British Standard

BRITISH STANDARD

BS 4872-1: 1982

(Reprinted, incorporating Amendment No. 1)

Specification for

Approval testing of welders when welding procedure approval is not required —

Part 1: Fusion welding of steel

UDC 621.791.007.2:331.108.376:[669.14:621.791.55]

Cooperating organizations

The Welding Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

Aluminium Federation*
Associated Metal Workers' Union
Associated Offices Technical Committee*
British Compressed Gases Association
British Constructional Steelwork Association*
British Railways Board*
British Shipbuilders
British Steel Industry
Crown Agents for Oversea Governments and Administrations
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Society of Motor Manufacturers and Traders Limited
Water-tube Boilermakers' Association*
Welding Institute*
Welding Manufacturers' Association*

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

Association of Consulting Scientists
British Gas Corporation
Electricity Supply Industry in England and Wales
Engineering Equipment Users' Association
Heating and Ventilating Contractors' Association
National Coal Board
Power Generation Association (BEAMA)
Stainless Steel Fabricators' Association of Great Britain
United Kingdom Atomic Energy Authority

This British Standard, having been prepared under the direction of the Welding Standards Committee, was published under the authority of the Board of BSI and comes into effect on 30 November 1982

First published December 1972
First revision November 1982

The following BSI references relate to the work on this standard:
Committee reference WEE/36
Draft for comment 81/72456 DC

ISBN 0 580 13037 1

Amendments issued since publication

Amd. No.	Date of issue	Comments
4640	July 1984	Indicated by a sideline in the margin

Contents

Foreword

This revision of this Part of BS 4872 has been prepared under the direction of the Welding Standards Committee. It incorporates technical and editorial changes developed from experience gained in the use of the standard since it was first published in 1972. This Part of BS 4872 supersedes BS 4872-1:1972 which is withdrawn.

This revision does not invalidate welder approvals previously accepted according to the requirements of the 1972 edition of the standard, provided the details of such approvals are still relevant to the production work on which the welders are to be employed. The extent of approval given by a previous test in accordance with the 1972 edition may now be related to those ranges indicated in this revised edition. All new approval testing of welders should be made in accordance with the requirements of this revised edition.

Welders already approved in accordance with the requirements of BS 4871-1 should thereby be considered to be also approved in accordance with the requirements of BS 4872-1 for the same test conditions without undergoing further tests.

This British Standard is one of a series of standards on the approval testing of welders and welding procedures, the latter having a bearing on the former for certain applications. This link has been used as a means of arranging the series of standards into:

a) approval testing of welding procedures (see BS 4870 "*Approval testing of welding procedures*" — Part 1: "Fusion welding of steel");

b) welder approval when approval of the welding procedure is required (see BS 4871 "*Approval testing of welders working to approved welding procedures*" — Part 1: "*Fusion welding of steel*");

c) welder approval when approval of the welding procedure is not required (for either technical or contract reasons).

The simple approval of welders on sheet, plate and pipe[1)] when no welding procedure approval is required is covered by this standard. For the purposes of this Part of this standard, welders are considered to be already capable of passing training tests such as those given in BS 1295 "*Tests for use in the training of welders. Manual metal-arc and oxy-acetylene welding of mild steel*".

To complete the philosophy behind the series of standards, it is considered useful to give details of the practices relating to welding procedure approval even though they are not strictly relevant to this standard. Depending upon the emphasis placed on quality control in the production of welded components, the approval of welding procedures covered in this series of standards may be administered in one of several ways which should be stipulated at the enquiry and/or order stage. The alternatives currently employed are the following:

1) each individual contractor (or sub-contractor) may have proved, by actual test pieces, every weld form he wishes to use, in every thickness and material; or

2) each individual contractor (or sub-contractor) may have proved, by actual test pieces, a set of welds representative on a group basis of all the various thicknesses and materials to be used in production; or

3) each individual contractor (or sub-contractor) need not make procedure test pieces, providing he can prove by appropriate authentic documentation of an independent nature that he has previously satisfactorily welded the type of joint and material in question.

[1)] In this standard the word "pipe", alone or in combination, is used to mean "pipe" or "tube" or "structural hollow section" (circular or rectangular), although these terms are often used for different categories of product by different industries.

In respect of 1) and 2) it should be appreciated that once the welding procedure tests have been approved, they need never be repeated unless there is a change in certain variables. As an extension beyond 3), it may be possible by agreement between the contracting parties for fully documented welding procedures, developed independently of the particular contractor, to be employed without the need for further approval tests.

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 to iv, pages 1 to 20, 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.

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Section 1. General

1 Scope

This Part of this British Standard specifies requirements for the approval testing of welders to be engaged on the manual or semi-automatic fusion welding of those ferritic steel or austenitic stainless steel fabrications for which the welding procedure does not itself have to be approved.

NOTE Users of this standard should be aware that some steels may require special treatment during welding if defects, such as cracks and porosity, are to be avoided. This may entail careful selection of welding consumables, their drying or conditioning prior to use, applying preheat and/or post-weld heat treatment and control of welding heat input. When such a steel is encountered consideration should be given to the provision of a detailed welding procedure with corresponding approval of the procedure and welders in accordance with the companion standards mentioned in the foreword.

2 Information to be given to the welder

The welder shall be provided with written instructions and information covering the following details:

a) parent metal (ferritic steel or austenitic stainless steel);

b) welding process and polarity;

c) welding consumables (electrode or filler material specification, type of flux, shielding gas composition);

d) welding position;

e) metal thickness and, for pipe, the outside diameter or dimension;

f) joint type, with sketch of weld preparation;

g) weld dimensions required.

Other factors shall be left to the choice of the welder but the relevant details shall be recorded.

3 Test welds

3.1 Selection of test welds. The selection of a test weld, or welds, for the welder shall be made from the tests given in section 2, according to which is most representative of the type of work on which he will be employed. The welder shall make a further test weld or welds whenever the work on which he will be employed changes sufficiently in respect of the items listed in clause **2** as to make the test weld or welds, on which he is already approved no longer representative of the new work.

