British Standard

BRITISH STANDARD

BS 2971 : 1991

Including Amendment No. 1, not issued separately

Specification for

Class II arc welding of carbon steel pipework for carrying fluids

ICS 25.160.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Welding Standards Policy Committee (WEE/-) to Technical Committee WEE/21, upon which the following bodies were represented:

Associated Offices Technical Committee
British Gas plc
British Non-ferrous Metals Federation
British Nuclear Fuels Ltd.
Electricity Association
Engineering Equipment and Materials Users' Association
Health and Safety Executive
Heating and Ventilating Contractors' Association
Institute of Refrigeration
Institution of Gas Engineers
Institution of Mechanical Engineers
Joint Industry Board for Plumbing Mechanical Engineering Services in England and Wales
National Association of Plumbing, Heating and Mechanical Services Contractors
Power Generation Contractors' Association (BEAMA Ltd.)
Stainless Steel Fabricators' Association of Great Britain
United Kingdom Atomic Energy Authority
Welding Institute
Welding Manufacturers' Association (BEAMA Ltd.)

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Amendments issued since publication

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Foreword

This revision of this British Standard has been prepared under the direction of the Welding Standards Policy Committee. It embodies the technical developments that have taken place since the 1977 edition, which is superseded and withdrawn. On common aspects the standard has generally been aligned with BS 2633.

The relevant application standard, where it exists, should specify whether class II welding of pipework is required, but the factors to be taken into account in coming to such a conclusion are the operating conditions of the pipework, the degree of inspection and the acceptance requirements (see also appendix A).

It is recommended that carbon steels with a carbon content exceeding 0.25 % and all ferritic alloy steels be welded in accordance with BS 2633 irrespective of the operating conditions.

Purchasers ordering to this standard are advised to specify in their contracts that the manufacturer operates a quality system in compliance with the appropriate standard in the BS EN ISO 9000 series to assure themselves that pipework claimed to have been welded in accordance with BS 2971 consistently achieves the required level of quality.

The following are companion standards to this standard.

BS 1821	Specification for class I oxy-acetylene welding of ferritic steel pipework for carrying fluids
BS 2633	Specification for class I arc welding of ferritic steel pipework for carrying fluids
BS 2640	Specification for class II oxy-acetylene welding of carbon steel pipework for carrying fluids
BS 4204	Specification for flash welding of steel tubes for pressure applications
BS 4677	Specification for arc welding of austenitic stainless steel pipework for carrying fluids

Inspecting authority. For the purposes of this British Standard the term 'inspecting authority' refers to that competent independent body or association which verifies compliance with this standard.

Contracting parties. For the purposes of this British Standard, the term 'contracting parties' is intended to cover the purchaser, the manufacturer and the inspecting authority in any relevant combination according to the particular circumstances.

Pipe and tube. For the purposes of this British Standard the word 'pipe', alone or in combination, is used to mean 'pipe' or 'tube' although these terms are often used for different categories of product by different industries.

Pipework dimensions. Unless otherwise qualified, for the purposes of this British Standard 'pipe diameter' relates to the nominal value of the outside diameter and 'pipe thickness' relates to the nominal value of the wall thickness specified in the standard to which the pipe is ordered.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Section 1. General

1 Scope

This British Standard specifies requirements for both shop and site class II arc welding of joints in carbon steel pipework intended to carry fluids. It covers manual, automatic or semi-automatic arc welding or combinations of these processes, but it also allows joints to be made with an oxy-acetylene root run without a backing ring by agreement between the contracting parties.

NOTE 1. For details of oxy-acetylene welding see BS 2640.

This standard is only applicable where there is adequate access available for welding and, when required, non-destructive testing.

NOTE 2. In cases of poor access, a mechanical connection could be used.

In addition to the definitive requirements, this standard also requires the items detailed in clause **2** to be documented. For compliance with this standard, both the definitive requirements and the documented items have to be satisfied.

NOTE 3. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Information and requirements to be agreed and to be documented

2.1 Information to be supplied by the purchaser

The following information to be supplied by the purchaser at the contract stage shall be fully documented. Both the definitive requirements specified throughout the standard and the documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

a) The application standard to be used, if any.

b) Whether records of materials used during fabrication are required (see **3.2**).

c) Whether permanent backing rings are required (see **8.1**).

d) Whether all welds are to be heat-treated after welding (see **18.1**).

e) Whether completed welds are to be ground (see **32.1**).

f) The category required for non-destructive testing of butt joints (see **34.1**).

g) Whether a written welding procedure specification is required (see **39.1**).

h) Whether an approved welding procedure is required to be used (see **39.2**).

i) Whether welding procedure tests using pipe of specified diameter and thickness are required (see **39.3**).

2.2 Requirements to be agreed

The following items to be agreed between the contracting parties, which are specified in the clauses referred to, shall be fully documented. Both the definitive requirements specified throughout the standard and the following documented items shall be satisfied before a claim of compliance with the standard can be made and verified.

a) The materials to be used for pipes and attachments (see **3.1**).

b) The precautions in inspection and welding procedure required when welding cast parts (see **3.3**).

c) The joint preparation to be used (see clause **9**).

d) The precautions to be taken when design factors are such that the meeting of more than two welded seams cannot be avoided (see clause **10**).

e) The service conditions for which gusseted bends are to be used (see **21.1**).

f) Details of joint design and fabrication when the branch angle is less than 60° (see **23.1**).

g) The method and amount of inspection for partial penetration welds on structural attachments (see **28.2**).

h) The use and extent of non-destructive testing (see clause **33**).

i) The inspection and testing requirements for other than butt joints (see **34.2**).

j) The use of a joint preparation incorporating a wider root gap for making a repair weld (see **37.3**(c)).

3 Parent metal

3.1 The parent metal for pipes (including those with a longitudinal or helical welded seam) and attachments shall be carbon or carbon-manganese steel containing not more than 0.25 % carbon. The materials selected shall be agreed between the contracting parties, taking account of their suitability for the service conditions (see **2.2**(a)).

NOTE. Appendix B gives details of grades in British Standards for the type of steel given in **3.1** and nearest similar grades in ASTM and DIN standards for pipe.

3.2 When required by the purchaser, the manufacturer shall maintain records of the materials used during fabrication (see **2.1**(b)).

3.3 While the requirements of this standard apply also to the welding of cast parts, additional precautions in inspection and welding procedure that may be necessary to deal with the presence of non-metallic inclusions or porosity shall be subject to agreement between the contracting parties (see **2.2**(b)).

4 Weld metal

4.1 Mechanical properties and chemical composition

The mechanical properties of the weld metal shall be suitable for the design requirements of the pipework system.

NOTE 1. In general, the requirements for yield strength should be at least equal to the minimum in the specification for the parent metal.

The chemical composition of the weld metal, including that from fusible inserts, shall be compatible with that of the parent material. The use of hydrogen-controlled weld metal shall be as given in **17.3**.

NOTE 2. The requirements of this clause are met by welding consumables of the types stated that comply with the following British Standards:

covered electrodes for manual metal-arc welding with BS EN 499;

filler materials for gas-shielded arc welding with BS EN 440;

filler wire/flux combinations for submerged-arc welding with BS EN 756 and BS EN 760;

tubular cored electrodes for arc welding with BS 7084.

As submerged-arc welding conditions can have a significant effect on the chemical composition of the weld metal, the welding conditions shall be controlled to ensure that the correct weld metal composition is consistently achieved.

4.2 Storage and handling

Electrodes, filler wires and rods, and fluxes shall be stored and handled in accordance with the manufacturer's recommendations so as to avoid damage or deterioration to them and to the containers in which they are transported. Electrodes, filler wires and rods, and fluxes that show signs of damage or deterioration shall not be used.

5 Gases for shielding and purging

5.1 Shielding gases

Where appropriate, gases or gas mixtures of the following quality shall be used.

a) *Argon*, complying with BS EN 439.

b) *Argon/oxygen mixtures*, consisting of argon with up to 5 % added oxygen and complying with BS EN 439.

c) *Argon/carbon dioxide mixtures*, consisting of argon with up to 20 % added carbon dioxide with or without up to 5 % oxygen and complying with BS EN 439.

d) *Argon/hydrogen mixtures*, consisting of argon with up to 5 % added hydrogen and complying with BS EN 439.

e) *Carbon dioxide*, complying with BS EN 439.

f) *Other gases or gas mixtures*, that have been proved to be satisfactory as a result of procedure approval tests.

NOTE. Certain gases are heavier than air and therefore precautions should be taken to ensure adequate ventilation and extraction for all welding processes.

5.2 Gases for back purging

For purging the back of a weld during welding, argon, argon/hydrogen mixtures or helium as specified in **6.1** one of the following gases shall be used:

a) *Nitrogen*, complying with BS EN 439.

b) *Nitrogen/hydrogen mixtures*, consisting of nitrogen, with up to 5 % hydrogen and complying with BS EN 439.

6 Equipment

Welding plant, instruments, cables and accessories shall comply with the appropriate Parts of BS 638, BS EN 50078, BS EN 60974-11 and BS EN 60974-12. Their capacity shall be adequate for the welding procedure proposed to be used.

The installation, operation and maintenance shall be effected by competent persons in accordance with the appropriate safety recommendations. All electrical equipment used in connection with the welding operation shall be adequately earthed.

