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BRITISH STANDARD 2633 : 1956

CLASS I
METAL-ARC WELDING
OF STEEL PIPELINES AND PIPE ASSEMBLIES FOR CARRYING FLUIDS

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BRITISH STANDARD SPECIFICATION

CLASS I
METAL-ARC WELDING
OF STEEL PIPELINES AND PIPE ASSEMBLIES FOR CARRYING FLUIDS

B.S. 2633 : 1956

Price 10/– net

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THIS BRITISH STANDARD, having been approved by the Welding Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council as a British Standard on 12th January, 1956.

The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 2500, indexed and cross-indexed for reference, together with an abstract of each standard, will be found in the Institution's Yearbook, price 12s. 6d.

This standard makes reference to the following British Standards:—

B.S. 534. Steel spigot and socket pipes and specials for water, gas and sewage.

B.S. 638. Arc welding plant and equipment.

B.S. 639. Covered electrodes for the metal-arc welding of mild steel.

B.S. 679. Protective filters for welding and other industrial operations.

B.S. 806. Ferrous pipes and piping installations for and in connection with land boilers.

B.S. 854. Welded steel boilers for steam central heating.

B.S. 1113. Water tube boilers and their integral superheaters.

B.S. 1295. Tests for use in the training of welders.

B.S. 1453. Filler rods for gas welding.

B.S. 1719. Classification of covered electrodes for the metal-arc welding of mild steel and of medium-high-tensile steels of welding quality.

B.S. 1821. Oxy-acetylene welding of high temperature and high pressure pipelines.

B.S. 2640. Class II oxy-acetylene welding of steel pipelines and pipe assemblies for carrying fluids.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following references relate to the work on this British Standard:—
Committee reference WEE/21. Draft for comment CO(WEE)8922

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CO-OPERATING ORGANIZATIONS

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

*Admiralty
Aluminium Development Association
Aluminium Industry Council
*Associated Offices Technical Committee
Association of Consulting Engineers, Incorporated
*British Acetylene Association
British Constructional Steelwork Association
*British Electrical and Allied Manufacturers' Association
*British Iron and Steel Federation.
British Railways. The British Transport Commission
*British Welding Research Association
Crown Agents for Oversea Governments and Administrations
D.S.I.R.—Mechanical Engineering Research Organization
*Institute of Welding
Institution of Civil Engineers
Institution of Electrical Engineers
*Institution of Mechanical Engineers
Institution of Structural Engineers
*Lloyd's Register of Shipping
Ministry of Labour and National Service (Factory Department)
*Ministry of Supply
Shipbuilding Employers' Federation
*Society of British Aircraft Constructors
War Office

The Government departments and 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:

Association of Heating, Ventilating and Domestic Engineering Employers
British Engineers Association
British Refrigeration Association
Central Electricity Authority and Area Boards
Institute of Plumbers
Individual Manufacturers
Ministry of Works
Oil Companies Materials Committee

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BRITISH STANDARD SPECIFICATION FOR

CLASS I METAL-ARC WELDING OF STEEL PIPELINES AND PIPE ASSEMBLIES FOR CARRYING FLUIDS

FOREWORD

Lack of uniformity in welds employed both for the joints in pipelines and for securing flanges and attachments, such as anchor plates, to pipes can result from variations in practice as regards weld preparation, welding and heat-treatment procedures, the training and testing of welders and the inspection and testing of production welds. Good practice in all these respects having now been established, a series of process standards is being issued to cover the production of welds in pipelines and pipe assemblies of any material used sufficiently widely to warrant its inclusion. The series is planned to comprise standards for welds made by each established welding process, viz.: oxy-acetylene, metal arc, flash butt and inert-gas arc welding. Where appropriate, i.e. generally in the case of the manual processes, the standards will be further sub-divided to cover welds of Class I and Class II quality.

The three standards so far completed are:

B.S. 1821.* Oxy-acetylene welding of high temperature and high pressure pipelines.

B.S. 2633. Class I metal-arc welding of steel pipelines and pipe assemblies for carrying fluids.

B.S. 2640.† Class II oxy-acetylene welding of steel pipelines and pipe assemblies for carrying fluids.

