Gas Industry Standard

GIS/WP1: 2024

Specification for

Weldability Testing of Pipe Fittings For Service at Pressure Above 7 Bar

Contents

FOREWORD 3

MANDATORY AND NON-MANDATORY REQUIREMENTS 3

DISCLAIMER 3

BRIEF HISTORY 4

1 SCOPE 5

2 REFERENCES 6

3 DEFINITIONS 7

4 QUALITY SYSTEMS 8

5 CRITERIA GOVERNING THE NEED TO TEST 9

6 ELECTRODES 14

7 WELDING 15

8 QUALIFIED WELDERS 20

9 EXAMINATION AND TESTING 21

10 ACCEPTANCE CRITERIA 23

11 RECORDS 24

12 VARIANTS 25

APPENDIX A – REFERENCES 26

APPENDIX B – DEFINITIONS 28

APPENDIX C – WELDABILITY TRIAL DATA SHEET (INFORMATIVE) 30

Foreword

Gas Industry Standards (GIS) are revised, when necessary, by the issue of new editions. Users should ensure that they are in possession of the latest edition. Contractors and other users external to Gas Transporters should direct their requests for copies of a GIS to the department or group responsible for the initial issue of their contract documentation.

Comments and queries regarding the technical content of this document should be directed in the first instance to the contract department of the Gas Transporter responsible for the initial issue of their contract documentation.

This standard calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Compliance with this engineering document does not confer immunity from prosecution for breach of statutory or other legal obligations.

Mandatory and Non-Mandatory Requirements

For the purposes of a GIS the following auxiliary verbs have the meanings indicated:

can indicates a physical possibility

may indicates an option that is not mandatory

shall indicates a GIS requirement

should indicates best practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment needs to be completed to show that the alternative method delivers the same, or better, level of protection.

Disclaimer

This engineering document is provided for use by Gas Transporters and such of their contractors as are obliged by the terms of their contracts to comply with this engineering document. Where this engineering document is used by any other party, it is the responsibility of that party to ensure that the engineering document is correctly applied.

Brief History

First published as BGC/PS/WP/1	January 1974
Published as BGC/PS/WP/1 Issue 2	November 1976
Revised and re-issued as BGC/PS/WP/1	November 1984
Amended issue published as GBE/WP1	June 1992
Errata No. 1 to GBE/WP1	January 1993
Editorial update to reflect demerger November 2000	June 2001
Editorial Update to reflect merger October 2002	November 2002
Editorial update to reflect Safety Case version 3 taking into account issues as detailed in the comments below. Additionally, compliance with mandatory terms along with the removal of non-specific normative phrases. (Re-numbered T/PR/WP/1)	July 2004
Editorial update to comply with GRM	October 2004
Editorial update for National Grid Rebranding	February 2006
Revised & Re-issued as T/SP/WP/1	December 2008
Document Update and Full Review	August 2011
Business Changes: GD/SP/WP/1 (Cadent) NGN/PR/WP/1 (NGN) T/PR/WP/1 (SGN) T/PR/WP/1 (WWU)	2004 – 2019
Reviewed, updated and published as a Gas Industry Standard	February 2024

1 SCOPE

This Specification gives the requirements for the weldability testing of fittings for service in pipelines and pipework of carbon and carbon-manganese based steels at pressures above 7 bar.

All fittings shall be assessed against the requirements of this specification. Where weldability tests are required, they shall be carried out using the selection, welding and testing procedures, and the acceptance criteria of this specification. The Supplier may submit alternative pre-qualified weldability test data to the Gas Transporter for consideration.

Where fittings are pre-pupped by the manufacturer, consideration shall be given to the weldability of both the fitting and the pup piece to be attached. All weldability testing shall meet the requirements of this specification.

This specification does not apply to fittings for offshore applications or fittings for use on CO_2 pipelines and installations.

2 REFERENCES

This Specification makes references to the documents listed in Appendix A. Unless otherwise specified, the latest edition of the document apply, including all amendments.

The Gas Transporter specifications referenced by this specification are all listed as GIS documents e.g. GIS/F1. However, at the time of writing it is known that not all documents are available in GIS format. In the intervening period, Gas Transporter internal specifications of the same code shall be utilized until a GIS document becomes available and has been adopted by the relevant Gas Transporter.

3 DEFINITIONS

3.1 Terms and Definitions

The requirements and definitions applying to this Specification are listed in Appendix B.

3.2 Abbreviations

- CE Carbon equivalent (also CEV)
- HV Vickers hardness
- NDT Non-destructive testing
- OD Outside diameter
- PAUT Phased array ultrasonic testing
- pWPS Preliminary welding procedures specification
- WPS Welding procedure specification

4 QUALITY systems

The manufacturer or supplier should apply the quality management system principles stated in ISO 9001. To ensure effective quality control of all stages of the welding process, (including as a minimum, planning, design, qualification, execution, inspection, testing and recording), a quality management system typical of that described in BS EN ISO 3834-1 and BS EN ISO 3834-2 shall be adopted. With prior agreement of the Gas Transporter, other technically equivalent supporting standards and documents may be substituted for the documents specified in BS EN ISO 3834-5.

5 CRITERIA GOVERNING THE NEED TO TEST

5.1 Initial Considerations, Procedures, Re-Qualifications

The size and grade of fitting (and matching pipe) selected for the weldability test shall be agreed with the Gas Transporter. It may be appropriate to select the fitting in order to qualify for additional applications other than those involved in the immediate purchase order.

