

Specification for

Vessels for use in heating systems —

**Part 1: Calorifiers and storage vessels
for central heating and hot water
supply**

ICS 27.060.01

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refrigeration, Heating and Air Conditioning Standards Policy Committee (RHE/-) to Technical Committee RHE/12, upon which the following bodies were represented:

Associated Offices Technical Committee
Boiler and Radiator Manufacturers Association Limited
British Non-Ferrous Metals Federation
Chartered Institution of Building Services Engineers
Copper Development Association
Department of the Environment (Property Services Agency)
Department of Transport (Marine Directorate)
Health and Safety Executive
Hevac Association
Institution of Mechanical Engineers
Waterheater Manufacturers Association

This British Standard, having been prepared under the direction of the the Refrigeration, Heating and Air Conditioning Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 30 September 1990

© BSI 2011

First published October 1939
First revision November 1960
Second revision December 1981
Third revision September 1990

The following BSI references relate to the work on this standard:
Committee reference RHE/12
Draft for comment
07/30171878 DC

ISBN 978 0 580 60491 1

Amendments issued since publication

Amd. No.	Date	Comments
8157	June 1994	
8979	March 1996	
A3	September 2011	See Foreword

Contents

	Page
Committees responsible	Inside front cover
Foreword	iii
1 Scope	1
2 Definitions	1
3 Classification	1
4 Design pressure and design temperature	2
5 Materials	2
6 Welding procedure and welder approval tests	5
7 Determination of scantlings design	6
8 Construction	20
9 Heating batteries	21
10 Mountings	30
11 Inspection, testing, marking and manufacturer's certificate	32
A3 Annex A3 A Information supplied by the purchaser	34
A3 Annex A3 B Guidance for plant layout and installation	34
Figure 1a — Example of a history sheet	6
Figure 1 — Typical longitudinal and circumferential weld preparations for carbon steel calorifiers and storage vessels	8
Figure 2 — Typical longitudinal and circumferential weld preparations for copper calorifiers and storage vessels	9
Figure 3 — Domed end	10
Figure 4 — Values for K	10
Figure 5 — Shape factors for domed ends	11
Figure 6 — Typical examples of flange backing rings	12
Figure 7 — Compensation for openings in steel shells	15
Figure 8 — Compensation for opening in cylindrical copper shells (shell flanged)	17
Figure 9 — Compensation for opening in cylindrical copper shells (neckpiece and shell flanged)	23
Figure 10 — Welds for unflanged flat endplates	26
Figure 11 — Welding of carbon steel flanges and branches	27
Figure 12 — Welding of carbon steel pads	28
Figure 13 — Overlap of plates in lapped circumferential seams for copper and carbon steel	29
Figure 14 — Fillet welds	29
Figure 15 — Brazing of copper flanged connection up to 100 mm diameter	29
Figure 16 — Brazing of copper lifting eye	29
Figure 17 — Brazing of copper screwed connection	29
Figure 18 — Typical tube attachment to tubeplates	30
Figure 19 — Typical tube attachment in headers	30
Figure 20 — Circular cast iron spherically shaped chest	31
A3 Table 1 — Design stress for materials of construction of calorifiers and storage vessels A3	3
Table 1a — Number of test specimens required for procedure approval for copper	5
Table 1b — Number of test specimens required for welder approval for copper	6
Table 2 — Filler and brazing materials, forgings and hot pressing stock, bolt and nut materials	7

	Page
Table 3 — Minimum length of thread	17
Table 4 — Maximum permissible stress for bolts and studs	18
Table 5 — Minimum requirements for inspection openings	24
Table 6 — Sizes of vent pipes	32
Publications referred to	36

Foreword

This British Standard has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee.

BS 853-1:1990+A3:2011 supersedes BS 853-1:1996, which incorporated Amendment Nos. 1 and 2 and is withdrawn.

The start and finish of text introduced or altered by Amendment No. 3 is indicated in the text by tags. Minor editorial changes are not tagged.

