BRITISH STANDARD

BS 3198:1981

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Specification for

Copper hot water storage combination units for domestic purposes

UDC 696.46:683.97

Cooperating organizations

The Building Services Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

Aluminium Federation
Association of District Councils
Bath Manufacturers' Co-ordinating Committee
British Gas Corporation*
British Ironfounders' Association
British Plastics Federation
British Plumbing Employers' Council
British Precast Concrete Federation Ltd.
Builders' Merchants Federation
Building Services Research and Information Association
Chartered Institution of Building Services*
Clay Pipe Development Association Limited
Consumer Standards Advisory Committee of BSI
Convention of Scottish Local Authorities
Council of British Ceramic Sanitaryware Manufacturers
Department of Health and Social Security
Department of the Environment (PSA)*
Department of the Environment (Building Research Establishment)*
Department of the Environment (Housing and Construction)
Department of the Environment (Water Engineering Division including Water Data Unit)
Domestic Solid Fuel Appliances Approval Scheme
Environmental Health Officers' Association
Greater London Council
Heating and Ventilating Contractors' Association*
Incorporated Association of Architects and Surveyors
Institute of Plumbing*
Institution of Gas Engineers
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National Brassfoundry Association
National Coal Board
National Federation of Building Trades Employers
National Water Council*
Royal Institute of British Architects*
Royal Institution of Chartered Surveyors
Royal Society of Health
Scottish Development Department
Trades Union Congress
Water Companies Association

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the Technical Committee entrusted with the preparation of this British Standard:

Association of Manufacturers of Domestic Electrical Appliances
British Non-ferrous Metals Federation
Copper Cylinder and Boiler Manufacturers
Copper Development Association
Copper Tube Fitting Manufacturers' Association
Electricity, Supply Industry in England and Wales
Galvanizers' Association
Institute of Building
London Boroughs Association
Manufacturers' Association of Radiators and Convectors Ltd.
Royal Institute of Public Health and Hygiene
Solid Fuel Advisory Service
Thames Water Authority Metropolitan Water Division
Zinc Development Association
Individual expert

This British Standard, having been prepared under the direction of the Building Services Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 December 1981

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4372	July 1984	
6599	September 1990	Indicated by a sideline in the margin

Contents

Foreword

This British Standard has been prepared under the authority of the Building Services Standards Committee. It has been revised in terms of metric units and now provides details of the essential requirements for hot water storage units, in capacities between 65 litres and 180 litres, of a type which incorporates a cold water feed cistern. These appliances, known as "combination units", are designed for use with water heating appliances which are connected by pipework, but provision can also be made to use either an electric immersion heater or gas circulator fitted to the unit itself either as an auxiliary or as the sole method of heating. An "indirect" type of combination unit is intended for service where it is essential that the circulating water is kept separate from the domestic hot water. There is provision for both single feed and double feed indirect types. Single feed indirect units should not be used in sealed systems and they have limited application on direct pump circulation.

There has been general rationalization to align the standard with BS 699 and BS 1566-1 and BS 1566-2, which include a specification for area of heating surfaces of primary heaters and revised performance tests.

Appendix F gives a list of information that should be supplied by the purchaser with an enquiry or order.

The drafting committee is considering the question of the requirement in clause **5** of measuring thickness of copper sheet before forming, and it is the intention to deal with this matter in the revision of BS 699 and BS 1566-1 and BS 1566-2. When this matter is resolved, it is intended to issue an amendment to this standard.

The requirements specified in this standard are those considered to be necessary to ensure good performance and reliability of the appliance whilst leaving the manufacturers free to develop actual design, and for this reason, careful consideration has been given to the inclusion of requirements for materials, construction and performance tests rather than to dimensions, which have been omitted as far as possible.

The inclusion of integral plastics cold feed cisterns was considered but it was decided to omit reference to these. This matter will be kept under review.

The following is a list of standards covering water storage vessels, mainly for domestic use, to which others may be added when considered necessary.

BS 417, *Galvanized mild steel cisterns and covers, tanks and cylinders.*

BS 417-1, *Imperial units.*

BS 417-2, *Metric units.*

BS 699, *Copper cylinders for domestic purposes.*

BS 1565, *Galvanized mild steel indirect cylinders, annular or saddle-back type.*

BS 1565-1, *Imperial units.*

BS 1565-2, *Metric units.*

BS 1566, *Copper indirect cylinders for domestic purposes.*

BS 1566-1, *Double feed indirect cylinders.*

BS 1566-2, *Single feed indirect cylinders.*

BS 2777, *Asbestos-cement cisterns.*

BS 4213, *Cold water storage cisterns (polyolefin or olefin copolymer) and cistern covers.*

This revised British Standard supersedes BS 3198:1960 which is now withdrawn. Since manufacturers will require time to change existing procedures for testing, certification to BS 3198:1960 will remain valid until 31 March 1982.

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 British Standard specifies requirements for direct, double feed indirect and single feed indirect types of combination hot water storage units having hot water storage capacities in a series of ranges between 65 litres and 210 litres, in which, when water is drawn off from the hot water storage vessel, there is automatically:

a) replacement of water withdrawn by that from a cold water feed cistern incorporated in the unit and adjacent to the hot water vessel; and

b) controlled replacement of the water in the cold water feed cistern from the water supply by means of a float operated valve.

NOTE The preferred hot water storage capacities are 85, 115, 130, 140, 150, 180 and 210 litres.