In addition, the thickness and type of the parent metal, the welding process, and the consumables chosen shall be of the same type as is used on the work which the test weld or welds represent, and all test welds shall be made with normal production equipment where possible.

A test butt weld in pipe shall also cover for a butt weld in plate for the same test conditions, but the converse shall not apply.

3.2 Test conditions. Tack welds shall be made from the side to be welded and their location shall be marked on the test piece. The location of stop/starts shall be marked on the test piece.

No method of restraint other than by tack welding shall be used.

NOTE Distortion or mis-alignment caused by tacking may be corrected before the test weld is made.

3.3 Submission of test welds. If the welder realizes that for some reason the test weld he has made is likely to fail the subsequent examination and testing, he shall have the option to withhold the test piece and make a second test weld. If the welder does choose to make a second test weld, it is the second test piece that shall be examined and tested, the first test piece being scrapped.

Weld tests shall be submitted in the as-welded condition without any grinding or peening.

4 Assessment of test welds

4.1 Sequence of assessment. The sequence of assessment of completed test welds shall be:

a) visual examination and assessment of the test piece in accordance with clause **17**;

b) selection of the appropriate destructive tests for the particular test weld(s) in accordance with clause **18**;

c) implementation and assessment of the appropriate destructive tests as given in clause **19**.

4.2 Repeat tests. If a test piece fails to meet the requirements of clause **17** or **19**, two further test pieces of the type which failed shall be welded and assessed. The option given in **3.3** shall not apply in this case. If either of these repeat test welds fail to satisfy the requirements of clause **17** or **19**, the welder shall be regarded as incapable of meeting the requirements of this standard for the particular type of test weld without further training.

5 Statement of results of welder testing

A statement of the results of assessing each test piece, including repeat tests, shall be made for each welder, preferably on a form of the type recommended in Appendix A. The items required under clause **2** shall be included, together with details of any features that would fail to meet the acceptance criteria of clauses **17** and **19**.

NOTE 1 The welder's employer should hold and regularly maintain adequate records of all approval tests for each welder.

NOTE 2 If an independent inspecting authority or test house witnesses the welder approval tests carried out in accordance with this standard and all the relevant provisions are fulfilled, it is recommended that such approval should be accepted by others.

6 Reapproval of welder

The reapproval of a welder shall be required if any of the following apply:

a) the welder is to be employed on work outside the extent of his current approval (see **3.1**);

b) the welder changes his employer without the transfer of his approval test certificate;

c) six months or more have elapsed since the welder undertook any welding;

d) there is some specific reason to question the welder's ability.

NOTE Reapproval every two years is recommended.

Section 2. Test weld details

7 Test 1. Butt weld in sheet

7.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 1 provided that the test conditions listed have been met.

7.2 Deposition of test weld. The test weld shall be made in a single run and shall be stopped and restarted within the central 50 mm of its length. In the case of manual metal-arc welding the restart shall be made with a fresh electrode. A sealing run on the reverse side shall not be deposited.

Table 1 — Butt weld in sheet

	Test conditions	Extent of approval
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**	Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode
Welding position[a]	Flat	Flat
	Vertical-up	Vertical-up and flat
	Vertical-up and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
	Vertical-down	Vertical-down
Thickness, t	3 mm max.	0.75 t to 1.5 t
Joint type	Square butt as Figure 1	Any butt weld in sheet in above thickness range

[a] If a combination of test positions other than those specified is used, the welder is approved only for that combination.

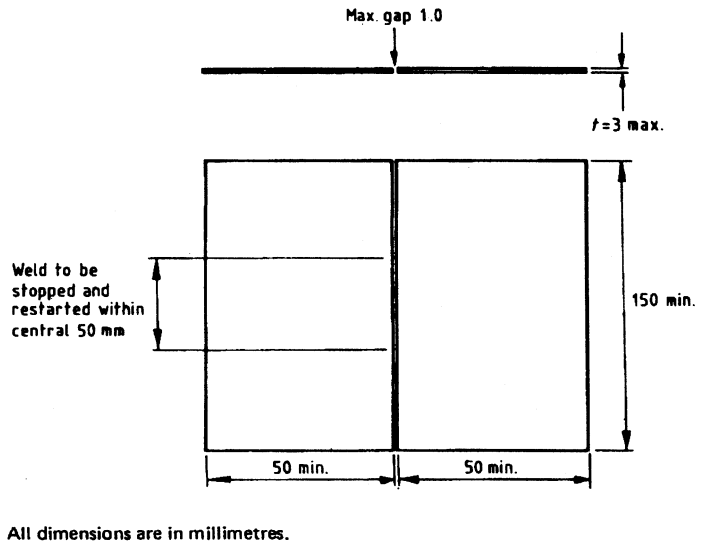


Figure 1 — Test piece for butt weld in sheet

8 Test 2. Fillet weld in sheet

8.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 2 provided that the test conditions listed have been met.

8.2 Deposition of test weld. The test weld shall be made in a single run on only one side of the joint, with approximately equal leg lengths of 4 mm. The weld shall be stopped and restarted at about 75 mm from one end. In the case of manual metal-arc welding the restart shall be made with a fresh electrode.

Table 2 — Fillet weld in sheet

	Test conditions	Extent of approval
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**	Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode
Welding position[a]	Horizontal-vertical	Horizontal-vertical and flat
	Vertical-up	Vertical-up, horizontal-vertical and flat
	Overhead	Overhead, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
	Vertical-down	Vertical-down
Thickness, t	3 mm max.	0.75 t to 1.5 t
Joint type	T joint as Figure 2	Any fillet weld in sheet in above thickness range

[a] If a combination of test positions other than those specified is used, the welder is approved only for that combination.