NOTE. Attention is drawn to the advice on safety precautions contained in Guidance Note PM 64 'Arc welding electrical safety' issued by the Health and Safety Executive and published by HM Stationery Office.[1)]

Adequate means of measuring current shall be available either as part of the welding plant or by the provision of a portable ammeter. In the case of semi-automatic, automatic and mechanized welding, means shall be provided for measuring the arc voltage since this may exert considerable influence on the form, composition and soundness, e.g. porosity, of the weld. When using a gas-shielded welding process, means of measuring the gas flow shall be provided.

Where necessary, staging and protection from the weather shall be provided to enable the welding operation to be performed properly.

[1)] Available from The Stationery Office, 49 High Holborn, London WC1 for personal callers, or by post from The Stationery Office, PO Box 276, London SW8 5DT.

7 Welding processes

7.1 Complete welds

Welds shall be made by one of the following welding processes or by a combination of those processes:

manual metal-arc welding

MIG welding

metal active-gas welding

TIG welding

submerged-arc welding

tubular cored arc welding with or without gas-shielding.

7.2 Root runs

Methods of making the initial root run in butt joints by the various welding processes shall be as given in table 1.

Table 1. Methods of making initial root runs in butt joints[1)]

Welding processes	Type of joint
Manual metal-arc welding MIG welding Metal active-gas welding Tubular cored arc welding with or without gas-shielding	With temporary[2)] or permanent (if permitted, see **8.1**) backing ring or unbacked without purge
TIG welding: a) with fusible insert b) without fusible insert but using filler wire c) fusing root without using either fusible insert or filler wire	Backed or unbacked with or without purge
Submerged-arc welding	With temporary[2)] or permanent (if permitted, see **8.1**) backing ring

[1)] By agreement between the contracting parties, joints in certain materials may be made with an oxy-acetylene root run without a backing ring (see BS 2640).

[2)] The use of temporary backing rings is dependent upon access for their removal on completion of the weld (see also clause **8**).

8 Backing rings

8.1 Permanent steel backing rings

When permanent steel backing rings are permitted by the application standard or are required by the purchaser (see **2.1**(c)), the gap between the outside diameter of the backing ring and bore of the pipe end shall not exceed 1 mm.

Backing rings fitting tightly into machined recesses with square or sharp corners, or of such a shape as to restrict longitudinal contraction, shall not be used as they increase the tendency to weld root crack formation.

When a machined backing ring is split to allow it to spring against the internal surface of the pipe, the gap between the ends of the split ring, after fitting, shall not exceed 3 mm.

8.2 Material for permanent or temporary steel backing rings

Backing rings shall be of carbon steel up to 0.25 C provided that the sulphur and phosphorus contents do not exceed 0.050 % each.

NOTE. A high or segregated sulphur content in the backing ring may produce flaws at or in the root run.

9 Joint preparations

Joint preparations shall be agreed between the contracting parties (see **2.2**(c)).

NOTE. Typical joint preparations are given in appendix C.

10 Proximity of welds

The design of joints shall be such as to provide adequate access for the deposition of weld metal to comply with this standard.

If design factors are such that the meeting of more than two welded seams cannot be avoided, then appropriate precautions shall be taken which shall be agreed between the contracting parties (see **2.2**(d)).

11 Fusion faces

The fusion faces and the adjacent material shall be free from moisture, scale, rust, paint, grease or other foreign matter immediately prior to welding.

NOTE. Certain proprietary protective coatings are specially formulated with the intention that they should not interfere with subsequent welding. The use of such coatings is not excluded by the requirements of this clause but, if so required by the purchaser, the manufacturer should demonstrate their acceptability by means of specimen welds (see BS 6084).

12 Assembly for welding

To maintain the specified alignment and gap, where used, during welding (see **20.1**), the parts to be welded shall be securely held in position by mechanical means, welded-on bridge pieces or by tack welding.

NOTE. The dimension of the root gap is the dimension after tack welding. It is appreciated that there may be difficulty in complying strictly with the specified requirements for the root gap. Slight modifications imposed by practical considerations may be permitted.

The preheating requirements given in clause **17** shall be applied and maintained during tack welding and the welding-on of bridge pieces or other attachments.

Electrodes or filler materials used for tack welding shall be of the same type and class as, and of a size not larger than, those to be used for completing the first run of weld metal.

Attention shall be paid to the quality of tack welds. The throat thickness of tack welds shall be similar to that of the initial root run. Where necessary, the extremities of these tack welds shall be dressed by grinding or chipping to facilitate proper fusion when they are incorporated in the root run. All cracked tack welds shall be completely removed.

When used, clamps for aligning pipes shall not be removed until at least half the root run has been completed and is uniformly distributed round the circumference of the joint.

Where welded-on bridge pieces are used, the pipe surfaces shall not be left in a damaged condition after the bridge pieces are removed.

13 Purging

When back purging, air shall be removed in the vicinity of the weld by the admission of a sufficient volume of purging gas such that oxidation of the penetration bead is prevented.

14 Damage to parent metal by arc strikes

While arc strikes are to be avoided, any that do occur shall be assessed and when necessary shall be either ground smooth or filled to restore the metal thickness. A piece of scrap plate clamped to the pipe near the weld shall be used for dabbing the electrode where such a procedure is necessary for removing slag from the tip or to facilitate the starting of the arc.

NOTE 1. It is recommended that electrode holders be of the fully insulated type.

NOTE 2. Stray arcing between the work and either the welding earth return lead or any part at earth potential can be avoided by a firm earth connection (see clause **6**).

15 Inter-run cleaning

Each run of weld metal shall be clean before a further run is applied, particular attention being paid to the junctions between the weld metal and the fusion faces. Visible flaws such as cracks, cavities and other deposition faults shall be removed before deposition of further weld metal.

16 Cold pull

Where the effects of thermal expansion in service are to be counteracted by 'cold pull' during erection of the pipe assembly, the 'cold pull' shall be maintained during preheating (where applicable; see clause **17**), welding, any post-weld heat treatment and cooling.

Before applying 'cold pull' to a joint, all other joints in the pipe assembly shall have been welded, subjected to any post-weld heat treatment, inspected and accepted.

17 Preheating for cutting and welding

17.1 General

No thermal cutting, welding or tack welding shall be carried out when the temperature of the parent material within 150 mm of the joint or cut is less than 5 °C.

17.2 Preheating for cutting

Preheating for thermal cutting shall be applied when the temperature of the parent metal is less than 5 °C.

17.3 Preheating for welding

When welding material of a thickness[1)] greater than 20 mm with non-hydrogen controlled weld metal, or of a thickness[1)] greater than 30 mm with hydrogen controlled weld metal[2)], a minimum preheating temperature of 100 °C shall be used, unless welding procedures have proved that different conditions are acceptable.

17.4 Methods

Preheating shall be applied by one of the following means, the choice being dependent on local conditions:

a) gas rings, gas radiant panels or muffle furnaces;

b) electric resistance heaters;

c) induction heating;

d) oxy-acetylene or other gas torches.

[1)] The greatest component thickness at the joint.

[2)] Hydrogen controlled weld metal as defined in BS EN 499 contains not more than 15 ml of diffusible hydrogen per 100 g of deposited metal when determined by the method given in BS 6693 : Part 2.

The procedure used shall ensure a satisfactory temperature distribution around and through the joint to be welded and shall not interfere with access for welding.

NOTE. To check that the preheating temperature distribution through the pipe is satisfactory, particularly when thick material is involved and/or heating is from the outside only, it is recommended that temperature measurements be made at the root of the joint. For details of temperature measurement, see BS 2633.

Where preheating is applied manually by gas torches, care shall be taken to ensure an even distribution of heat. Excessive local heating of the pipe surface shall be avoided.

18 Heat treatment after welding

18.1 General

Post-weld heat treatment shall not be required for pipe or weld-throat thicknesses up to and including 35 mm, unless the purchaser states in the enquiry and order that all welds are to be heat treated (see **2.1**(d)).

NOTE. It is advisable for the purchaser in all cases to inform the manufacturer of the use to which the pipework will be put.

18.2 Heat treatment conditions

When post-weld heat treatment is required, the soaking temperature shall be within the range 580 °C to 620 °C and the time at this temperature shall be 2.5 min per millimetre of thickness with a minimum of 30 min, for both furnace and local heat treatment.

Other relevant details of heat treatment conditions and temperature measurement shall be in accordance with BS 2633.

Section 2. Butt joints

19 General

Section 1 of this standard details the basic procedure requirements with which all welded joints between pipes and fittings shall comply. These basic requirements are supplemented by the specific requirements detailed in this section 2. Both section one and section two of this standard shall be applied in determining the full procedure requirements.

20 All types of butt joint

20.1 Matching of bores

The welding of pipe[1)] joints shall include the matching by the welding contractor of the pipe ends at each joint, if necessary.

NOTE 1. The bores of the ends of adjacent pipes should preferably match exactly. Typical acceptable limits for bore difference and alignment for manual welding are given in table 2. For mechanized welding closer limits may be necessary.

Matching shall be effected by selection, drifting, machining, swaging or by the use of a suitable expander. When hot drifting or expanding is used, the pipe shall be heated to a temperature within the range 900 °C to 975 °C or alternatively to a temperature within the range 450 °C to 650 °C.

Wherever the thickness is reduced by drifting, machining, swaging or expanding, the thickness at every point in the circumference clear of the weld preparation shall be not less than the design thickness for the particular pipe. Any machining on the inside of the pipe shall run out smoothly into the bore at a taper not steeper than 1 in 4.

NOTE 2. If the maximum permissible amount of machining is insufficient to match the ends, drifting should be employed, but a combination of drifting or expanding with machining within the permitted limits may also be used.