2 References

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

3 Definitions

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

3.1
feed cistern

the cistern, attached to the hot water storage vessel, for supplying cold water to that vessel to replace the hot water as it is drawn off

3.2
primary feed and expansion cistern

the cistern for supplying water to the primary circuit and for accommodating the expansion of water therefrom

3.3
hot water storage vessel

the container in which the heated water is stored

3.4
hot water storage capacity

the actual volume of secondary water which can be stored in the hot water storage vessel

3.5
inter-connection

the arrangements for connecting the feed cistern and hot water storage vessel by means of which there takes place an adequate flow of cold water from the feed cistern into the storage vessel to replace the hot water as it is drawn off

3.6
warning pipe

an overflow pipe so fixed that its outlet, whether inside or outside a building, is in a conspicuous position where the discharge of any water therefrom can be readily seen

3.7
combination hot water storage unit

a) *Direct type.* A hot water storage vessel which has provision for an immersion heater or which can be coupled by pipework to an external water heating appliance and to which cold water is fed from an attached feed cistern.

b) *Double feed indirect type.* A hot water storage vessel similar to the direct type except that the stored water is heated indirectly by the water circulating in an integral primary heater. This type requires an additional cistern open to atmosphere from which the feed is taken to the primary circuit and into which the primary circuit is vented. The increase in volume of primary water due to expansion is accommodated in this primary feed and expansion cistern which may be incorporated in the combination unit.

c) *Single feed indirect type.* A hot water storage vessel similar to the direct type except that the stored water is heated indirectly by the water circulating in an integral primary heater but the primary feed and venting arrangement is an integral part of the primary heater within the hot water section of the combination unit. The increase in volume of the primary water due to expansion is accommodated within the primary heater and is prevented from coming into contact with the secondary water.

3.8
primary heater

a heat exchanger mounted inside a hot water storage vessel for the transfer of heat to the stored water from circulating primary hot water

3.9
primary water

the water in the primary circuit including the water in the primary heater, boiler, radiators, pipework, and associated fittings

3.10
primary capacity

the total volume of primary water

3.11
secondary water

the water that can be drawn off for use

3.12
screwed connection

any threaded connection to which pipes or apparatus can be fitted

3.13
length of threaded portion (of screwed connection)

the distance from the front face of the connection (including any chamfer or radius) to either the leading face of a plug or screw ring gauge, 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 of the connection

3.14
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

4 Designation of copper combination units for ordering purposes

For ordering purposes copper combination units shall be designated BS 3198 followed by the shape, i.e. cylindrical, rectangular, etc., the type and the capacity in litres as follows:

DIR direct;

DF double feed indirect;

SF single feed indirect.

For example, BS 3198: Rectangular: DF:115.

The information needed to be supplied with an enquiry or order is set out in Appendix F.

5 Materials

Units shall be constructed from copper sheet complying with section 8 of BS 2870:1980. The minimum nominal thicknesses before forming shall be shown in Table 1.

On cylindrical units the cold cistern shall be reinforced by the inclusion of a swage in the body of the cistern at the water line (see **7.2**).

NOTE Thicker copper sheet may be necessary for certain units to ensure that permanent distortion does not occur on filling (see **13.1**).

Where the copper is pressed, spun, swaged or manipulated to form a seam, the thickness after forming shall be not less than 67 % of that specified for sides in Table 1.

NOTE In this calculation the values specified are not subject to the tolerances allowed in BS 2870.

The thickness other than in the area of forming shall not be less than the minimum nominal thickness before forming specified in Table 1.

The primary heater shall be constructed from one of the following:

a) 28 mm size copper tube complying with the requirements of BS 2871-1 but in suitable temper for forming; or

b) copper sheet as specified in Table 1; or

c) a combination of the sheet and tube specified in a) and b).

Copper tube for other purposes shall comply with the requirements of BS 2871-1 but where appropriate, before forming, it shall have been in a suitable temper for forming.

Table 1 — Minimum nominal thickness of copper sheet before forming

Component	Type	Capacity	Thickness, mm		
			Sides	Top	Bottom
Hot water vessel	Cylindrical	up to 145 L over 145 L	0.55 0.7	0.6 0.7	0.9 0.9
	Non-cylindrical	All capacities	0.7	0.55	0.9
Feed cistern	Cylindrical	up to 145 L over 145 L	0.55 0.7	— —	0.6 0.7
	Non-cylindrical	up to 45 L over 45 L	0.55 0.7	— —	0.55 0.7
Integral primary feed and expansion cistern			0.55	0.55	0.55
Primary heater			0.55	0.55	0.55

Screwed connections shall be made of copper, gunmetal or alpha brass (inhibited against dezincification) and shall be attached to the vessel either by brazing, welding or mechanical means. Filler alloys for brazing shall comply with the requirements of 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 comply with the requirements of type C1 of BS 1453, or types C7, C8, C9 and C21 of BS 2901-3.

Every float operated valve shall comply with the requirements of BS 1212-1 or BS 1212-2. Any non-metallic materials shall not, under the expected usual conditions of use for which the unit is designed, impart to the water with which they will come into contact unpleasant taste or odour, any cloudiness or discoloration, or any toxic or undesirable substances.

NOTE 1 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)]".

NOTE 2 Attention is drawn to the fact that, while not covered by this British Standard, aluminium protector rods are available, which may be fitted to a copper unit during manufacture and which will ensure longer service under the extreme conditions that have been known to cause premature failure of a very small proportion of units in certain known water supply areas. When required, aluminium protector rods need to be specified at the time of ordering.

Leaflet MP 538 (revised) published by the BNF Metals Technology Centre, Grove Laboratories, Denchworth Road, Wantage, Oxfordshire OX12 9BJ gives further information.

6 Primary heaters

6.1 Double feed indirect type. Where the primary feed and expansion cistern is not an integral part of the combination unit the primary heater shall be made from 28 mm size copper tube. The minimum area of heating surface shall be as specified in Table 2.

NOTE This type of combination unit is suitable for a maximum working pressure of 3.5 bar[2)].

Where the primary feed and expansion cistern is an integral part of the combination unit the primary heater shall be constructed from 28 mm size copper tube, from copper sheet or from a combination of both. The minimum area of heating surface shall be as specified in Table 2.

The primary feed and expansion cistern shall be capable of containing the expansion from systems having a primary capacity of 115 litres.

6.2 Single feed indirect type

6.2.1 *Primary capacity.* The primary heater shall be suitable for a system having a primary capacity of 110 litres.

6.2.2 *Dimensions.* The minimum area of heating surface shall be as specified in Table 2.

7 Manufacture

7.1 General. As far as is practicable, after manufacture, the copper forming the combination unit shall be in the work-hardened condition. 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 with adequate penetration;

c) butt welting.