When last revised, this British Standard was re-numbered BS 853-1:1996 and re-titled “Specification for vessels for use in heating systems — Part 1: Calorifiers and storage vessels for central heating and hot water supply” without any change to the content, as a consequence of the publication of — Part 2 of this standard entitled “Specification for vessels for use in heating systems — Part 2: Tubular heat exchangers and storage vessels for buildings and industrial services”.

The standard was first published in 1939 and revised into two parts, covering carbon steel and copper, in 1960. A second revision was carried out in 1981, when the two parts were again combined, and this has now been updated to take account of current practice. No provision has been included for thermal performance tests.

NOTE Information concerning SI units is given in BS ISO 80000-1.

Text deleted

Further information is available in Health and Safety Executive Guidance Note EH/10, Environmental Hygiene, Asbestos.

Table 1 lists the latest European material designations. The elevated design stress values are based upon equivalent materials that have been listed in previous issues of this British Standard.

Annex B gives guidance for plant layout and installation.

Part 2 of this standard covers tubular heat exchangers and storage vessels for building and industrial services with higher duty requirements than Part 1, but for which the requirements of PD 5500 are unnecessarily stringent.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot 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 37, 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.

1 Scope

This British Standard specifies the strength and method of construction of calorifiers and storage vessels designed for central heating and hot water supply. It also specifies suitable safety devices and methods of pressure testing. The standard covers units with shells made from copper or carbon steel. Reference is made to the protection from corrosion of carbon steel shells, by galvanizing, sealed zinc spraying or copper lining.

This standard covers calorifiers heated by steam, water, heat transfer fluid or electricity, but does not cover calorifiers with steam on the outside of the tube battery.

The information that the purchaser is recommended to supply to the manufacturer at the time of enquiry and order is given in **Annex A**.

NOTE The titles of the publications referred to in this standard are listed on page 36.

2 Definitions

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

2.1

calorifier

a closed cylindrical vessel in which water is indirectly heated under a pressure greater than atmosphere for the supply of hot water services, for central heating purposes and for industrial applications. The water is heated by tubular primary heaters, with hot water, steam or oil as the heating medium, or electric immersion heating elements

2.2

storage vessel

a closed cylindrical vessel containing water at a pressure greater than atmosphere for hot water services, central heating and industrial applications

2.3

design pressure

the value of pressure to be employed for calculation (see **4.1**)

2.4

design temperature

the value of temperature to be employed for calculation (see **4.2**)

2.5

secondary working pressure

the total pressure on the secondary side of the calorifier, i.e. the sum of the static and circulating pressures

2.6

purchaser

the organization or individual who buys the calorifier for its own use or as an agent for the owner

2.7

inspecting authority

the body or association which checks that the design, materials and construction are in accordance with this standard

3 Classification

3.1 General

Calorifiers and storage vessels shall be classified into grade A or B, as specified in **3.2** and **3.3**.

NOTE For calorifiers and storage vessels with operating conditions above those specified in this clause, reference should be made to BS 3274.

3.2 Grade A

Grade A calorifiers and storage vessels shall comply with the following requirements.

- The working pressure in the shell shall not exceed 0.7 N/mm^2 (7.0 bar)¹⁾.
- The design pressure in the shell shall be not less than 0.17 N/mm^2 .
- The operating temperature in the shell shall not exceed 120°C .
- The design pressure in the calorifier tube battery shall be not less than 0.17 N/mm^2 nor exceed 1.75 N/mm^2 (17.5 bar).
- The operating temperature in the calorifier tube battery shall not exceed 300°C .

3.3 Grade B

The grade B classification shall be used for copper units only. The units shall comply with the following requirements, which specify less severe operating conditions than those required for grade A.

- The working pressure in the shell shall not exceed 0.45 N/mm^2 (4.5 bar).
- The design pressure in the shell shall be not less than 0.1 N/mm^2 .
- The operating temperature in the shell shall not exceed 90°C .

¹⁾ $1 \text{ bar} = 0.1 \text{ N/mm}^2 = 0.1 \text{ MPa} = 10.2 \text{ m head}$

- d) The design pressure in the calorifier tube battery shall be not less than 0.17 N/mm nor exceed 0.45 N/mm² (4.5 bar).
- e) The operating temperature in the calorifier tube battery shall not exceed 300 °C.