20.2 Preparation of pipe ends

The ends shall be prepared by machining, grinding, plasma arc cutting or machine gas cutting, or by manual flame cutting with subsequent filing or grinding.

NOTE. Typical joint preparations for pipe ends are shown in **C.1** (see also clause **9**).

The joint preparation shall be concentric with the bore of the pipe within the tolerance limits for the root face.

For pipes that are intended to be in axial alignment, the plane of the ends shall be square with the axis of the pipe. For pipes that are intentionally out of axial alignment, the plane of the joints shall bisect the angle between adjacent pipes.

21 Gusseted bends

21.1 General

The service conditions for which gusseted bends are to be used shall be the subject of agreement between the contracting parties except where an application standard permits the use of such bends (see **2.2**(e)).

NOTE. Gusseted bends are of the following types.

a) Segmental: separate pieces of pipe cut at an angle and welded together.

b) Cut-and-shut: wedge-shaped pieces cut from one side of a pipe, the pipe pulled round until the cut edges come to the correct welding position and then welded.

21.2 Preparation

21.2.1 *General*

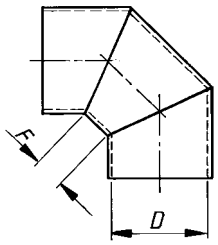
The preparation of any gusset for any gusseted bend shall be done by cutting the pipe end to the correct angle followed by the weld preparation as specified in **20.2**.

To prepare the gussets for welding, all spatter, oxide and ragged edges shall be removed from the prepared edge and the bore of the pipes, the correct gap shall be set and the gussets tacked in position.

Table 2. Typical limits for bore difference and alignment for manual welding

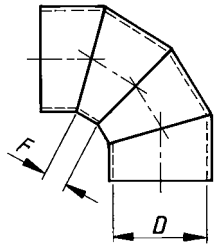
Bore	Maximum difference in bore (rounded to the nearest 0.5 mm)		Maximum out of alignment at the bore (rounded to the nearest 0.5 mm)	
	with backing ring	without backing ring	with backing ring	without backing ring
mm	mm	mm	mm	mm
Up to and including 150	1.5	3.0	1.5	2.5
Over 150	2.5	5.0	2.5	3.0

[1)] In this section the term 'pipe' is intended to cover pipes and fittings, e.g. welding neck flanges, forged tees, welding elbows.



2 cuts, 1 *D* radius

Inside diameter, *D*	**Outside diameter**	***F***
mm	mm	mm
50	60.3	16.5
65	76.1	22.5
75	88.9	25.0



3 cuts, 1 *D* radius

Inside diameter, *D*	**Outside diameter**	***F***
mm	mm	mm
90	101.6	21.0
100	114.3	23.0
115	127.0	28.0
125	139.7	29.5
150	165.1	36.0
150	168.3	35.5
180	193.7	44.5
200	219.1	48.5
230	244.5	57.5
250	273.0	61.0
300	323.9	74.0
—	355.6	95.0
—	406.4	109.0

Figure 1. Segmental bends

21.2.2 *Segmental bends*

The planes of the ends of the separate pieces of pipe prepared for welding to form a segmental bend shall all be inclined at the same angle to the axis of the piece.

The width of a segment at the throat of a bend measured at the outside diameter of the pipe shall be not less than 16.5 mm. For right-angle bends of radius equal to the bore of the pipe, the dimensions of the segments shall be as shown in figure 1, with only two cuts being necessary for pipe not exceeding 88.9 mm outside diameter.

NOTE. Bends over 406.4 mm outside diameter may be difficult to produce as segmental bends, that is by preparing and assembling as separate segments of pipe. In such cases it is permissible first to prepare, close and tack weld as a cut-and-shut bend, and thereafter to complete the weld preparation by gouging the back of the bend in line with the extremities of the weld formed by the cut-and-shut method and so produce a continuous weld preparation as in a segmental bend.

21.2.3 *Cut-and-shut bends*

A cut-and-shut bend shall have the angle of cut equally disposed about a line at right angles to the axis of the pipe (see figure 2). The change of angle of the centre line at each cut shall not exceed approximately 30° and the width of the segment at the throat of the bend measured at the outside diameter of the pipe shall be not less than 16.5 mm as shown in figure 2.

21.3 Welding procedure

All welds in a segmental bend shall be treated as butt welds and the requirements of clauses **12, 19** and **20.2** shall apply. The welds shall be sound and shall penetrate at all points.

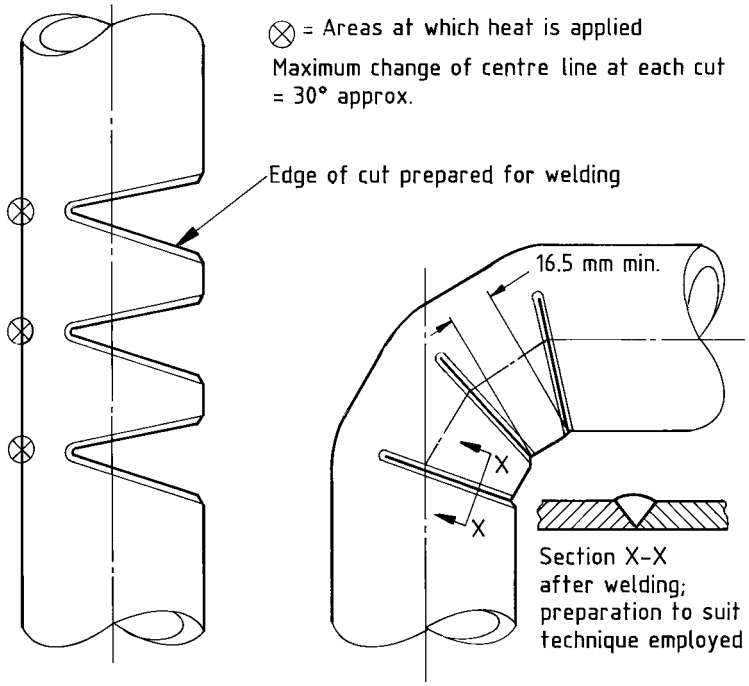


Figure 2. Cut-and-shut bend

Section 3. Branches and small bore connections

22 General

Section 1 of this standard details the basic procedure requirements with which all welded joints between pipes and fittings shall comply. For branches or small bore connections that are made from pipe, tube or bar, the basic requirements are supplemented by the specific requirements detailed in this section 3. Both section 1 and section 3 of this standard shall be applied in determining the full procedure requirements.

NOTE 1. It is preferable that branches and small bore connections be welded at the works.

NOTE 2. When the bore of the branch is 50 mm or less, the guidance given in **C.3** should be taken into account. (See clause **3** regarding parent metal and clause **4** on weld metal).

23 Branches

23.1 Angle of branch

In view of the additional difficulty involved in making a satisfactory joint at the intersection of two pipes not at right angles, for branch pipes sloping away from a main, a right-angle branch and a bend to give the required slope shall be used whenever possible.

Where a sloping branch has to be connected directly to the main, the angle between the centre line of the main and that of the branch shall whenever possible be not less than 60°. Where the angle is unavoidably less than 60°, details of joint design and fabrication shall be agreed between the contracting parties (see **2.2**(f)).

NOTE. The difficulty of making a weld at the acute crotch position might make special precautions necessary to ensure a sound weld at that position.

23.2 Spacing of branches

Spacing of branches on the main pipe and the lengths of flanged branches shall be such that there is adequate access for satisfactory welding (see also clause **10**).

23.3 Joint preparation

Branch connections and branch openings in the main pipe shall be cut by machining or thermal cutting. To remove any roughness the cut edges shall be dressed by chipping, filing or grinding.

NOTE. Typical edge shapes are given in **C.2** (see also clause **9**).

23.4 Welding procedure

23.4.1 *Gap*

The gap, where specified, shall be maintained during deposition of the first run (see clause **12**).

23.4.2 *Internal root runs*

When, in order to satisfy the requirements of section 8, it is necessary to apply an internal root run, access for the manual metal-arc welding of such an internal weld shall be considered possible where:

a) the main is 450 mm bore or larger, irrespective of branch length; or

b) the main is less than 450 mm bore, and the branch length (face of branch to flank of joint) does not exceed the bore of the branch.

NOTE. Using other welding processes it may be possible to weld in the bore of branches that have a length greater than that given in (b).

Section 4. Sleeve joints and socket-welding fittings

24 General

Section 1 of this standard details the basic procedure requirements with which all welded joints between pipes and fittings shall comply. These basic requirements are supplemented by the specific requirements detailed in this section 4. Both sections 1 and 4 of this standard shall be applied in determining the full procedure requirements.

25 Sleeve joint details

A sleeve joint shall be one of the types shown in figure 3.

NOTE. A sleeve joint is formed when the end of one pipe enters the swelled end of the next adjoining pipe and the two pipes are joined by means of a fillet weld.

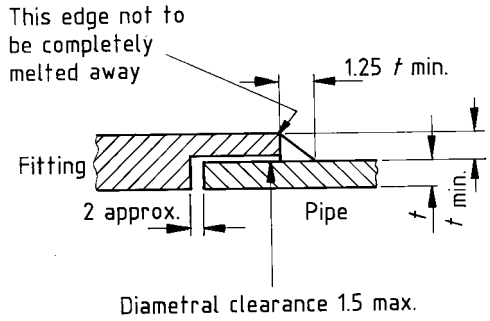
No melting of the corners shall be allowed to occur to such an extent as to reduce the throat thickness of the fillet weld. (see figure 4).

