Gas Industry Standard

GIS/P1: 2024

Specification for

Welding of Steel Pipe Designed to Operate at Pressures Not Greater Than 7 Bar

Cadent Your Gas Network

Gas Networks Ireland

Northern Gas Networks

SGN Your gas. Our network.

WALES&WEST UTILITIES

Contents

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/P1	October 1976
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1 SCOPE

This specification details the Gas Transporter requirements for the welding and inspection of carbon, carbon manganese and low alloy steel pipe and steel fitting components for gas distribution systems delivering natural gas at pressures not greater than 7 bar.

This specification contains the requirements for the arc welding of full penetration butt welds and fillet welds. It is applicable to pipe and fitting components of nominal diameter equal to or greater than 15 mm, with a wall thickness of 3.2 mm or greater. It applies to socket joints not greater than 50 mm nominal diameter and fillet welded flanges with a nominal bore between 15 mm and 450 mm. Slip-on flanges of larger sizes may be used at the discretion of the Gas Transporter in such case special consideration shall be given to the welding procedure used with respect to weldability.

Only arc welding processes approved by the Gas Transporter shall be used.

This specification does not apply to welding on pipelines or pipe work in-service and operating under-pressure or to the partial penetration welding of butt-welded joints.

2 REFERENCES

This Specification makes reference to the documents listed in Appendix A. Unless otherwise specified, the latest edition of the documents applies, 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 definitions applicable to this Specification are listed in Appendix B.

3.2 Abbreviations

The following abbreviations are used in this specification:

- CE Carbon equivalent value (also CEV)
- HV Vickers hardness
- MMA Manual metal arc welding (also SMAW)
- MPI Magnetic particle inspection (also MT)
- NDT Non-destructive testing
- OD Outside diameter
- PWHT Post weld heat treatment
- SMYS Specified minimum yield strength
- TIG Tungsten inert gas welding (also GTAW)
- WPS Welding procedure specification

4 QUALITY SYSTEMS

To ensure effective quality control of all stages of the welding process (including as a minimum, planning, design, qualification, execution, inspection, testing, and recording) the manufacturer or contractor shall hold BS EN ISO 3834-2 accreditation. The accrediting test body shall be UKAS certified.

5 HEALTH & SAFETY REQUIREMENTS

All personnel involved with welding shall be suitably qualified and experienced.

The Gas Transporter and Contractor(s) shall comply with relevant health and safety legislation.

Safety precautions include, but are not limited to:

a) Safe assembly, set-up, and turn-off procedures

b) Safe control of welding fumes and gases

Note: Particular attention is drawn to recent changes in HSE guidance reclassifying welding fumes from carbon steel as carcinogenic.

c) Personal protection

d) Fire hazards

e) Welding in confined spaces

f) Awareness of welding environment

g) Environment of increased hazard electric shock

h) Radiation from the arc

i) Effects of stray arcing

j) Safe storage, handling and use of compressed gases

k) Leak detection on gas hoses and fittings

6 EQUIPMENT

The contractor shall maintain all welding plant and ancillary equipment in good working order. Welding and cutting plant, instruments, cables, and accessories shall comply with the requirements of the appropriate British Standard where it exists, e.g., BS EN 50525-1 for cables.

All welding equipment shall be validated in accordance with BS EN IEC 60974-14:2018.

Pipe handling equipment, rollers and line-up clamps shall be of such design and capacity that they avoid damage to the pipe and ensure that pipe axes are aligned as specified in clause 13.4.

Adequate means of measuring current shall be available by the provision of a portable ammeter. In the case of semi-automatic welding processes means shall be provided for measuring the arc voltage since this may exert considerable influence on the form, composition, and soundness of the weld. The welding equipment shall be capable of controlling the welding parameters given in Table 2 to within the limits stated in the qualified welding procedure specification. If different equipment is being utilised than that used to perform the approval test weld(s) then verification of this shall be carried out prior to welding project material.