A weldability test shall be made for each new source or specification of material. Where a supplier proposes a steel of Category C (see section 5.3c) not previously supplied to the Gas Transporter, a weldability test is required. New steels proposed by a Supplier are subject to assessment by the Gas Transporter, and contractors should supply initial information to the Gas Transporter.

Requalification shall be undertaken if one or more of the following circumstances are considered to affect the result of the weldability test:

a) There is a change in the source of plate, pipe or forging supply.

b) There is a change in the specification for plate, pipe or forging material.

c) There is a change in the manufacturing procedure specification including the place of manufacture.

Selection, welding and testing shall be supervised by the Gas Transporter.

5.2 Classification of Fittings – Governing Factors

Selection for test shall be according to the following factors:

a) Material grade, generally in accordance with API 5L designation and BS EN ISO 3183.

b) Combined thickness, which shall comprise the sum of the nominal wall thickness of pipe plus the maximum tolerance allowed by the appropriate Company pipe specification, plus the equivalent thickness of the fitting + 10%, summarised by the following equation:

$$T_c = T_p + \left(1.1 \times T_{eq}\right)$$

Where:
$T_c =$ Combined thickness
$T_p =$ Nominal wall thickness plus maximum tolerance allowed by relevant pipe specification
$T_{eq} =$ Equivalent thickness

The equivalent thickness of the fitting, taken over the end 75 mm length shall be derived as shown in Figure 2.

a) Carbon equivalent (CE)

The International Institute of Welding (IIW) empirical formula shall be used when calculating carbon equivalent values. Heat/cast analyses shall be used.

$$CE_{IIW} = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Cu + Ni)}{15} \quad [values\ in\ weight\ percent]$$

c) Source and specification of material, as specified in 5.1.

5.3 Categories and Relation Testing

The steel for the fittings shall be classified as follows to determine the requirement for weldability test:

a) **Category A** – Grades B (L245) and X42 (L290)
Test not required for fittings within the range of sizes in the Gas Transporter specifications, except for GIS/F1 Class flange fittings with a wall thickness greater than 15.9 mm and/or a diameter greater than 914 mm OD.

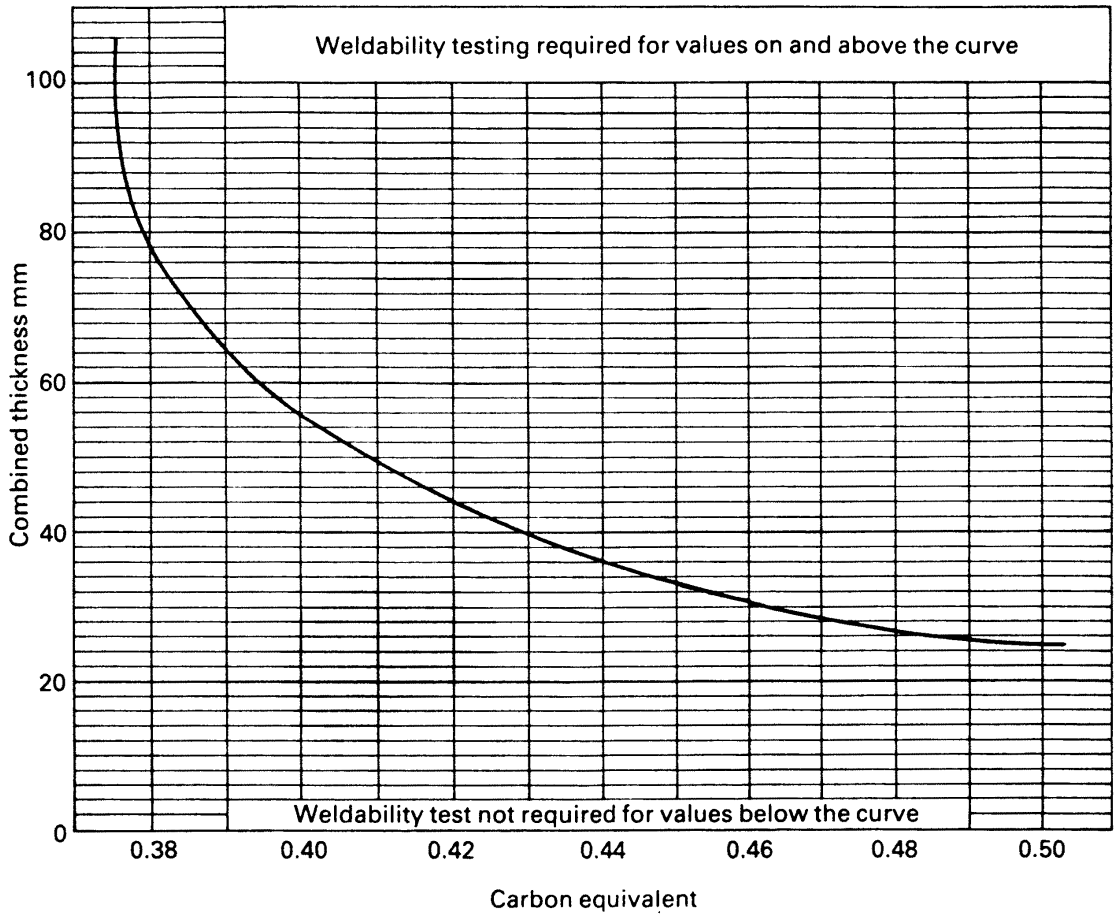
b) **Category B** – Grade X46 (L320) to X52 (L360)
Test not required for fittings being welded to pipe of 12.7 mm nominal wall thickness or below except for fittings with a CE greater than 0.45% unless otherwise agreed by the Gas Transporter.

c) **Category C** – Grade X52 (L360) greater than 12.7 mm; and higher grades, X60 to X80 (L415 to L555)
For fittings greater than 114.3 mm OD (i.e. where the welding procedure qualification test in GIS/P2 or GIS/P8 would require fusion line Charpy testing) a weldability test is mandatory for the initial qualification of all new steels.