26 Socket joint details

Forged socket-welding fittings shall be used within the limitations in the appropriate application standard and shall comply with BS 3799.

NOTE 1. A socket joint is formed when the end of a pipe enters the socket end of a socket-welding fitting and the pipe and socket are joined by means of a fillet weld. Socket joints should not be used where corrosion resistance is important. Socket-welding fittings may be machined from bar of suitable composition and quality.

Preparation and assembly of the joint for welding shall be such as to ensure that the pipe end is axially square to the base of the fitting and that there is a gap of approximately 2 mm between the pipe end and the base of the fitting (see figure 5). To achieve this gap, the pipe end shall first be fully inserted and the outside surface of the pipe marked in line with the end face of the socket. The pipe shall then be withdrawn approximately 2 mm before welding.



All dimensions are in millimetres.

Figure 5. Socket joint details

NOTE 2. It is to be expected that the gap will have reduced after welding.

The diametral clearance between the outside diameter of the pipe and the bore of the fitting shall not exceed 1.5 mm. The fillet weld leg lengths for socket joints shall be at least t by $1.25t$ where t is the nominal pipe thickness (see figure 5). For pipe of nominal thickness 5 mm or less, care shall be taken to avoid over-heating or burn-through of the pipe (see clauses **40** and **42**).

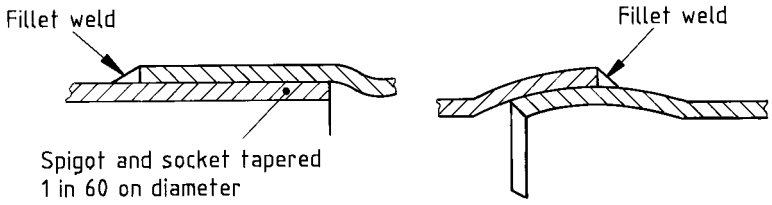


Figure 3. Sleeve joints

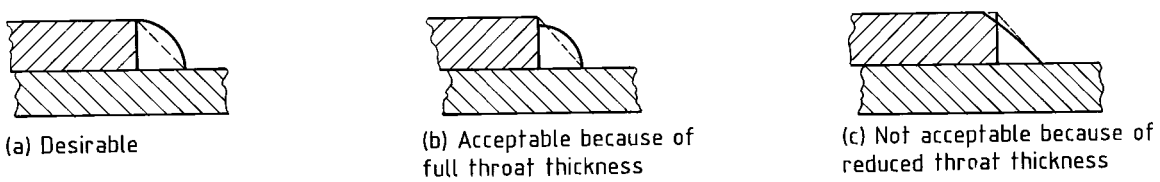


Figure 4. Fillet welds for sleeve joints

Section 5. Structural attachments

27 General

Section 1 of this standard details the basic procedure requirements with which all welded joints between pipes and fittings shall comply. These basic requirements are supplemented by the specific requirements detailed in this section 5. Both section 1 and section 5 of this standard shall be applied in determining the full procedure requirements.

Attachments to pressure parts shall comply with this section.

NOTE. For the design of attachments the relevant application standard should be consulted.

28 Welding procedure

28.1 Each run of weld metal shall be clean and free from slag before the next run is deposited. To ensure full penetration in a double-sided weld, the under-surface of the root run shall be removed by chipping or grinding to give a clean metallic surface, before welding from the other side is commenced, unless the welding procedure has proved that full penetration will be achieved without back gouging.

28.2 If partial penetration welds are used, the form of the preparation shall be specified on the drawings. The method and amount of inspection shall be agreed between the contracting parties (see **2.2**(g)).

28.3 Any necessary preheating and post-weld heat treatment shall be as given in clauses **17** and **18** respectively.

28.4 For pipe of nominal thickness 5 mm or less, care shall be taken to avoid over-heating or burn-through of the pipe (see clauses **40** and **42**).

Section 6. Flanges

29 General

Section 1 of this standard details the basic procedure requirements with which all welded joints between pipes and fittings shall comply. These basic requirements are supplemented by the specific requirements detailed in this section 6. Both section 1 and section 6 of this standard shall be applied in determining the full procedure requirements.

30 Welding neck flanges

The procedure to be applied for the welding of welding neck flanges (see figure 6) shall be the same as for normal butt welds, for which the requirements of section 2 shall apply.

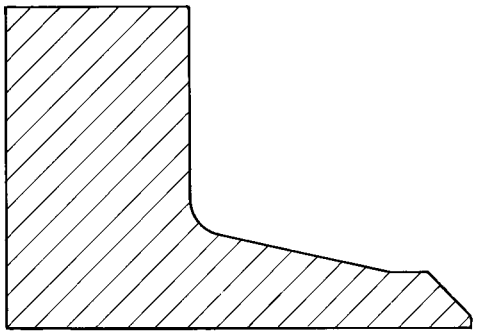


Figure 6. Welding neck flange

31 Welded-on flanges

The flange shall be a loose fit on the pipe but the clearance between the outside diameter of the pipe and bore of the flange shall not exceed 3.0 mm at any point and the sum of the clearances on any diameter shall not exceed 5.0 mm.

NOTE 1. The flange should be substantially concentric with the pipe.

NOTE 2. Typical forms of welded-on flanges are given in **C.4**.

Section 7. Inspection

32 Requirements for visual examination of completed welds

32.1 General

All welds shall be visually examined (see BS 5289) on the outside surface and, where practicable, in the bore (with the aid of optical instruments if necessary) and shall show the features detailed in **32.2, 32.3** and **32.4**.

Visually detectable flaws shall be assessed in accordance with the requirements of clause **35**.

If the purchaser requires completed welds to be ground, this shall be stated in the enquiry and order (see **2.1**(e)). When a weld is to be ground, over-heating the joint due to the grinding action shall be avoided.

32.2 Profile of external surface

Weld metal shall be properly fused with the parent metal. Undercutting or overlapping at the toes of the weld shall be permitted provided that either or both do not exceed a total of 25 mm in any 100 mm length of weld. Undercutting, irrespective of length, shall not exceed a depth of 20 % of the nominal pipe thickness or 2 mm, whichever is the smaller.

There shall be external weld reinforcement, between 1.5 mm and 5 mm high measured from the outer surface of the parent metal. This reinforcement shall be substantially symmetrical about the centre line of the joint and shall be of smooth contour.

NOTE. The shape of the reinforcement may vary according to the type of filler metal used, the welding technique and the welding position.

The surface of the weld shall be free from porosity, cavities and loose or excessive scale.

32.3 Smoothness of the weld

The stop and start of each run of weld shall merge smoothly and shall show no pronounced hump or crater in the weld surface.

32.4 Profile of internal surfaces

The weld shall fuse the pipe at the root without protruding excessively into the bore. The penetration bead shall not exceed 3.0 mm for pipes up to and including 150 mm bore or 6.0 mm for pipes over 150 mm bore.

Root concavity (or sinkage) at the bore shall be acceptable provided that:

a) there is complete root fusion;

b) the thickness of the weld is not less than the pipe thickness.

33 Testing of completed welds

The use and extent of non-destructive testing of completed welds shall be in accordance with the requirements either specified in the relevant application standard or agreed between the contracting parties at the enquiry and order stage taking account of the requirements of **34.1** for the non-destructive testing of butt joints (see **2.2**(h)).

NOTE. The use of destructive testing is impracticable for production welds, but it may sometimes be useful for certain types of sample welds.

34 Non-destructive testing

34.1 Butt joints

The non-destructive testing of butt joints shall be carried out according to one of the following categories as stated by the purchaser (see **2.1** (f)):

category A - the complete non-destructive testing of at least 10 % of each welder's production of butt joints;

category B - the complete non-destructive testing of at least 10 % of all butt joints in the fabrication;

category C - only visual examination of all butt joints.

The method of non-destructive testing used in category A or B shall be radiographic examination (see BS 2910) or ultrasonic examination (see BS 3923 : Part 1).

NOTE. In using radiographic or ultrasonic examination for the assessment of class II welds, attention is drawn to the fact that apart from weld metal quality, the revelation of improper joint set-up could of itself be cause for rejection since such a condition may not meet the requirements of this standard.

34.2 Other than butt joints

The inspection, testing and acceptance requirements for joints other than butt joints shall be agreed between the contracting parties (see **2.2**(i)).

34.3 Re-examination

When random radiographic or ultrasonic examination of a weld reveals unacceptable flaws (see clause **35**), one further weld in the group represented by this weld shall be so tested to the same extent. If this further weld shows no unacceptable flaws, the flaws in the first weld shall be repaired and then re-examined by the original method. If the repair is satisfactory, the group of welds shall be accepted.

If the further weld shows unacceptable flaws, each weld in the group shall be tested by the same method and to the same extent. Unacceptable flaws shall be repaired and then re-examined by the original method.

35 Flaw limitations

Taking account of the non-destructive testing method used, any ONE of the following flaws shall be sufficient cause for rejection.

NOTE 1. The effects of weld flaws on the service performance of a joint are influenced by the location and disposition of the flaws; in general, those located in the body of the weld are less serious than those in the root, a factor that should be borne in mind by the inspector when considering the rejection of joints that appear to be borderline in quality as assessed by the flaw limitations specified.