7 WELDING PROCESSES

This specification covers the following manual, semi-automatic or mechanised welding processes, or combination of processes:

111 Manual Metal Arc welding (MMA, or SMAW)

131 Metal Inert Gas welding with solid wire electrode (MIG)

135 Metal Active Gas welding with solid wire electrode (MAG)

136 Metal Active Gas welding with flux-cored electrode (GS-FCAW)

138 Metal Active Gas welding with metal-cored electrode

141 Tungsten Inert Gas welding with solid electrode (TIG)

Note: Welding process numbering is taken from BS EN ISO 4063.

Other arc welding processes such as submerged arc welding (SAW) may be used at Gas Transporter's discretion.

Self-shielded tubular cored metal arc welding (114) is not permitted.

Technical guidance for arc welding of ferritic steels can be found in BS EN 1011-2.

8 MATERIALS

This specification applies to the welding of pipe and fitting components manufactured to the requirements of the Gas Transporter specifications and Gas Industry Standards.

a) Pipe – GIS/L2

b) Fittings & attachments – GIS/F7

Pipe or fittings manufactured to alternative standards may be used provided that the design, the mechanical and compositional properties, and dimensions are equivalent to the requirements of the Gas Transporter pipe or component specification and have been approved for use by the Gas Transporter.

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

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

Material groups for welding are defined by PD CEN ISO/TR 15608.

9 ELECTRODES, FILLER MATERIALS AND SHIELDING GASES

9.1 General

Welding consumables shall be approved by the Gas Transporter before use and shall be in accordance with the classification standard applicable to the proposed welding process (see Table 1).

The chemical composition of the deposited weld metal shall be compatible with the materials being welded.

Electrodes, filler wires and wire/flux combination shall produce weld metal that has a tensile strength at least equal to the minimum specified for the parent material.

In the case of joints between dissimilar strength materials, the weld metal shall have a tensile strength at least equal to that of the higher strength parent material.

When baking of electrodes is required to achieve a given level of diffusible hydrogen, the electrode manufacturers' recommendations shall be followed. Vacuum packed electrodes shall be used in accordance with the manufacturers' instructions.

Cellulosic coated electrodes shall not be used for the welding of fillet welds.

Self-shielding (i.e., 'gas-less') flux-cored arc welding consumables are not permitted.

Table 1. Welding Consumable Classification Standards.

	Welding Process	Consumable Classification Standard
111	Manual metal arc welding	BS EN ISO 2560 System A
131	Metal inert gas welding	BS EN ISO 14341 System A
135	Metal active gas welding	BS EN ISO 14341 System A
136	Tubular cored metal arc welding, active gas	BS EN ISO 17632
138	Metal cored metal arc welding, active gas	BS EN ISO 17632
141	Tungsten inert gas welding	BS EN ISO 636

9.2 Storage and Handling

Different grades of electrodes and filler materials shall be individually identifiable and be completely separated during both storage and use. When the electrode manufacturer recommends that electrodes are stored at a stated temperature, the contractor shall follow such recommendations. The electrodes and filler materials shall be stored and handled at all times during construction so as to avoid damage to them and to the containers in which they are transported. Those in open containers shall be protected from excessive moisture changes. Electrodes, filler wires and fluxes that show signs of damage or deterioration shall not be used and shall be removed from the vicinity of welding.

Any special precautions for the storage and handling of welding consumables shall be agreed between the contracting parties and shall be proven to be appropriate in the welding procedure approval tests. These precautions shall be detailed in a consumable handling procedure.

9.3 Shielding Gases

9.3.1 General

Shielding gases used shall be in accordance with BS EN ISO 14175.

The gases or gas mixtures used shall be qualified during weld procedure qualification testing. Any change to the gas or gas mixture shall require requalification of the weld procedure.

9.3.2 Storage and Handling

Where there is a requirement for mixed gases to produce field welds, the gas mixtures shall be provided in proprietary pre-mixed bottles supplied by the gas manufacturer and shall not be mixed in the field.

