

Specification for

Fusion welding of steel castings

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- Associated Offices Technical Committee
- BCIRA
- British Foundry Association
- British Gas Corporation
- Electricity Supply Industry in England and Wales
- Engineering Equipment and Materials Users' Association
- Institute of British Foundrymen
- Institution of Mechanical Engineers
- Ministry of Defence
- Power Generation Association (BEAMA Ltd)
- Steel Casting Research and Trade Association
- Welding Institute
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Foreword

This British Standard has been prepared under the direction of the Welding Standards Committee. It is a combined revision of BS 4570-1:1970 and BS 4570-2:1972 which are withdrawn. There was much common ground between these two Parts and in this revision it was felt preferable to produce a single standard, with attention drawn to where differing requirements apply according to the purpose of welding. This revision incorporates changes resulting from experience in the use of the previous Parts and from technical developments in the welding of steel castings.

Steel castings may require welding to make them satisfactory for their intended service, and this has long been accepted as part of the normal production process. The procedures in this standard can be specified to ensure good welding practice during the production, repair, rectification and fabrication of steel castings. In fabrication, the use of welding has to be taken into account at the design and/or foundry stages.

Fabrication welding principles require that proven welding procedures are used and although full details on procedure testing are included, the requirements have been kept to the minimum necessary to ensure that sound joints can be produced. Where an established fabricator can offer documentary evidence as proof of possessing satisfactory welding procedures without the need for approval, testing need not be carried out. Also, when more comprehensive testing than was done for an already approved procedure has to be carried out, it is necessary to perform only those specific additional tests and not the entire range of tests required by this standard.

Unlike fabrication welding, in the case of repair and rectification welding there are no “standard” types of weld and each location where welding is required has to be considered in respect of its particular characteristics. It is for this reason that in some clauses of this standard guidance is given to assist in determining the action required. Similarly, no acceptance levels for completed welds are specified and these should be the subject of agreement between the contracting parties.

Care is needed in the interpretation of the results of non-destructive testing, bearing in mind that allowable defects may be present in the castings in the vicinity of the welded joint.

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

At the time of publication of this British Standard, no corresponding International Standard exists.

In the preparation of this revision much assistance has been derived from the information in the document “*Recommended procedure for the fusion welding of steel castings*” published by the Steel Castings Research and Trade Association.

Inspecting authority. The term “inspecting authority” refers to that competent independent body or association which verifies compliance with this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 30, an inside back cover and a back cover.

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

1 Scope

This British Standard specifies requirements for the fusion welding of steel castings when it is used:

- a) to rectify a casting as part of the normal production process;
- b) to rectify a casting that has been in service;
- c) for the joining together of steel castings by fusion welding, where the sub-sections of the final fabrication are designed for that purpose or when welding is introduced at the foundry planning stage.

This standard covers the manual metal-arc, gas-shielded, self-shielded and submerged-arc welding of the materials given in Table 1, but additional guidance for other processes has been given in some clauses.

Although this standard does not directly cover the welding of steel castings to wrought steels, nor the surface deposition of weld metal for applications such as corrosion resistance and hard facing, it may be used as a guide for the fabrication by joining of these forms of steel involving similar and dissimilar metals.

In addition to the definitive requirements, it 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 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 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) whether details of the welding procedure are to be supplied for approval by the purchaser (see 3.2);
- b) whether weld metal of a particular chemical composition is to be used and if so the details (see 4.1.3);
- c) when a welding procedure test is to be carried out, whether a separate procedure test for the particular steel is required (see 20.1.2);
- d) the type of joint or weld for welding procedure approval purposes when this is not to be agreed between the contracting parties [20.4.2 a)].