Table 2 — Minimum area of heating surface of primary heater

Hot water storage capacity		Minimum area of heating surface of primary heater	
Range	Preferred size	Coil type	Sheet or combined sheet and tube type
litre	litre	m^2	m^2
65 to 90	85	0.33	0.50
90.1 to 115	115	0.43	0.65
115.1 to 130	130	0.48	0.72
130.1 to 140	140	0.52	0.78
140.1 to 150	150	0.56	0.84
150.1 to 180	180	0.66	0.99
180.1 to 210	210	0.66	0.99

NOTE For sizes up to 180 litres, in a suitably designed system, heaters complying with the requirements of Table 2 are capable of giving a heat-up period of 1 h for gravity circulated systems and 30 min for pumped systems.

7.2 Hot water storage vessel. The hot water storage vessel shall either be totally enclosed or have an open top with a loose fitting lid which shall comply with the requirements of **7.4**.

NOTE It may be necessary in the case of rectangular vessels for the sides to be stayed or otherwise supported to prevent undue distortion in the finished unit.

If the body of a cylindrical combination unit is swaged, the swages shall be rounded and not sharp edged. For direct type units and indirect type units not having a heat source with thermostatic control, primary circulation connections to the vessel shall be so arranged as to enable circulation to take place below the draw-off level.

[1)] This publication can be obtained from the National Water Council, Fittings Testing Station, The Causeway, Staines, Middlesex.

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

7.3 Feed cistern and method of attachment to hot water storage vessel. The feed cistern shall be of a size and shape sufficient to allow satisfactory operation of the float operated valve and shall accommodate expansion from the hot water vessel without discharge via the warning pipe. It shall be attached to the top or the side of the hot water storage vessel in a manner such as to give the performance specified in **13.2**. The feed cistern and hot water storage vessel shall be insulated from each other if necessary in order to satisfy this requirement. Where any casing does not provide adequate support, the top edge of the feed cistern shall be stiffened by hollow beading or by being wired with a non-ferrous corrosion resistant material.

7.4 Lid. The feed cistern shall be provided with a lid which is rigid and effectively excludes light. The lid shall be so designed that it is loose fitting and cannot be readily dislodged and it shall extend beyond the outside of the cistern aperture and be so designed as to prevent the ingress of any substance which could adversely affect the quality of the stored water. The lid shall be of a corrosion resistant material and shall not adversely affect any component with which it comes in contact. The material of which the lid is made shall not be liable to fragment. The material on the underside of the lid shall not affect adversely the quality of any condensate which forms thereon.

7.5 Interconnection. The interconnection supplying the make-up water from the feed cistern to the hot water storage vessel shall have a cross-sectional area of not less than 285 mm throughout, and can also act as an expansion outlet from the hot water storage vessel. The outlet from the feed cistern to the hot water storage vessel shall be not less than 25 mm above the bottom of the feed cistern. Provision shall be made for free venting of air at the initial filling stage and also under all subsequent operating conditions. Where the hot water storage vessel is enclosed, venting shall be provided by means of either a single copper tube not less than 22 mm nominal size or two copper tubes each not less than 15 mm nominal size attached to the hot water storage vessel in such a way as to release any trapped air in the top of the vessel, and attached to the feed cistern or positioned so that any discharge is directed into the cistern, clear of the float operated valve and the float.

Where the feed of the primary circuit is integral with the unit, the nominal size of the tube shall be not less than 15 mm for the primary feed pipe and not less than 22 mm for the vent pipe.

7.6 Provision of float operated valve, warning pipe and water level marking. If a float operated valve is supplied, it shall comply with the requirements of either Part 1 or Part 2 of BS 1212, and be fitted with a float complying with the requirements of either BS 2456 or class C of BS 1968, and shall be securely and rigidly fixed to the feed cistern.

If a feed cistern is supplied with a connector for the fitting of a warning pipe, such a connector shall have a waterway greater than the internal diameter of the inlet pipe and in no case shall it be less than 19 mm[3)].

A water line shall be clearly and permanently marked on the inside of the feed cistern, preferably by a swage mark embossed on the cistern wall. This line is for setting the water level at which the float operated valve shuts off when the apparatus is cold.

The relative levels of the float operated valve, warning pipe and water line marking with regard to the feed cistern shall be as follows.

a) The float operated valve shall be fitted in such a position that it discharges at a level higher than the overflowing level of the warning pipe, by not less than the internal diameter of the said warning pipe.

b) The overflowing level of the warning pipe shall be not less than 65 mm below the spill-over level of the feed cistern.

c) The water line marking shall be at least 115 mm[4)] below the spill-over level and at such a level that when the apparatus is tested in accordance with Appendix B or Appendix C, the highest level the water can reach, when expanded, is 25 mm[5)] below the overflowing level of the warning pipe.

7.7 Insulation. A combination unit supplied by the manufacturer with insulation as an integral part of the unit, shall have insulating material of a type and thickness to give a heat loss not greater than 1 W/litre of the hot water storage capacity, when tested in accordance with the method given in Appendix E, at a stored water temperature of 60 °C.

[3)] The corresponding requirement in Scotland is that the internal diameter of the warning pipe shall be not less than twice the internal diameter of the inlet pipe and in no case shall it be less than 32 mm.

[4)] The corresponding requirement in Scotland is 122 mm.

[5)] The corresponding requirement in Scotland is 35 mm.

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.

The insulating material shall comply with either of the following requirements:

a) it shall be designated non-combustible when tested in accordance with BS 476-4; or

b) when tested in accordance with BS 4735, a test specimen of 150 mm × 50 mm × 13 mm exposed to a small flame shall show an extent of burn less than 125 mm.

NOTE The test method described in BS 4735 is used in this standard primarily for the purpose of monitoring the consistency of production of the rigid urethane and isocyanurate foam. Its use indicates that the formulation is suitable. In no circumstances should the test results thus obtained be considered as an overall indication of the potential fire hazard presented by the foam under actual conditions of use.

8 Hand holes

Any cistern and open top unit which is more than 1 140 mm high and less than 350 mm wide shall be provided with a hand hole and cover so that it may be cleaned internally.

If required, a cistern and open top unit of dimensions less than 1 140 mm high and/or more than 350 mm wide shall be provided with a hand hole and cover.