NOTE 2. Multiple-type flaws contained within the same weld, either superimposed or interposed, which are individually acceptable as isolated flaws should be considered collectively by the inspector when assessing the weld quality.

a) Any type of crack.

b) Misalignment exceeding the limits given in table 2.

c) Root penetration and concavity: the requirements of **32.4** apply.

d) Lack of penetration; Lack of root fusion; Lack of side wall fusion; Lack of inter-run fusion; Slag inclusions; Circumferential wormholes — Total length exceeding 25 mm in any 100 mm length of weld, or height greater than 20 % of nominal pipe thickness.

e) Porosity.

1) *Isolated gas pores.* Any individual spherical gas pore whose maximum diameter exceeds 25 % of the wall thickness or 3 mm, whichever is the smaller.

2) *Scattered gas pores.* Smaller than those permitted in (1), the diameters of which in aggregate exceed 10 mm in any 25 mm length of weld. The distance between any two adjacent pores shall be not less than five times the diameter of the larger pore.

3) *Localized porosity*, i.e. stop-start porosity. Any circle 10 mm in diameter in which the total area of individually acceptable randomly distributed gas pores exceeds the equivalent area of six pores 1 mm in diameter.

Section 8. Rectification of unacceptable welds

36 Removal of flaws

Where welds fail to comply with section 7, all unacceptable flaws shall be removed.

Flaws shall be removed by chipping, grinding, machining, thermal cutting or thermal gouging.

Major repairs involve:

a) cutting through the weld, or;

b) cutting out a length of pipe containing the weld, or;

c) removing weld metal down to the backing ring (where used).

A cut through a weld as in (a) above, or through the pipe as in (b) above, shall be made by machine thermal cutting, guided hand thermal cutting, saw cutting or by machine cutting. The amount of material to be removed from the cut faces after thermal cutting shall be such that a smooth surface free from serrations is obtained.

NOTE. When thermal cutting is used, it may be necessary to compensate for any loss of length that may occur.

37 Preparation for rewelding

37.1 General

Any repair to a weld shall be reported to the inspecting authority or purchaser. If the repair is made as a consequence of non-destructive testing, the records relating to the original flaws shall be made available.

37.2 Partial removal of weld

The cut-out portion shall be sufficiently deep and long to remove the flaw. At the ends and sides of the cut there shall be a gradual taper from the base of the cut to the surface of the weld metal. The width and profile of cut shall be such as will give adequate access for rewelding.

NOTE. When the root of the weld is accessible from the bore of the pipe, a repair may be made from that position (see **23.4.2**).

37.3 Complete removal of weld

Where a cut has been made through a faulty weld and there has been no serious loss of pipe length, the weld preparation shall be remade in accordance with the appropriate section of this standard.

Where it is necessary to compensate for loss of pipe length, this shall be done as follows:

a) by inserting a new length of pipe and preparing the two joints required as described in section 2; or

b) by building up the base of the groove with suitable weld metal; or

c) by adopting a joint preparation incorporating a wider root gap, provided agreement between the contracting parties is obtained on the use of this method (see **2.2**(j)).

38 Rewelding

Before rewelding, the repair procedure shall have been approved by the inspecting authority or the purchaser if it differs significantly from the original welding procedure.

A repaired weld shall be subjected to at least the same testing and inspection requirements as the original weld.

Section 9. Welding procedures

39 General

39.1 If required by the purchaser or by the application standard, the manufacturer shall, at the enquiry and order stage, submit written welding procedure specifications in accordance with BS EN 288-2 (see **2.1**(g)).

39.2 When, according to **39.1**, welding procedure specifications are to be provided, the purchaser or the application standard shall state at the enquiry and order stage whether or not approved welding procedure specifications are required to be used (see **2.1**(h)).

NOTE. Provided a welding procedure specification is submitted, it is recommended that an approved welding procedure is not required when any of the steels covered by the following list of standards and grades is employed:

Standards	*Grades*
BS 1387	
BS 3059 : Part 1	320
BS 3059 : Part 2	360
BS 3601	320 and 360
BS 3602 : Part 1	360
BS 3606	320

39.3 When, according to **39.2**, approved welding procedure specifications are required, the manufacturer, prior to commencing production welding, shall produce procedures approved in accordance with BS EN 288 as defined below.

All welding shall be performed in accordance with the welding procedure specification or other work instruction written in accordance with BS EN 288-2. These welding procedure specifications shall be substantiated by a welding procedure test, either:

a) in accordance with BS EN 288-3; or

b) a pre-existing weld procedure test performed to BS 4870 : Part 1 previously acceptable to an examiner or test body, except that the range of approval of this test shall be in accordance with the ranges in BS EN 288-3.

Existing procedures to BS 4870 : Part 1 shall be considered technically equivalent to BS EN 288-3 when similar types of test have been carried out. Thus, the bend tests in BS 4870 : Part 1 shall be considered equivalent to those in BS EN 288-3 even though the exact number and bend angle differ. Similarily, visual, radiographic, ultrasonic, surface crack detection, transverse tensile, hardness, macro-examination and impact tests shall be considered equivalent.

Where BS EN 288-3 calls for a type of test to be performed and this has not been carried out on the pre-existing BS 4870 : Part 1 procedure qualifications test, additional testing, as described in clause **0** of BS EN 288-3 : 1992 shall be carried out. For example, if impact tests have not been carried out on the BS 4870 : Part 1 test piece it is only necessary to do an additional set of impact tests on a test piece made in accordance with BS EN 288-3.

The alternative methods of approval of welding procedures addressed in BS EN 288-1 shall not be permitted for pipe welding in accordance with BS 2971. By agreement, where specific joint types are not compatible with the testing requirements of BS EN 288-3, then a pre-production test shall be considered and shall be subjected to the relevant tests of BS EN 288-3 where practicable.

When the purchaser requires that welding procedure tests employ pipe of specified diameter and thickness, such a requirement shall be stated on the enquiry and order (see **2.1**(i)).

NOTE. It is recommended that welding procedure tests carried out in accordance with the requirements of this clause and witnessed by an examiner or test body be accepted by other examiners or test bodies provided that all the provisions have been fulfilled.

40 Attachments to thin pipes and branch welds

40.1 Attachments to thin pipes

When attachment welds are to be made to pipes equal to or less than 5 mm, a test shall be made using a typical weld detail to determine that burn-through does not occur. The test shall be made on pipe of contract thickness and the minimum approved thickness shall be the thickness welded.

NOTE. The approval may apply to other contracts.

40.2 Branch welds

Branch weld tests shall be performed in accordance with BS EN 288-3.

NOTE. This may need to be supplemented by a butt weld test piece to obtain relevant mechanical data.

Section 10. Welder approval

41 General

For the manufacture and erection of pipework made in accordance with this British Standard, welders shall be employed who satisfy one of the following alternatives.

a) Have satisfactorily carried out the relevant welder approval tests in accordance with BS 4872 : Part 1 (see clause **42**). If non-destructive testing is required on the contract, the test welds submitted for welder approval shall have been similarily non-destructively tested prior to taking test specimens and results assessed in accordance with clause **35**.

b) Have satisfactorily carried out the relevant welded approval tests in accordance with BS EN 287-1. Welders who previously held approvals to BS 4871 : Part 1 shall be considered to be approved to work with the following provisos.

i) The range of approval of the welder shall be in accordance with BS EN 287-1.

ii) Welder approval tests to BS 4871 : Part 1 shall be considered technically equivalent to BS EN 287-1, except that for MIG/MAG welding, bend tests shall be carried out. If bend tests for these processes have not been carried out during the original test, reapproval to BS EN 287-1 shall be performed.

iii) The prolongation of a BS 4871 : Part 1 approval test, if required, shall be made at six-monthly intervals by the employer/ manufacturer, in accordance with **10.1** of BS EN 287-1 : 1992 for the period of two years from the date of effect of BS EN 287-1, i.e. from 1 May 1992.

iv) The prolongation of a BS 4871 : Part 1 approval test in excess of the initial two years from 1 May 1992 shall be made in accordance with **10.2** of BS EN 287-1 : 1992 in conjunction with an examiner or test body.

The welder who satisfactorily completes the welding procedure test shall thereby be approved in those procedures without undergoing welder approval tests except for fillet welds where the extra tests required by BS EN 287-1 (two macros or test piece fracture) shall be completed.

NOTE. It is recommended that welder approval tests carried out in accordance with the requirements of this clause and witnessed by an independent inspecting authority should be accepted by other inspecting authorities, provided that all the provisions have been fulfilled.

42 Attachments to thin pipes

Welders to be engaged in welding attachments to pipes shall demonstrate their ability. The test weld shall be made on pipe of contract thickness and the minimum thickness shall be the thickness welded.

Appendices

Appendix A. Classes of operating conditions

Table 3 gives guidance on class I and class II operating conditions of pipework which, as stated in the foreword, are only one set of factors that have to be taken into account in deciding the class of welding required. The relevant application standard, when it exists, should specify the class of welding required.

Table 3. Classes of operating conditions

Service	Temperature	Pressure (bar)[1]		
		Up to and including 17	Over 17 up to and including 24	Over 24
	°C			
Gases (including steam)	Below −20	Class II	Class I	Class I
	Over −20 up to and including 220	Class II	Class I	Class I
	Over 220	Class I	Class I	Class I
Liquids	Below −20	Class II	Class I	Class I
	Over −20 up to and including 95	Class II	Class II	Class I
	Over 95 up to and including 200	Class II	Class I	Class I
	Over 200	Class I	Class I	Class I

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

Appendix B. Grades of steel in British Standards and similar grades for pipe in ASTM and DIN standards

B.1 Table 4 gives details of grades in British Standards for the types of steel given in **3.1**.