Weldability testing is also required if:

a) The CE of the steel exceeds that previously tested by the limit in section 5.5.

b) The combined thickness of the fitting exceeds that previously tested and exceeds the limit in Figure 1 for the CE proposed.



Welding conditions		
Electrode type	Cellulosic (see 6)	Basic Low Hydrogen (see 6)
Heat input	1.1 kJ/mm root run	1.5 kJ/mm root run
Preheat	70°C	70°C

Figure 1. Requirement to Test Based on Combined Thickness and Carbon Equivalent.

5.4 Information From Supplier

The Supplier shall notify the Gas Transporter and provide information of any change to the source of supply, location of manufacture, composition of the steel and dimensions of the fitting in relation to section 5.1 and section 5.2 to enable the Gas Transporter to determine requirements for any weldability test.

5.5 Retest of Steels Having Higher Carbon Equivalent

If fittings are qualified by a weldability test on a cast of steel having a low CE for the agreed range of composition, a further test shall be undertaken if subsequent fittings are manufactured from steels having compositions which exceed that CE by more than 0.025, (approximately 5% of CE of original).

5.6 Selection and Marking of Fittings for Test

Fittings or fabricated components for weldability tests shall be selected by the Gas Transporter. The fitting reference numbers shall be painted on the exterior and on the bore surface of the fitting.

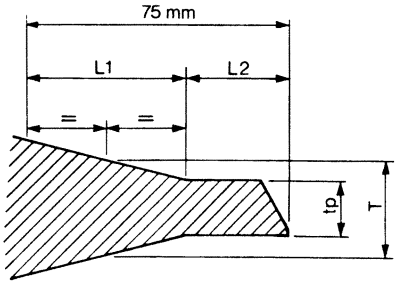
Complete fittings shall be supplied for weldability testing. For flanges, full machining of the flange body is not necessary provided the weld neck and the weld bevel are finish machined. Test plates are not acceptable for weldability testing purposes according to this specification.

The following information shall be supplied with the fitting:

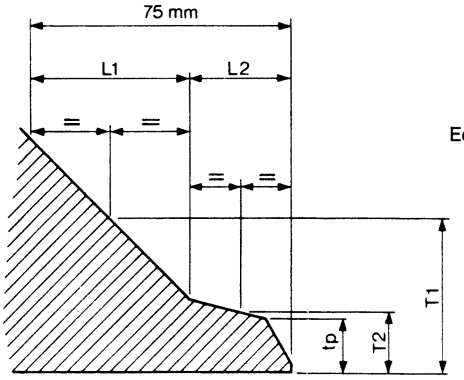
a) Supplier’s name, contract reference, the Gas Transporter order number (if applicable) and date.

b) Name of raw material manufacturer, the location of manufacture and relevant test certificates for composition and properties of materials used.

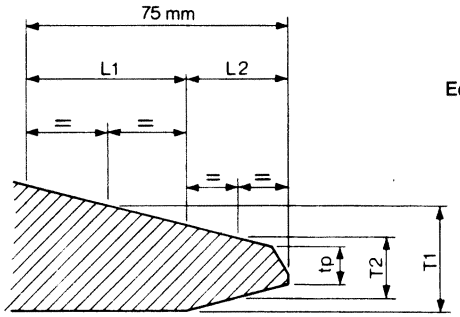
c) Copy of Supplier’s manufacturing procedure specification and a copy of each certificate issued during manufacture and testing of the fitting.



Equivalent thickness = $\frac{(L1 \times T) + (L2 \times tp)}{75}$ mm



Equivalent thickness = $\frac{(L1 \times T1) + (L2 \times T2)}{75}$ mm



Equivalent thickness = $\frac{(L1 \times T1) + (L2 \times T2)}{75}$ mm

Notes:

1) tp = nominal thickness of pipe wall plus maximum tolerance allowed by the relevant Company specification.

2) On flanges where the tapered hub blends into the flange through a fillet radius, the minor effect of the radiused zone shall be disregarded.

3) On small flanges the length of tapered hub may be less than 75 mm. The nominal thickness at 75 mm shall be derived by calculation and the fact that the position actually lies within the flange shall be disregarded.

4) L1 = a section of the 75 mm hub, which over its length, the internal and external taper angle is consistent.

5) T1 = average material thickness of L1 (taken at mid-point of L1).

6) L2 = remaining section of 75 mm hub having a consistent internal and external taper changing at the intersect of L1 and L2.

7) T2 = average material thickness of L2 (taken at mid-point of L2, or for sections without tapering taken as Tp).

Figure 2. Examples of the Calculation of Equivalent Thickness Values for the Tapered Sections of Weld Ends of Fittings.

6 ELECTRODES

Electrodes for tack welding and for deposition of the root run shall conform to AWS A5.1 E6010 or E6011. Electrodes for fill and cap runs shall conform to AWS A5.5 E7010 for materials of specified minimum yield strength 360 N/mm² and below, and to AWS A5.5 E8010 for materials of specified minimum yield strength above 360 N/mm².

