BRITISH STANDARD

BS 1306:1975

Incorporating Amendment No. 1

Specification for

Copper and copper alloy pressure piping systems

UDC 621.643.24–987:669.3:621.642

Co-operating organizations

The Pressure Vessel Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices Technical Committee*
Association of Consulting Engineers*
Association of Shell Boilermakers
British Chemical Engineering Contractors' Association*
British Gas Corporation*
British Insurance (Atomic Energy)
British Mechanical Engineering Confederation
British Steel Industry*
Chemical Industries Association
Council of British Manufacturers of Petroleum Equipment*
Department of Employment
Department of Energy
Department of Trade
Electricity Supply Industry in England and Wales*
Engineering Equipment Users' Association*
Institution of Chemical Engineers
Institution of Gas Engineers*
Institution of Mechanical Engineers
Lloyd's Register of Shipping*
Oil Companies Materials Association
Process Plant Association*
United Kingdom Atomic Energy Authority
University of Manchester Institute of Technology and Science
Water-tube Boilermakers' Association
Welding Institute

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

Aluminium Federation
Association of Hydraulic Equipment Manufacturers
British Compressed Air Society
British Electrical and Allied Manufacturers' Association
BNF Metals Technology Centre
British Valve Manufacturers' Association
Copper Development Association
Department of Trade (Marine Division)
High Pressure Pipework Consultative Committee
Ministry of Defence

This British Standard, having been approved by the Pressure Vessel Industry Standards Committee, was published under the authority of the Executive Board on 30 September 1975

BS 1306-1 first published April 1946
BS 1306-1 first revision December 1955
BS 1306-2 first published November 1948
BS 1306-2 withdrawn as superseded by BS 2871-2:1972
BS 1306 first published September 1975

The following BSI references relate to the work on this standard:
Committee references PVE/10, PVE/10/2
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Amendments issued since publication

Amd. No.	Date of issue	Comments
3124	February 1980	Indicated by a sideline in the margin

Contents

Foreword

This British Standard is the second revision of BS 1306 and has been prepared under the authority of the Pressure Vessel Industry Standards Committee. This revised version is issued in one Part only since Part 2, withdrawn in 1973, has been superseded by BS 2871 "Copper and copper alloys — tubes", Part 2 "Tubes for general purposes". To reflect current requirements the title of this revision has been changed from that of BS 1306-1:1955.

This standard is one of a series on pressure piping. Complementary standards are BS 806 "Ferrous pipes and piping installations for and in connection with land boilers" and BS 5222 "Aluminium piping systems", Part 1 "Dimensions, materials and construction of components" and Part 2 "Design".

For those items in the system for which separate British Standards exist, only references to such standards are given in this revision. The design stresses specified in this standard have been supplied by the BNF Metals Technology Centre, who based their recommendation on BS 3274 "Tubular heat exchangers for general purposes".

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 and ii, pages 1 to 8, an inside back cover and a back cover.

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

Section 1. General

1 Scope

This British Standard specifies the design, manufacture, installation and inspection of copper and copper alloy pipework subject to internal pressure for industrial and marine systems. The following systems are specifically covered:

a) steam boiler, feed and hot water;

b) hydraulic (water or oil);

c) oil fuel (BS 799);

d) pneumatic and gas;

e) refrigeration and cryogenic.

This standard does not specifically apply to piping systems for petroleum refineries and petrochemical plants, which are covered by BS 3351.

NOTE Users of this standard, when applying it to marine work, should note that it is essential to ensure compliance with such statutory requirements, rules and regulations of the Regulatory Bodies and classification societies concerned. Attention is also drawn to the requirements of BS MA 18, BS MA 51, BS MA 60 and BS MA 67.