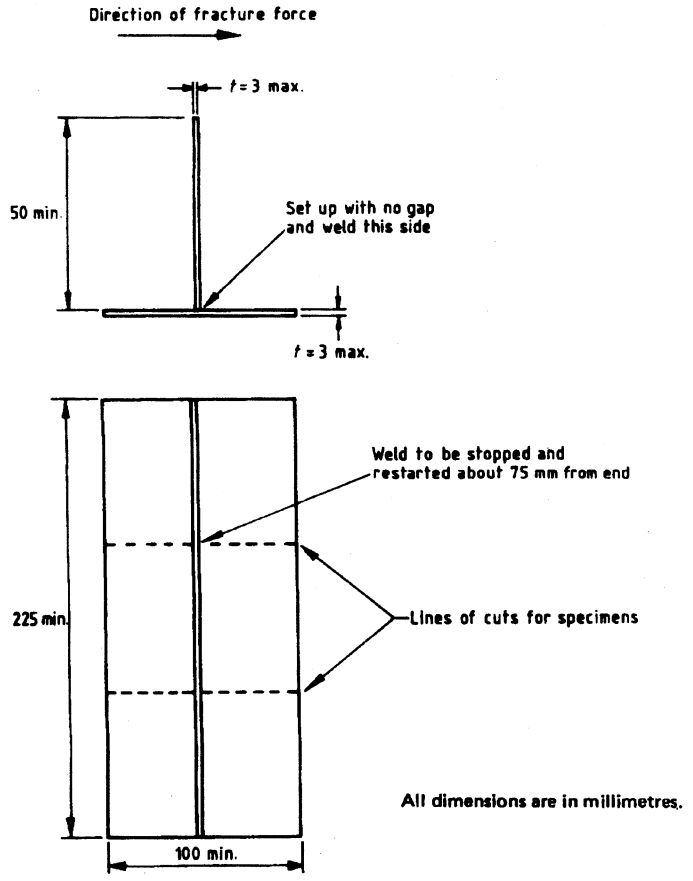


Figure 2 — Test piece for fillet weld in sheet

9 Test 3. Butt weld in plate (without backing, welded from one side)

9.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 3 provided that the test conditions listed have been met.

9.2 Deposition of test weld. The root run of the test weld shall be stopped and restarted within the central 50 mm of its length. In the case of manual metal-arc welding the restart shall be made with a fresh electrode. A sealing run on the reverse side shall not be deposited.

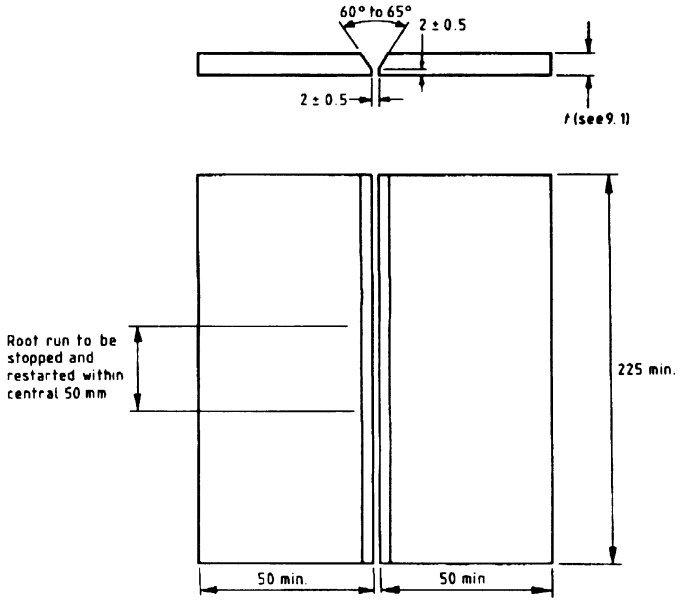
Table 3 — Butt weld in plate (without backing, welded from one side)

	Test conditions	Extent of approval
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**	Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode
Welding position[a]	Flat	Flat
	Vertical-up[b]	Vertical-up and flat
	Vertical-up and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
	Vertical-down	Vertical-down
Thickness, t	At least 6 mm, but less than 12 mm	0.5 t to 2 t
	12 mm or thicker	8 mm and thicker
Joint type	Single-V butt without backing, as Figure 3[c]	For plate in above thickness ranges: (a) any single sided butt weld preparation, with or without backing, welded from one side only (b) any single sided butt weld preparation welded from both sides with or without back gouging (c) any double sided butt weld preparation

[a] If a combination of test positions other than those specified is used, the welder is approved only for that combination.

[b] For MIG welding the root run may be deposited in the vertical-down position.

[c] The dimensions of the weld preparation are typical for manual metal-arc welding in the flat position but for other processes or positions it may be necessary for modifications to be made. In all cases recording of the details is required (see clause **2** and Appendix A).



All dimensions are millimetres

Figure 3 — Test piece for butt weld in plate (without backing, welded from one side)

10 Test 4. Butt weld in plate (welded from both sides)

10.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 4 provided that the test conditions listed have been met.

10.2 Deposition of test weld. The final run on each side of the test weld shall be stopped and restarted within the central 50 mm of its length. In the case of manual metal-arc welding the restart shall be made with a fresh electrode.

The back of the first run shall be gouged out by suitable means to clean, sound metal before welding is started on the gouged-out side.