For fittings of grade X70 (L485) or higher, equal to or larger than 914 mm OD, low hydrogen welding electrodes shall be used for the weldability test. The detailed welding procedure requirements shall be agreed with the Gas Transporter. Electrodes for tack welding and for deposition of the root run shall conform to AWS A5.1 E7016-1. Electrodes for fill and cap runs shall conform to AWS A5.5 E9018-G for X70 grades and AWS A5.5 E10018-G for X80 materials.

Note: Covered electrodes classified in accordance with BS EN ISO 2560 System A may be used.

7 WELDING

7.1 Joint Preparation and Test Weld Set-Up

The test joint shall be obtained by attaching to the selected fitting a pipe pup of the agreed specification and of length not less than twice the nominal diameter. The weld preparation on the fitting shall be in accordance with GIS/P16 or that specified in the appropriate fitting specification. The joint set-up for the test joint shall be in accordance with Figure 3.

Where applicable, at least 300 mm of coating shall be removed from the end of the fitting and the pipe. The exposed areas shall be dressed by mechanical wire brushing or other suitable means to reveal a smooth metal surface without evidence of coating material.

The fitting and pipe end joint preparation shall be cleaned free from scale, paint, rust or other contaminants. The fitting and pipe bore shall also be cleaned to sound metal for a distance of 25 mm minimum from the end.

Guidance on arc welding of carbon manganese steels is given in BS EN 1011-2.

7.2 Assembly

The fitting and pipe shall be supported on blocks or skids ensuring suitable alignment and the correct joint gap. The method of support shall be capable of maintaining the components in the correct relationship to each other throughout the preheating cycle and subsequent welding of the joint.

The joint shall be tack welded at not less than the minimum preheat temperature as specified in section 7.3. For fittings above 323.9 mm OD, the tack welds shall be a minimum of 50 mm in length and shall be deposited as shown in Figure 4a). For fittings 323.9 mm OD and below, tack welds shall be deposited as shown in Figure 4b) although the length of weld may be reduced dependent upon the diameter of the fittings being welded. The tack welds shall not be less than 25 mm. Tack welding shall be undertaken as part of the root pass welding cycle (see 7.4.5.2).

7.3 Temperature Control

Temperature control shall be in accordance with the following requirements, unless stated otherwise:

a) The fitting or fabricated component shall be preheated to 70 ±5°C before welding. The minimum temperature between weld passes shall be 65°C.

b) Fittings of 323.9 mm OD or below shall be heated by propane gas torch.

c) Fittings above 323.9 mm OD shall be heated by radiant heat coils (resistance heating mats) or induction coils positioned on both the pipe and fitting.

d) The temperature of both the fitting and the pipe shall be measured by using an approved contact pyrometer. For electric (radiant) heating, the required temperature shall be maintained for 30 minutes before welding is started. For propane heating, the temperature shall be taken 30 seconds after removal of the torch.

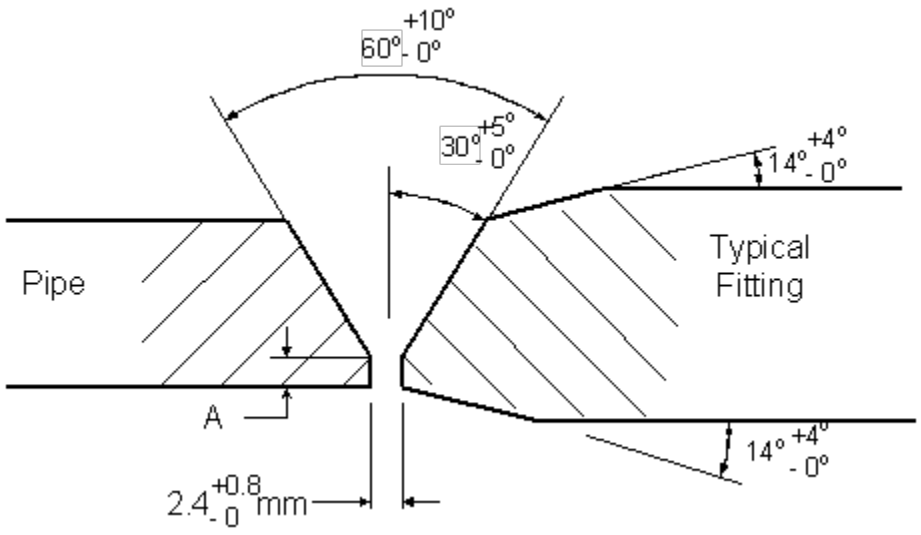
e) For the weldability test the method of heating for set-in or set-on fittings shall be agreed with the Gas Transporter prior to approval of the welding procedure.

7.4 Welding Procedure

It is important that, prior to the commencement of the contract test weld, that the welders employed are shown to be competent in performing welds on short lengths of pipe of the same dimensions and quality (see section 8).

7.4.1 Preliminary Welding Procedure Specification (pWPS)

Prior to start of welding, a Preliminary Welding Procedure Specification (pWPS) shall be drafted and agreed with the Gas Transporter. As a minimum, the preliminary WPS shall include of all the essential variables in BS EN ISO 15609.