2 References

The titles of the British Standards 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
design pressure

the value of pressure to be used for the calculation of pipe thickness. It is to be not less than the highest set pressure of any safety valve or protective device

3.2
design temperature

the design temperature to be considered for determining the design stress in Table 1 is, in general, the maximum temperature of the medium inside the pipe

3.3
test pressure

the pressure to which the system and its components are subjected under test conditions (see clause **23**)

4 Information to be supplied by the purchaser

The purchaser of the system shall state the following in all enquiries and orders:

a) the system requirements and environment, including the design pressures and temperatures, and service conditions for all pipes and equipment which are to comply with the requirements of this standard;

b) the name of the Inspecting Authority, if any;

c) any special statutory or other regulations with which the pipes or piping installations are required to comply;

d) method of pipe joining;

e) whether or not the purchaser or his representative desires to witness the tests;

f) whether test certificates are required;

g) whether the required material has to be suitable for hot bending (see clause **18**);

h) cleanliness requirements of the installed system (see clause **22**).

5 Materials

Materials shall normally be copper or copper alloy and shall comply with one of the following standards except as otherwise agreed between manufacturer and purchaser.

a) *Tubes.* Materials shall be selected from Table 1 of this British Standard.

b) *Flanges.* Materials shall comply with the requirements of BS 4504-2.

c) *Castings.* Materials shall comply with the requirements of BS 1400 or of Table 1 in BS MA 18:1974.

d) *Fittings.* Materials for fittings shall comply with the requirements of BS 66 & BS 99, BS 143 & BS 1256, BS 864-2, or BS 2051-1.

In certain applications materials other than copper alloys, as specified in one of the following standards, may be used, or may be as otherwise agreed between manufacturer and purchaser.

e) *Flanges.*Materials shall comply with the requirements of BS 4504-1.

f) *Castings.*Materials shall comply with the requirements of Table 1 in BS MA 18:1974.

g) *Fittings.*Materials for fittings shall comply with the requirements of BS 143 & BS 1256 or BS 4368-1 and BS 4368-3.

NOTE Normal precautions against corrosion should be observed in the choice of materials in their particular application and environment.

Table 1 — Mechanical properties and design stresses for copper and copper alloy seamless pipe and tubes

Material	Designation	BS 2871: Part no.	Condition	Tensile strength (min.)	0.2 % Proof stress (min.)	Values of design stress for metal temperatures not exceeding											
						–200 °C to 50 °C	100 °C	150 °C	175 °C	200 °C	225 °C	250 °C	275 °C	300 °C	325 °C	350 °C	375 °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	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2
Copper	C106 or C107	2	Annealed 0	200	62	41	40	34	26	18							
			Light drawn ½H	250	93	62	59	55	34	18							
			As drawn M	280	108	70	69	55	34	18							
Aluminium brass	CZ110	2	Annealed 0	300	108	72	71	69	54	25	15						
Special 70/30 arsenical brass	CZ126	2	Annealed 0	280	108	70	69	67	57	25	15						
90/10 Cu-Ni-Fe	CN102	2	Annealed 0	300	108	72	70	66	63	60	58	54	49	44			
70/30 Cu-Ni	CN107	2	Annealed 0	350	123	82	79	77	76	75	73	72	71	70	68	65	61
7 % aluminium bronze	CA102	3	Annealed 0	390	128	85	82	80	67	44	31	18					
Al-Ni-Si brass	CZ127	2	Annealed 0	380	115	76	74	71	69	66	63	53	43	33			
			Heat treated WP	420	220	105	102	94	84	74	63	53	43	33			

NOTE For copper tubes that are heated during fabrication or joining, see **6.2** to **6.5**.

Section 2. Design requirements

6 Maximum permissible design stresses and temperatures

6.1 The temperature limits within which pipes and pipe fittings of copper and copper alloy materials are permitted to be used and maximum design stress values are given in Table 1.

6.2 If copper tubes in the ½H or M condition are heated during fabrication or jointing to temperatures not exceeding 600 °C the 0 condition values shall be used for design calculations.

6.3 If copper tubes in the 0.½H or M condition are heated during fabrication or jointing to temperatures over 600 °C then values of design stress lower than those given for the 0 condition shall be agreed between manufacturer and purchaser.