The hand hole shall be either circular of diameter not less than 100 mm, or elliptical of area not less than 7 850 mm^2, and having major and minor axes not greater than 125 mm or less than 75 mm respectively. The hand hole shall be so positioned that its edge is not less than 25 mm from any change in plane of the surface of the cistern or unit; subject to this, the centre of the hole shall be not more than 125 mm above the lowest horizontal internal surface of the cistern or unit.

9 Screwed bosses for draining taps

A drain off boss, having a G½ internal thread complying with the requirements of BS 2779, shall be fitted on the hot water storage vessel and shall be located to ensure satisfactory draining of the vessel and operation of the draining tap.

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.

10 Screwed connections for pipes

10.1 Connections shall comply with the requirements of either **10.2** or **10.3**. Taper thread attachments shall not be used.

10.2 Connections shall be threaded internally or externally as follows:

a) internal threads shall comply with the requirements of Table 4M of BS 2779:1973 and shall have a threaded portion of not less than 11 mm;

b) external threads shall comply with the requirements of Table 3M class B of BS 2779:1973, and shall have a threaded portion of not less than 13 mm.

The minimum sizes of flow and return connections shall be either G1 for internal threads or G1B for external threads if not intended for pumped primary circuits. The connections intended for pumped primary circuits shall be G½ or G¾ for internal threads or G½B or G¾B for external threads.

The minimum size of any draw off connection shall be G¾ for internal threads or G¾B for external threads.

10.3 Threaded connections complete with nuts and compression rings shall comply with the requirements of BS 864-2, and be of the same nominal sizes as specified in **10.2**.

10.4 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.

11 Fixing provision for immersion heaters

If one or more immersion heaters are to be used in the unit, the connections shall be threaded internally with G2¼ threads complying with the requirements of Table 4M of BS 2779:1973 and the threaded portion shall be between 13 mm and 15 mm.

The minimum 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 bosses shall be positioned to ensure that the elements are always totally immersed under operating conditions and do not touch any part of the vessel or primary heater. One boss shall be positioned to ensure that the maximum amount of water is heated.

NOTE It is recommended that any connections for immersion heaters should be fitted during manufacture of the combination unit and not subsequently. If not required immediately, they should be blanked off. Electric immersion heaters are specified in BS 3456-2.21 and thermostats are specified in BS 3955-2B.

12 Fixing provision for a gas circulator

If required, provision shall be made for the attachment of a gas circulator of the type specified by the purchaser (see Appendix F).

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. Guidance on the connection of gas circulators is given in BS 5546. Any gas circulator should be supported in such a manner that no distortion occurs in the wall of the combination unit to which it is fitted.

13 Performance requirements

13.1 Water tightness. Storage vessels and primary heaters shall not show any leak or any significant permanent distortion as a result of the tests specified in Appendix A.

13.2 Insulation between the hot water vessel and feed cistern. When direct combination units, double feed indirect combination units, or single feed indirect combination units, are tested by the methods in Appendix B, Appendix C, or Appendix D respectively, the temperature of the water in the feed cistern shall not exceed 38 °C.

13.3 Mean temperature of stored hot water. Immediately at the end of the heat-up tests described in Appendix B, Appendix C, and Appendix D it shall be possible to draw off, at a continuous rate of between 10 litres/min and 20 litres min, 70 % of the stated hot water storage capacity at a mean temperature of not less than 70 °C.

13.4 Isolation of primary and secondary water. It is essential that there shall be no mixing of the primary and secondary waters in indirect combination units. When double feed indirect combination units or single feed indirect combination units are tested by the methods in Appendix C or Appendix D, respectively, there shall be no trace of dye in the secondary water.

13.5 Purchaser's certificate. The purchaser shall be entitled, on request, to a certificate testifying that the combination units and primary heaters, when fitted, have complied with the requirements given in **13.1**, **13.2**, **13.3** and **13.4**, as appropriate.

14 Marking

14.1 Direct units

14.1.1 *Permanent marking*

14.1.1.1 Each combination unit shall be permanently and clearly marked as described in **14.1.1.2** to **14.1.1.4** with the following information.

a) The number and date of this British Standard[6] followed by the type reference, i.e. BS 3198:1981:DIR.

b) The manufacturer's name or identification mark.

14.1.1.2 Combination units without permanent insulation shall be marked by stamping, embossing or etching on the body of the unit or by means of a copper or brass plate soldered to the body of the unit.

14.1.1.3 Combination units which are supplied complete with factory applied insulation not enclosed by a rigid outer casing, shall be marked by one of the following methods.

a) By one of the methods in **14.1.1.2** and in addition the position of the marking shall be indicated by repeating the marking on the outside of the insulation. For outside marking a less permanent form is acceptable, e.g. labelling.

b) By stamping, embossing or etching the inside surface of the feed cistern or by means of a copper or brass plate soldered to this surface. Such marking shall be above the water line and in a position where it can be seen after removing the feed cistern lid.

14.1.1.4 Combination units which are supplied complete with insulation within a rigid outer casing shall be marked by one of the following methods.

a) By the methods given in **14.1.1.3**, a) or b), except that in a) the marking shall be on the outside of the casing instead of the insulation.

b) By means of a self adhesive plastics label complying with the requirements of BS 4781-1 fixed to the outer casing.

[6] Marking BS 3198 on or in relation to a product is a claim by the manufacturer that the product' has been manufactured in accordance with 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, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

14.1.2 *Other marking.* The following additional marking shall be applied, but a less permanent form (e.g. by means of a label) is permissible.

a) If the feed cistern is supplied without a float operated valve, the level at which the centre line of the float operated valve has to be fixed shall be clearly marked on the feed cistern.

b) If the feed cistern is supplied without a warning pipe union, the level at which the centre line of the warning pipe ought to be fixed shall be clearly marked on the feed cistern.

c) If the feed cistern is supplied without a float operated valve, a label shall be affixed to the unit stating that the purchaser should fit a float operated valve complying with the requirements of either Part 1 or Part 2 of BS 1212 and a float complying with the requirements of class C of BS 1968 or BS 2456. Attention shall be drawn to the location of the float operated valve in relation to any discharge from the vent pipe.

d) The thickness before forming, of copper sheet used to manufacture:

1) the hot water storage vessel;

2) the feed cistern(s).

e) The maximum length of any immersion heater to be fitted to the hot water storage vessel.

f) A suitable location for an immersion heater connection if such a connection is not fitted at the time of manufacture.

g) Hot water storage capacity in litres.