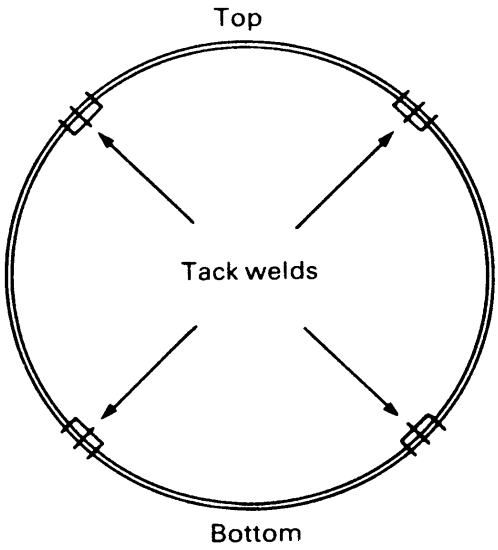


Pipe OD	Nominal Wall Thickness	Root Face 'A'
≤ 457 mm	< 19 mm	1.5 ±0.8 mm
≥ 610 mm		1.5 +1/-0 mm
> 610 mm	≥ 19 mm	1.5 +1/-0 mm

Note:

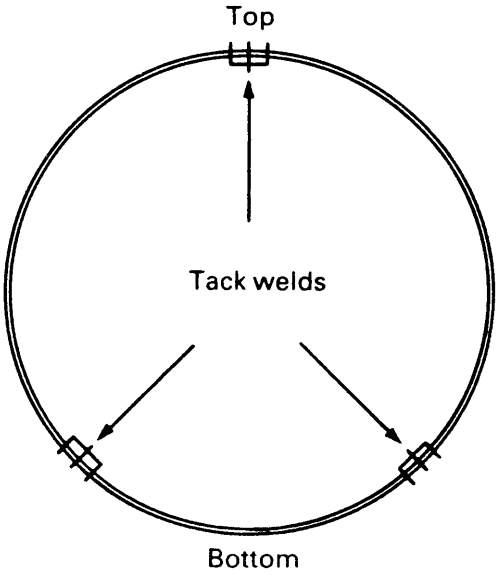
1) For X70 (L485) Grade material and above, when using low hydrogen electrodes, the root gap can be increased to 3.0 mm +1/-0 mm, if required.

Figure 3. Joint Preparation Showing Root Gap and Tapers Allowed for Reducing the Section of the Fitting.



Tack welds to be 50 mm minimum in length deposited equidistant around the pipe periphery at 45° 135°, 225° and 315° positions.

a) Tack welding sequence for fittings above 323.9 mm OD .



Tack welds to be deposited equidistant around the pipe periphery at 0°, 120° and 240° positions. Depending upon the pipe diameter each tack weld shall be from 50 mm to not less than 25 mm in length. *The tack welds should be substantial and should be included as part of the completed joint.*

b) Tack welding sequence for fittings 323.9 mm OD or less.

Figure 4. Position for Tack Welds.

7.4.2 Welding Direction

The procedure should test both conventional and stovepipe capping runs as follows:

a) Root: Vertically up (conventional).

b) Filling: Vertically down.

c) Capping pass: One side (12–3–6 o'clock) vertically down
Second side (6–9–12 o'clock) vertically up.

7.4.3 Component Position

Horizontal (all positional welds).

7.4.4 Electrodes and electrical Parameters

The following electrodes and electrical parameters shall apply:

a) Root (Cellulosic): 3.2 mm diameter electrode, DC supply, electrode positive *

b) Root (Low Hydrogen): 2.5 mm diameter electrode, DC supply, electrode positive.

c) Filling and capping: 4 mm or 5 mm diameter electrode, DC supply, electrode positive.

***Note**: A negative polarity may be used, depending on the type of electrode approved for use.*

7.4.5 Deposition Sequence

7.4.5.1 General

Two welders shall be used throughout for fitting diameters 457 mm and above. One welder shall be used for fitting diameters below 457 mm.

7.4.5.2 First Pass (Root Bead)

Tack welding and welding of the root pass shall be undertaken in a continuous welding cycle with the tack welds included as part of the root bead.

In each case, welding shall be balanced about the neutral axis of the joint to ensure that the root gap is maintained and that the induced stresses are uniformly distributed, i.e., two welders welding diametrically opposite quadrants of the joint, or one welder depositing sections of the root bead alternately at opposite quadrants of the joint (see Figure 5.).

Welding of the complete root bead shall be undertaken with a minimum of delay.

7.4.5.3 Second and Third Pass

A time interval of 6 minutes shall be allowed to elapse between completion of the root bead and commencement of the second pass, during which time cleaning of the root bead shall be completed. The third pass shall be deposited immediately after the second pass has been suitably cleaned, but shall be within a period not exceeding 6 min from completion of the second pass.

When using Low Hydrogen electrodes on the larger Fittings equal to or greater than 914 mm OD the time interval allowed to elapse between completion of the root bead and commencement of the second pass may be increased to 12 minutes.