6.4 Heating of Al-Ni-Si brass tubes in the WP condition to temperatures over 700 °C during fabrication or jointing will cause a reduction in strength. In such situations either the design stress values for the 0 condition shall be used or the properties shall be restored to those of the WP condition by a precipitation treatment as described in **19.3**.

6.5 The design stress values for Al-Ni-Si brass in the WP condition and other copper alloys in the 0 condition are applicable to systems where normal, accepted fabrication and jointing procedures are used. They do not apply to abnormally prolonged heating during fabrication and in such cases the manufacturer shall be consulted with regard to the condition of the material.

7 Thickness of straight pipes

7.1 The minimum thickness of straight pipes shall be determined by the following equation.

$$t = \frac{pd}{p + 20F} \qquad (1)$$

where

t is the minimum thickness (mm)

p is the design pressure (bar[1])

d is the outside diameter of the pipe (mm)

F is the design stress (N/mm^2)

7.2 Normally no corrosion allowance is necessary for copper or copper alloy pipes. The value of t is the minimum thickness; provision shall be made for minus tolerances. Where the conditions of service are such that corrosion, erosion or mechanical damage to the surface of the tubes may occur, an appropriate thickness allowance shall be added to the thickness derived from equation 1. Alternatively the thickness allowance shall be in accordance with the requirements of the Regulatory Bodies.

8 Thickness of pipe bends

8.1 The minimum thickness of bent seamless copper and copper alloy pipes shall be determined as follows.

$$t_b = t + b \qquad (2)$$

where b is the bending allowance (mm)

The value of allowance b is such that the calculated stress in the bend, due to internal pressure only, does not exceed the allowable stress given in Table 1.

8.2 Where the bending allowance is not determined by the procedure in **8.1**, the allowance is to be not less than the value derived from the following equation.

$$b = \frac{d}{2.5r} \times t \qquad (3)$$

where

d is the outside diameter of the tube (mm)

r (> 3d normally) is the radius of curvature of the bend measured to the centre line of the pipe (mm)

9 Thickness for test pressure

If the pipes are to be tested to pressures greater than the working pressure, e.g. 1.5 times the working pressure, then the conditions given in clause **23** shall apply.

10 Joints

10.1 General. The type of joint used shall be suitable for the pipe materials, pressure and temperature conditions, the medium handled and the mechanical strength required under service conditions.

Pipes may be joined by welding, brazing, soldering or mechanical means, as agreed between the purchaser and the manufacturer.

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

10.2 Pipe joints. Pipe joints shall be as specified in the following list.

a) Unless otherwise specified by the purchaser, flanges shall comply with the requirements of BS 4504-2.

b) Fittings shall comply with the requirements of clause **5** d) and shall meet the design requirements of the system. Where pipe connector threads are used for the attachment of fittings or flanges, the threads shall comply with the requirements of BS 21, BS 61 or BS 2779, as appropriate.

NOTE Other fittings, subject to agreement by the purchaser, may be selected by the manufacturer to meet the requirements of **10.2** c) or clause **11**.

c) Proprietary types of fittings may be used for the assembly of smaller sizes of copper pipe of a diameter up to and including 57 mm. These fittings can be either capillary or compression types with socket diameter tolerances complying with the requirements of BS 864-2 and BS 2051; the capillary may be either integral solder ring type or end feed type. The manufacturer's recommendations for the procedures to be adopted for cleaning, fluxing and heating should be adhered to for the production of sound joints.

d) Compression fittings may be either the non-manipulative type, in which a ring is compressed onto the outside surface of the tube in the joint, or the manipulative type, which requires the end of the tube to be flared. When brass tube ends are flared for use with these joints; they should be stress relieved after flaring. Because of the danger of stress corrosion cracking, non-manipulative types shall not be used with brass pipes.

Where non-manipulative type fittings are to be used with soft temper tubes, reference should be made to the manufacturer to ensure that the make of the fittings is suitable for the application. Manipulative fittings are not suitable for use with hard temper tubes.