~~Any application standard requiring welds for pipelines or other pipe~~ assemblies carrying fluids, for example,

B.S. 534. Steel spigot and socket pipes ~~and~~ specials for water, gas and sewage.

B.S. 306. Ferrous ~~pipes~~ and piping installations for and in connection with land boilers.

B.S. ~~854.~~ Welded steel boilers for steam central heating.

~~B.S. 1113. Water tube boilers and their integral superheaters,~~

* Covering mild steel and carbon steels (carbon not exceeding 0·4 per cent), ½ per cent molybdenum steels (e.g. B.S. 806) and 1 per cent chromium ½ per cent molybdenum steels (e.g. B.S. 806 ' Ferrous pipes and piping installations for and in connection with land boilers ').

† Covering only mild steel (carbon not exceeding 0·26 per cent).

~~will specify the forms of joints permitted for particular services but~~ will not deal with requirements for welds. ~~For welding~~ requirements they will refer to standards ~~in the present~~ series considered appropriate to the service ~~conditions covered by the particular application standard.~~

NOTE. Until such times as the necessary application standards exist in all fields, it is suggested that the Class I and Class II pipe weld standards be applied as shown in the following table. The service conditions for which gusseted bends and sleeve welds may be used should be the subject of agreement between the purchaser, manufacturer and inspecting authority, except where an application standard permits the use of such bends, e.g., B.S. 534, ' Steel Spigot and socket pipes, and specials for water, gas and sewage '.

Service	Class	
	Class I	Class II
Steam	Over 250 lb/sq. in. or over 425°F (220°C)	Up to 250 lb/sq. in. and up to 425°F (220°C)
Water	Over 350 lb/sq. in. or over 400°F (204°C)	Up to 250 lb/sq. in. and up to 400°F (204°C)
		Over 250 lb/sq. in. up to 350 lb/sq. in. and up to 200°F (93°C)
Refrigerants*	Over 250 lb/sq. in. or below 0°F (−18°C)	Up to 250 lb/sq. in. and down to 0°F (−18°C)

* It is essential that pipe material, and deposited metal suitable for the particular service conditions be used.

SPECIFICATION

In 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.

NOTE. The terms ' Class I ' and ' Class II ' welding standards are of long standing and are well understood in the welding industry. However, it is desirable to mention that, in the aircraft industry, the terms ' Class I ' and ' Class II ' are also used ; they define structural members and joints, both of which can include applications of welding, among them those of pipelines and pipe assemblies. In that context, ' Class 1 ' defines a part, the failure of which might be the direct cause of certain drastic consequences to the aircraft ; ' Class 2 ' defines any other highly stressed part. The full definitions are given in AP. 970, ' Design Requirements for Aeroplanes for the Royal Air Force ', Vol. 1, Chap. 400, Paragraph 2. As welding contractors may well, from time to time, be engaged in both fields of activity, it is possible that confusion may arise between the two sets of definitions and it is, therefore, suggested that they be distinguished Class I (General engineering) or Class I (Aircraft), etc., as appropriate, when confusion could otherwise arise.

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PART 1. GENERAL

SCOPE

1. This British Standard covers Class I shop and site metal-arc welding of joints in steel pipe and pipe assemblies up to and including 24 in. diameter, also the standards of workmanship of which the welders shall be capable and the standards to which the welds shall conform. It covers metal-arc welding with or without a backing ring or with an oxy-acetylene base run. (For details of oxy-acetylene welding see B.S. 1821, 'Oxy-acetylene welding of high temperature and high pressure pipelines'.)

PARENT METALS

2. This specification relates to pipes and attachments made from steels of the following classes but this clause does not purport to specify the materials to be used in the manufacture of the pipelines ; for this purpose, reference should be made to the appropriate British Standards.

a. Mild steel containing up to 0·26 per cent carbon (e.g. B.S. 806,* Class A, B or C).

b. Carbon steels containing over 0·26 per cent and up to 0·4 per cent carbon.

c. Alloy steels of the 0·5 per cent molybdenum type, with carbon content not exceeding 0·27 per cent (e.g. B.S. 806).

d. Alloy steels containing not less than 0·6 per cent and not more than 1·2 per cent chromium, not less than 0·4 per cent and not more than 0·7 per cent molybdenum, and not more than 0·25 per cent carbon (e.g. B.S. 806).