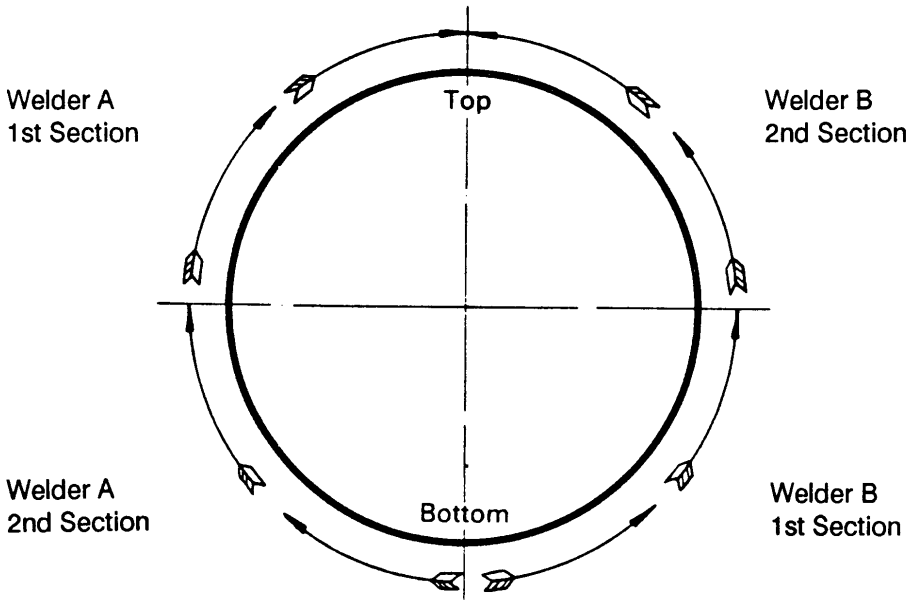
7.4.5.4 Subsequent Passes

Welding of subsequent passes shall proceed in a continuous cycle until the joint is completed.

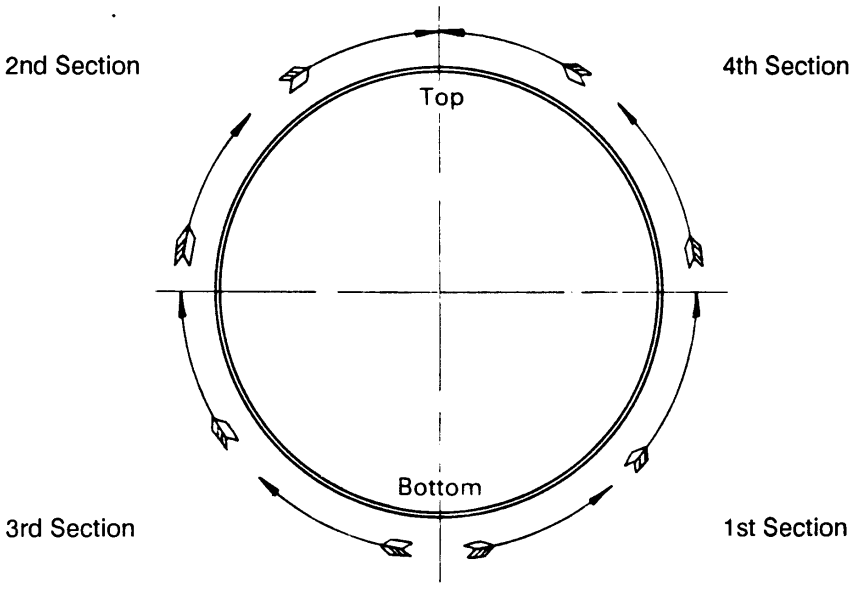
7.5 Recording of Essential Variables and Weld Parameters

All weld essential variables and weld parameters shall be recorded on a standard form similar to that shown in Appendix C. In addition to this, the ambient temperature shall be recorded.

A calibrated welding arc monitor that provides a printed record shall be used to record the welding parameters of all test welds.



a) Greater than or equal to 406.4 mm – Two welders A and B shall be employed to weld simultaneously on either side of the vertical centre-line.



b) Less than 406.4 mm – One welder to weld on either side of the vertical centre-line alternately.

Figure 5. Root Deposition Sequence.

8 QUALIFIED WELDERS

All welders used in this specification shall be qualified in accordance with either GIS/P1, GIS/P2, GIS/P8 or BS EN ISO 9606-1. Other welder qualification schemes may be used subject to approval by the Gas Transporter. The welding essential variables shall comply with the range of approval stated in BS EN ISO 9606-1.

The name or identification of the welder used in this specification shall be recorded in the weldability test records as shown in example in Appendix C. Welding Qualification Test certificate and applicable welder performance records shall be included as part of the final records.

9 EXAMINATION AND TESTING

9.1 Non-destructive Testing

The completed weld shall be visually examined and shall show a consistent regular profile, free from defects.

Upon cooling to the prevailing ambient temperature, the welded assembly shall be allowed to stand for a minimum of 24 hrs prior to radiography and subsequent evaluation. The weld shall be examined first by X-radiography with the root bead intact, and then by magnetic particle crack detection of the root area after the internal root bead reinforcement has been removed by grinding (see Figure 6, Note 6). Phased Array Ultrasonic Testing (PAUT) is an acceptable method of Volumetric NDE. The use of Gamma radiography may only be used if approved by the Gas Transporter. The approved inspection techniques are specified in GIS/NDT2.

The weld should meet the acceptance criteria of GIS/P2 or GIS/P8, except that small deviations may be allowed, subject to the Gas Transporter written approval, and provided they can be shown not to influence the results of the weldability test. Any cracking detected by radiography or magnetic particle crack detection shall be noted.

BS EN ISO 15614-1 may be referred to for further information regarding the inspection and testing of welds.

9.2 Destructive Testing

9.2.1 Microstructure

A minimum of 15 cross-sections shall be taken from the weld at locations selected by the Gas Transporter. The locations shall include any areas containing crack-like indications which have been revealed by non-destructive testing and shall also enable hardness testing to be carried out as specified in 9.2.2.