Compressed gases shall only be stored and handled in accordance with industry guidelines and best practice. Gases that are of questionable purity/quality and those in containers which show signs of damage must not be used. Damaged gas containers must be dealt with in accordance with the manufacturer's recommendations or in the case of an emergency, in accordance with the relevant the Company contingency plans.

10 WELD PROCEDURES & CHANGES AFFECTING APPROVAL

All new welding procedure specifications (WPS) shall be prepared in accordance with BS EN ISO 15609-1 and shall include the relevant essential variables listed in Table 2.

For pipe of 406.4 mm outside diameter and above, a minimum of two welders shall be used working diametrically opposite for all weld passes.

All fittings shall be welded with the root pass welded in the vertical-up direction and the weld shall be completed in a single heat cycle.

Roll welding shall only be used with the Gas Transporter's approval and only when it can be demonstrated that the joint can be adequately supported to maintain its axial alignment, particularly during deposition of the first three weld passes.

All fillet weld procedures shall provide for a minimum of two weld passes utilising vertical-up welding. The major portion of the first pass shall be deposited preferentially on to the pipe or major component body.

Where a repair welding procedure is identical to the welding procedure used to make the original weld joint, separate procedure qualification is not required unless the repair procedure infringes the essential variables given in Table 2. However, separate welding procedure specification documents shall be written for all repair weld scenarios covering both partial and full penetration repairs.

If back-weld repair welding is considered viable for a particular situation, then separate welding procedures shall be qualified.

10.1 Changes Affecting Approval (Essential Variables)

When any of the changes given in Table 2 are made to a welding procedure, it shall be regarded as a new welding procedure and shall be re-approved.

Weld procedure tests carried out on pipe may be used to qualify those for fittings of the same material, grade, and strength, provided that all other essential variables remain the same.

10.2 Pre-Qualified Weld Procedures

Where a manufacturer or Contractor proposes the use of a previously qualified welding procedure that remains valid within the changes affecting approval given in Table 2 of this specification, it shall be offered for the Gas Transporter's consideration at the earliest opportunity, ideally at project tender or contract award stage. The approval or use of a previously qualified welding procedure will be at the sole discretion of the Gas Transporter.

Fillet welding procedures that have been qualified previously by the Gas Transporter are given in Appendix C. These procedures may be used without the need for further qualification on pipe and fitting components purchased to the company specifications provided that the procedure remains valid within the changes affecting approval given in Table 2. When an Appendix C procedure is proposed, a project specific welding specification sheet shall be prepared by the manufacturer or contractor and submitted to the Gas Transporter for approval.

Table 2. Welding Procedure Specification Details and Changes Affecting Approval.

Item		WPS Detail	Essential Variable
Welding process	a1	The specific arc welding process (or combination)	Any change from one arc welding process to another
	a2	Whether manual, semi-automatic or mechanised	Any change between manual, semi-automatic or mechanised
Base material specification	b1	Specified standard and strength grade	Any increase
	b2	Heat treatment condition (e.g. normalised (N), quench & tempered (Q), or thermo-mechanically control rolled (M))	Any change
	b3	Composition	Any change greater than +0.05% of CE Value tested
Diameter	c	Nominal outside diameter D of pipe	A change outside the range 0.5D to 2D
Thickness	d	Nominal wall thickness t of pipe	A change outside the range 0.75t to 2t
Joint configuration (with a sketch, including tolerances)	e	Pipe end preparation including the following:	
	e1	Type of bevel	Any Change
	e2	Angles(s) of bevel (2)	Any change outside agreed (unspecified) tolerances
	e3	Size of root face (2)	Any change outside (unspecified) approved tolerances
	e4	Width of root gap (2)	Any change outside (unspecified) approved tolerances
	e5	Any use of backing rings	Any addition or deletion, or change in material
	e6	Dimensions of fillet welds (2)	Not restricted as an essential variable
Electrode or filler metal	f	The following is needed for each run:	
	f1	Nominal diameter of filler/electrode core wire.	Any change for the first two layers or the capping layer. Any increase for other runs
	f2	Trade name	Any change