4 Design pressure and design temperature

4.1 Design pressure

4.1.1 The secondary design pressure shall be:

- a) not less than two-thirds of the hydraulic test pressure;
- b) not less than the secondary working pressure where an open vent is fitted and the working head does not exceed 25 m (see **10.2.3**) and;
- c) not less than the pressure at which the safety valve is set to lift when the working head exceeds 25 m and in all cases where an open vent is not fitted (see **10.2.1.4**).

4.1.2 The primary design pressure shall be not less than the highest pressure which can be reached in the primary heater, including any pumping head which may be additional to the set pressure of the boiler safety valve. In no case shall the primary design pressure be less than two-thirds of the hydraulic test pressure.

4.2 Design metal temperature

4.2.1 The design temperature of the shell of the calorifier or storage vessel shall be the maximum operating temperature of its contents unless specified otherwise by the purchaser.

4.2.2 The design temperature of the calorifier primary header, tubes, tubeplates, and other heating surfaces shall be the maximum design inlet temperature of the primary fluid unless specified otherwise by the customer. If the primary fluid is saturated steam, the design metal temperature shall be the saturation temperature at the maximum design pressure.

NOTE For superheated steam, the design metal temperature may be regarded as being the saturation temperature at the maximum design pressure, provided that the superheated steam temperature is not more than 165 °C above the saturation temperature.

5 Materials

5.1 Materials for calorifiers

Table 1 lists the design stress values for the construction of calorifiers and storage vessels that shall be used in the design equations for the relevant design metal temperatures given in the table.

Materials shall not be used at temperatures higher than those for which allowable stresses are given in Table 1.

Where other materials, having properties equivalent to those listed in Table 1, are proposed, the manufacturer shall, on request, show that the properties are comparable with those for materials given in Table 1.

NOTE The formulae are intended to apply to calorifiers and storage vessels for use with fresh water. Special consideration should be given to the selection of materials (both separately and in combination) and to the corrosion allowance required for calorifier and storage vessel components which are likely to be in contact with aggressive, brackish or other impure water.

Table 1 – Design stress for materials of construction of calorifiers and storage vessels

Material	British Standard designation	Relevant note(s)	Design stress values (f) ^a									
			Design temperature not exceeding									
			50 °C	100 °C	150 °C	175 °C	200 °C	225 °C	250 °C	275 °C	300 °C	
			N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	
<i>Shells and branches</i>												
Carbon	steel plate		108	108	108	108	108	104	100	93	91	
	pipes and tubes	BS EN 10216-1 and BS 10217-1, grade P265TR2	103	103	103	101	96	91	87	82	78	
	pipes and tubes	BS EN 10216-2 and BS 10217-2, grade P265GH	103	103	103	103	103	99	95	89	84	
Copper	tubes	BS EN 12452, grade CW024A or BS EN 12451, grade CW024A	41	40	34	26	18	–	–	–	–	
	sheet	BS EN 1653, grade CW024A	48	46	34	26	18	–	–	–	–	
	plate	BS EN 1653, grade CW024A	48	46	34	26	18	–	–	–	–	
<i>Bars and sections (for welding)</i>												
Carbon steel	BS EN 10273, grade P265GH		108	108	108	108	108	104	100	93	91	
Copper	BS EN 12167 and BS EN 12163, grade CW024A	12	41	40	34	26	18	–	–	–	–	
<i>Tubeplates</i>												
Carbon steel	BS EN 10028-2, grade P265GH	2	108	108	108	108	108	104	100	93	91	
Aluminium bronze	BS EN 1653, grade CW304G	12	137	127	111	103	94	87	77	71	63	
90/10 Cu.Ni.	BS EN 1653, grade CW352H	12	72	70	66	63	60	58	54	49	44	
70/30 Cu.Ni.	BS EN 1653, grade CW354H	12	82	79	77	76	75	73	72	71	70	
Aluminium brass	BS EN 1653, grade CW702R	12	72	71	69	54	25	15	–	–	–	
Naval brass	BS EN 1653, grade CW712R	12	86	79	72	55	17	–	–	–	–	
60/40 brass	BS EN 1653, grade CW610N	12	86	79	72	55	17	–	–	–	–	
<i>Tubes</i>												
Copper	BS EN 12451, grade CW024R	11, 12	41	40	34	26	18	–	–	–	–	
90/10 Cu.Ni.	BS EN 12451, grade CW352H	12	72	70	66	63	60	58	54	49	44	
70/30 Cu.Ni.	BS EN 12451, grade CW354H	12	82	79	77	76	75	73	72	71	70	
Aluminium brass	BS EN 12451, grade CW702R	10, 11, 12	72	71	69	54	25	15	–	–	–	
70/30 arsenical brass	BS EN 12451, grade CW707R	10, 11, 12	72	71	69	54	25	15	–	–	–	

