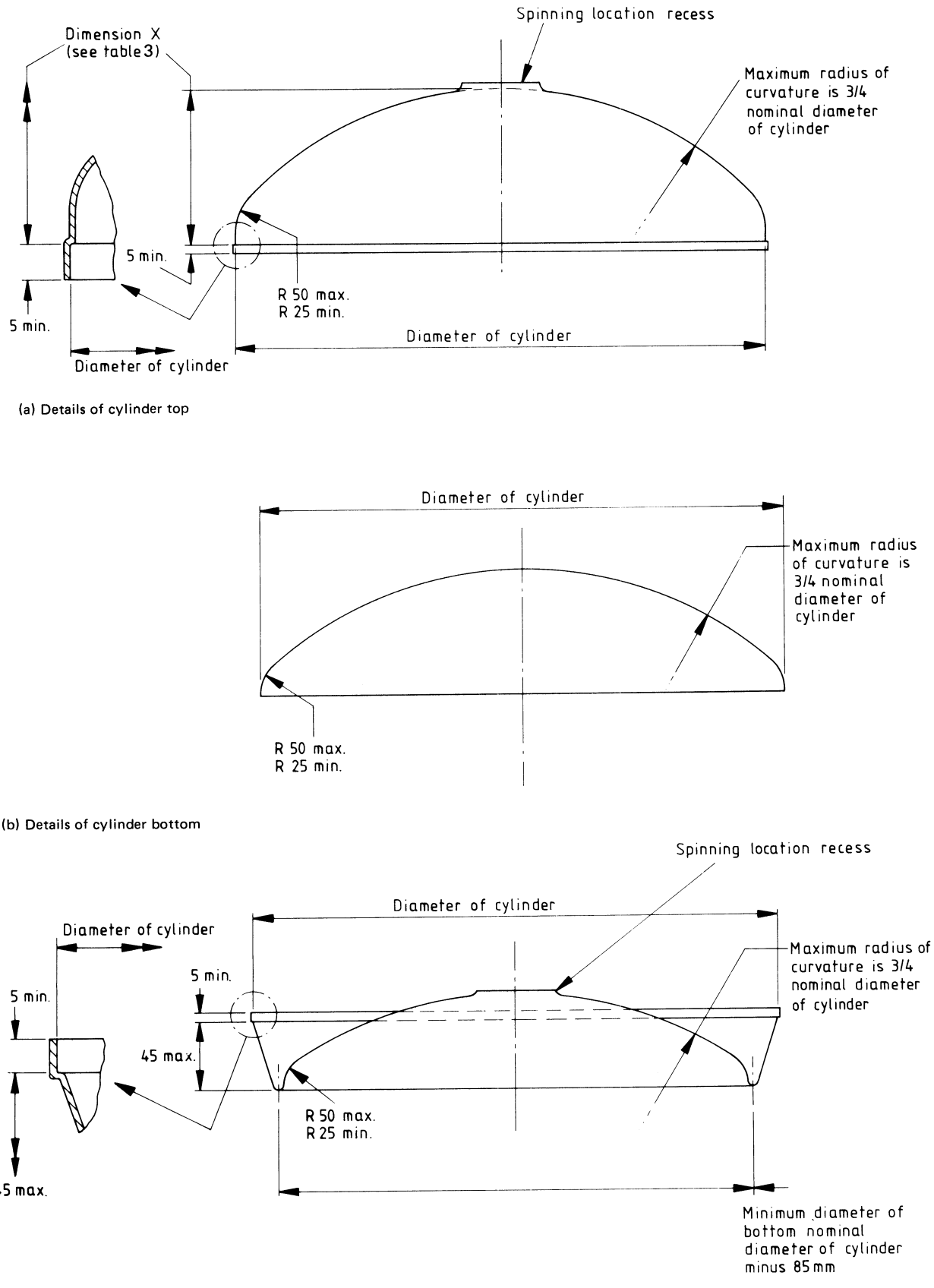
Fill the entire system with cold water from the feed cistern, close valve C and drain out the secondary water by opening draining tap D. Switch on the heaters for long enough to enable the thermostats to be adjusted so that the water temperature in the cylinder is as given in **C.1**. Switch off the heaters and drain out the primary water by opening draining tap E.

C.3 Test procedure. Open valve F and pour in approximately 10 g of fluorescein aniline dye dissolved in 0.5 L of water. Close valve F. Slowly open valve C and fill the system at a normal rate.