Item		WPS Detail	Essential Variable
	f3	Classification	Any Change
	f4	Any drying or pre-treatment for hydrogen-controlled electrodes.	Any relaxation
	f5	Number of wires for each run.	Any change
Number of runs and number of sides welded	g1	Number of runs from each side.	A change from single to multi-run or vice versa.
	g2	Sides welded first and last (double sided welds only)	Any change
Shielding gas or flux	h1	Choice of shielding gas	Any change in the gas selected
	h2	Composition of any gas mixture	A change exceeding 10% of the nominal addition in a mixture
	h3	Gas flow rate (2)	Any change exceeding 10%
	h4	Trade name and type of flux	Any change
Electrical characteristics	i	Current (a.c. or d.c.) and polarity	Any change
Welding parameters	j	The following information is needed for each wire size (different values (2) may be used for different runs)	
	j1	Electrical stick-out (SAW, MAG, FCAW) (2)	Any change exceeding 5 mm
	j2	Arc voltage (2)	Any change exceeding 10%
	j3	Wire feed speed (SAW, MAG, FCAW) (2) or welding current	Any change exceeding 10% (15% for cellulosic electrodes)
	j4	Travel speed (2)	Any change exceeding 10%
	j5	Calculated value of heat input	No separate restriction
Welding position	k	Angle of pipe axis to the horizontal	Any change exceeding 25°
Direction of welding	l	Vertical up, vertical down or horizontal	Any change

Item		WPS Detail	Essential Variable
Welding technique	m	The following information is needed for each wire size (different values (2) may be used for different runs)	
	m1	Maximum amplitude of any mechanised weave	To be agreed between the contracting parties
	m2	Frequency of any mechanised weave	To be agreed between the contracting parties
	m3	Dwell time at the side of any mechanised weave	To be agreed between the contacting parties
Number of welders	n	Number of root run and second run welders	Any reduction
Time lapse between runs (cellulosic electrodes only)	o	Time lapse between the start of the root run and the start of the second run	Any increase
Partially completed joint	p	Number of runs before cooling to ambient	Any reduction
Line up clamp	q1	Internal, external, or alternative methods	A change from internal to external, or from clamp to alternative (see clause 13.4)
	q2	Number of runs before removal of the clamp	Any reduction
Lowering off	r	Minimum number of runs	Any reduction
Cleaning of bevel	s	Whether by power driven or hand tools	No restriction
Pre-heating	t1	Pre-heat temperature (see Table 10)	Any reduction to the temperature qualified or an increase exceeding 50ºC
	t2	Method of applying heat	Any change
	t3	Method of controlling temperature	Any change
	t4	Method of measuring temperature	Any change
	t5	Initial temperature of pipe not requiring pre-heat	Any reduction (below 5°C ambient)
	t6	Maximum or minimum interpass temperatures for each run	Any change

Item		WPS Detail	Essential Variable
Post weld heat treatment	t7	PWHT (Thermal stress relief)	Any addition, or deletion
Repair welds	u1	Welding procedure details for repair welding	Any of the changes affecting approval listed above
	u2	Welding procedure details for the weld to be repaired	Any change affecting the approval of the procedure for the weld on which the repair welding procedure was qualified.

Notes:

1) These items shall be specified on the proposed WPS but are not mandatory for the production WPS if they are controlled through other parameters.
2) These parameters shall be specified as single nominal values on the proposed WPS but as qualified ranges (nominal values ± permitted variation) on the production WPS. In the cases where the mean value measured in qualification differs from the nominal value, the qualified range shall be calculated from the mean value measured in qualification.
3) SAW = Submerged arc welding, MAG = Metal active gas, FCAW = Flux cored arc welding.