The specimens shall be prepared for microscopic examination by grinding to 600 grit paper finish and then polishing to 1 micron diamond finish. The prepared surface shall be etched using a suitable etchant (e.g. 2% Nital) and examined microscopically at 250 magnifications.

Evaluation of the microstructure shall be made by a suitably qualified and experienced person.

9.2.2 Hardness Testing

In order to test both conventional and stovepipe capping runs (see 7.4.5.2), a minimum of six sections shall be selected for hardness testing as follows:

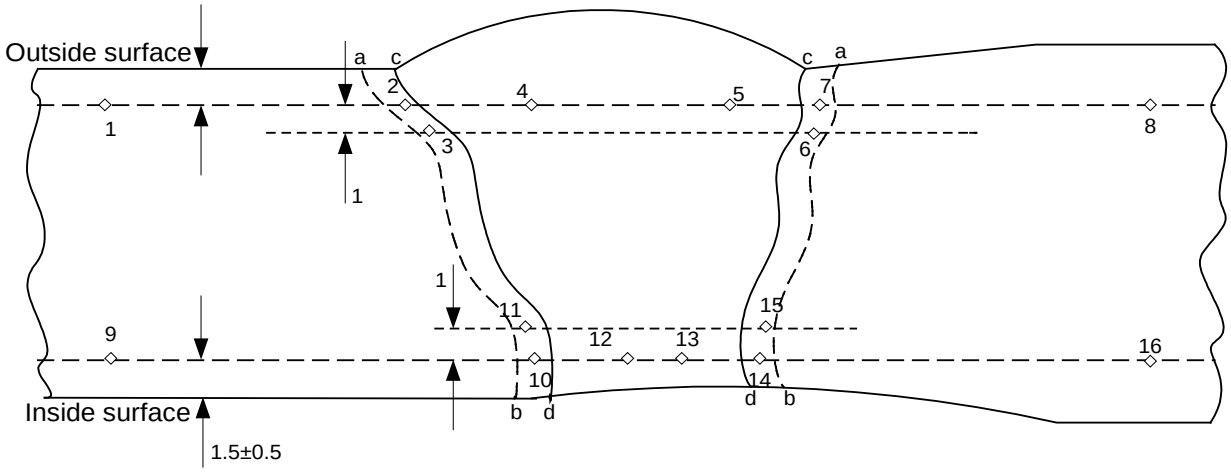
a) One each from the three o'clock and nine o'clock positions.

b) One from the side capped with a conventional weld and one from the side capped with a stovepipe weld, both to be taken from within 10° of the twelve o'clock position.

c) One from each side taken from within 10° of the six o'clock position.

Vickers hardness surveys shall be carried out at all positions. The tests shall be conducted in accordance with BS EN ISO 6507 Parts 1-4 and BS EN ISO 9015-1 using a 10 kg load. Test indentations shall be placed in accordance with Figure 6.

Acceptance requirements shall be in accordance with clause 10.



Notes:

1) Line a–b (seen after etching) indicates boundary between visible heat affected zone and parent metal.

2) Line c–d (seen after etching) indicates boundary between visible heat affected zone and weld metal, known as the 'fusion boundary'.

3) The hardness traverse consisting of indentations 1 to 8 inclusive shall be approximately 1.5 mm below the outside surface, crossing the fusion boundary at the change in section between the capping run and final filling run.

4) The hardness traverse consisting of indentations 9 to 16 inclusive shall be 1.5 ± 0.5 mm above the inside surface.

5) Hardness indentations 2, 3, 6, 7, 10, 11, 14 and 15 shall be entirely within the heat affected zone but located as close as possible to the fusion boundary.

6) Line d–d is surface after the root bead reinforcement has been removed by grinding (see 6.1).

Figure 6. Locations for Hardness Test Indentations (HV10).

9.2.3 Impact Toughness Testing

Weld metal and fusion line Charpy impact toughness tests shall be conducted in accordance with the requirements of Company specification GIS/P2 or GIS/P8. The test temperature shall be -10°C.

When required by the Gas Transporter, additional heat affected zone Charpy impact specimens shall be tested at the fusion line +2 mm and fusion line +5 mm locations.

10 ACCEPTANCE CRITERIA

The fitting shall be considered acceptable provided that:

a) There are no surface breaking cracks.

b) There are no internal cracks larger than 1.25 mm in the through thickness direction.

c) The hardness in the heat-affected zone of the fitting does not exceed 330 HV.

d) The hardness of the weld metal does not exceed that of the harder parent metal by more than 75 points HV10.

e) The requirements covering fusion line Charpy impact tests in GIS/P2 or GIS/P8 are met. Note that the weld metal Charpy impact tests are for information only.

11 RECORDS

For each test a weldability test report shall be prepared that includes the following information:

a) Approved weld procedure specification

b) Welding parameter record (see Appendix C)

c) NDT reports

d) Mechanical test report

e) Hardness survey results & macro photographs

f) Microsection evaluation

g) Pipe and welding consumable test certificates

h) Cutting plan

i) Welder qualification test certificate and performance record

12 VARIANTS

A contractor shall only propose variants to this specification where the text indicates that variants would be considered by the Gas Transporter.

APPENDIX A – REFERENCES

This Specification makes reference to the documents listed below (see clause 2).