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 pre-heating temperature, welding consumables and post-weld heat treatment for joining steels of widely different chemical composition in fabrication welding (see 3.3);
- b) requirements for weld metal when creep resisting properties in service are not important and when an alternative to the requirements in 4.1.1 a) or 4.1.1 b) is to be used [see 4.1.1 c)];
- c) weld metal mechanical properties when these do not have to match those of the steel casting [see 4.1.2 b)];
- d) weld metal chemical composition for submerged-arc welding when it is not similar to that of the parent metal [see 4.1.4 b)];
- e) the use of permanent backing material (see 7.1);
- f) the use of carbon steel for temporary backing [see 7.2 b)];
- g) the method and frequency of inspection and the standard of acceptance for completed welds (see clause 17);
- h) whether records showing the location of welds are to be supplied (see clause 19);
- i) the need for welding procedure tests when the other requirements in 20.1.1 do not apply [see 20.1.1 b)];
- j) the material for a welding procedure test piece when an alternative to the requirements of 20.4.1 a) is to be used [see 20.4.1 b)];
- k) the type of joint or weld for welding procedure approval purposes when this is not stated by the purchaser [see 20.4.2 b)];
- l) the length of weld to be ignored in non-destructive testing if other than the first and last 25 mm [see 20.7.1 b)];
- m) whether transverse tensile or round proportional test specimens are to be used for welding procedure approval purposes (see 20.8.2.1);
- n) whether supplementary tests are required for welding procedure approval purposes and if so the details of the tests and the requirements to be satisfied (see 20.9.1);

- o) when impact tests are used for welding procedure approval purposes, the number of specimens, position of notches and impact values to be obtained (see 20.9.2).

3 Castings and welding procedures

3.1 The steel castings to be welded shall have been made to the appropriate British Standard and type of steel given in Table 1.

3.2 The manufacturer shall maintain written details of the welding procedures he proposes to use. When required by the purchaser, the manufacturer shall supply the details of the welding procedure for approval by the purchaser before welding commences. [See 2.1 a) and also clause 20.]

3.3 When it is necessary, in fabrication welding, to join steel castings of widely different chemical composition, the pre-heating temperature, welding consumables and post-weld heat treatment shall be agreed between the contracting parties [see 2.2 a)].

4 Welding consumables

4.1 Weld metal

4.1.1 General. Electrodes, filler wire, filler wire/flux combinations, filler rods and fusible inserts¹⁾ shall be of a type that complies with one of the following, as appropriate:

- a) the relevant British Standard listed in Table 1; or
- b) when no British Standard is listed in Table 1, the requirements of 4.1.2, 4.1.3 and 4.1.4; or
- c) when creep resisting properties in service are not important, requirements for the weld metal agreed between the contracting parties [see 2.2 b)].

4.1.2 Mechanical properties. The mechanical properties of the weld metal shall be either:

- a) at least equal to the minimum in the British Standard for the type of steel casting being welded; or
- b) when it is not necessary to have matching mechanical properties, subject to agreement between the contracting parties [see 2.2 c)].

4.1.3 Chemical composition. Except in those cases where it is not essential for design purposes, nor always desirable for reasons of weldability or behaviour in service, weld metal shall be of similar chemical composition to that of the parent metal. Weld metal having a different chemical composition from that of the parent metal shall only be used provided that the manufacturer can demonstrate its suitability for the service intended or, alternatively, it is specified by the purchaser. [See 2.1 b)].

NOTE Flux-cored filler wires are available although there is no British Standard for them. They may be used provided that the chemical composition of the weld metal is similar to that of the parent metal or is otherwise agreed between the contracting parties.

4.1.4 Submerged-arc welding consumables.

Electrode wire/flux combinations shall be such that the weld metal chemical composition is either:

- a) similar to that of the parent metal; or
- b) as agreed between the contracting parties [see 2.2 d)].

Since welding conditions have a significant effect on the chemical composition of the weld metal, the required composition shall be established by testing under conditions similar to those to be used on the actual fabrication. Particular care shall be taken in controlling welding conditions to ensure consistent weld metal composition, especially where the alloying elements are contained in the flux.

4.2 Storage and handling

Electrodes, filler wires, rods and fluxes shall be stored at a temperature of not less than 20 °C. Handling and use of welding consumables shall be in accordance with the manufacturer's recommendations. Covered electrodes shall be dried before use in accordance with the electrode manufacturer's recommendations that are intended to give a hydrogen level of not more than 10 mL of hydrogen per 100 g of weld metal. (See BS 639 for hydrogen level classification.) Electrodes, filler wires, rods and fluxes that show signs of damage or deterioration shall not be used.

4.3 Shielding and purging gases

When a gas or gas mixture is used, it shall be of the following quality, as appropriate:

- a) argon complying with BS 4365;
- b) carbon dioxide complying with type 1 specified in BS 4105;
- c) gas mixtures that have been proved to be satisfactory as a result of procedure approval tests.

¹⁾ "A pre-placed filler material which is fused to aid the formation of a weld made from one side only." (This definition is taken from BS 499-1.