A3 Table 1 Continued

Material	British Standard designation	Relevant note(s)	Design stress values (f) ^a									
			Design temperature not exceeding									
			50 °C	100 °C	150 °C	175 °C	200 °C	225 °C	250 °C	275 °C	300 °C	
			N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	N/mm ²	
Castings												
Steel	BS EN 10213, grade P265GH		107	97	88	86	83	82	81	77	73	
Grey cast iron	BS EN 1561, grade EN-GLJ-150 or ISO 185, grade JL/200	3, 4, 5	16	16	16	16	16	^a	—	—	—	
	BS EN 1561, grade EN-GLJ-200 or ISO 185, grade JL/225	3, 4, 5	19	19	19	19	19	^a	—	—	—	
	BS EN 1563, grade EN-GJS-400-18 U-LT or RT		60	60	60	60	60	60	—	—	—	
Admiralty gunmetal	BS 1400, grade G1 ²⁾	6, 12	55	55	55	52	49	25	25	—	—	
Leaded gunmetal	BS EN 1982, grade CuSn5Zn5Pb5-C CC491K	7, 12	48	48	48	47	45	34	34	22	—	
	BS EN 1982, grade CuSn7Zn2Pb3-C CC492K		59	59	59	56	51	—	—	—	—	
Naval brass	BS 1400, grade SCB4 ²⁾	8, 9, 12	—	—	—	—	—	—	—	—	—	
Brass for brazable castings	BS EN 1982, grade CuZn15As-CCC760S	8, 12	30	30	20	—	—	—	—	—	—	
^a See Note 3.												
NOTE 1 Linear interpolation may be used to determine the appropriate design stress value when the design metal temperature lies between two temperatures.												
NOTE 2 Steel tubeplates may be used in calorifiers and storage vessels with copper shells, provided that they are not galvanized and:												
a) the waterside surface is clad, lined or otherwise treated to prevent corrosion;												
b) the effective seals are made between the protecting surface treatment of the tubeplate and the other surface of the tubes; and												
c) the steel of the tubeplate is at no point in contact with the contained water.												
NOTE 3 Grey cast iron is not suitable for pressures exceeding 1.03 N/mm ² or for temperatures exceeding 220 °C, at which temperature the values for f at 200 °C should be used.												
NOTE 4 Refer to BS EN 1561 for estimated thickness of cast iron greater than 30 mm. The design stress used should be 10% of the tensile strength for the grade of material selected and thickness required.												
NOTE 5 Iron castings that are stressed by the working pressure should have the number and grade of the relevant British Standard cast upon them so that the maximum operating pressure and temperature for which they are suitable may be assessed at any time.												
NOTE 6 May be welded only if the lead content is less than 0.5%.												
NOTE 7 Cannot be welded, but may be brazed.												
NOTE 8 Not suitable for operating temperatures greater than 150 °C.												
NOTE 9 Suitable for non-pressure parts only.												
NOTE 10 If these materials are to be screwed they should be ordered in the as-drawn condition instead of the annealed condition.												
NOTE 11 The recommended tempers for tubes for expanding and/or bending are half-hard for copper and brasses.												
NOTE 12 Refer to Foreword. ⁶³												

^a See Note 3.

NOTE 1 Linear interpolation may be used to determine the appropriate design stress value when the design metal temperature lies between two temperatures.