11 WELD PROCEDURES – TESTING, QUALIFICATION AND APPROVAL

11.1 General

Approval and testing of welding procedures shall consist of the following stages:

a) The contractor shall submit to the Gas Transporter details of the preliminary welding procedure and welding repair procedures.

b) The Gas Transporter shall indicate his acceptance of the preliminary welding procedures, after any discussion with the Contractor.

c) Before production welding begins, test welds using these procedures shall be made by the Contractor under simulated site conditions on full pipe lengths. Shorter pipe lengths may be used by agreement between the contracting parties.

d) The quality of the test welds shall be determined by non-destructive and destructive testing after specimens have been allowed to cool to ambient temperature in production conditions for a period of at least 24 hours.

e) For the procedures to be approved the results of the tests on the welds shall show that sound welds having the required mechanical properties can be made using the submitted procedures.

f) In the event of failure of any destructive tests, re-tests shall only be permitted as described in clause 11.5.3.

g) Recorded details for each welding procedure approval test shall be submitted by the Contractor to the Gas Transporter for approval prior to production welding commencing.

11.2 Procedure Qualification Records

The details of each approved procedure shall be recorded and shall show the complete results of the procedure approval tests. All documentation relating to procedure approval welds including the test results (see clauses 11.5 and 11.6) shall be submitted to the Gas Transporter for approval prior to the commencement of production welding and the approval of welders. The documentation shall include authenticated mill results of mechanical and a chemical analysis carried out on the parent material used for procedure approval. Certification specific to the exact batch/lot of consumables used during the qualification test shall also be included. The records shall include all the essential variables listed in clause 10.1 and details of the welding variables for every pass which includes the following:

a) Consumables size, type, and batch number

b) Current and voltage

c) Weld length

d) Arc time

e) Interpass temperature

11.3 Welding Procedure

11.3.1 General

New procedure approval tests shall be carried out on one of the following options, listed in order of preference:

a) Pipe made from the same material, diameter, and thickness as that to be used in production.

b) When approved by the Gas Transporter, pipe made from the same material but of a diameter and thickness from the ranges allowable in Table 2. The components comprising the test joint shall be of the same dimensions.

c) The Gas Transporter may agree to a variation in the diameter and thickness ranges given in Table 2 when such variation will not affect the integrity of the qualified procedure or the performance of the welded joint in service.

11.4 Welding of Test Weld

11.4.1 Procedure Approval Tests for Butt Welds

Procedure approval testing shall be carried out in accordance with BS EN ISO 15614-1, plus the additional requirements as defined in this specification.

Procedure approval tests shall be made between full pipe lengths, except as permitted in clause 11.1 c), under simulated production conditions and shall follow the specified procedure including removal of line up clamps, lowering off, partial completion and re-commencement of welding where applicable. Details of these operations shall be recorded and included on the qualification document and associated welding procedure.

Where the Contractor would like to leave a partially completed weld as part of the construction sequence (e.g., overnight), this situation shall be simulated during procedure qualification testing.

All weld passes shall be cleaned until free from slag and visible defects prior to deposition of subsequent weld passes. Weld stop/start positions shall be staggered/offset as per good workmanship.

11.4.2 Procedure Approval Tests for Fillet Welds

The fillet weld procedure shall be simulated by a weld made between the pipe material and the plate material (typically BS EN 10025 Part 2 Grade S275) of equivalent thickness to the attachment. Where the procedure specifies a fillet weld on both sides, the weld shall be welded from one side only to facilitate fracture tests. The weld tested shall be the side with the greatest number of weld passes.

Fillet weld test welds shall be set-up as specified in Appendix C for the applicable weld type.

11.4.3 Procedure Approval Tests for Repair Welds

For butt welds the repair welding procedure shall be carried out by placing the area to be repaired in the overhead welding position.

Welding procedures shall be qualified for both full and partial penetration repairs. The partial penetration repair shall be excavated to a minimum depth of 50% of the pipe wall thickness centered on the toe of the original weld.

Partial penetration repair procedure qualification is not required for pipe wall thicknesses less than 5 mm.

Back-weld repairs shall be made with a minimum of two passes and shall be separately qualified.

11.5 Testing of Butt Welds for Procedure Approval

11.5.1 Non-Destructive Testing

The extent of inspection and non-destructive testing of test butt welds shall be as per Table 3.