B.2 Table 5 gives details of corresponding grades in ASTM and DIN standards for the grades of pipe in British Standards, on the basis of similar weldability although they may not have identical mechanical properties or chemical composition.

Table 4. Grades of steel in British Standards

Type of steel	Pipe standards	Grades and types of steel	Pipe fittings standards	Flange standards
C and C-Mn (≤ 0.25 C)	BS 1387	—	BS 1640 : Part 3	BS 1560 : Section 3.1
	BS 3059 : Part 1	320	BS 1965 : Part 1	BS 4504 : Section 3.2
	BS 3059 : Part 2	360 and 440	BS 3799	
	BS 3601	320, 360, 430		
	BS 3602 : Part 1	360, 430 and 500 Nb		
	BS 3602 : Part 2	430		
	BS 3603	430 LT		
	BS 3606	320 and 440		

Table 5. Grades in ASTM and DIN standards of similar weldability to British Standard grades of pipe

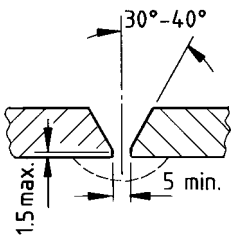
British Standard	Grades and types of steel	ASTM standard	DIN standard
BS 1387		A106 Gr A	
BS 3059 : Part 1	320	A106 Gr B (if carbon is restricted to 0.25 % max.)	
BS 3059 : Part 2	360 and 440		DIN 17175 St 35.8
BS 3601	320, 360 and 430		DIN 17177 St 37.8
BS 3602 : Part 1	360, 430 and 500 Nb		DIN 17175 St 45.8
BS 3602 : Part 2	430		DIN 17177 St 42.8
BS 3606	320 and 440		DIN 17175 17 Mn 4 DIN 17175 19 Mn 5
BS 3603	430 LT	A333 Gr 1 and Gr 6 (if carbon is restricted to 0.20 % max.)	DIN 17173 DIN 17174 TT St 35N

Appendix C. Typical joint preparations

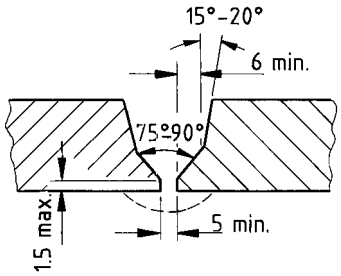
C.1 Typical butt joint preparations are shown in figures 7 and 8.

C.2 Typical preparations for branch connections are shown in figures 9 to 13.

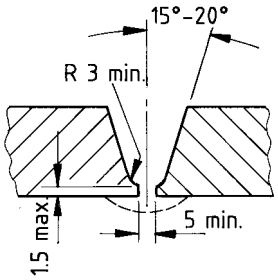
C.3 Typical forms of small bore connections are shown in figures 14 to 16 with guidance on their use.



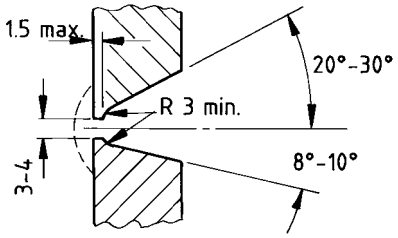
(a) Single-V for use with backing ring (pipes up to and including 12.5 thick)



(b) Double angle-V for use with backing ring (pipes over 12.5 thick)



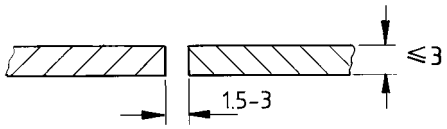
(c) Normal single-V preparation for use with backing ring (pipes over 12.5 thick)



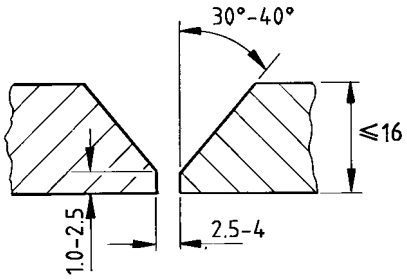
(d) Permissible alternative preparation to (c) for vertical or nearly vertical pipe

All dimensions are in millimetres.

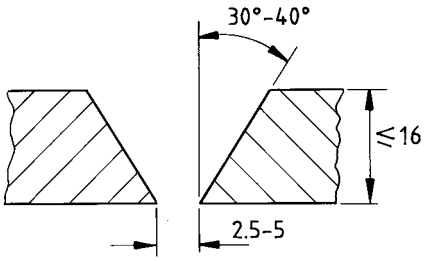
Figure 7. Typical butt joint preparations for use with backing rings



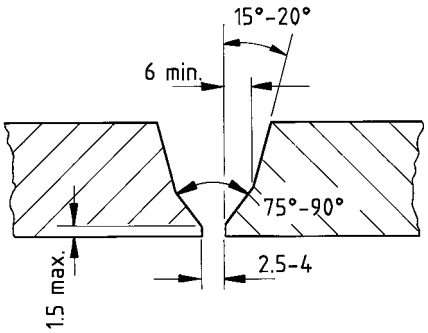
(a) Square butt



(b) Single-V with root face



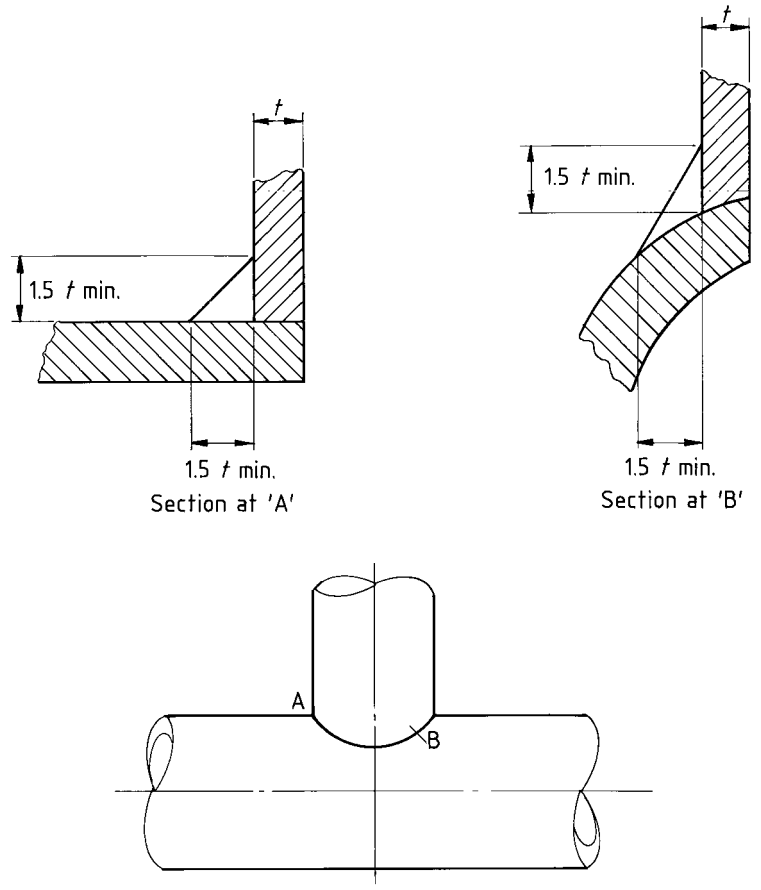
(c) Single-V without root face for use with special welding technique



(d) Double angle-V for pipes over 12.5 thick

All dimensions are in millimetres.

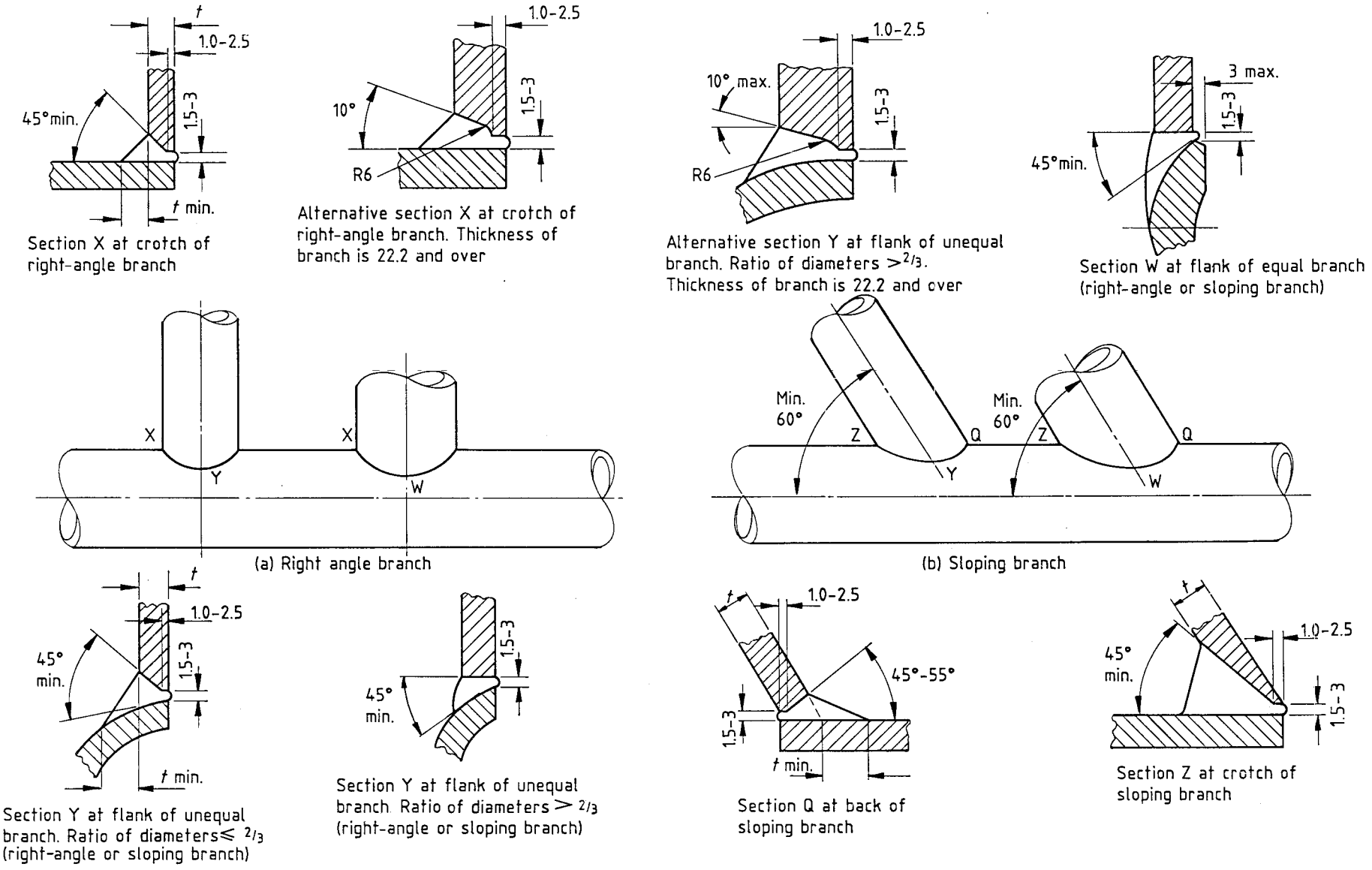
Figure 8. Typical butt joint preparations for use without backing rings