NOTE 2 Steel tubeplates may be used in calorifiers and storage vessels with copper shells, provided that they are not galvanized and:

a) the waterside surface is clad, lined or otherwise treated to prevent corrosion;

b) the effective seals are made between the protecting surface treatment of the tubeplate and the other surface of the tubes; and

c) the steel of the tubeplate is at no point in contact with the contained water.

NOTE 3 Grey cast iron is not suitable for pressures exceeding 1.03 N/mm² or for temperatures exceeding 220 °C, at which temperature the values for f at 200 °C should be used.

NOTE 4 Refer to BS EN 1561 for estimated thickness of cast iron greater than 30 mm. The design stress used should be 10% of the tensile strength for the grade of material selected and thickness required.

NOTE 5 Iron castings that are stressed by the working pressure should have the number and grade of the relevant British Standard cast upon them so that the maximum operating pressure and temperature for which they are suitable may be assessed at any time.

NOTE 6 May be welded only if the lead content is less than 0.5%.

NOTE 7 Cannot be welded, but may be brazed.

NOTE 8 Not suitable for operating temperatures greater than 150 °C.

NOTE 9 Suitable for non-pressure parts only.

NOTE 10 If these materials are to be screwed they should be ordered in the as-drawn condition instead of the annealed condition.

NOTE 11 The recommended tempers for tubes for expanding and/or bending are half-hard for copper and brasses.

NOTE 12 Refer to Foreword. A3

²⁾ Superseded, withdrawn.

5.2 Filler materials and bolting materials

Filler and brazing materials, forging or hot pressing stock, and bolt and nut materials shall be as detailed in Table 2 or of equivalent quality.

5.3 Material test certificates

Test certificates shall be provided, covering the chemical and mechanical properties of materials used in the construction of calorifiers or storage vessel and for the hydraulic test of tubes, where these are called for in the purchase order.

6 Welding procedure and welder approval tests

A3 Text deleted **A3**

6.1 Grade A calorifiers and storage vessels

6.1.1 General

Manufacture of grade A calorifiers and storage vessels shall be in accordance with approved welding procedures and using approved welders.

6.1.2 Welding procedures

The preparation of welding procedures, the approval of welders, testing and the maintenance of records shall be the responsibility of the manufacturer.

6.1.3 Approval of procedure

A3 Approval testing of welding procedures for steel shall be conducted, recorded and reported in accordance with BS EN ISO 15614-1.

Approval testing of welding procedures for copper shall use the methods of testing welds given in BS EN 895³⁾, BS EN ISO 5173, BS EN 1320 or BS EN 1321. The copper test piece shall be subject to visual examination, penetrant testing and destructive tests. The number of test specimens shall be as listed in Table 1a. The

welding procedures shall be certified to BS 853 using relevant documentation and records complying with BS EN ISO 15614-1.

Each welding procedure test and the accompanying test results shall be recorded as Welding Procedure Approval Records as defined in BS EN ISO 15614-1.

Each welding procedure test shall be documented to include all items referred to in 6.1.4 or BS EN ISO 15609-1.**A3**

6.1.4 Welder approval

A3 Approval testing of welders for steel shall be conducted, recorded and reported in accordance with BS EN 287-1 as defined in Annex B of BS EN 287-1:2011.

Approval testing of welders for copper shall use the methods of testing welds given in BS EN 895³⁾, BS EN ISO 5173, BS EN 1320 or BS EN 1321. The copper test piece shall be subject to visual examination and destructive tests, augmented by penetrant testing if necessary. The number of test specimens shall be as given in Table 1b.

Welder approval shall be certified to BS 853 using relevant documentation and records taken from BS EN 287-1.**A3**

6.1.5 Reapproval of welder

For the purposes of this standard a welder's approval shall remain valid **A3** for a period of two years providing **A3** it can be shown, as signified at intervals of six months by a senior responsible person in the firm that employs the welder, that the welder has, subsequent to the test, been employed with reasonable continuity on work within the extent of his approval and has continued to produce satisfactory welds as verified by traceable records for the type of production work.