All test butt welds shall be examined in accordance with the requirements of GIS/NDT2. Any supplementary examination methods used shall be as specified by the Gas Transporter.

All test houses shall be either approved by United Kingdom Accreditation Service (UKAS), or to an equivalent to standard which shall be agreed by the Gas Transporter.

The results from visual examination and non-destructive testing shall be recorded and assessed according to the appropriate acceptance criteria specified in clause 15.

All non-destructive tests must be completed prior to cutting of specimens for destructive testing.

Table 3. Inspection and Test Requirements for Qualification of Butt Weld Procedures.

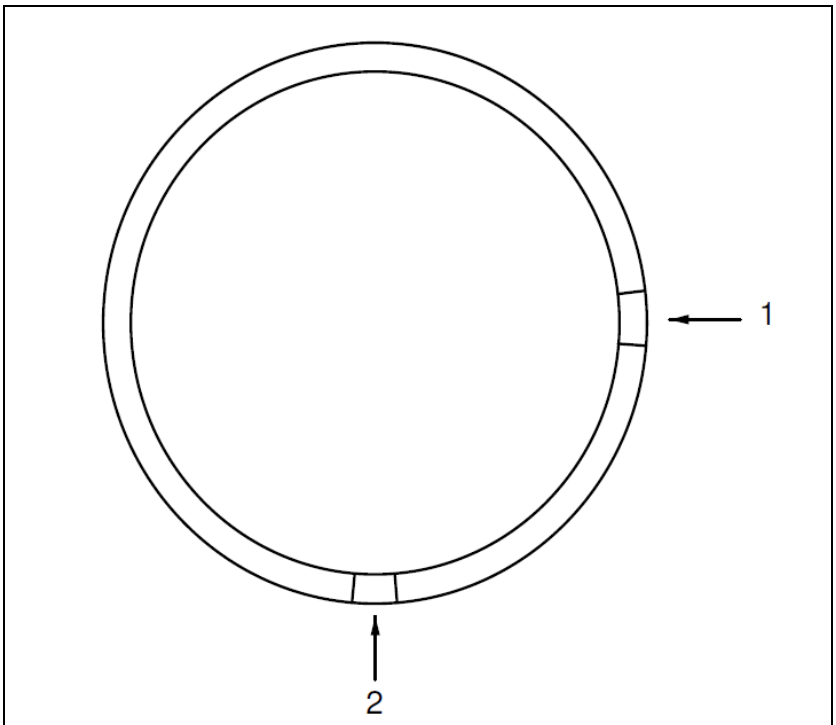
Inspection/Test Method	Extent of Testing		Notes
	≤ 114.3 mm	**> 114.3 mm**	
Visual inspection	100%	100%	
Radiographic or Ultrasonic Testing	100%	100%	
Surface crack detection	100%	100%	MPI
Transverse tensile test	—	2 specimens	
Transverse bend test	—	4 specimens	When volumetric inspection is by UT, and/or when welding processes 13X used.
Charpy impact toughness test	—	2 sets	When WT is ≥ 8.0 mm: 1 set VWT0 (Weld centreline) 1 set VHT0 (Fusion line)
Hardness test	2 specimens	3 specimens	Not required for Group 1.1 materials (e.g., Grade B/L245N)
Macroscopic examination	2 specimens	3 specimens	