ELECTRODES AND FILLER RODS

3. *a.* **Electrodes.** Electrodes for the welding of mild steel up to 0·26 per cent carbon shall be of the normal penetration type complying with B.S. 639 : 1952 (Parts 1 and 2)†. Electrodes for the welding of other steels shall be agreed between purchaser and contractor. In all cases, the electrodes shall be such that the quality of welds will meet the requirements of this standard.

b. **Filler rods (for oxy-acetylene base runs).** The filler rods shall comply with B.S. 1453, 'Filler rods for gas welding' as follows:

(i) *For mild steels containing up to* 0·26 *per cent carbon.* B.S. 1453, specification A2: Mild steel filler rod.

* B.S. 806, 'Ferrous pipes and piping installations for and in connection with land boilers'.

† B.S. 639, 'Covered electrodes for metal-arc welding of mild steel'.

(ii) *For carbon steels containing over* 0·26 *per cent and up to* 0·4 *per cent carbon.* B.S. 1453, specification A3 : Medium tensile steel filler rod.

(iii) *For alloy steels of the* 0·5 *per cent molybdenum type, with carbon content not exceeding* 0·27 *per cent.* B.S. 1453, specification A6: Carbon molybdenum steel filler rod.

(iv) *For alloy steels containing not less than* 0·6 *per cent and not more than* 1·2 *per cent chromium, not less than* 0·4 *per cent and not more than* 0·7 *per cent molybdenum, and not more than* 0·25 *per cent carbon.* B.S. 1453, specification A6: Carbon molybdenum steel filler rod.

NOTE. With a chromium content greater than 0·6 per cent the welding becomes more difficult owing to the formation of a scum on the molten metal.

In all cases where oxy-acetylene welding is employed, the filler rods used shall be such that the base runs comply with the requirements of Clauses 20 *c* and *d*.

SUPERVISION, WORKMANSHIP AND EQUIPMENT

4. The contractor shall employ sufficient competent supervisors to ensure that the workmanship complies with the requirements of this standard and that the welding material used is correct for the pipe assembly being welded.

The contractor shall also take the necessary steps to ensure that all welders employed on pipe assemblies, of which the welded joints are required to comply with this standard, are capable of making welds of the types required and of passing the tests laid down in Part 7.

Welding plant, instruments, cables and accessories shall comply with the requirements of the appropriate British Standard where available. Their capacity shall be adequate for the welding procedure laid down. The contractor shall maintain all welding plant in good working order.

NOTE. The following British Standards are applicable:

B.S. 638, 'Arc welding plant and equipment'.

B.S. 679, 'Protective filters for welding and other industrial operations'.

The attention of the contractor is drawn to the memorandum on electric arc welding Form 329, issued by the Factory Department of the Ministry of National Service and published by H.M. Stationery Office.

All electrical plant used in connection with the welding operation shall be adequately earthed.

NOTE. Particular attention is drawn to Section 4 *a*—Welding Earth—of the above mentioned Factory Department memorandum.

Adequate means of measuring the current shall be available either as part of the welding plant, or by the provision of a portable ammeter.

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

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WELDING TECHNIQUES

5. Welds shall generally be by the metal-arc process, except that under certain conditions oxy-acetylene welded base runs may be used and such runs shall be made by the rightward or all-position rightward technique in accordance with the requirements of Appendix A of B.S. 1821, ' Oxy-acetylene welding of high temperature and high pressure pipelines ', except that the preparation shall be as shown in Figs. 18, 19, 20 and 27. The purchaser may specify one of the three procedures, viz. unbacked, with backing ring or with an oxy-acetylene base run, to be used on the contract.

Where the details of the joint preparation and welding technique differ from those specified in this British Standard such variation shall be permitted, provided the contractor can show by the results of procedure qualification tests that the final welds are of the quality demanded by this standard.

BACKING RINGS

6. Where backing rings are used in the welding of a joint, they may be rolled from strip to circumferential form, or may be machined from pipe of suitable dimensions. A good fit may be achieved with a machined ring by a split in the ring to allow the ring to spring into the pipe. The gap between the ends of a fitted split ring shall not exceed ⅛ in.