14.2 Double feed indirect units. The marking shall be as for direct units as specified in **14.1** and the following additional marking shall be supplied in any of the forms specified in **14.1**:

a) maximum working pressure of heat exchanger in bar;

b) the thickness before forming of any copper sheet used to manufacture the primary heater;

c) area of heating surface of primary heater;

d) the maximum permissible quantity of primary water if primary feed and expansion cistern is incorporated.

14.3 Single feed indirect units. The marking shall be as for direct units as specified in **14.1** and the following additional marking shall be supplied in any of the forms specified in **14.1**:

a) the maximum permissible quantity of primary water excluding the primary heater contents;

b) the thickness before forming of any copper sheet used to manufacture the primary heater;

c) the area of heating surface of the primary heater.

Appendix A Pressure tests

A.1 Complete combination units. After assembly, test each unit by one of the following methods:

a) completely fill with water to at least the level of the water line in the feed cistern and allow to stand filled for 10 min; or

b) subject the complete combination unit to a pneumatic test pressure, of 0.1 bar, for not less than 2 min.

A.2 Primary heaters. Before assembly in the combination unit, subject every primary heater to a test pressure applied internally, either hydraulically for a period of not less than 5 min, or pneumatically for a period of not less than two minutes as follows:

a) double feed without integral feed and expansion cistern, 7.0 bar;

b) double feed with integral feed and expansion cistern, 0.1 bar;

c) single feed, 0.1 bar.

Appendix B Performance tests for direct combination units

B.1 Test apparatus and layout. Arrange the test apparatus as shown in Figure 1. Use a circulator as detailed in Figure 1 consisting of 75 ± 3 mm bore pipe, 450 mm long, into which a thermostatically controlled 3 kW electric immersion heater is screwed.

Use sufficient 28 mm copper tube and connections to connect the circulator to the combination unit to be tested which shall be positioned with its base not less than 900 mm and not more than 1 200 mm above the floor level. Arrange the 28 mm copper flow and return circulatory pipes with pipe falls and generous radius bends to facilitate good thermo-syphonic circulation. Ensure that the total water content of the circulator and pipework does not exceed 5 litres.

Use two suitable thermometers (complying with the requirements of BS 593) graduated in degrees Celsius, one (thermometer T) positioned in the water in the feed cistern and the other (thermometer S) at the hot water draw off tap G, as shown in Figure 1.

B.2 Test procedure. Fill the combination unit to be tested and the whole apparatus with water from the mains through a float operated valve, positioned as specified in **7.6**. Place the loose cover on the cistern and switch on the immersion heater. Adjust the immersion heater thermostat to give a water temperature of 80 ± 3 °C on thermometer S at the hot water draw off tap G. Switch off the immersion heater and then drain the complete apparatus of water.

Refill the combination unit, circulator and connecting pipework with mains water through the float operated valve to the correct water level and leave for a minimum period of 12 h in a room in which the temperature is maintained at 20 ± 5 °C.

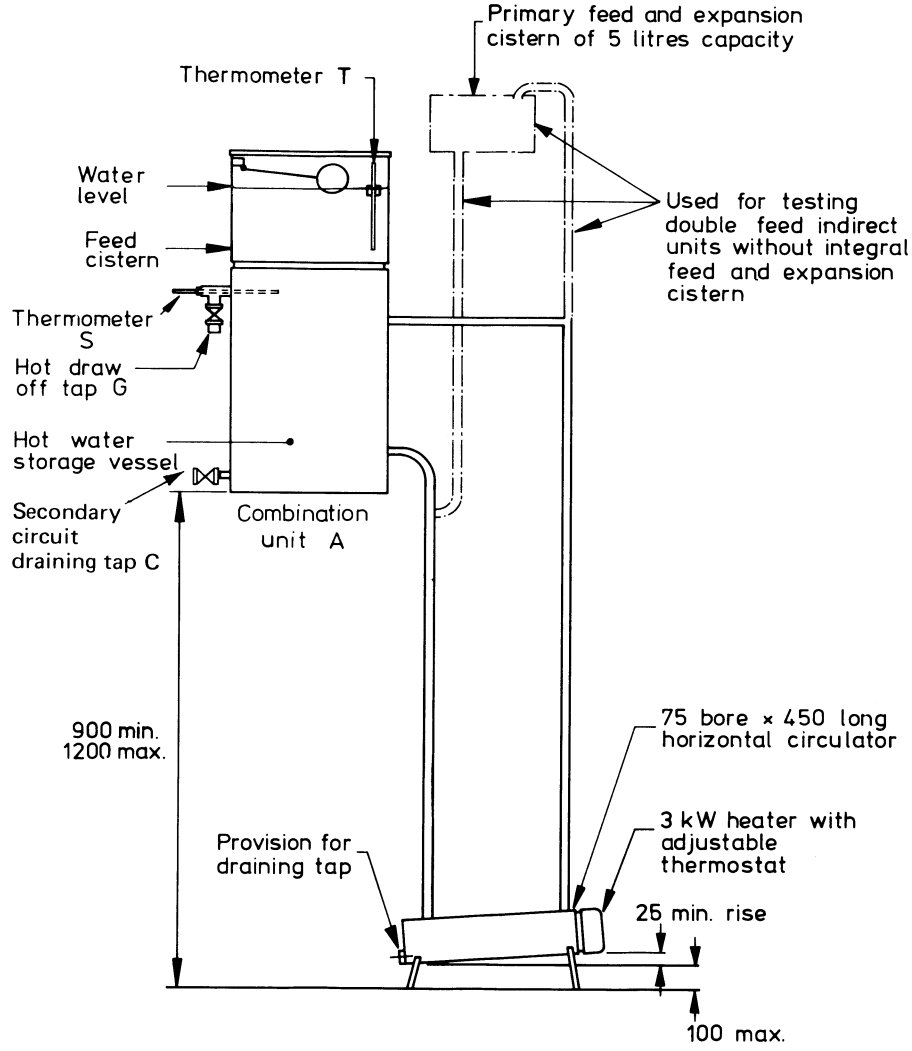
Switch on the immersion heater and at the end of an 8 h period, agitate the water to render the temperature of the contents of the feed cistern uniform and measure the temperature of the water in the feed cistern by temperature of the water in the feed cistern by thermometer T (see **13.2**). Do not add or draw off water during this period of the test but immediately afterwards record the temperature on thermometer S, and then draw off 5 % of the hot water storage capacity from the hot water draw off tap G, at a continuous rate of between 10 litres/min and 20 litres/min, and again record the temperature. Repeat this procedure until 70 % of the capacity has been drawn off. The mean of the fifteen readings is the mean temperature of the stored water (see **13.3**).