The feed to the float operated valve shall be direct from the water main and the temperature of the feed water shall not exceed 16 °C.

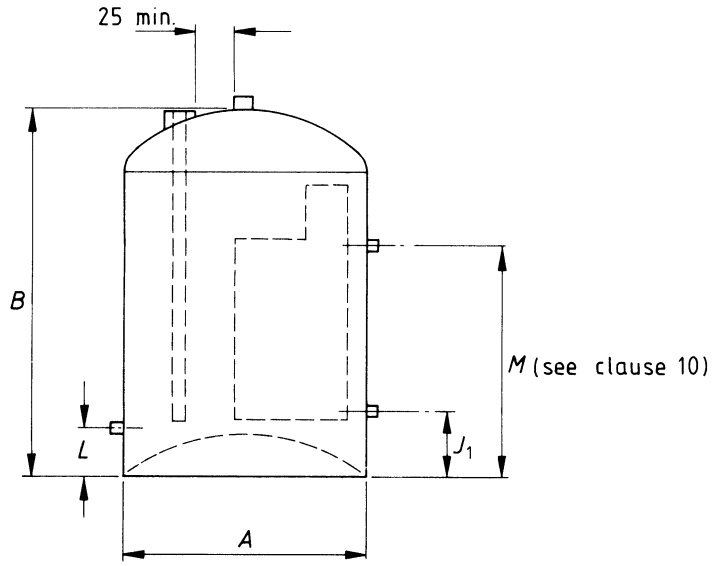
Switch on the heaters and leave in operation for 8 h. Allow the system to cool over a period of not less than 72 h. Switch on the heaters again and leave in operation for a further 8 h. Draw off a quantity of water equal to the storage capacity of the cylinder A through tap H. This water shall not show any sign of green staining.

At the end of each intermediate stage of the test it is possible to draw off, through tap H (see Figure 6) a maximum of 1 L. If this water shows any sign of green staining the test shall be abandoned.



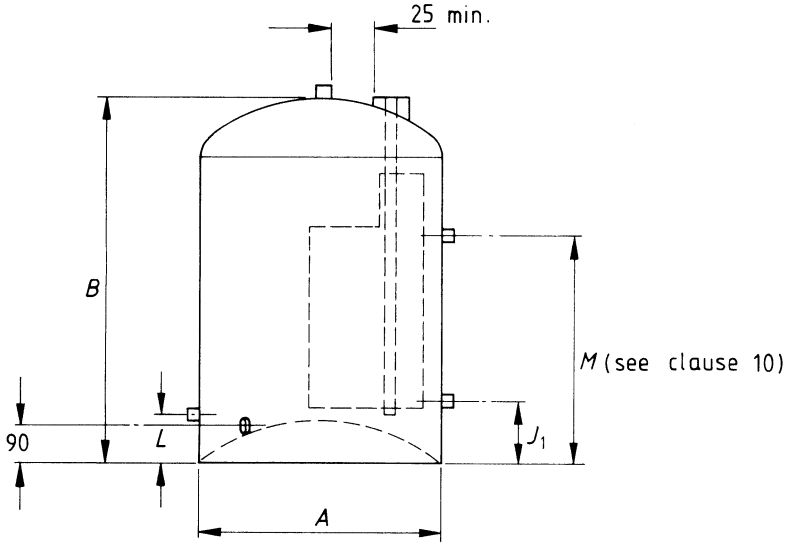
All dimensions are in millimetres.

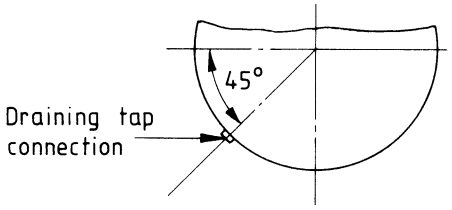
Figure 1 — Cylinder top and bottom details



Dimension is in millimetres.