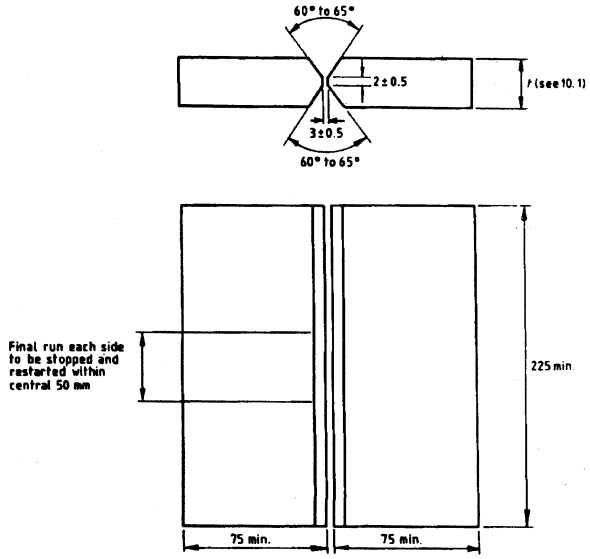
Table 4 — Butt weld in plate (welded from both sides)

	Test conditions			Extent of approval
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**			Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode
Welding position[a]	**First side**	**Second side**		
	Flat	Overhead		Flat, overhead and horizontal-vertical
	Vertical-up[b]	Vertical-up[b]		Vertical-up and flat
	Vertical-up[b]	Vertical-up[b]	2 test welds	Vertical-up, horizontal-vertical and flat
	Horizontal-vertical	Horizontal-vertical		
	Vertical-up[b]	Vertical-up[b]	2 test welds	Vertical-up, overhead, flat and horizontal-vertical
	Overhead	Flat		
	Vertical-down	Vertical-down		Vertical-down
Thickness, t	At least 6 mm, but less than 12 mm			0.5 t to 2 t
	12 mm or thicker			8 mm and thicker
Joint type	Double-V butt, as Figure 4[c]			For plate in above thickness ranges: (a) any double sided butt weld preparation (b) any single sided butt weld preparation welded from both sides with back gouging

[a] If a combination of test positions other than those specified is used, the welder is approved only for that combination.

[b] For MIG welding the root run may be deposited in the vertical-down position.

[c] The dimensions of the weld preparation are typical for manual metal-arc welding in the flat and overhead positions, but for other processes or positions it may be necessary for modifications to be made. In all cases recording of the details is required (see clause **2** and Appendix A).



All dimensions are millimetres

Figure 4 — Test piece for butt weld in plate (welded from both sides)

11 Test 5. Butt weld in plate (with backing)

11.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 5 provided that the test conditions listed have been met.

11.2 Deposition of test weld. The final run of the test weld shall be stopped and restarted within the central 50 mm of its length. In the case of manual metal-arc welding the restart shall be made with a fresh electrode.

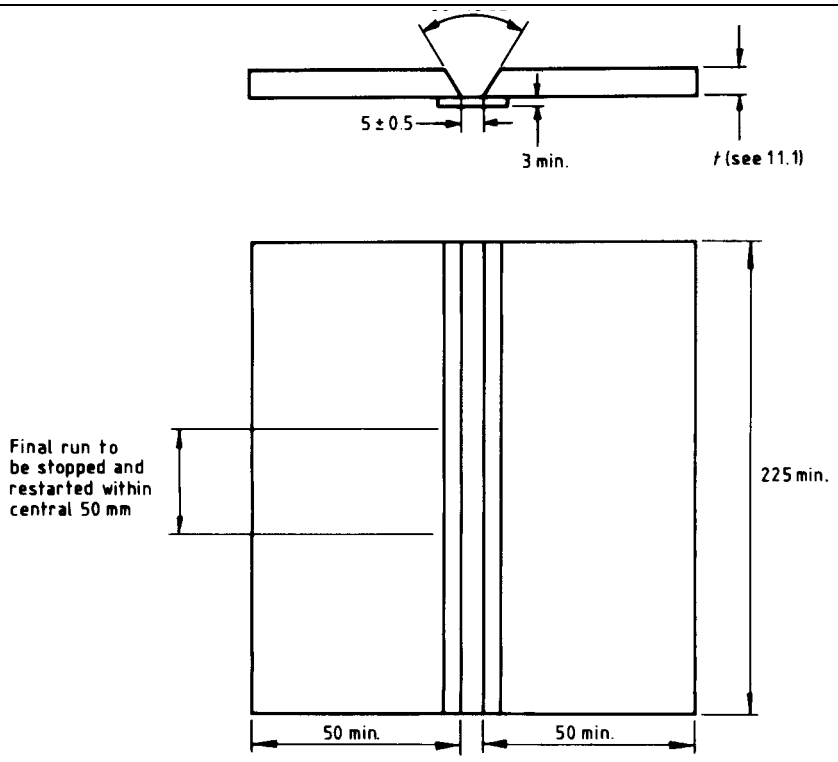
Table 5 — Butt weld in plate (with backing)

	Test conditions	Extent of approval
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**	Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode
Welding position[a]	Flat	Flat
	Vertical-up[b]	Vertical-up and flat
	Vertical-up[b] and horizontal-vertical (2 test welds)	Vertical-up, horizontal-vertical and flat
	Vertical-up and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
	Vertical-down	Vertical-down
Thickness, t	At least 6 mm, but less than 12 mm	0.5 t to 2 t
	12 mm or thicker	8 mm and thicker
Joint type	Single-V butt with backing, as Figure 5[c]	Any single sided butt weld preparation with backing in plate in above thickness ranges

[a] If a combination of test positions other than those specified is used, the welder is approved only for that combination.

[b] For MIG welding the root run may be deposited in the vertical-down position.

[c] The dimensions of the weld preparation are typical for manual metal-arc welding in the flat position, but for other processes or positions it may be necessary for modifications to be made. In all cases recording of the details is required (see clause **2** and Appendix A).



All dimensions are millimetres

Figure 5 — Test piece for butt weld in plate (with backing)

12 Test 6. Fillet weld in plate

12.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 6 provided that the test conditions listed have been met.