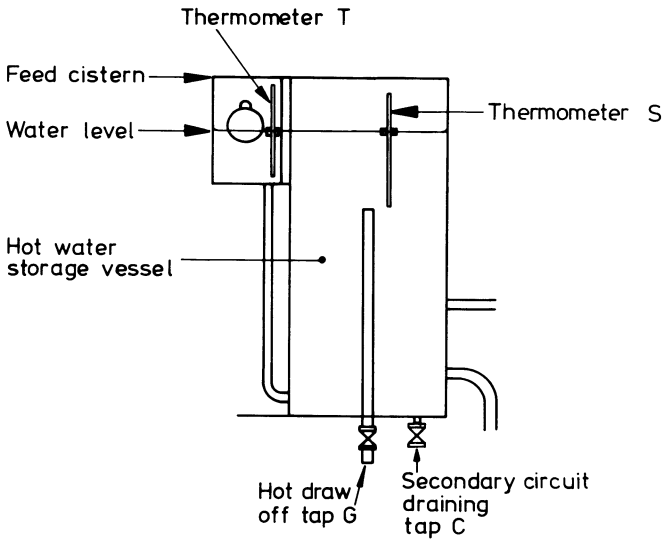
Appendix C Performance tests for double feed indirect combination units

C.1 Test apparatus and layout. Arrange the test apparatus, as described in **B.1** and shown in Figure 1, with the additional primary water feed, venting and expansion arrangement for combination units without an integral feed and expansion cistern.

NOTE The additional apparatus required is indicated in Figure 1 by dotted lines.

C.2 Test procedure. Fill the combination unit to be tested and the whole apparatus with water from the mains through a float operated valve, positioned as specified in **7.6**, and place the loose cover on the cistern. Where the combination unit to be tested does not have an integral primary feed and expansion cistern, fill the primary system to the bottom of the expansion cistern. Switch on the immersion heater and adjust the thermostat to give a water temperature of 80 ± 3 °C on thermometer S. Switch off the immersion heater and drain the complete apparatus of water.





Alternative type of combination unit A

All dimensions are in millimetres.

NOTE The dotted lines indicate additional apparatus required for testing double feed indirect combination units (see Appendix B).

Figure 1 — Layout of testing apparatus for direct and double feed indirect combination units

Dissolve approximately 0.5 g of fluorescein dye in 0.3 litres of water and introduce it into the primary feed and expansion cistern. Refill the combination unit and apparatus to the correct water level as described above. Add 4 litres of water to the primary feed and expansion cistern and leave the whole apparatus for a minimum period of 12 h in a room at a temperature of 20 ± 5 °C.

Switch on the immersion heater and at the end of an 8 h period agitate the water to ensure that the temperature of the contents of the feed cistern is uniform and measure the temperature of the water in the feed cistern by means of thermometer T (see **13.2**). Do not draw off or add water during this period of the test, but immediately afterwards record the temperature on thermometer S and then draw off 5 % of the hot water storage capacity from the hot water draw off tap G, at a continuous rate of between 10 litres/min and 20 litres/min, and again record the temperature. Repeat this procedure until 70 % of the capacity has been drawn off. The mean of the fifteen readings is the mean temperature of the stored water (see **13.3**).

Allow the combination unit to reheat and remain heating over a 20 h period, after which disconnect the immersion heater thermostat to enable the primary water to boil. Allow the primary water to boil continuously for 30 min and then switch off the immersion heater. After a further 24 h draw off 70 % of the hot water capacity. Examine the water drawn off for any trace of dye as an indication of the mixing of primary and secondary waters (see **13.4**).

Appendix D Performance tests for single feed indirect combination units

D.1 Apparatus and layout. Arrange the apparatus as shown in Figure 2. Connect the single feed combination unit A to a cylinder B complying with the requirements of type 2, Grade 3, of BS 699, by means of 28 mm size copper tube to facilitate good thermosyphonic circulation. Provide cylinder B with two thermostatically controlled 3 kW immersion heaters complying with the requirements of BS 3456-2.21, a suitable thermometer R complying with the requirements of BS 593 to measure the primary water temperature and a valve arrangement E and F as shown, to enable fluorescein dye to be added. Place a suitable thermometer T complying with the requirements of BS 593 in the feed cistern.

D.2 Preparation: adjustment of immersion heater thermostats. Fill the entire system with cold water from the mains through the feed cistern, ensuring that taps C, D and G and valve E are closed. Switch on the heaters for sufficient time to enable the thermostats in cylinder B to be adjusted so that the primary water temperature at the top of cylinder B as indicated by thermometer R is maintained at 80 ± 3 °C. Switch off the heaters, close the water mains supply to the float operated valve, and drain off the secondary and primary waters through taps C and D respectively.

D.3 Test procedure. After closing taps C, D and G and valve E, refill the system through the float operated valve direct from the main and ensure that the temperature of the feed water does not exceed 16 °C. Leave the apparatus when filled to the correct water level for a minimum period of 12 h in a room at a temperature of 20 ± 5 °C, and then switch on the heaters and leave in operation for 8 h. Agitate the water to ensure that the temperature of the contents of the feed cistern is uniform and measure the temperature of the water in the feed cistern by means of thermometer T (see **13.2**).

Introduce approximately 1 g of powdered fluorescein dye into cylinder B through the open valve F (with valve E remaining closed) and then by closing valve F and opening valve E. Allow the system to cool over a period of not less than 72 h. Switch on the heaters and leave in operation for a further 8 h.