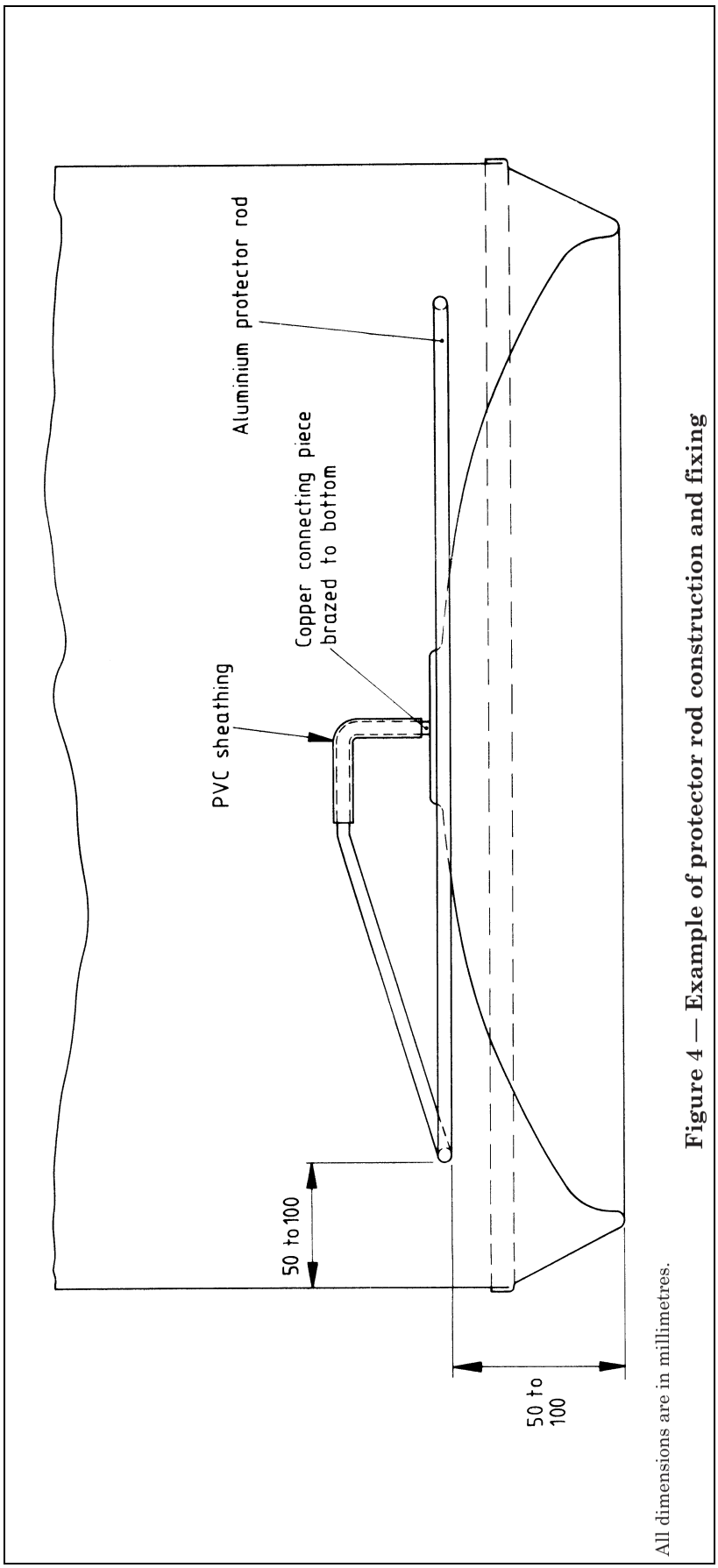
Figure 2 — Single feed indirect cylinder showing position of connections for pipes and immersion heater (see clauses **10** and **11**)