A.1 British Standards

BS 499-1	Welding terms and symbols. Glossary for welding, brazing and thermal cutting.
BS EN 1011-2	Recommendations for welding of metallic materials
BS EN ISO 2560	Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification
BS EN ISO 3183	Petroleum and natural gas industries — Steel pipe for pipeline transportation systems
BS EN ISO 3834-1	Quality requirements for fusion welding of metallic materials - Criteria for the selection of the appropriate level of quality requirements
BS EN ISO 3834-2	Quality requirements for fusion welding of metallic materials - Comprehensive quality requirements
BS EN ISO 3834-5	Quality requirements for fusion welding of metallic materials - Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4
BS EN ISO 6507-1	Metallic materials. Vickers hardness test - Test method
BS EN ISO 6507-3	Metallic materials. Vickers hardness test - Verification and calibration of testing machines
BS EN ISO 6507-3	Metallic materials. Vickers hardness test - Calibration of reference blocks
BS EN ISO 6507-4	Metallic materials. Vickers hardness test - Tables of hardness values
BS EN ISO 9001	Quality management systems. Requirements
BS EN ISO 9015-1	Destructive tests on welds in metallic materials. Hardness testing - Hardness test on arc welded joints
BS EN ISO 9606-1	Qualification testing of welders. Fusion welding. Steels

BS EN ISO 15614-1	Specification and qualification of welding procedures for metallic materials. Welding procedure test

A.2 Company Specifications

GIS/F1	Carbon and carbon manganese steel forged flanges and forged welding fittings for operating pressures greater than 7 bar
GIS/P1	Welding of Steel Pipe Designed to Operate at Pressures Not Greater Than 7 Bar
GIS/P2	Specification for the welding of steel and land pipelines designed to operate at pressures greater than 7 bar
GIS/P8	Specification for welding onshore natural gas installations designed to operate at pressures greater than 7 bar
GIS/P16	Specification for the dimensions and applications of standard weld end preparation for steel pipe fittings and valves
GIS/NDT2	Specification for non-destructive testing of welded joints in steel pipelines and pipework

A.3 American Petroleum Institute Publication

API 5L	Specification for line pipe

A.4 American Welding Society Publications

AWS A5.1	Mild steel covered arc-welding electrodes
AWS A5.5	Low alloy steel covered arc-welding electrodes

APPENDIX B – DEFINITIONS

The definitions applying to this specification are listed below. Welding terms and symbols are given in BS 499-1.

B.1 Miscellaneous Definitions

Supplier	The person, firm or company with whom the Gas Transporter enters into a contract to which this specification applies, including the Supplier's personal representatives, successors and permitted assigns.
Approved welding procedure	The specified, detailed and proven method used to produce a sound weld in the materials involved.
Manufacturing procedure specification	The detailed description of the sequence of processes required to manufacture and inspect a fitting.
Welder	The operator performing the welding, who shall have previously demonstrated his ability to produce sound welds using this specification.
Gas Transporter	The owner/operator of the pipeline, or its nominated representative.

B.2 Pipe, Fittings and Welding Definitions

Capping run	The final pass, constituting the external surface of the weld, which is not subject to thermal cycling through subsequent deposition.
Carbon Equivalent (CE)	An empirical formula which embodies within a single factor those aspects of the composition of a steel which have a significant effect on its susceptibility to cold cracking. The International Institute of Welding (IIW) formula is used herein.
Conventional weld	A vertical-up weld in which the axes of fitting and pup are horizontal and welding commences at the six o'clock position and proceeds to the twelve o'clock position.
Fittings	Tees, bends, forgings, reducers, hot tap and stopping off connections, and end caps.
Pipe	The pipe to which the fitting undergoing weldability testing should be welded in the field.
pWPS	Preliminary Welding Procedure Specification
Root bead	The first deposit made in the root run of a multi-run weld.
Root bead reinforcement	Excess weld metal lying outside the plane joining the toes of the root bead.

Root gap	The distance between fitting and pup measured at the root of the weld preparation.
Stovepipe weld	A vertical down, full penetration weld made with a cellulosic electrode, in which the axes of fitting and pup are horizontal and welding commences at the twelve o'clock position and proceeds to the six o'clock position
Tack weld	A weld used to assist assembly or maintain alignment during welding
Weld	Any completed joint in a pipeline system made by an electric arc process

APPENDIX C – Weldability Trial Data Sheet (Informative)

GD/SP/WP/1	WELDABILITY TEST PARAMETER RECORD			Date:
				Test Number:
				Revision:
Test Description:		Welder's Name - Side A		Joint Details :	Pass Sequence:
		Welder's Name - Side B			
Fittings/Pipe details:		Welding Process:			
Type:		Welding Position:			
Material Grades:		Method of Bevelling:			
Diameter:		Preheat Applied (Y/N):			
Wall Thickness:		Preheat Temp. (°C)			
Manufacturer:		Method of Preheat:			
Fitting/ Pipe Nos:		Preheat Measurement Technique:			
Heat Nos.					

Pass No.	Start Time	Finish Time	ARC Time(s)	Welding Direction	Welding Consumable	Size (mm)	Polarity (AC/DC +/-)	Run Time (mins)	Inter Run Time (mins)	Interpass Temp (°C)	AMPS (A)	Volts (V)	R.O.L. (mm)	Travel Speed (mm/min)	Heat Input (kj/mm)

Notes:		
1. Ambient Temperature at Start: 2. Ambient Temperature at Re-start: 3. Clamp Removal Stage: 4. Total time to Complete Weld 5. PWHT details	Signed	Checked