Do not draw off or add water during this period of the test, but immediately afterwards record the temperature on thermometer S and then draw off 5 % of the hot water storage capacity from the hot water draw off tap G, at a continuous rate of between 10 litres/min and 20 litres/min and again record the temperature. Repeat this procedure until 70 % of the capacity has been drawn off. The mean of the fifteen readings is the mean temperature of the stored water (see **13.3**).

Examine the water drawn off for any trace of dye as an indication of the mixing of primary and secondary waters (see **13.4**).

Appendix E Heat loss test

E.1 Test apparatus and layout

E.1.1 Fit the combination unit to be tested with an immersion heater which complies with the requirements of BS 3456-2.21. Connect a suitable thermostatic control to ensure that the water temperature can be maintained at 60 ± 2 °C.

E.1.2 Support the unit on a suitable insulating spacer in a draught free position and protect it from direct radiation or changes in temperature so that the ambient temperature is maintained at 22 ± 2 °C during the period of the test. A suitable arrangement is shown in Figure 3.

E.1.3 Position three thermocouples 700 mm to 1 000 mm from the hot water section of the combination unit 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.

E.1.4 Attach a thermocouple to the copper surface of the hot water section at a height one third from the base and connect to a temperature recorder.

E.1.5 Ensure that any exposed plugs, caps or fittings (e.g. draw-off or draining taps) and any pipework provided for drawing off or draining, are insulated within 150 mm of the unit, with 50 mm thickness of glass/rock fibre or cellular plastics, having a thermal conductivity not greater than 0.07 W/(m·K).

All temperatures shall be measured to an accuracy of 0.5 °C.

E.2 Test procedure using a heater thermostat

E.2.1 Fill the combination unit with water up to the cistern water level mark, switch on the immersion heater and adjust the thermostat to give a water temperature of 60 ± 2 °C, at the thermocouple position.

E.2.2

E.2.2.1 Determine the standing heat losses over successive 24 h test periods as described in **E.2.2.2** and **E.2.2.3**.

E.2.2.2 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 . . . E_N) 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 **E.1.3** and **E.1.4** respectively for each corresponding 24 h test period (T_{W1}, T_{W2}, . . . T_{WN} and T_{A1}, T_{A2} . . . T_{AN} respectively).

E.2.2.3 Continue the test until the standing heat loss as determined in **E.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.

E.3 Calculation of results. Calculate the heat loss for each test period expressed in W/litre of hot water capacity, corrected for a 38 °C differential between hot water and ambient temperature as follows:

$$\text{Heat loss} = \frac{38\,000E}{24C\,(T_W - T_A)}$$

where

C is the hot water capacity as marked on the combination unit (in litres);

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

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

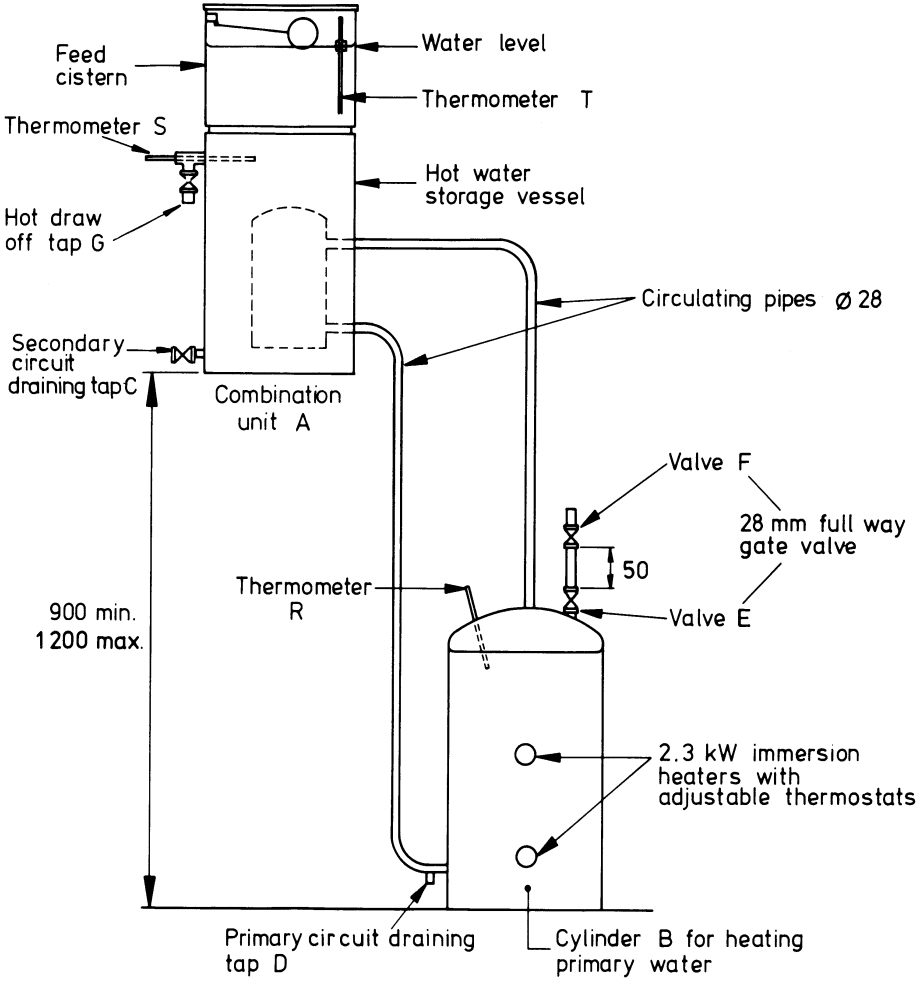
T_A is the mean ambient temperature over the 24 h test period (in °C).