Table 1a — Number of test specimens required for procedure approval for copper (see note)

Test specimen	Butt joint in plate of thickness		Butt joint in pipe of thickness		Fillet weld in plate
	Less than 10 mm	10 mm and over	Less than 10 mm	10 mm and over	
Macro-examination	1	1	2	2	2
Transverse tensile	1	1	1	1	1
Root bend	2	0	2	—	—
Face bend	1	0	1	—	—
Side bend	0	2	—	2	—
Fillet weld fracture (for test piece with only single side weld)	0	0	—	—	3

NOTE When more than one specimen of a particular type is **A3** required, the specimens have to **A3** be taken as far apart as possible with one specimen for macro-examination taken from that part of the joint considered to have been welded in the most difficult welding position or from a stop/start position.

³⁾ Superseded, withdrawn.

Table 1b — Number of test specimens required for welder approval for copper (see note)

Test specimen	Butt joint in plate or pipe of thickness		Fillet weld in plate or pipe
	Less than 10 mm	10 mm and over	
Macro-examination	2	2	2
Root bend	1	—	—
Face bend	1	—	—
Side bend	—	2	—
Fillet weld fracture (for test piece with only single side weld)	—	—	3

NOTE When more than one specimen of a particular type is $\sqrt{A_3}$ required, the specimens have to $\sqrt{A_3}$ be taken as far apart as possible with one specimen for macro-examination taken from that part of the joint considered to have been welded in the most difficult welding position or from a stop/start position.

(Organization's symbol or logo)	Welder approval test certificate	Test record no.
Manufacturer's name	Welder's name and identity no.	Issue no.

Declaration

I, the undersigned, declare that the welder named above has been regularly and satisfactorily employed on work covered by this certificate during the six months preceding the date of my signature.

Date	Personal signature	Position or title

Figure 1a — Example of a history sheet

Reapproval shall be required if any of the following apply.

- The welder is to be employed on work outside the extent of his current approval.
- The welder changes his employer without the transfer of his test records.
- Six months or more have elapsed since the welder was engaged in welding on work within the extent of his approval. However, subject to the agreement of the inspecting authority, a complete reapproval test may be waived provided the first production weld by the welder is supplemented with $\sqrt{A_3}$ Text deleted $\sqrt{A_3}$ a bend test for copper.
- There is some specific reason to question the welder's ability.

$\sqrt{A_3}$ Reapproval of welders for steel shall be in accordance with BS EN ISO 15614-1. $\sqrt{A_3}$

Proof of the welder's continued use of the approved procedure shall be the maintenance of a history sheet such as that illustrated in Figure 1a.

7 Determination of scantlings design

7.1 Cylindrical shells

7.1.1 Calculated shell thickness

The calculated thickness t_c (in mm) of a cylindrical shell subject to pressure on its internal surface shall be determined from the following equation:

$$\sqrt{A_3} t_c = \frac{p D_i}{2 f J} + c \sqrt{A_3}$$

where

- p is the design pressure (in N/mm²);
- D_i is the internal diameter of the shell or, if the shell is made in more than one ring of plates and the circumferential seams are lapped, the diameter inside the outermost ring (in mm);
- f is the design stress value for the shell material from Table 1 (in N/mm²);
- c is the corrosion allowance, with a value of 1.0 mm for carbon steel and a value of 0 mm for copper or corrosion protected steel;

- J is the joint factor, which has the following values:
- a) for carbon steel, $J = 0.7$ when longitudinal seams are butt-welded (see Figure 1);
 - b) for copper, $J = 0.8$ when longitudinal seams are butt-welded (see Figure 2).
 - c) for copper, $J = 0.8$ when longitudinal seams are clenched and brazed.

7.1.2 Actual shell thickness

7.1.2.1 Carbon steel shells

In no case shall the actual thickness of material used for carbon steel shells be less than t_c , $0.005 D_i$ or 4.5 mm, whichever is the greater.

7.1.2.2 Copper shells

In no case shall the actual thickness of material used for copper shells be less than t_c , $0.002 D_i$, or the following, whichever is the greater;

- a) 1.4 mm for grade A calorifiers and storage vessels;
- b) 1.0 mm for grade B calorifiers and storage vessels.