11.5.2 Destructive Testing

11.5.2.1 Test Specimens

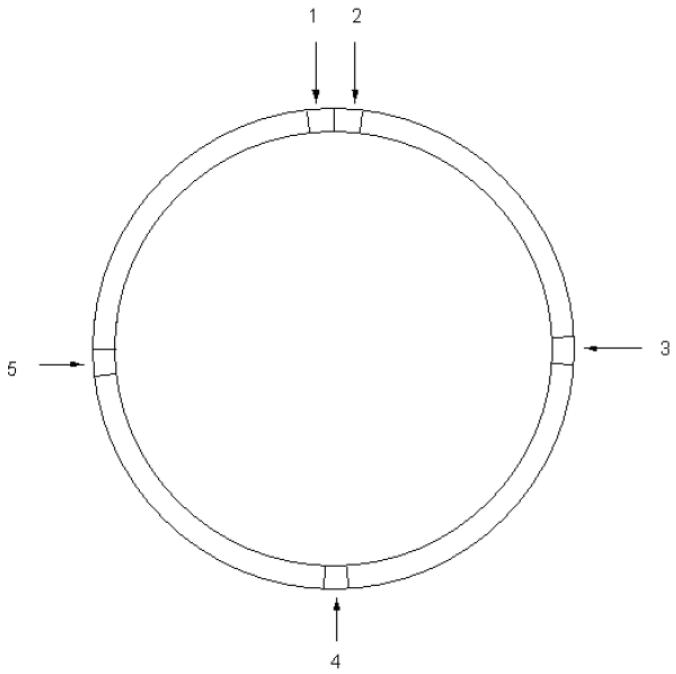
Test specimens shall be cut from the test weld at the locations shown in Figure 1 and Figure 2. The minimum number of specimens and the test to which they shall be subjected shall be as given in Table 3.

Transverse tensile test specimens are not required on nominal pipe diameters up to and including 114.3 mm OD.



Specimen	Location
Macro examination and Hardness test	1
Macro examination and Hardness test	2

Figure 1. Location of Test Specimens for Diameters Not Greater Than 114.3 mm OD.



Specimen	Location
Macro and Hardness	1
Tensile & Bends (2 off)	2
Macro and Hardness	3
Charpy impacts	3 or 4
Macro and Hardness	4
Tensile & Bends (2 off)	5

Figure 2. Location of Test Specimens for Diameters Greater Than 114.3 mm OD.

11.5.2.2 Transverse Tensile Test

Method

The specimens shall be prepared in accordance with BS EN ISO 4136 and tested in accordance with BS EN ISO 6892-1.

Weld cap reinforcement and root penetration bead should not be removed.

Requirements

When tested as specified in clause 11.5.2.2, the tensile strength of the weld, including the fusion zone of each specimen shall, be equal to or greater than the specified minimum tensile strength of the pipe material. If the specimen breaks in the weld metal, it shall be considered acceptable provided that the minimum tensile strength of the pipe material has been achieved.

The tensile strength of the weld metal for welds between dissimilar materials shall be equal to or greater than the specified minimum tensile strength of the higher strength parent material.

If the specimen breaks outside the weld or fusion zone at a tensile strength not less than 95% of the specified minimum tensile strength of the pipe material. That specimen shall be deemed to meet the test requirement.

Any specimen that breaks outside the weld or fusion zone, at a tensile strength less than 95% of the specified minimum tensile strength of the pipe material shall be rejected.

11.5.2.3 Transverse Bend Test

Method

When required, bend test specimens shall be carried out in accordance with BS EN ISO 5173.

For thicknesses less than 12 mm, two root and two face bends must be tested. For thicknesses equal to or greater than 12 mm, four side bend specimens shall be used instead of foot and face bend tests.

The specimens shall be prepared by machining or thermal cutting. If thermal cutting is used, at least 3 mm of the heat affected material must be removed from the cut edges by grinding. In all cases, the edges of the specimens must be smooth and parallel.

Requirements

Test specimens shall not reveal any one single flaw greater than 3 mm in any direction. Flaws appearing at the corners of a test specimen during testing shall be ignored in the evaluation.

11.5.2.4 Macro Examination

Method

Transverse sections shall be cut as close as possible to the locations shown in Figure 1 and Figure 2, but at positions shown to be free from defects after non-destructive testing in accordance with clause 11.5.1. The specimens shall be suitable for examination of the weld, the adjacent parent material and for subsequent hardness surveys, as applicable.

The specimens shall be prepared and etched as described in BS EN ISO 17639. The polished and etched specimens shall be examined at x5 magnification. A macrograph of each macro shall be provided for record purposes and the degree of photographic magnification shall be clearly shown with a scale marker. After examination, the macro specimen(s) shall be preserved by coating with a suitable clear lacquer.