NOTE. For design pressures over 10 bar[1)] an internal seal weld is necessary (see **23.4.2**).

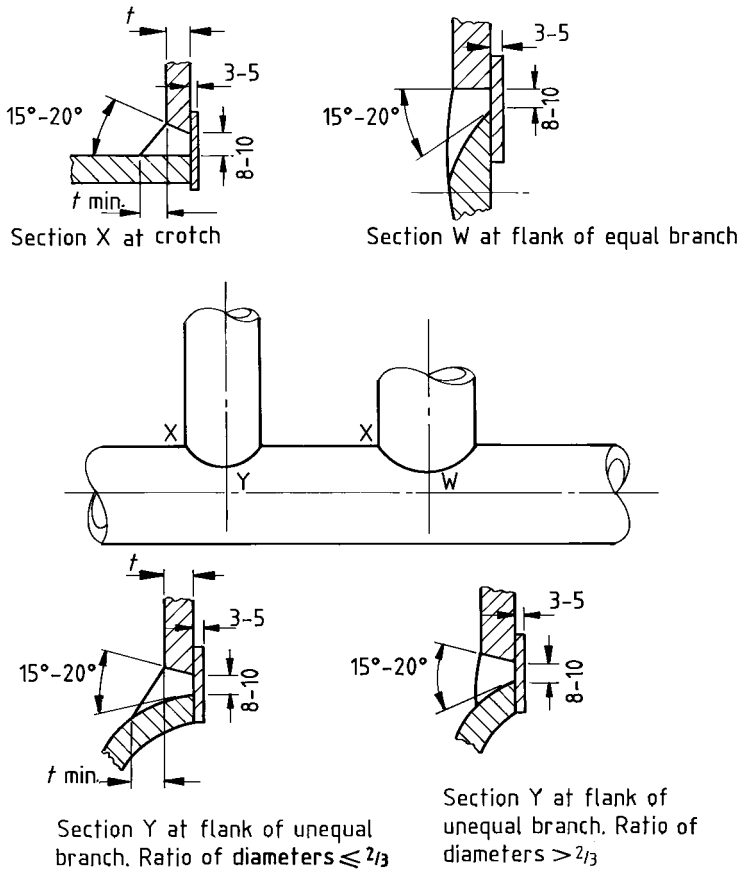
[1)] 1 bar = 10^5 N/m^2 = 100 kPa.

Figure 9. Typical set-on branch without weld preparation



All dimensions are in millimetres

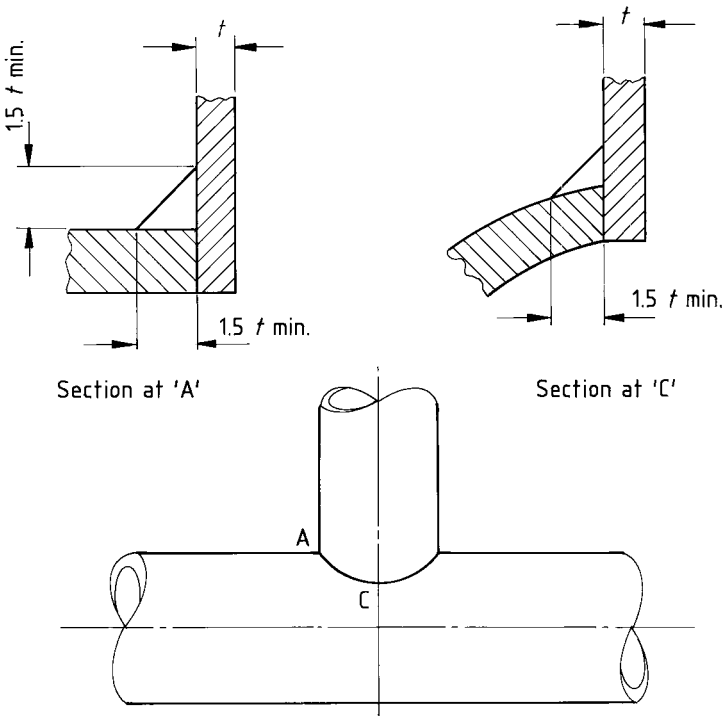
Figure 10. Typical preparation and assembly of set-on branches without backing



All dimensions are in millimetres.

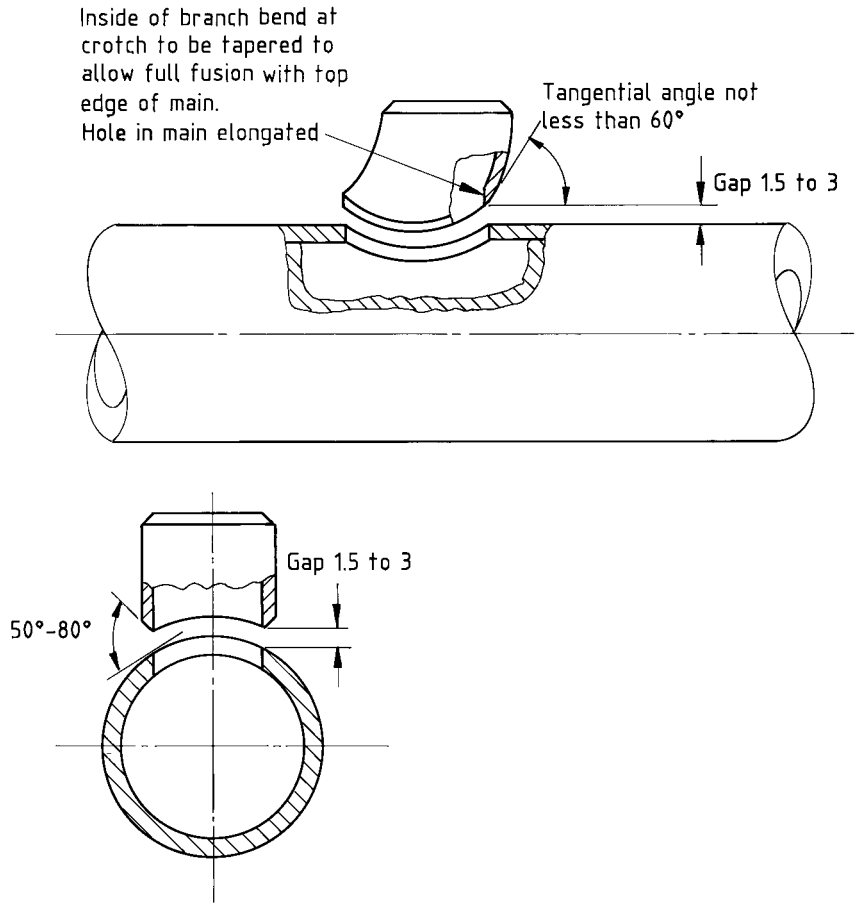
NOTE. Root run in each corner in all cases.
Backing ring removed after welding.