7.2 Endplates

7.2.1 Domed ends

7.2.1.1 Form of domed end

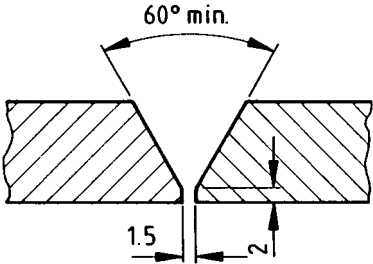
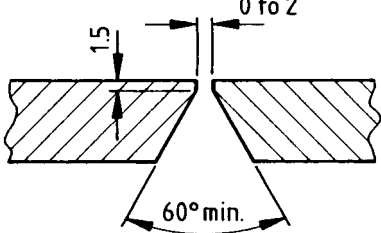
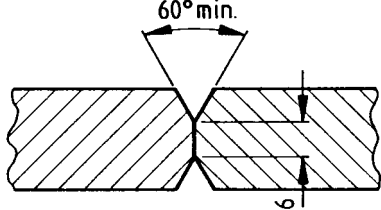
Domed ends shall be torispherical in form as shown in Figure 3.

Table 2 — Filler and brazing materials, forgings and hot pressing stock, bolt and nut materials

Material	British Standard designation	Relevant note(s)
<i>Filler rods, wires and fluxes for welding</i> For manual metal-arc welding of carbon steel For submerged arc welding of carbon steel For TIG and MIG welding of carbon steel For TIG and MIG welding of copper For gas welding of copper	BS EN ISO 2560 BS EN ISO 14171 and BS EN 760 BS EN ISO 14341, grade G4Si1 and BS EN ISO 636, grade AW423W3Si1 BS EN ISO 24373 ⁴⁾ BS 1453, grade C1	
<i>Brazing filler metals</i> Copper phosphorus	BS EN ISO 17672, grades CuP 284, CuP 281 and CuP 280	1
<i>Filler alloys for attaching steel non-pressure parts (e.g. support brackets) to copper shells</i> For bronze welding For flame brazing For soft soldering (tin content exceeding 33 %)	BS 1453, grades C2, C4, C5 or C6 BS 1845, grade CZ 112 ⁵⁾ BS EN ISO 9453	2
<i>Forging or hot pressing stock (for handhole fittings, etc.)</i> Copper Naval brass Aluminium bronze	BS EN 12165, grade CW024A BS EN 12165, grade CW712R BS EN 12165, grade CW307G	
<i>Bolts, studs, nuts and tie-bars</i> Steel Leaded brass Steel pipe fittings (for screwed connections)	BS 4882, BS 3692, BS 4190 or BS 4439 BS EN 12167, grade CW614N BS EN 10241	3 and 4
NOTE 1 For brazed seams exposed to aggressive water, which might give rise to dezincification or other forms of selective attack, brazing alloys in accordance with BS EN ISO 17672, grade CuP284 or grade CuP280 should be used. NOTE 2 Soft solders may be used only for the external attachment of brackets and similar fittings and may only be applied to parts not in contact with either the heated or the heating medium in the calorifier or storage vessel. Soft solder should not be used in the construction or assembly of electrical immersion heater sheaths. The operating temperature for soft solder should not exceed 150 °C. NOTE 3 Free cutting steels should not be used in the manufacture of calorifiers and storage vessels. NOTE 4 These standards include details of bolting in addition to details of materials. A3		

⁴⁾ Grade not determined.

⁵⁾ Superseded, withdrawn.

Joint	Preparation	Remarks
a) 	Close square butt	Plates having thickness not greater than 6 mm welded from both sides or up to 10 mm submerged arc welded from both sides
b) 	Single-V butt	Plates having thickness not greater than 16 mm with no inside access. First pass with tungsten inert gas (TIG) root run
c) 	Single-V butt	Plates having thickness not greater than 20 mm second side cut back to sound metal before welding
d) 	Double-V butt	Plates having thickness not greater than 20 mm submerged arc both sides

All dimensions are in millimetres.

NOTE Details of other weld preparations for carbon steel may be obtained from BS EN 1011-1 and BS EN 1011-2.

Figure 1 — Typical longitudinal and circumferential weld preparations for carbon steel calorifiers and storage vessels