11 Branches

These may take the form of castings, forgings, extrusions or fabrications. Designs leading to a more streamlined flow into the branch will reduce turbulence and thus decrease the risk of corrosion by impingement attack. Swept or angled branches are therefore preferred to the right angled type. For branches of 57 mm diameter or less, proprietary types of tee-piece fitting may be used.

NOTE Reinforcement of the branches may be necessary, particularly for pipes of large diameter. The requirement for the means of reinforcement should be agreed between manufacturer and purchaser.

12 Expansion allowance

The allowance for expansion of copper and various copper alloys shall be based on Table 2.

13 Flexibility

13.1 Piping systems are to be designed with adequate flexibility so that expansion of the piping and equipment together with vibration will not result in overstressing of the system or leakage at joints.

13.2 Flexibility can be provided where practicable by the use of plain piping bent to a suitable radius.

13.3 Alternatively, or where space limitations prevail, flexible pipes, flexible joints or bellows expansion pieces may be used. These are essential for connection to resiliently mounted equipment. They shall be installed in an undistorted condition.

13.4 The pressure of fluid in a piping system can result in distortion, particularly of bends, branches and flexible units, if adequate anchorage is not provided.

13.5 Pipework adjoining flexible units shall be supported as closely as possible to the flexible unit. The support shall be designed to prevent the pressure loads transmitted by the flexible unit which distort the attached pipework and equipment.

14 Pipework supports

The design of supports shall be capable of adequately supporting the piping system without undue distortion. In addition to supporting gravitational loads, the supports shall provide for concentrated loads imposed by valves and risers and for axial loadings due to expansion and the pressure of fluid.

15 Drainage of steam systems

Provision shall be made for the removal of water (whether formed continuously or only occasionally) from the system. In addition, provision shall also be made for complete drainage of the working fluid.

16 Venting

Provision shall be made for the installation of either manual or automatic types of vents at the high point(s) of the system for clearance of the pipeline and equipment. Where such devices are of an automatic type they shall clear the system without loss of the process or service fluid carried.

Table 2 — Coefficient of linear thermal expansion (20 °C to 300 °C)

Material	Designation	Temperature range °C	Expansion per °C × 10^{-6}
Copper	C106 or C107	20 to 200	17
Aluminium brass	CZ110	20 to 200	19
		20 to 300	20
Special 70/30 arsenical brass	CZ126	20 to 100	19
		20 to 300	20
90/10 copper-nickel-brass	CN102	20 to 300	17
70/30 copper-nickel	CN107	20 to 300	16
7 % aluminium bronze	CA102	20 to 100	16
		20 to 300	17
Al-Ni-Si brass	CZ127	20 to 200	19

Section 3. Construction and workmanship

17 General

Pipes and components shall be stored in a clean dry condition and be free from mechanical or other damage.

18 Manipulation

18.1 Wherever practicable the centreline radius of bends for pipes shall be not less than three times the outside diameter of the pipe.

18.2 It is recommended that copper and copper alloy pipes shall be cold bent on a machine, preferably with a mandrel attachment, or on a machine using the principle of an internal rotary cold rolling head.

18.3 All tools used in the process shall be of a size appropriate to the tube being bent and be in a good clean operating condition, free from damage, cracks or other defects. The tools should preferably be confined to use with copper and copper alloys only.

18.4 Where pipes are required to be stress relieved after cold bending, or are otherwise heated in the vicinity of the bend (see **19.1**), a water soluble oil or soap shall be used to lubricate the mandrel during bending. The residual lubricant after bending shall be completely removed from the bore of the pipe before commencing any heat treatment.

18.5 For larger sizes of pipe where no mandrel is available, filler materials should be used, such as sodium thiosulphate (hypo), synthetic wax, resin, or mixtures of resin and pitch. Because of the difficulty of ensuring complete removal of deleterious residues of resin or mixtures of resin and pitch fillers, such fillers should not be used for pipelines conveying fresh water or sea water.