Figure 11. Typical preparation and assembly of set-on right-angle branches with temporary backing



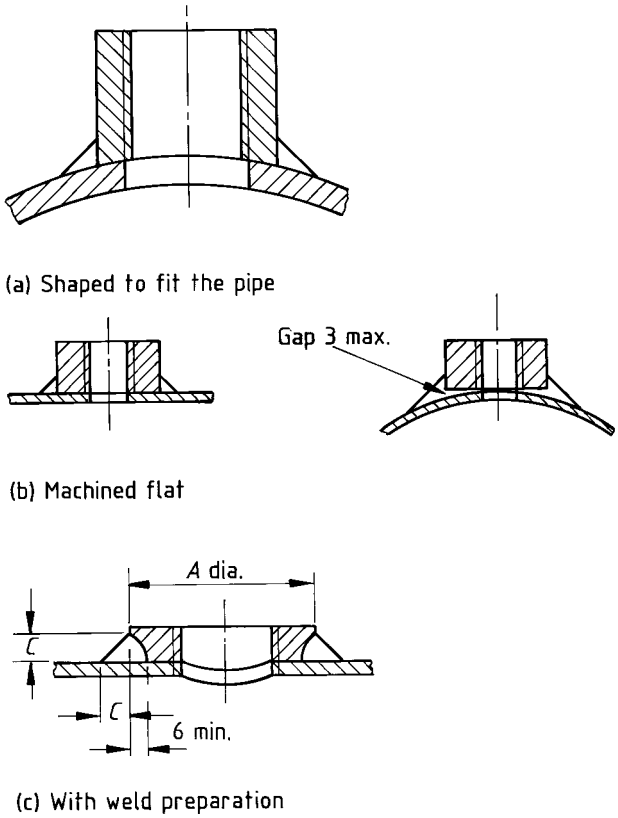
NOTE. For pressures over 10 bar an internal seal weld is necessary (see **23.4.2**).

Figure 12. Typical set-in branch without weld preparation



All dimensions are in millimetres.

Figure 13. Typical curved or 'easy sweep' branch joint



A dia.	*C*
50	10
75	12

All dimensions are in millimetres.

Figure 14. Typical set-on (shaped) small bore connections

Figures 14 and 15. Where the pressure is not more than 10 bar and the fluid is neither a refrigerant nor a corrosive substance, the small bore connections may be either set-on as shown in figure 14(a), (b) or (c) or set-in as shown in figure 15. The fillet weld leg length should be at least equal to the pipe thickness but in no case less than 8 mm. The surface of the set-on connection in contact with the pipe should be machined flat except where the gap at the flanks would exceed 3 mm. In other cases connections should have the contact surface shaped to the contour of the pipe.

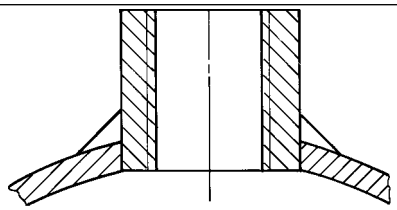


Figure 15. Typical set-in small bore connection

Figure 16. Where the pressure is more than 10 bar or where the fluid is either a refrigerant or a corrosive substance, the small bore connections should be of the type shown in figure 16(a), or (b).

The type of connection shown in figure 16(a) is made from forged or rolled bar welded on with a pilot hole in the bore. It is then bored to finished or tapping size after welding.

The type of connection shown in figure 16(b) is made from screwed sockets, couplings or tube shaped to suit the bore of the main pipe.

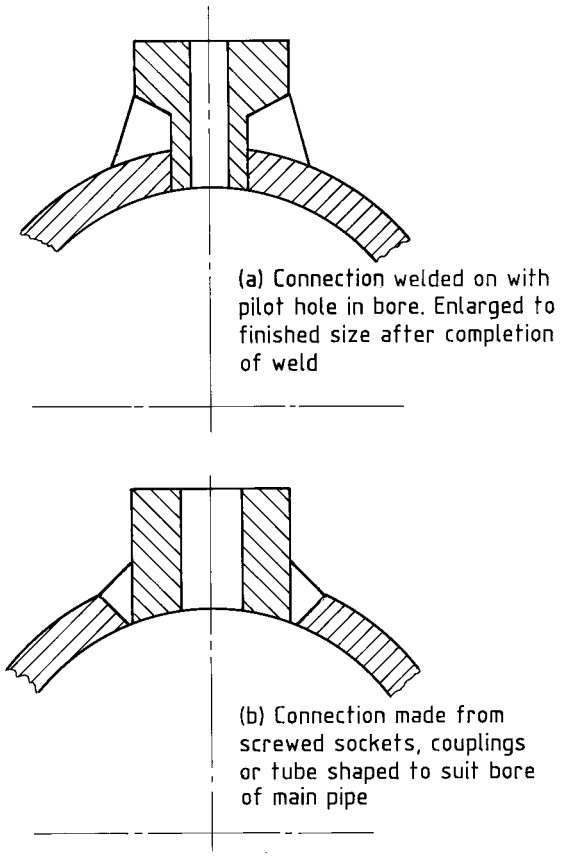


Figure 16. Typical small bore connections for pressures over 10 bar or for refrigerants or corrosive fluids

C.4 Typical forms of welded-on flanges are shown in figures 17 and 18.

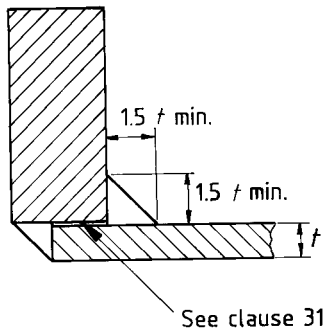


Figure 17. Typical 'slip-on' welded-on flange

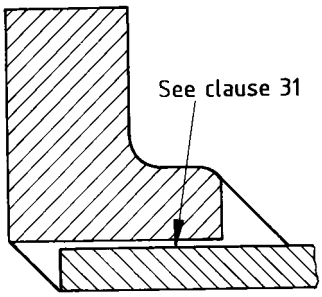


Figure 18. Typical 'slip-on' hubbed welded-on flange

Publications referred to

BS 638	Arc welding power sources, equipment and accessories
BS 1387	Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads
BS 1560	Circular flanges for pipes, valves and fittings (class designated) Part 3 Steel, cast iron and copper alloy flanges Section 3.1 Specification for steel flanges
BS 1640	Specification for steel butt-welding pipe fittings for the petroleum industry Part 3 Wrought carbon and ferritic alloy steel fittings. Metric units
BS 1821[1)]	Specification for class I oxy-acetylene welding of ferritic steel pipework for carrying fluids
BS 1965	Specification for butt-welding pipe fittings for pressure purposes Part 1 Carbon steel
BS 2633	Specification for Class I arc welding of ferritic steel pipework for carrying fluids
BS 2640	Specification for Class II oxy-acetylene welding of carbon steel pipework for carrying fluids
BS 2910	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
BS 3059	Steel boiler and superheater tubes Part 1 Specification for low tensile carbon steel tubes without specified elevated temperature properties Part 2 Specification for carbon, alloy and austenitic stainless steel tubes with specified elevated temperature properties
BS 3601	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes
BS 3602	Specification for steel pipes and tubes for pressure purposes: carbon and carbon manganese steel with specified elevated temperature properties Part 1 Specification for seamless and electric resistance welded including induction welded tubes
BS 3603	Specification for steel pipes and tubes for pressure purposes: carbon and alloy steel with specified low temperature properties
BS 3606	Specification for steel tubes for heat exchangers
BS 3799	Specification for steel pipe fittings, screwed and socket-welding for the petroleum industry
BS 3923	Methods for ultrasonic examination of welds Part 1 Methods for manual examination of fusion welds in ferritic steels
BS 4204[1)]	Specification for flash welding of steel tubes for pressure applications
BS 4504	Specification for flanges and bolting for pipes, valves and fittings. Metric series
BS 4677[1)]	Specification for arc welding of austenitic stainless steel pipework for carrying fluids
BS 4870	Specification for approval testing of welding procedures Part 1 Fusion welding of steel (withdrawn)
BS 4871	Specification for approval testing of welders working to approved welding procedures Part 1 Fusion welding of steel (withdrawn)

[1)] Referred to in the foreword only.

BS 4872	Specification for approval testing of welders when welding procedure approval is not required Part 1 Fusion welding of steel
BS 5289	Code of practice. Visual inspection of fusion welded joints
BS 6084	Method of test for comparison of prefabrication primers by porosity rating in arc welding
BS 6693	Diffusible hydrogen Part 2 Method for determination of hydrogen in manual metal-arc weld metal
BS 7084	Specification for carbon and carbon-manganese steel tubular cored welding electrodes
BS EN 287-1	Approval testing of welders for fusion welding — Steels
BS EN 288-1	Specification and approval of welding procedures for metallic materials — Part 1 General rules for fusion welding
BS EN 288-2	Specification and approval of welding procedures for metallic materials — Part 2 Welding procedures specification for arc welding
BS EN 288-3	Specification and approval of welding procedures for metallic meterials — Part 3 Welding procedure tests for the arc welding of steels
BS EN 439	Welding consumables — Shielding gases for arc welding and cutting
BS EN 499	Welding consumables — Covered electrodes for manual metal arc welding of non alloy and fine grain steels — Classification
BS EN 756	Welding consumables — Wire electrodes and wire-flux combinations for submerged arc welding of non alloy and fine grain steels — Classification
BS EN 760	Welding consumables — Fluxes for submerged arc welding — Classification
BS EN 50078	Torches and guns for arc welding
BS EN 60974-11	Arc welding equipment — Part 11 Electrode holders
BS EN 60974-12	Arc welding equipment — Part 12 Coupling devices for welding cables
BS EN ISO 9000	Quality management and quality assurance standards
ASTM A106	Standard specification for seamless carbon steel pipe for high temperature service
ASTM A333	Standard specification for seamless and welded steel pipe for low temperature service
DIN 17173	Seamless tubes made from steels with low temperature toughness. Technical conditions of delivery
DIN 17174	Welded tubes made from steels with low temperature toughness. Technical conditions of delivery
DIN 17175	Seamless tubes of heat resistant steels. Technical conditions of delivery
DIN 17177	Electric pressure welded steel tubes for elevated temperatures. Technical conditions of delivery

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