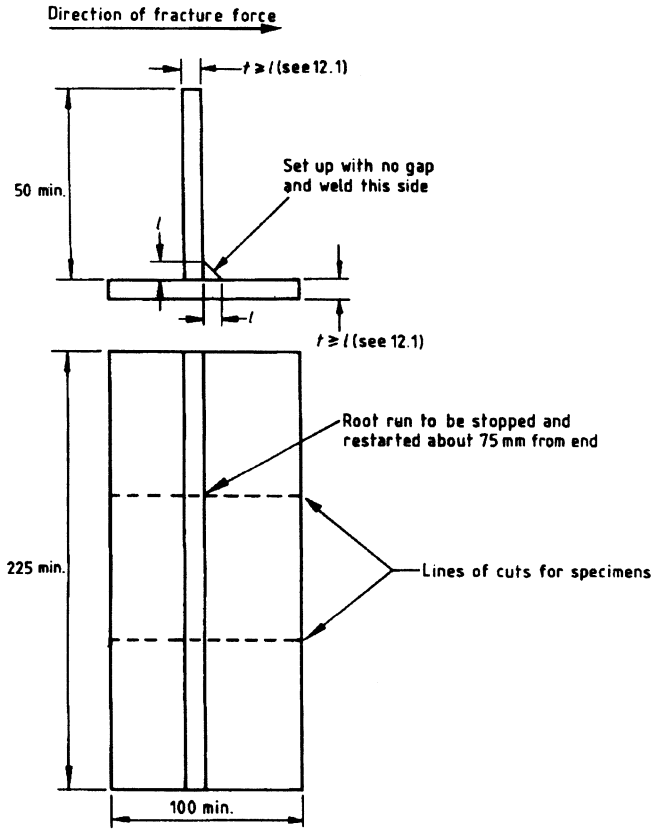
12.2 Deposition of test weld. The test weld shall be made on only one side of the joint, with approximately equal final leg lengths.

The root run shall be stopped and restarted at about 75 mm from one end. In the case of manual metal-arc welding the restart shall be made with a fresh electrode.

Table 6 — Fillet weld in plate

	Test conditions	Extent of approval
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**	Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode
Welding position[a]	Horizontal-vertical	Horizontal-vertical and flat
	Vertical-up[b]	Vertical-up, horizontal-vertical and flat
	Overhead	Overhead, horizontal-vertical and flat
	Vertical-up[b] and overhead (2 test welds)	Vertical-up, overhead, horizontal-vertical and flat
	Vertical-down	Vertical-down
Parent metal thickness, t, to be equal to or greater than the fillet weld leg length, l	Leg length at least 6 mm, but less than 12 mm	0.5 l to 2 l
	Leg length 12 mm or greater	8 mm and greater
Joint type	T joint as Figure 6	For plate, any fillet weld of leg length in above ranges

[a] If a combination of test positions other than those specified is used, the welder is approved only for that combination.
[b] For MIG welding the root run may be deposited in the vertical-down position.



All dimensions are millimetres

Figure 6 — Test piece for fillet weld in plate

13 Test 7. Butt weld in pipe (without backing)

13.1 Extent of approval and test conditions.
The extent of approval for this test shall be as given in Table 7 provided that the test conditions listed have been met.

Table 7 — Butt weld in pipe (without backing)

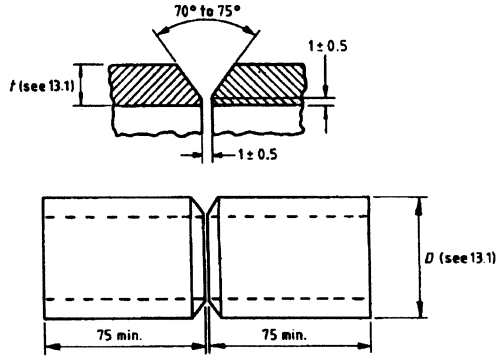
	Test conditions		Extent of approval	
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**		Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode	
Position[a]	Pipe positions	Axis horizontal, pipe rotating	Welding positions	Flat
		Axis horizontal, pipe fixed (vertical-up[b])		Overhead, vertical-up and flat
		Axis horizontal, pipe fixed (vertical-down)		Flat, vertical-down and overhead
		Axis vertical		Horizontal-vertical and flat
		Axis inclined at 45°, pipe fixed (vertical-up[b]) or Axis horizontal, pipe fixed (vertical-up[b]) and axis vertical (2 test welds)		Overhead, vertical-up, horizontal-vertical and flat
Thickness, *t*	Less than 20 mm		0.5 *t* to 2 *t*	
	20 mm or thicker		15 mm and thicker	
Outside diameter or dimension, *D* (For rectangular hollow sections *D* is dimension of smaller side)	Less than 165 mm[c]		0.5 *D* to 2 *D*	
	165 mm or larger		80 mm and larger	
Joint type	Single-V butt without backing, as Figure 7[d]		For pipe in above thickness and diameter ranges: (a) any butt weld in pipe, with or without backing (b) any branch joint with a hole in the main pipe Also for butt welds in plate as given in Table 3, but in above thickness ranges and welding positions	

[a] If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.

[b] For MIG welding, the root run in a multi-run weld or a single run weld for thin pipe may be deposited in the vertical-down position. In the case of the single run weld approval would then be for the vertical-down position.

[c] For MIG welding the test pipe diameter to be at least 100 mm.

[d] The dimensions of the weld preparation are typical for manual metal-arc welding but for other processes it may be necessary for modifications to be made. The same essential dimensions apply for rectangular hollow sections, in all cases recording of the details is required (see clause **2** and Appendix A).



All dimensions are millimetres

Figure 7 — Test piece for butt weld in pipe (without backing)

14 Test 8. Butt weld in pipe (with backing)

14.1 Extent of approval and test conditions.
The extent of approval for this test shall be as given in Table 8 provided that the test conditions listed have been met.