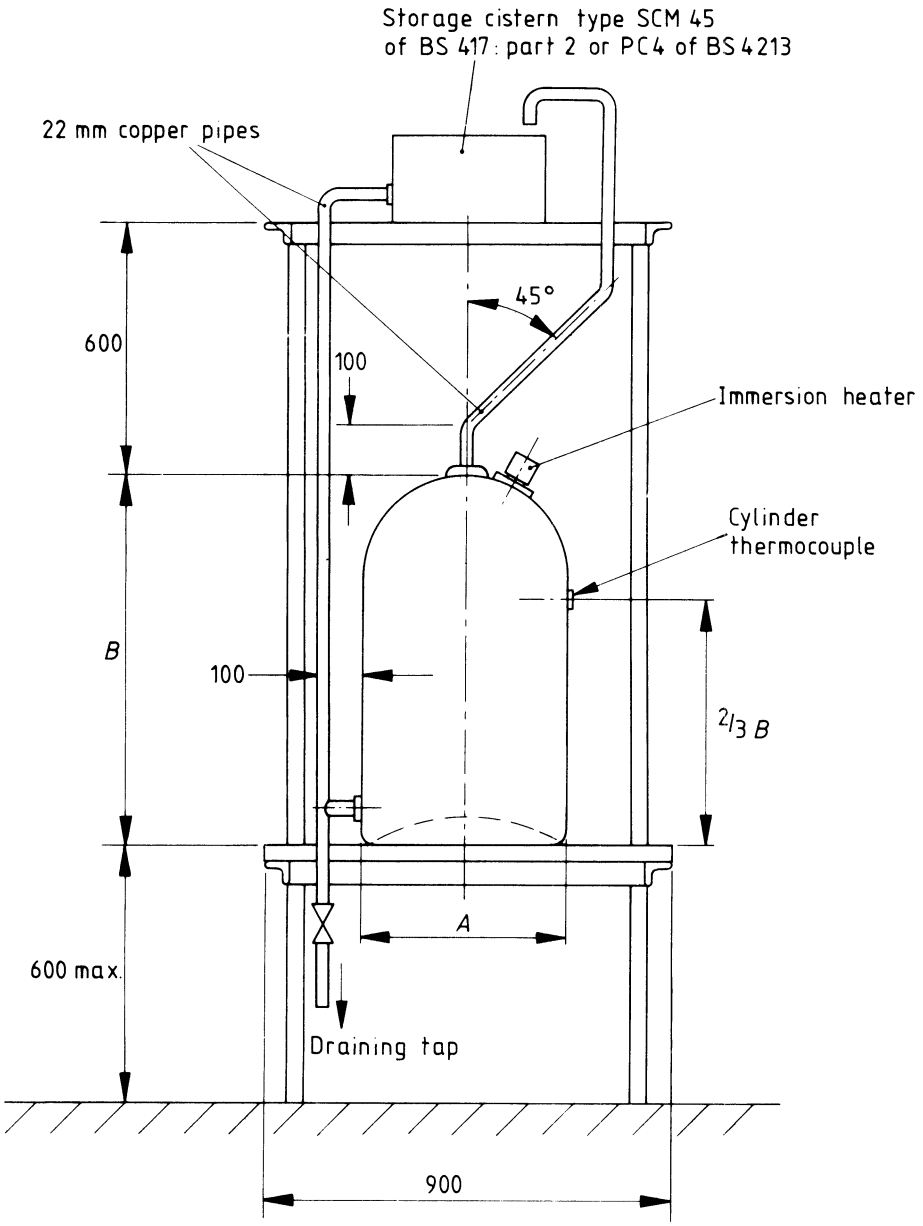
All dimensions are in millimetres.

Figure 3 — Single feed indirect cylinder showing positions of connections for pipes, draining tap and alternative position for immersion heater



All dimensions are in millimetres.

Figure 4 — Example of protector rod construction and fixing



NOTE
A is the external diameter (see Table 1);
B is the external height (see Table 1).

All dimensions are in millimetres.