18.6 Bends made on machines, with or without mandrel attachments, shall be smooth and free from wrinkles. Wrinkles formed on filled tubes bent on a machine or by a press shall be dressed before the filler is removed. Bends containing sharp wrinkles that cannot be dressed back to form a smooth surface in the throat shall be deemed not to comply with the requirements of this standard. Dressing, which shall be kept to a minimum, shall be carried out by appropriate coppersmithing tools maintained in good condition.

18.7 The copper and copper alloy pipes listed in Table 1, except those of designation CN102, CN107 and CZ127, may be hot bent. The pipes shall be filled with clean, dry silica sand which is free from metallic or carbonaceous contamination.

19 Heat treatment and final condition

19.1 Stress relieving. This treatment does not significantly soften pipes, but does reduce to a safe level the adverse tensile stresses induced by cold working operations.

Stress relieving of copper and copper alloy pipes shall be subject to agreement between the purchaser and manufacturer, having due regard to the operating environment and the degree of cold work being undertaken.

NOTE Stress relieving, where required, should preferably be carried out in a pyrometrically controlled furnace.

19.2 Annealing. Materials that have been hardened by cold work can be softened by the following annealing treatments.

Copper and 70/30 brass	600 °C to 650 °C
Aluminium brass	625 °C to 675 °C
7 % aluminium bronze	650 °C to 700 °C
Al-Ni-Si brass	750 °C to 800 °C
90/10 Cu-Ni-Fe	750 °C to 800 °C
70/30 Cu-Ni	800 °C to 850 °C

The temperature of the pipes shall be maintained within the above ranges for not less than 10 min.

NOTE Wherever practicable these heat treatments should be carried out in a pyrometrically controlled furnace.

Al-Ni-Si pipes shall be cooled rapidly from the annealing temperature. Pipes of this material that have been annealed can be converted to the WP condition by the further heat treatment specified in **19.3**.

19.3 Precipitation treatment. CZ127 (Al-Ni-Si brass) pipe heated in the course of fabrication or jointing to temperatures in excess of 700 °C shall be precipitation treated at a temperature of 400 °C to 550 °C for 30 min and air cooled. This treatment basically restores the properties of the pipe to those stated for the WP condition in Table 1.

19.4 Other forms of heating. If no suitable pyrometrically controlled furnace is available, the pipes may be stress relieved or annealed with one or more suitable gas torches. The torches shall be adjusted to give an appropriate size of neutral to slightly reducing flame large enough to heat the pipe to the required temperature range uniformly and moderately quickly. If torch heating is used, temperature-indicating crayons, optical pyrometers or contact pyrometers shall be used to measure the temperature of the pipe.

19.5 Pickling (acid cleaning). After all hot or cold forming, removal of residues and stress relieving operations have been completed, the tubes may be acid cleaned as agreed between the purchaser and the manufacturer.

20 Permanent joining methods

20.1 Soldering. Soldering shall be carried out using appropriate solders that comply with the requirements of BS 219. The maximum working temperatures and pressures of joints shall not exceed those given in Table 1 of BS 864-2:1971.

20.2 Brazing. Brazing shall be carried out so as to comply with the requirements of BS 1723 or, where appropriate, BS MA 18. The maximum working temperatures for brazed joints shall not exceed 200 °C. Unless otherwise specified, the composition of brazing filler metals used for socket type joints in copper alloys and to attach flanges and other fittings shall be as detailed in Table 2 of BS 1845:1977 (group AG, silver brazing filler metals). Types AG1 and AG5 are particularly recommended for sea water application. Similar socket type joints in copper can also be made using an filler metal selected from Table 3 of BS 1845:1977 (group CP, copper-phosphorus brazing filler metals).

On no account shall group CP filler metals be used with alloys containing nickel or iron.

20.3 Bronze welding. Where corrosion by dezincification of the weld fillet or bead is not a hazard, the welding shall be in general accordance with BS 1724. The joining by this process is generally confined to copper only and not to its alloys.