Table 8 — Butt weld in pipe (with backing)

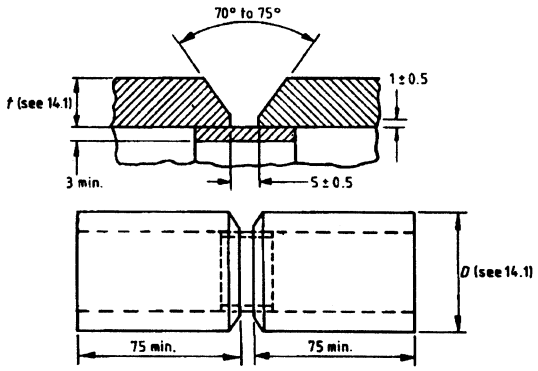
	Test conditions		Extent of approval	
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**		Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode	
Position[a]	Pipe positions	Axis horizontal, pipe rotating	Welding positions	Flat
		Axis horizontal, pipe fixed (vertical-up[b])		Overhead, vertical-up and flat
		Axis horizontal, pipe fixed (vertical-down)		Flat, vertical-down and overhead
		Axis vertical		Horizontal-vertical and flat
		Axis inclined at 45°, pipe fixed (vertical-up[b]) or Axis horizontal, pipe fixed (vertical-up[b]) and axis vertical (2 test welds)		Overhead, vertical-up, horizontal-vertical and flat
Thickness, *t*	Less than 20 mm		0.5 *t* to 2 *t*	
	20 mm or thicker		15 mm and thicker	
Outside diameter or dimension, *D* (For rectangular hollow sections *D* is dimension of smaller side)	Less than 165 mm[c]		0.5 *D* to 2 *D*	
	165 mm or larger		80 mm and larger	
Joint type	Single-V butt with backing, as Figure 8[d]		Any butt weld in pipe or plate with backing in above thickness and diameter ranges	

[a] If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.

[b] For MIG welding, the root run in a multi-run weld or a single run weld for thin pipe may be deposited in the vertical-down position. In the case of the single run weld approval would then be for the vertical-down position.

[c] For MIG welding the test pipe diameter to be at least 100 mm.

[d] The dimensions of the weld preparation are typical for manual metal-arc welding but for other processes it may be necessary for modifications to be made. The same essential dimensions apply for rectangular hollow sections, in all cases recording of the details is required (see clause **2** and Appendix A).



All dimensions are millimetres

Figure 8 — Test piece for butt weld in pipe (with backing)

15 Test 9. Branch connection (fillet weld)

15.1 Extent of approval and test conditions. The extent of approval for this test shall be as given in Table 9 provided that the test conditions listed have been met.

15.2 Deposition of test weld. The test weld shall change gradually from a fillet weld at the crotch to a butt weld at the flank. The fillet weld at the crotch shall have approximately equal leg lengths corresponding to the thickness t or 4 mm whichever is the greater.

Table 9 — Branch connection (fillet weld)

	Test conditions		Extent of approval	
Parent metal, welding process and welding consumables	As to be used for work on which welder will be employed and to be specified in accordance with clause **2**		Material, welding process and welding consumables of types used for the test, except that approval using a basic covered electrode includes approval for a rutile covered electrode	
Position[a]	Pipe positions	Axis of main and branch horizontal, fixed during welding but branch turned through 180° (vertical-up[b]) [see Figure 9 (b)]	Welding positions	Vertical-up, horizontal-vertical and flat
		Axis of main horizontal and axis of branch vertical, fixed above the main		Flat and horizontal-vertical
		Axis of main and branch horizontal-fixed (vertical-up[b])		Overhead, vertical-up, horizontal-vertical and flat
		Axis of main and branch horizontal-fixed (vertical-down)		Flat, horizontal-vertical, vertical-down and overhead
Thickness, t	Less than 20 mm		0.5 t to 2 t	
	20 mm or thicker		15 mm and thicker	
Outside diameter or dimension, D (For rectangular hollow sections D is dimension of smaller side)	Less than 165 mm[c]		0.5 D to 2 D	
	165 mm or larger		80 mm and larger	
Joint type	Right angle branch, as Figure 9 (a)		Any fillet weld in pipe in above thickness and diameter ranges	

[a] If a combination of test pipe positions other than those specified is used, the welder is approved for the welding positions derived only from that combination.

[b] For MIG welding, the root run in a multi-run weld or a single run weld for thin pipe may be deposited in the vertical-down position. In the case of the single run weld approval would then be for the vertical-down position.

[c] For MIG welding the test pipe diameter to be at least 100 mm.

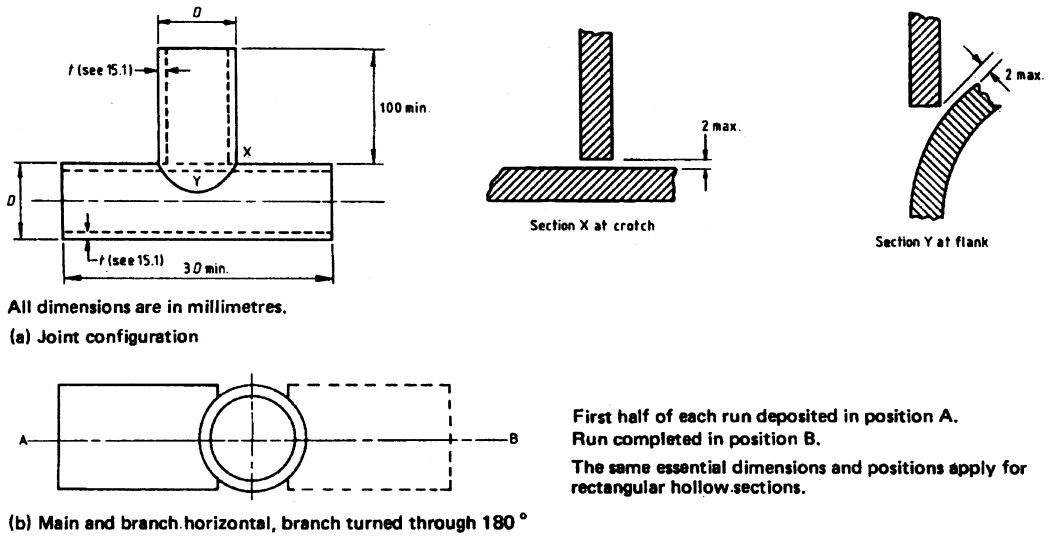


Figure 9 — Test piece for branch connection (fillet weld)

Section 3. Assessment of test welds

16 General

Each test weld shall be subjected to visual examination in accordance with clause **17** and destructive testing in accordance with clauses **18** and **19**. All the requirements given in clauses **17** and **19** shall be met before approval of a welder is given, unless it can be established that defects revealed through destructive testing have arisen as a result of metallurgical or other extraneous causes and are not attributable to the welder's workmanship.