Backing rings shall be of mild steel with a sulphur content not exceeding 0·060 per cent (a high or segregated sulphur content of the backing ring may produce defects at the base of the weld), or, if desired, may be of the same material as the pipe. Copper backing rings shall not be used owing to the danger of pick-up of copper by the weld metal.

FUSION FACES

7. The fusion faces and the adjacent material shall be thoroughly cleaned of scale, rust, paint or other foreign matter.

ASSEMBLY FOR WELDING

8. To maintain the specified alignment and gap during welding (see Table 3 and Figs. 13 to 22), the pipes to be welded shall be securely held in position by mechanical means, welded-on bridge pieces, or by tack welding. Electrodes or filler rods used for tack welding shall be of the same quality as those used for completing the first run of weld metal. Where welded-on bridge pieces are used for lining-up assemblies, care shall be taken that the pipe surfaces are not left in a damaged condition after the bridge pieces are removed.

The throat thickness of tack welds shall be similar to that of the initial root run to be deposited in the groove and, 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. This procedure shall also be adopted in the case of an oxy-acetylene welded base run or, alternatively, the tacking welds may be melted out during completion of the oxy-acetylene welded base run.

COLD PULL

9. 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), welding, subsequent heat treatment and cooling.

PREHEATING

10. *a.* Preheating for oxy-acetylene welded base runs shall be as specified in Table 1 and the specified temperature shall be maintained during welding.

TABLE 1. MINIMUM PREHEATING TEMPERATURES FOR OXY-ACETYLENE BASE RUNS

Thickness		Preheating* temperature (min.)
Over	Up to and including	
in.	in.	
7/16	11/16	100°C (212°F)
11/16	⅞	200°C (390°F)
⅞	—	300°C (570°F)

b. Preheating for metal-arc welding shall be as specified in Table 2 and the specified temperature shall be maintained during welding.

* The temperature may be ascertained by means of a thermocouple or by the use of temperature indicating paints or crayons, bearing in mind that there may be a time lag and that one paint or crayon will not indicate by how much the minimum temperature is exceeded. Some types of paints and crayons will not show, once the temperature has been reached, that this temperature is being maintained. In these cases the paint or crayon has to be re-applied if continued temperature observations are to be made.

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TABLE 2. MINIMUM PREHEATING TEMPERATURES FOR METAL-ARC WELDING

Parent metal	Thickness		Preheating* temperature (min.)
	Over	Up to and including	
	in.	in.	
a. Mild steel (up to 0·26 per cent C)	—	¾	See note
	¾		200°C (390°F)
b. Carbon steel (0·26–0·40 per cent C)	All thicknesses		200°C (390°F)
c. Molybdenum steel	—	½	Optional (but see note)
	½	—	200°C (390°F)
d. Chromium-molybdenum steel	All thicknesses		200°C (390°F)

NOTE. No welding or tack welding shall be carried out when the temperature of the parent materials within 6 in. of the joint is less than 40°F (5°C).

c. Preheating shall be carried out by any of the following :

(i) Gas rings or muffle furnaces.

(ii) Electric resistance heaters.

(iii) Induction heating.

(iv) Oxy-acetylene or other gas torches.

The choice of method is dependent on local conditions. So long as the equipment maintains satisfactory temperature distribution and does not interfere with the welding operation, all these methods are acceptable.

THICKNESS OF OXY-ACETYLENE BASE RUN

11. The thickness of such a base run shall be between ⅛ and ¼ in.

* The temperature may be ascertained by means of a thermocouple or by the use of temperature indicating paints or crayons, bearing in mind that there may be a time lag and that one paint or crayon will not indicate by how much the minimum temperature is exceeded. Some types of paints and crayons will not show, once the temperature has been reached, that this temperature is being maintained. In these cases the paint or crayon has to be re-applied if continued temperature observations are to be made.