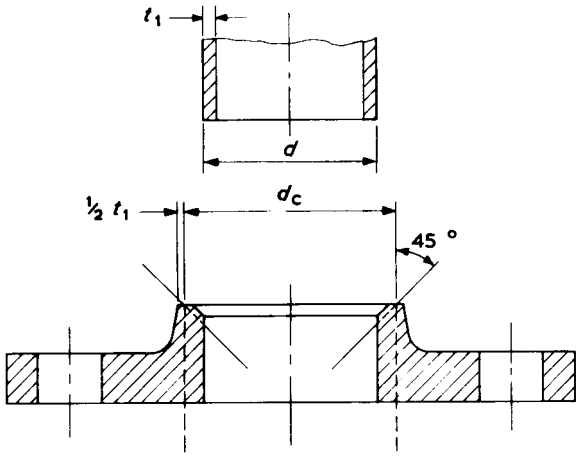

Figure 1 — Modified weld preparation for bronze welding complying with the requirements of BS 1724

The composition of the filler alloys used shall be as detailed in Table 4 of BS 1453:1972.

20.4 Gas shielded are welding (TIG or MIG welding). The fusion welding of pipelines in copper or copper alloy shall be by means of the inert gas tungsten arc or the inert gas metal arc process only. Fusion welded joints in copper pipelines shall comply with the requirements of BS 1077. Tests of fusion welded joints in copper alloys, if required by the purchaser, shall comply with the requirements of BS 4206.

Where appropriate the welding of aluminium brass, 90/10 Cu-Ni-Fe and 70/30 Cu-Ni pipelines shall comply with the requirements of BS MA 18. Filler metals for gas shielded arc welding of copper and copper alloys shall comply with the requirements of BS 2901-3.

NOTE Components made from leaded gun-metals are not generally recommended for gas shielded arc welding.

20.5 Oxy-acetylene welding. Oxy-acetylene welding of copper pipelines using copper filler materials is not recommended, since the weld bead cannot be hammered to improve the mechanical properties of the joint.

20.6 Other joining processes and methods. In all the joining processes referred to in this clause, other filler metal compositions may be used provided they have been proved to be at least equal in compatibility, strength and corrosion resistance to the filler metal quoted in the appropriate standards. The use of such filler metal, however, is subject to agreement between purchaser and manufacturer.

For an example of a method of steel flange preparation for welding to copper-nickel alloy pipes, see Figure 2.

21 Attachment of flanges and fittings

21.1 General. Flanges are generally attached to pipes by brazing, bronze welding (braze welding) or fusion welding (see clause **20**). Where flanges are attached by screwing in copper and copper alloys (now very little practised), the screw thread shall comply with the requirements of BS 61-2.

21.2 Chamfer. A 45° chamfer shall be machined in the bore of the collar at the back of the flange (see Figure 1). The maximum diameter of the chamfer shall be equivalent to the outside diameter of the pipe plus 4 times the thickness of the pipe or the outside diameter of the collar minus one thickness of pipe, whichever is the greater. The following equation demonstrates the former method of calculation.

$$d_c = d + 4t \qquad (4)$$

where

d_c is the diameter of the chamfer
d is the outside diameter of the pipe
t is the thickness of the pipe

22 Cleanliness

Immediately before erection and after erection, all parts of piping installations shall be checked for internal cleanliness appropriate to the medium being used.

23 Inspection and testing

Before conducting any system pressure test, the user shall be assured that all individual components have been pressure tested in accordance with the appropriate product standards. In the case of fabricated components for which product standards are not available, the user shall be assured that such components have been pressure tested individually or as part of a sub-system to a pressure test of 1.5 times the design pressure.

The final test shall be a system test to determine the integrity of the system, for which the test pressure shall normally be 1.3 times the design pressure. The maximum test pressure shall be 1.5 times the design pressure.