17 Visual examination of test welds

17.1 General. Each test piece shall be examined visually prior to sectioning for destructive testing.

NOTE A hand lens with a magnification of 2 to 2½ diameters may be used to assist in the examination.

The test pieces shall show the features detailed in **17.2**, **17.3**, **17.4**, **17.5** and **17.6**.

17.2 Weld contour. Welds shall be linear, of uniform profile, free from excessive undulations and shall have a consistent width of weld face. Weld ripples shall have a good and consistent form. The toes of welds shall blend smoothly with the parent metal without overlap.

Butt welds shall have uniform convexity up to a maximum height of 3 mm or $t/5$ whichever is the smaller, where t is the thickness of the parent metal.

Fillet weld leg lengths shall be not less than the value required and shall not differ from each other by more than 1 mm, except for single run fillet welds made in the horizontal-vertical position which shall not differ in leg length by more than 1.5 mm. The minimum throat thickness shall be not less than 0.7 times the minimum leg length recorded.

17.3 Undercut and incomplete filling. Slight intermittent undercut shall be permitted provided that the depth does not exceed approximately 10 % of the parent metal thickness or 1 mm whichever is the smaller.

There shall be no incomplete filling of butt joints.

17.4 Smoothness of joins where welding is re-started. The joins at all external stop/start positions shall merge smoothly and shall show no pronounced hump or crater in the weld surface.

17.5 Penetration in butt joints welded from one side only. In butt joints without backing which have been welded from one side only, there shall be full penetration visible for at least 75 % of the length of the weld distributed regularly. A slight penetration bead shall be permitted provided that it does not protrude more than 3 mm.

If there is complete root fusion, root concavity shall be acceptable provided that the thickness of the weld is not less than the parent metal thickness.

In butt joints with backing, the backing material shall not have been pierced due to excessive penetration.

17.6 Surface defects. The weld surface shall be free from cracks and substantially free from porosity, shrinkage cavities and trapped slag. The weld surface and adjacent parent metal shall be substantially free from arcing or chipping marks.

18 Selection of destructive tests

18.1 The destructive test(s) required for tests 1 to 9 in section 2 shall be as given in the following list. The individual tests shall be carried out by the methods given in clause **19**.

Test number and type	Destructive test(s) required
1. Butt weld in sheet	One macrosection to include the stop/start position.
2. Fillet weld in sheet	Three fracture tests after the end face at the stop/start position has been used for macro-examination.
3. Butt weld in plate (without backing, welded from one side)	One bend test (see **18.2**) to be taken from a location showing full penetration other than the central 50 mm. One fracture test to include the stop/start position.
4. Butt weld in plate (welded from both sides)	One bend test (see **18.2**) selected from other than the central 50 mm. One macrosection to include stop/start position.
5. Butt weld in plate (with backing)	One bend test (see **18.2**) selected from other than the central 50 mm. One fracture test from the central 50 mm.
6. Fillet weld in plate	Three fracture tests after the end face at the stop/start position has been used for macro-examination.
7. Butt weld in pipe (without backing)	Two root bend tests taken from locations having full penetration, but for MIG welded pipe 10 mm thick and over two side bends.

8. Butt weld in pipe (with backing)	Two root bend tests, but for MIG welded pipe 10 mm thick and over two side bends.
9. Branch connection (fillet weld)	Four macrosections (one at each crotch and flank).

18.2 In tests 3, 4 and 5, for plate less than 10 mm thick a root bend test shall be used and for plate 10 mm thick and over a side bend test shall be used.

19 Method and assessment of destructive tests

19.1 Macro-examination. The specimen shall be the full thickness of the material at the welded joint and the excess weld metal and penetration bead, or backing material when used, shall be left intact. The specimen shall contain a length of the joint of at least 10 mm and shall extend on each side of the weld for a distance that includes the heat-affected zone and some parent metal. For tests 2 and 6 the end face of the fillet weld fracture test specimen at the stop/start position shall be used for macro-examination before the specimen is fractured.

The face of the specimen containing the weld cross section shall be prepared, polished and etched using an established method and etching solution (see Appendix B).

The etched face shall be examined visually, in conjunction with a hand lens of magnification not greater than five diameters, in accordance with the requirements of **19.6**.

19.2 Side bend test. The specimen shall be taken from a location where there is full penetration other than the central 50 mm. Any backing material shall be removed prior to testing.

The specimen shall be a parallel strip cut transversely to the weld containing a length of the joint of at least 10 mm. The width of the specimen shall be to the full thickness of the material at the welded joint. The edges of the specimen shall be rounded to a radius not exceeding 10 % of the specimen thickness.

The specimen shall be bent through at least 90° over a former of a diameter equal to approximately four times the specimen thickness, such that the cross section of the weld is in tension.

If the specimen bends through 90° without failure, slight opening-out at the edges or on the tension surface shall not be cause for rejection. If the specimen fails across the surface in tension, it shall be broken open and assessed in accordance with the requirements of **19.6**.

19.3 Root bend test. The specimens shall be taken from a location where there is full penetration. Any backing material shall be removed prior to testing.