Figure 5 — Apparatus for heat loss test

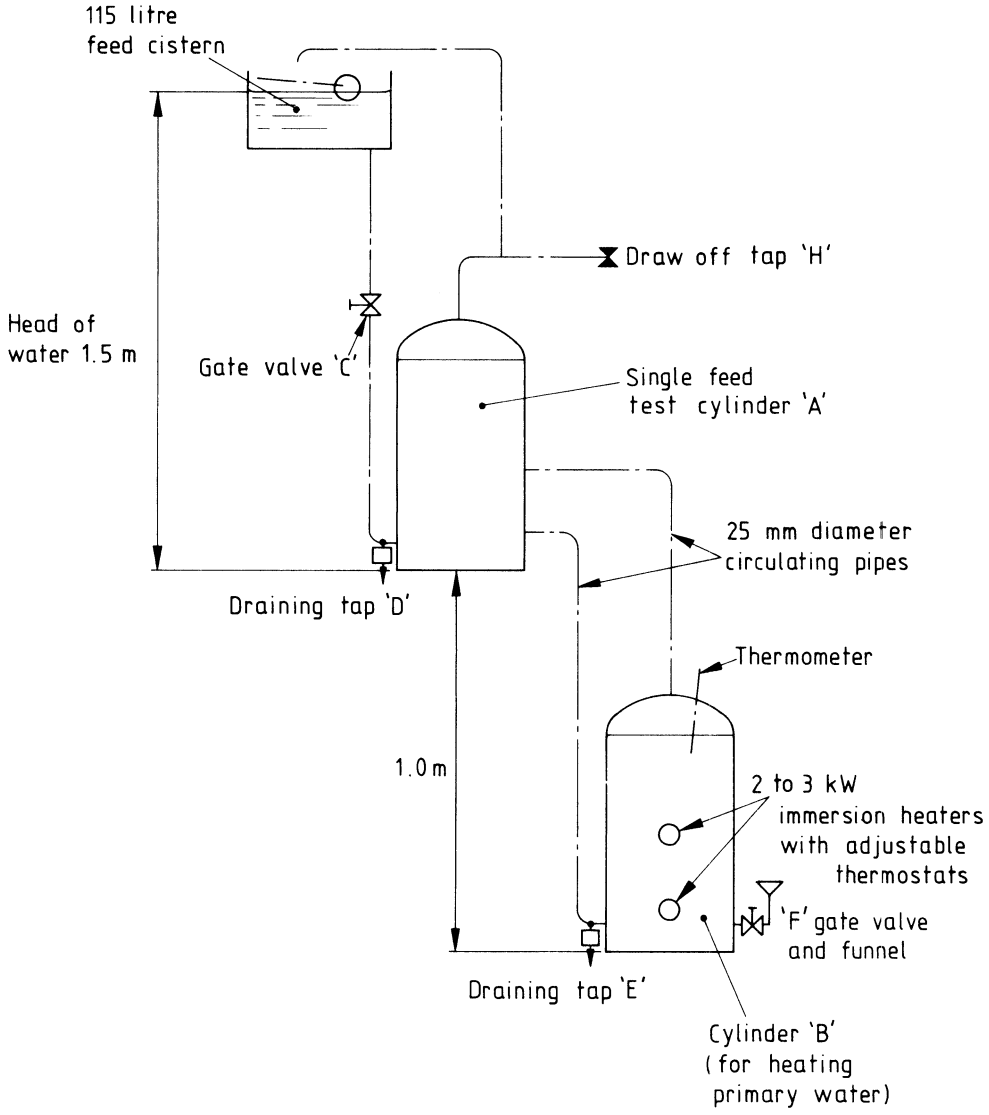


Figure 6 — Isolation testing apparatus

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Publications referred to

BS 417, *Galvanized mild steel cisterns and covers, tanks and cylinders*[4)].
BS 417-1, *Imperial units.*
BS 417-2, *Metric units.*
BS 476, *Fire tests on building materials and structures.*
BS 476-4, *Non-combustibility test for materials.*
BS 476-11, *Method for assessing the heat emission from building materials.*
BS 699, *Specification for copper direct cylinders for domestic purposes.*
BS 864, *Capillary and compression tube fittings of copper and copper alloy.*
BS 864-2, *Specification for capillary and compression fittings for copper tubes.*
BS 1475, *Wrought aluminium and aluminium alloys for general engineering purposes — wire.*
BS 1565, *Galvanized mild steel indirect cylinders, annular or saddle-back type*[4)].
BS 1565-1, *Imperial units.*
BS 1565-2, *Metric units.*
BS 1566, *Copper indirect cylinders for domestic purposes*[4)].
BS 1566-1, *Specification for double feed indirect cylinders.*
BS 1845, *Specification for filler metals for brazing.*
BS 2777, *Asbestos-cement cisterns*[4)].
BS 2779, *Pipe threads where pressure-tight joints are not made on the threads.*
BS 2782, *Methods of testing plastics.*
BS 2782:Method 140D, *Flammability of a test piece 550 mm × 35 mm of thin polyvinyl chloride sheeting (laboratory method).*
BS 2870, *Specification for rolled copper and copper alloys: sheet, strip and foil.*
BS 2871, *Copper and copper alloys. Tubes.*
BS 2871-1, *Copper tubes for water, gas and sanitation.*
BS 2901, *Filler rods and wires for gas-shielded arc welding.*
BS 2901-3, *Copper and copper alloys.*
BS 3198, *Specification for copper hot water storage combination units for domestic purposes*[4)].
BS 3456, *Specification for safety of household and similar electrical appliances.*
BS 3456-2.21, *Electric immersion heaters.*
BS 4213, *Cold water storage cisterns (polyolefin or olefin copolymer) and cistern covers*[4)].
BS 4735, *Laboratory methods of test for assessment of the horizontal burning characteristics of specimens no larger than 150 mm × 50 mm × 13 mm (nominal) of cellular plastics and cellular rubber materials when subjected to a small flame.*
BS 5546, *Code of practice for installation of gas hot water supplies for domestic purposes (2nd family gases).*
BS 5615, *Specification for insulating jackets for domestic hot water storage cylinders*[4)].

[4)] Referred to in the foreword only.

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