When a gas mixture is used which has specified additions, the variation of such additions shall be within $\pm 10\%$ of the specified levels.

Moisture content shall correspond to a dew point of $-30\text{ }^{\circ}\text{C}$ or lower.

5 Equipment

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

NOTE 1 BS 638 and BS 679 are applicable.

NOTE 2 The attention of the contractor is drawn to the advice on safety precautions contained in the Health and Safety at Work Booklet No. 38 "Electric Arc Welding" issued by the Health and Safety Executive and published by HM Stationery Office.

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

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 mechanized, automatic and semi-automatic welding, means shall be provided for measuring accurately the arc voltage since this exerts 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.

NOTE 3 Manufacturers' recommendations should be followed with respect to gas pressure and/or flow rate.

All measuring equipment used in welding and heat treatment shall be suitably calibrated.

Where necessary, staging and protection from the weather shall be provided to enable the welding operation to be performed properly, particularly when using a gas-shielded welding process.

6 Preparation for welding

6.1 Types of weld preparation

For fabrication welding, weld preparations shall be based on thickness and access for welding as for wrought materials. Typical preparations for castings are shown in Figure 1 and Figure 2. However, for a casting repair, a different form of weld preparation shall be used consisting of a contained, profiled cavity, typical shapes being given in Figure 3.

Fabricated joints shall take the form of butt welds between equal thickness sections where possible, in order to facilitate welding and inspection.

6.2 Methods of preparation

The following methods of preparation shall be used, but the final method of preparation shall be determined by the configuration required:

- a) mechanical methods, including machining;
- b) flame gouging;
- c) carbon-arc or metal-arc gouging in combination with air or oxygen or other suitable gases;
- d) powder washing.

The use of these methods for specific steels shall be as given in Table 1 and pre-heating requirements for thermal methods shall be as specified in clause 12. Grinding wheels for use on austenitic stainless steels shall be of the "iron free" type and shall have been used only on such steels.

NOTE Sound welding is more likely to be achieved if preparation for welding is taken into account at the design and foundry stages. In some instances the casting can be provided with a preparation without the need for further mechanical or thermal preparation, other than shot blasting.

6.3 Fusion faces

The foundation for welding and the exposed material shall be sound and free from all deleterious matter.

NOTE When the service conditions demand, it may be necessary to apply suitable non-destructive examination to prove that the fusion faces and adjacent areas are acceptable to the contracting parties. In certain cases, filamentary shrinkage may be sealed-off by suitable means, subject to agreement between contracting parties.

7 Backing materials

7.1 Permanent backing

Permanent backing, either separate or integral, shall only be used by agreement between the contracting parties [see 2.2 e)].

7.2 Temporary steel backing

When temporary steel backing is used it shall be either:

- a) of a chemical composition similar to that of the casting; or
- b) where it is agreed between the contracting parties that carbon steel can be used this shall be of up to 0.25 % carbon, provided that neither the sulphur nor the phosphorus contents exceed 0.04 % [see 2.2 f)].

NOTE Carbon steel "buttered" with an adequate thickness of austenitic weld metal may be used with austenitic steel castings. Temporary backing shall not be welded all round its perimeter, as this would increase the risk of basal cracking. Temporary steel backing shall be completely removed after completion of welding.

7.3 Temporary non-metal backing

Temporary non-metal backing shall be completely removed after completion of welding.

Table 1 — Steels, weld preparation, electrodes and filler wires, pre-heating and post-weld heat treatment

NOTE Where alternatives are given, no order of preference is implied.