WORKMANSHIP

12. *a.* **Unnecessary contact with pipe.** Unnecessary contact of the electrode and of non-insulated electrode holders with the pipe shall be avoided. A piece of scrap plate clamped to the pipe near the weld groove should be used for dabbing of the electrode where such a procedure is necessary for removing slag from the tip or for facilitating the starting of the arc.

b. **Removal of slag and visible defects.** All slag shall be removed from each run of weld metal before a further run is superimposed, particular attention being paid to the junctions between weld metal and fusion faces. Each run of weld metal shall be free from visible defects such as cracks, cavities and other deposition faults. All such defects shall be removed before deposition of a subsequent run.

c. **Metal-arc welding on oxy-acetylene welded base run.** The metal-arc welding shall proceed immediately after the oxy-acetylene welded base run has been completed, without cooling below the minimum preheat temperature specified in Clause 10 and Table 2.

d. **Continuity of welding.** Welding shall not be interrupted when a groove is only partially filled unless the thickness of the weld metal deposited is more than half the thickness of the final design weld thickness at all points of the joint.

HEAT TREATMENT AFTER WELDING

13. A. **Butt joints, bends and sleeve welds.** Butt welded joints in mild steel pipes with a design thickness greater than ½ in. and all butt welded joints in the carbon and alloy steels specified in Clause 2 *b*, *c* and *d* shall be heat treated after the completion of all welding. The welds involved in making gusseted bends and sleeve welds according to this British Standard shall also be treated in the same manner.

Heat treatment shall be carried out by one of the following methods:

(i) Local heating using a portable muffle furnace, induction coils or other suitable heating appliance. Particular care shall be taken to apply heat uniformly over the area to be treated. The use of procedures that do not provide adequate control for this purpose, such as manual operation of gas torches, is not permissible. The temperature shall be maintained symmetrically, over a peripheral band of metal of a minimum width of three times the width of the butt weld preparation or fillet leg length. The temperature shall be measured by thermocouples peened, welded or otherwise suitably attached to the surface of the pipe and, where necessary, protected from flame impingement.

(ii) Heating in a stationary industrial furnace. The temperature of the joint shall be measured by thermocouples so disposed within the furnace as to give a true measure of the joint temperature.

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When the outside diameter is 4½ in. or less, this heat treatment shall preferably be carried out as described in *a* below, but where conditions of access make this impossible, they shall be normalized as described in *b* below using an open flame. In all other circumstances, heat treatment shall be stress relieving as described in *a* below.

a. Stress relieving. The stress relieving temperature shall be:

for mild steel and carbon steel within the range 600/650°C (1110/1200°F)

for alloy steels within the range 630/660°C (1170/1220°F).

The stress relieving temperature shall be maintained for approximately one hour per inch of pipe thickness with a minimum of half an hour.

b. Normalizing. The normalizing temperature shall be:

for mild steel and carbon steel within the range 900/950°C (1650/1740°F)

for alloy steels within the range 925/975°C (1700/1790°F).

The higher temperatures 950/975°C (1740/1790°F) shall be used for the alloy steels having a carbon content up to and including 0·12 per cent and the lower temperatures of 925/950°C (1700/1740°F) shall be used for the alloy steels having a carbon content of more than 0·12 per cent.

The normalizing temperature shall be maintained for not less than two minutes, the temperature being judged with the aid of a colour card or temperature measuring paints or crayons, or measured by means of one or more thermocouples or by means of an optical pyrometer. The width of the zone heat treated at the specified temperature shall extend at least ½ in. on either side of the weld reinforcement.

Immediately after normalizing, the joint shall be covered with a suitable muff or asbestos cloth to ensure slow and even cooling.

B. Plate flanges, branches and attachments

(i) *Plate flanges and attachments.* The following welds shall be stress relieved as described in (iii) below after the completion of all welding :

a. Welds connecting plate flanges or major attachments to mild steel pipes with a design thickness greater than ½ in.

b. Welds connecting major attachments to mild steel pipes where the distance between the edges of adjacent welds (as required in design) is less than four times the design pipe thickness.

c. Welds connecting plate flanges or attachments to pipes of the carbon and alloy steels specified in Clause 2 *b*, *c* and *d*.

NOTE. For site work, it is recommended that heavy welded attachments should not be made direct to the pipe. Instead, intermediate plate or plates should be welded to the pipe, stress relieved where necessary, and the heavy attachments welded to the intermediate plates.