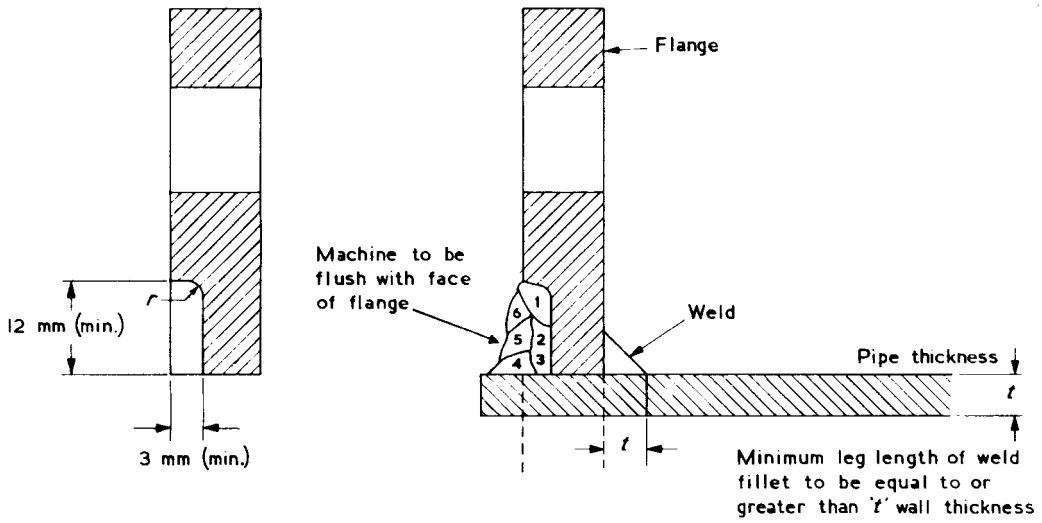

Figure 2 — A method of steel flange preparation for welding to copper-nickel alloy pipes

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Publications referred to

This standard makes reference to the following British Standards:

BS 21, *Pipe threads for tubes and fittings where pressure-tight joints are made on the threads.*

BS 61, *Copper tubes (heavy gauge) for general purposes.*

BS 61-2, *Threads for light gauge copper tubes and fittings.*

BS 66 & BS 99, *Cast copper alloy pipe fittings for use with screwed copper tubes.*

BS 143 & BS 1256, *Malleable cast iron and cast copper alloy screwed pipe fittings for steam, air, water, gas and oil.*

BS 219, *Soft solders.*

BS 799, *Oil burning equipment.*

BS 864, *Capillary and compression tube fittings of copper and copper alloy.*

BS 864-2, *Metric units.*

BS 1077, *Fusion-welded joints in copper.*

BS 1400, *Copper alloy ingots and copper and copper alloy castings.*

BS 1453, *Filler materials for gas welding.*

BS 1723, *Brazing.*

BS 1724, *Bronze welding by gas.*

BS 1845, *Filler metals for brazing.*

BS 2051, *Tube and pipe fittings for engineering purposes.*

BS 2051-1, *Copper and copper alloy capillary and compression tube fittings for engineering purposes.*

BS 2779, *Pipe threads where pressure-tight joints are not made on the threads.*

BS 2871, *Copper and copper alloys, tubes.*

BS 2871-2, *Tubes for general purposes.*

BS 2901, *Filler rods for gas-shielded arc welding.*

BS 2901-3, *Copper and copper alloys.*

BS 3351, *Piping systems for petroleum refineries and petrochemical plants.*

BS 4206, *Methods of testing fusion welds in copper and copper alloys.*

BS 4368, *Carbon and stainless steel compression couplings for tubes.*

BS 4368-1, *Heavy series.*

BS 4368-3, *Light series (metric).*

BS 4504, *Flanges and bolting for pipes, valves and fittings. Metric series.*

BS 4504-1, *Ferrous.*

BS 4504-2, *Copper alloy and composite flanges.*

BS MA 18, *Salt water systems in ships.*

BS MA 51, *Summary and application of pipework flanges for marine use.*

BS MA 60, *Copper and copper alloy tubes for marine pipework systems.*

BS MA 67, *Summary and application of pipe couplings for use in marine pipework systems.*

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