Steel type	British Standard		Method of weld preparation (see 6.2)	Electrodes and filler wires (see clause 4)			Minimum pre-heating temperature (see clause 12) °C	Post-weld heat treatment temperature (see clause 14) (note 2) °C
	BS 3100	BS 1504 and others		Manual metal-arc welding	Gas-shielded processes (note 1)	Submerged-arc welding		
0.25 % C max.	A1	161, grade 430	a), b), c) or d)	BS 639: E51 XXB	BS 2901-1: A15, A17, A18	BS 4165: M300 or T300	None	580 to 650 (note 3)
0.30 % C max.	—	161, grade 480	a), b), c) or d)	BS 639: E51 XXB	BS 2901-1: A16, A17, A18	BS 4165: M350 or T350	(note 4)	600 to 650
0.35 % C max.	A2	161, grade 540	a), b), c) or d)	BS 639: E51 XXB	BS 2901-1: A16, A17, A18	BS 4165: M350 or T350	(note 4)	600 to 650
0.45 % C max.	A3	—	a), b), c) or d)	BS 639: E51 XXB (notes 5 and 6)	BS 2901-1: A16, A17, A18 (note 5)	BS 4165: M350 or T350 (note 5)	150 (note 7)	600 to 650 (note 8)
1½ % Mn	A4	BS 2772-3	a), b), c) or d)	BS 639: E51 XXB (note 5)	BS 2901-1: A18 (note 5)	BS 4165: M350 or T350 (note 5)	(note 4)	600 to 650 (note 9)
1½ % Mn	A5 A6	—	a), b), c) or d)	BS 639: E51 XXB (note 5)	BS 2901-1: A18 (note 5)	BS 4165: M350 or T350 (note 5)	150 (note 7)	600 to 650 (note 9)
0.20 % C max. (low temperature)	AL1	430, grade LT40	a), b), c) or d)	BS 639: E51 54B	(note 10)	(note 10)	None	600 to 680
0.15 % C max. (magnetic permeability)	AM1	—	a), b), c) or d)	BS 639: E51 21B	BS 2901-1: A17, A18	BS 4165: M300 or T300	None	600 to 680 (note 3)
0.25 % C max. (magnetic permeability)	AM2	—						
0.10 % C to 0.18 % C (case hardening)	AW1	—	a), b), c) or d)	BS 639: E51 21B	BS 2901-1: A17, A18	BS 4165: M300 or T300	None	None (note 11)
0.40 % C to 0.50 % C	AW2	—	a), b), c) or d) (note 12)	BS 639: E51 56B (note 6)	BS 2901-1: A16, A18 (note 6)	BS 4165: M450 or T450 (note 6)	200	600 to 650 (note 13)
0.50 % C to 0.60 % C	AW3	—	a) or c) (note 12)	BS 639: E51 56B (note 6)	BS 2901-1: A16, A18 (note 6)	BS 4165: M450 or T450 (note 6)	250	600 to 650 (note 13)
C-½ % Mo	B1	245	a), b), c) or d)	BS 2493: MoB	BS 2901-1: A30	(note 10)	150 (note 7)	600 to 680
1¼ % Cr-Mo	B2	621	a), b), c) or d) (note 12)	BS 2493:1 CrMoB	BS 2901-1: A32	(note 10)	200	630 to 680
2¼ % Cr-Mo	B3	622	a), b), c) or d) (note 12)	BS 2493: 2 CrMoB	BS 2901-1: A33	(note 10)	250	680 to 720 (note 14)
3 % Cr-Mo	B4	623						

Table 1 — Steels, weld preparation, electrodes and filler wires, pre-heating and post-weld heat treatment

Steel type	British Standard		Method of weld preparation (see 6.2)	Electrodes and filler wires (see clause 4)			Minimum pre-heating temperature (see clause 12) °C	Post-weld heat treatment temperature (see clause 14) (note 2) °C
	BS 3100	BS 1504 and others		Manual metal-arc welding	Gas-shielded processes (note 1)	Submerged-arc welding		
5 % Cr-Mo	B5	625	a), c) or d) (note 12)	BS 2493: 5 CrMoB	BS 2901-1A 34	(note 10)	250	670 to 720 (note 13)
9 % Cr-Mo	B6	629	a), c) or d) (note 12)	BS 2493: 9 CrMoB	BS 2901-1: A35	(note 10)	250	670 to 720 (note 13)
Cr-Mo-V	B7	660	a), b), c) or d) (note 12)	BS 2493: 2 CrMoB (note 15)	BS 2901-1: A33 (note 15)	(note 10)	250	690 to 720 (notes 13 and 16)
C-Mo (low temperature)	BL1	245 grade LT50	a), b), c) or d) (note 12)	(note 10)	(note 10)	(note 10)	150 (note 7)	630 to 680
3½ % Ni (low temperature)	BL2	503 grade LT60	a), b), c) or d) (note 12)	BS 2493: 3 NiB	(note 10)	(note 10)	200 (note 7)	600 to 680
High tensile	BT1 BT2 BT3	—	a), b), c) or d) (note 12)	(note 17)	(note 17)	(note 10)	200 (note 18)	600 to 650 (notes 5, 9 and 14)
3 % Ni-Cr-Mo (case hardening)	BW1	—	a), b), c) or d) (note 12)	(note 10)	(note 10)	(note 10)	250	600 to 680
C-1 % Cr	BW2 BW3	—	a), c) or d) (note 12)	(note 10)	(note 10)	(note 10)	250	600 to 650 (notes 9 and 13)
C-1 % Cr-Mo	BW4	—	a) (note 12)	(note 10)	(note 10)	(note 10)	300	600 to 650 (notes 9 and 13)
Austenitic manganese	BW10	—	a), c) or d)	BS 2926: 19.9.3, 23.12 or any suitable austenitic manganese deposit (notes 19 and 20)	BS 2901-2: 347S96 or any suitable austenitic manganese deposit (note 19)	(note 10)	(note 21)	None
13 % Cr	420C21 420C24 420C29	420C29	a), c) or d) (note 12)	BS 2926: 19.9, 19.12.3, 13 (notes 13, 15 and 22)	BS 2901-2: 316S96 (notes 13, 15 and 22)	(note 10)	250	680 to 750 (note 23)
13 % Cr-4 % Ni	425C11	425C11	a), c) or d)	(note 10)	(note 10)	(note 10)	100	590 to 630 (note 24)