(ii) *Branch connections.* Welds in branch connections in which both the main pipe and the branch pipe are of mild steel shall be stress relieved as described in (iii) below after the completion of all welding when the preparation is as follows:

a. Set-on type with a branch pipe of a design thickness exceeding ½ in.

b. Set-in type with a main pipe of a design thickness exceeding ½ in.

c. Set-on or set-in types where the distance (as required by design) from the edge of the branch weld to the edge of the weld on the adjacent branch or attachment is less than four times the design thickness of the main pipe.

Welds in all branch connections in which either or both the main pipe and the branch pipe are of the carbon or alloy steels specified in Clause 2 *b*, *c* and *d* shall be stress relieved as described in (iii) below after the completion of all welding.

(iii) *Stress relieving.* The stress relieving temperature shall be:—

for mild steel and carbon steel within the range 600/650°C (1110/1200°F)

for alloy steels within the range 630/660°C (1170/1220°F).

The stress relieving temperature shall be maintained for approximately one hour per inch of weld throat with a minimum of half an hour.

Stress-relieving shall be carried out by one of the following methods:

a. Local heating using a portable muffle furnace, induction coils or other suitable heating appliance. Particular care shall be taken to apply heat uniformly over the area to be treated. The use of procedures that do not provide adequate control for this purpose, such as manual operation gas torches, is not permissible. The temperature shall be measured by thermocouples peened, welded or otherwise suitably attached to the surface of the pipe and, where necessary, protected from flame impingement.

b. Heating in a stationary industrial furnace. The temperature of the joint shall be measured by thermocouples so disposed within the furnace as to give a true measure of the joint temperature.

INSPECTION

14. The purchaser or his representative shall have access, at all reasonable times, to those parts of the works engaged on the preparation, fabrication, and testing of the pipe assemblies which he has ordered.

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PART 2. BUTT JOINTS

GENERAL

15. All butt joints in pipes and fittings shall comply with the general requirements in Part 1 and with the specific requirements in the relevant sections of this part.

SECTION ONE : ALL TYPES OF BUTT JOINTS*

MATCHING OF BORES

16. The bores of the ends of adjacent pipes shall preferably, for welding purposes, match exactly, but in any case shall not differ at any diameter by more than the amounts given in Table 3, whilst the alignment shall be within the limits stated in the table.

It is recognized that the ends of pipes and welding fittings will be supplied to standard tolerances and may not match, especially if placed together at random. Additional workmanship may therefore be required to ensure the alignment here specified.

The welding of pipe joints to this specification includes the proper matching by the welding contractor of the pipe ends at each joint, by sizing or machining, if necessary, before welding.

Matching may be effected by selection, drifting, or machining, or by the use of a roller expander having an even number of rollers. If drifting is used, it shall be effected on a slow taper drift under the conditions defined in Table 4.

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

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 be used if desired.

* In this section the term ' pipe ' is intended to cover pipes and fittings (e.g. welding neck flanges, forged tees, etc.).

TABLE 3. SIZING OF PIPES

Bore		Maximum permissible difference in internal diameter		Maximum out of alignment at the bore (without backing ring)		
				Oxy-acetylene welded base run		Metal-arc welding
Over	Up to and including	With backing ring	Without backing ring	Preparation Fig. 20	Preparations Figs. 18 and 19	Preparations Figs. 21 and 22
in.	in.	in.	in.	in.		in.
—	4	1/64	1/32	1/32	Machined	1/32
4	12	1/64	1/16	1/32	to	1/16 } not to exceed root face.
12	24	1/32	3/32	3/64	match	1/16 } not to exceed root face.

TABLE 4. DRIFTING OF PIPE ENDS

Bore		Amount of expansion as percentage of diameter	Condition for expansion
Over	Up to and including		
in.	in.		
—	10	Not more than 3 per cent	Hot or cold (as desired)
—	10	Over 3 per cent	Hot
10	24	All values	Hot

NOTE. When drifting or expanding hot, the temperature shall be a normalizing temperature between 900°C and 950°C (1650–1740°F) for mild steel and between 925°C and 975°C (1700–1790°F) for alloy steels, or a temperature in the sub-critical range not exceeding 650°C (1200°F).

FORM OF BACKING RING

17. Permanent backing rings shall be one of the types shown in Figs. 1 to 7.

Where the backing ring is to be removed by machining, it may be of the form shown in Fig. 9. With this exception, backing rings to Figs. 9 to 12 shall not be used.

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