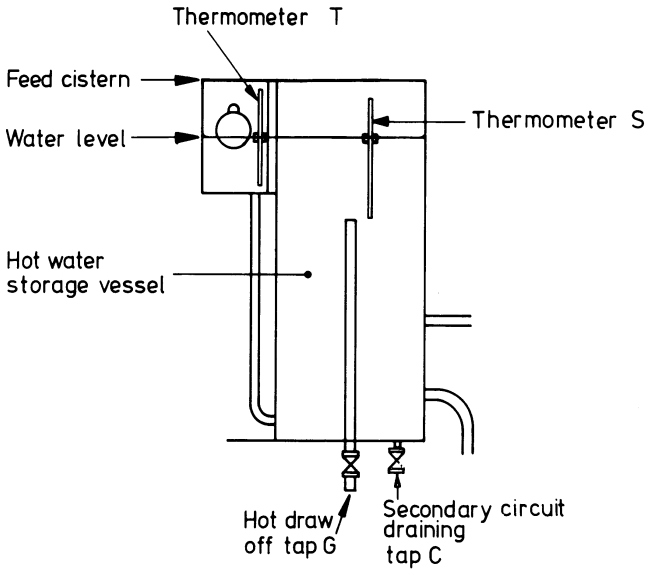
E.4 Test procedure using a differential thermostatic controller

E.4.1 Where an electronic differential thermostatic controller is available this may be used to replace the heater thermostat, and the procedure described in **E.4.2** to **E.4.6** adopted.

E.4.2 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 combination unit at a level half way up the hot water section.

E.4.3 Measure the hot water temperature by means of a thermocouple positioned with its hot junction at a height one third from the base of the hot water section of the unit. Ensure that the thermocouple adheres firmly to the surface of the copper so that there is good thermal contact and position it under the insulation so that it indicates the true temperature at that level.





Alternative type of combination unit A

All dimensions are in millimetres.

Figure 2 — Layout of testing apparatus for single feed indirect combination units

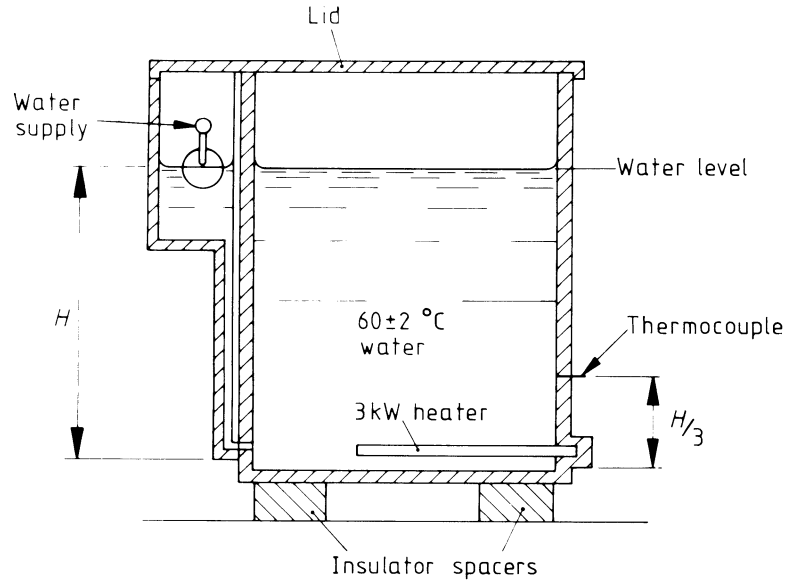


Figure 3 — Apparatus for heat loss test

E.4.4 Connect the temperature sensors to a controller capable of maintaining a temperature difference of 38 ± 1 °C between the hot water and the ambient air. For example, this may be achieved by means of a three term controller and thermocouples.

E.4.5 Fill the combination unit with water to the cistern water level mark, set the controller to maintain a temperature differential of 38 ± 1 °C and switch on the heater.

E.4.6 Record kilowatt hour meter readings described in **E.2.2** and calculate the standing heat loss for each 24 h test period in W/litre of hot water capacity as follows:

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

where

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

C is the hot water capacity as marked on the combination unit (in litres).

Appendix F Information to be supplied by the purchaser with an enquiry or order

When enquiring about or ordering units that comply with the requirements of this British Standard, the purchaser should provide the manufacturer with the following information.

a) The number of this British Standard, i.e. BS 3198.

b) The unit shape and dimensions.

c) Hot water storage capacity.

d) Type of unit, i.e. direct, double feed indirect with or without integral primary feed and expansion cistern or single feed indirect.

e) Whether a hand hole is required and, if so, the shape of the hand hole.

f) Details of connections required.

g) Whether provision is required for an immersion heater or gas circulator.

h) The size and type of float operated valve if required.

i) The size and type of warning pipe connection if required.

blank

Publications referred to

BS 417, *Galvanized mild steel cisterns and covers, tanks and cylinders*[7)].
BS 476, *Fire tests on building materials and structures.*
BS 476-4, *Non-combustibility test for materials.*
BS 593, *Laboratory thermometers.*
BS 699, *Copper cylinders for domestic purposes.*
BS 864, *Capillary and compression tube fittings of copper and copper alloy.*
BS 864-2, *Metric units.*
BS 1212, *Specification for float operated valves (excluding floats).*
BS 1212-1, *Piston type.*
BS 1212-2, *Diaphragm type (brass body).*
BS 1453, *Filler materials for gas welding.*
BS 1565, *Galvanized mild steel indirect cylinders, annular or saddle-back type*[7)].
BS 1565-1, *Imperial units.*
BS 1565-2, *Metric units.*
BS 1566, *Copper indirect cylinders for domestic purposes*[7)].
BS 1566-1, *Double feed indirect cylinders.*
BS 1566-2, *Single feed indirect cylinders.*
BS 1845, *Specification for filler metals for brazing.*
BS 1968, *Floats for ballvalves (copper).*
BS 2456, *Floats (plastics) for ballvalves for hot and cold water.*
BS 2777, *Asbestos cement cisterns*[7)].
BS 2779, *Pipe threads where pressure-tight joints are not made on the threads.*
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 3456, *Specification for safety of household electrical appliances.*
BS 3456-2.2.1, *Electric immersion heaters.*
BS 3955, *Electrical controls for domestic appliances.*
BS 3955-2B, *Thermostats for electrically heated hot water supply (a.c. only).*
BS 4213, *Cold water storage cisterns (polyolefin or olefin copolymer) and cistern covers*[7)].
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 4781, *Self-adhesive plastics labels for permanent use.*
BS 4781-1, *General purpose labels.*
BS 5546, *Code of practice for installation of gas hot water supplies for domestic purposes (2nd family gases).*

[7)] Referred to in the Foreword only.

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