Table 1 — Steels, weld preparation, electrodes and filler wires, pre-heating and post-weld heat treatment

Steel type	British Standard		Method of weld preparation (see 6.2)	Electrodes and filler wires (see clause 4)			Minimum pre-heating temperature (see clause 12) °C	Post-weld heat treatment temperature (see clause 14) (note 2) °C
	BS 3100	BS 1504 and others		Manual metal-arc welding	Gas-shielded processes (note 1)	Submerged-arc welding		
18 % Cr-8 % Ni	304C15 302C25 304C12	304C15 304C12	a), c) or d) (note 25)	BS 2926: 19.9, 19.9 Nb (notes 15 and 26) BS 2926:19.9 L (note 26)	BS 2901-2: 308S96, 308S92 (note 26)	BS 5465: S19.9, S19.9Nb (notes 15 and 26) BS 5465: S19.9L (note 26)	None (note 27)	1 000 to 1 100 (note 28)
18 % Cr-8 % Ni-Nb	347C17	347C17	a), c) or d) (note 25)	BS 2926: 19.9 Nb	BS 2901-2: 347S96	BS 5465: S19.9Nb	None	(note 16)
18 % Cr-8 % Ni-Mo	316C71 315C16	316C71 315C16		BS 2926: 19.12.3	BS 2901-2: 316S96	BS 5465: S19.12.3		
18 % Cr-10 % Ni-2½ % Mo	316C16 316C12	316C16 316C12	a), c) or d) (note 25)	BS 2926: 19.12.3, 19.12.3 L	BS 2901-2: 316S96, 316S92	BS 5465: S19.12.3, S19.12.3 L	None (note 27)	(note 16)
18 % Cr-10 % Ni-2½ % Mo-Nb	318C17	318C17		BS 2926: 19.12.3 Nb	BS 2901-2: 318S96	BS 5465: S19.12.3Nb		
18 % Cr-10 % Ni-3½ % Mo	317C16	317C16 317C12		BS 2926: 19.13.4	BS 2901-2: 317S96	BS 5465: S19.13.4		
Austenitic Cr-Ni-Mo-Cu	—	364C11 332C11	a) or c) (note 12)	(note 10)	(note 10)	(note 10)	None	1 000 to 1 150 Rapid cool
27 % Cr	452C11 452C12	—	a)	(note 10)	(note 29)	(note 29)	300	650 to 700 (note 13)
20 % Cr-10 % Ni	302C35	—	a), c) or d) (note 25)	(note 10)	(note 10)	(note 10)	None	None
25 % Cr-12 % Ni	309C40 309C30 309C32 309C35	—	a), c) or d) (note 25)	(note 10)	BS 2901-2: 309S92	(note 10)	None	None
25 % Cr-20 % Ni	310C45 310C40	310C40	a), c) or d) (note 25)	BS 2926: 25.20 H	BS 2901-2: 310S98	BS 5465: S25.20 H	None	None
25 % Ni-18 % Cr	311C11	—	a), c) or d) (note 25)	BS 2926: 25.20 H	BS 2901-2: 310S98	BS 5465: S25.20 H	None	None
35 % Ni-18 % Cr	330C12 330C11	330C11	a), c) or d) (note 25)	(note 10)	(note 10)	(note 10)	None	None
40 % Ni-20 % Cr	331C60 331C40	—						
60 % Ni-15 % Cr	334C11	—						

Table 1 — Steels, weld preparation, electrodes and filler wires, pre-heating and post-weld heat treatment**Notes to Table 1**

NOTE 1 Although there is no British Standard for flux-cored wires, they are available for welding some of the steels given in Table 1.