The specimen shall be a parallel strip cut transversely to the weld. For plate the specimen shall have a width of at least 20 mm. For pipe the specimen shall have a width of:

$t + D/10$ for pipes up to and including 60.3 mm outside diameter,

$t + D/20$ with a maximum of 40 mm, for pipes over 60.3 mm outside diameter,

where

t is the pipe thickness (in mm), and

D is the outside diameter (in mm).

The specimen shall be the full thickness of the material at the welded joint and the upper and lower surfaces of the weld shall be dressed flush with the original surface of the material. The edges of the specimen shall be rounded to a radius not exceeding 10 % of the specimen thickness.

The specimen shall be bent through at least 90° over a former of a diameter equal to approximately four times the specimen thickness such that the root of the weld is in tension.

If the specimen bends through 90° without failure, slight opening-out at the edges or on the tension surface shall not be cause for rejection. If the specimen fails across the surface in tension, it shall be broken open and assessed in accordance with the requirements of **19.6**.

19.4 Fillet weld fracture test. The test piece shall be cut to give at least three specimens of equal length. To ensure fracture in the weld, a central saw cut shall be made along the length of the weld surface to a maximum depth of $t/3$ below the weld face, where t is the thickness of the sheet or plate.

Each specimen shall be fractured by bending or by blows applied in the direction indicated in Figure 2 or Figure 6. The fracture surfaces shall be assessed in accordance with the requirements of **19.6**.

19.5 Butt weld fracture test. A central 50 mm length shall be cut out so as to include the stop/start position. The specimen shall be centrally saw cut along the length of the weld surface through the excess weld metal and to a maximum depth of $t/3$ below the plate surface, where t is the plate thickness.

The saw-cut specimen shall be fractured by bending or by blows. The fracture surface shall be assessed in accordance with the requirements of **19.6**.

19.6 Assessment of destructive tests

19.6.1 *General.* Macrosections and fracture faces shall be examined with a hand lens of magnification not greater than five diameters. Any defect revealed by, and not resulting from, destructive testing shall be assessed in accordance with the requirements of **19.6.2**, **19.6.3**, **19.6.4** and **19.6.5**.

19.6.2 *Cracks.* There shall be no cracks.

19.6.3 *Fusion.* There shall be no lack of fusion in specimens taken from tests 1 to 8, but slight lack of root fusion shall be allowable in specimens taken from the flank positions in test 9.

19.6.4 *Penetration.* For tests 2 and 6, there shall be penetration to the root of the joint along the entire joint length.

For tests 3 and 7, there shall be penetration into the root face for at least 75 % of the joint length distributed regularly.

For test 4, there shall be full penetration.

For tests 5 and 8, there shall be penetration into but not through the backing material.

19.6.5 *Quality of weld metal.* No individual slag inclusion or wormhole shall have a maximum dimension of more than 3 mm. Subject to this maximum individual ruling dimension of 3 mm, groups of slag inclusions and/or wormholes shall not collectively have a total dimension exceeding 25 % of the parent metal thickness.

There shall be no copper or tungsten inclusions visible.

There shall be no stop/start porosity or general porosity which is attributable to welder manipulation.

Appendix A Record of approval test of welder

The recommended form for recording details of the approval test and the results for a welder is as follows. One sheet should be completed for each test.

(Organization's symbol or logo)	**Welder approval test certificate (BS 4872-1:1982)**	**Test record no.**
Manufacturer's name	**Welder's name and identity no.**	**Issue no.**

Test piece details Welding process Parent material(s) Thickness Joint type Pipe outside diameter Welding position(s) Test piece position Fixed/rotated	**Date of test** **Extent of approval** Welding process(es) Materials range Thickness range Joint type Pipe outside diameter range Welding position(s) Consumables **Remarks**
Welding consumables *Filler material* Make and type Composition Specification Size(s) *Shielding gas/flux* Make and type Composition/specification	**Weld preparation** (dimensioned sketch)
Other factors (welder's choice)	

Test results

State "acceptable", "non-acceptable" (with reasons) or "not required".

Visual examination

Weld contour		*Penetration (no backing)*	
Undercut or incomplete filling		*Penetration (with backing)*	
Smoothness of joins		*Surface defects*	

Destructive tests

Macro-examination	*Side bend*	*Root bend*	*Fillet weld fracture*	*Butt weld fracture*

Remarks

The statements in this certificate are correct. The test weld was prepared, welded and tested in accordance with the requirements of BS 4872-1:1982.

Manufacturer's representative	Inspecting authority or test house (when applicable)
Position	Witnessed by
Date	Date

Appendix B Suggested method of preparing etched specimens

NOTE The following method of preparing etched specimens is suggested for convenience and is in no way intended to be a rigid requirement of this standard.

B.1 Preparation of surface for etching. The surface should be filed with a coarse file until all deep marks are removed. It should then be filed at right angles to the original coarse file marks with a smooth file. The smooth filed surface should be polished down with successively finer grades of waterproof silicon carbide paper, e.g., P280, P320, P400, the direction of polishing being at right angles to the marks made by the previous paper in each case, polishing being continued until the scratches of the previous paper have been removed before proceeding to the next finer grade. This procedure is indicated in order to show the means by which a first-class finish may be obtained.

B.2 Etching for macro-examination. In general for steel, a P400 grade finish will be smooth enough for a satisfactory etch to be obtained for macro-examination. Suitable etching solutions are as follows:

a) for ferritic steels:

10 mL to 15 mL nitric acid (70 % *m*/*m*) (16N);

85 mL to 90 mL alcohol (industrial spirit).

NOTE Great care should be exercised in the preparation of this solution as the mixing of concentrated nitric acid and alcohol can be extremely dangerous. The acid should be added slowly to the alcohol and the mixture should be constantly stirred. The solution should be stored in a stoppered container to avoid concentration by evaporation.

b) for austenitic steels:

40 mL hydrochloric acid (36 % *m*/*m*) (11N);

30 mL nitric acid (70 % *m*/*m*) (16N);

30 mL water.

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