NOTE 2 In certain cases it may be necessary to carry out full heat treatment to develop the specified mechanical properties of the steel casting.

NOTE 3 Due to the excellent weldability of these steels, while stress relieving after welding is desirable, it is not always essential.

NOTE 4 If the section thickness or configuration is such that pre-heating is necessary, the pre-heating temperature shall be 100 °C minimum.

NOTE 5 The tensile strength of these electrodes and filler wires is rather low compared with that of the cast steel, but the yield stress is satisfactory.

NOTE 6 This should not be used for surfaces subject to abrasion. When surface hardening is to be carried out, a suitable welding electrode should be used.

NOTE 7 Thin section castings may not require pre-heating.

NOTE 8 In special cases, e.g. if the carbon exceeds 0.35 % with castings having rapid changes in section and subject to a high degree of internal stress, it is recommended that immediate post-weld heat treatment at 600 °C to 650 °C, followed by air cooling, be applied.

NOTE 9 A lower post-weld heat treatment temperature may be necessary for certain hardened and tempered castings in order to maintain the specified tensile strength, but, if this is done, the time at that temperature may have to be extended to ensure adequate stress relief.

NOTE 10 No suitable electrode or filler wire complying with a British Standard is available, although suitable types are manufactured and marketed under various trade names.

NOTE 11 Stress relief is not required; this is effected by subsequent case hardening heat treatment.

NOTE 12 If any method except a) is used, the casting shall be pre-heated and the preparation may be followed by grinding.

NOTE 13 Care is needed when welding these steels which may include the need for immediate post-weld heat treatment to minimize the risk of cracking.

NOTE 14 For heavy sections and steels of certain compositions, note 13 may apply.

NOTE 15 These electrodes have non-matching composition and/or properties to the steel casting.

NOTE 16 Welds in this material shall be ground at the toes, before post-weld heat treatment, if any.

NOTE 17 The electrode used should be compatible with the mechanical properties of the steel casting.

NOTE 18 Depending on the composition of the steel, a higher temperature may be necessary.

NOTE 19 A BS 2901-2 347S96 or BS 2926: 23.12 deposit is not suitable for wearing surfaces unless a facing of austenitic manganese steel is applied.

NOTE 20 For major welds, buttering using any suitable Cr-Ni electrode, e.g. 23 Cr-12 Ni should precede the austenitic manganese weld.

NOTE 21 This steel shall not be pre-heated and the interpass temperature shall not be allowed to exceed 200 °C.

NOTE 22 In the case of steel castings to 420C24 and 420C29, the electrodes specified are not suitable for those parts of castings subject to abrasion. In the case of steel castings to 420C21, 420C29 and 420C24, the following considerations also apply:

a) In all cases, particularly when it is intended to use austenitic electrodes (BS 2926: 19.9 or 19.12.3) to minimize the risk of cracking, reference should first be made to the service requirements of the casting for hardness, corrosion and abrasion resistance, fatigue and tensile properties and appearance. In certain corrosive environments, it may be advisable to use electrodes BS 2926: 19.9 Nb and 10.12.3 Nb in place of BS 2926: 19.9 and 19.12.3.

b) A 13 % Cr or 13 % Cr/Ni electrode may be used.

NOTE 23 Extreme care is needed when welding this steel which preferably should have immediate post-weld heat treatment to avoid cracking. If this is not possible, slow cooling to below 50 °C after welding is required, with post-weld heat treatment applied later.

NOTE 24 Cool to room temperature prior to stress relief.

NOTE 25 If any method except a) is used, it may be followed by grinding.

NOTE 26 Welding before final heat treatment is recommended.

NOTE 27 Castings in the fully heat treated condition should be welded with an interpass temperature control of 175 °C maximum.

NOTE 28 Cool rapidly. If carbon is below 0.03 %, the post-weld heat treatment may be omitted.

NOTE 29 Not a suitable welding process for this type of steel.