Requirements

When tested as specified in clause 11.5.2.4, the specimen shall be free of cracks or lack of fusion defects. Any other defects shall be within the limits specified in clause 15.

11.5.2.5 Hardness Survey

Hardness surveys are not required for Group 1.1 parent materials, as defined in PD CEN ISO/TR 15608 (i.e., Re ≤ 275 N/mm^2, e.g., Grade B/L245N).

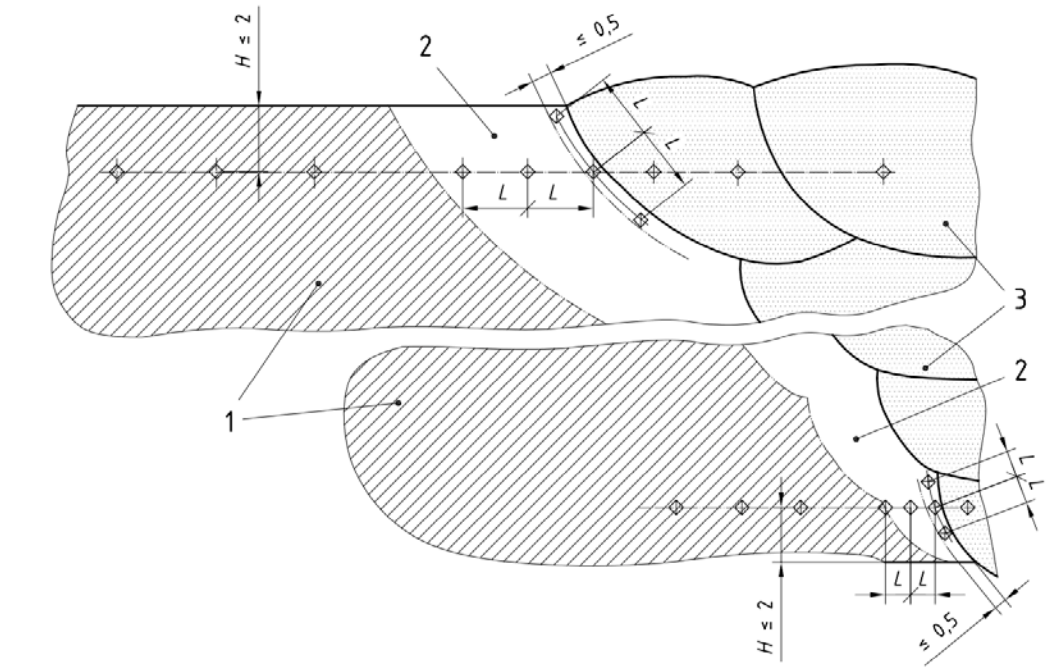
Method

A hardness survey shall be carried out on each macro specimen. The specimen shall be tested as described in BS EN ISO 9015-1, using the Vickers method in accordance with BS EN ISO 6507-1. A 10 kg load shall be used. The locations of the hardness impressions shall be as shown in Figure 7 of BS EN ISO 9015-1 (see Figure 3 below).

The hardness survey impressions shall be visible on the macrograph.

Requirements

When tested as specified in clause 11.5.2.5, the hardness values shall not be greater than those given in Table 4.



Key

1 Parent metal
2 Heat affected zone
3 Weld metal

Figure 3. Schematic showing locations of hardness indents for multi-run butt welds. (Figure 7 in BS EN ISO 9015-1.)

Table 4. Hardness Limits.

	Maximum Allowable Hardness (HV_{10})	
	Weld Metal	**Heat Affected Zone**
Manual Metal Arc Welding with Cellulosic Coated Electrodes	275	275 (root) 325 (cap)
Manual, Semi-Automatic, or Mechanised Welding Using Hydrogen Controlled Electrodes or Filler Metal	275	350
Note: a) Sour service applications are not covered in this specification.		

11.5.2.6 Impact Toughness Testing

General

Charpy impact testing is required for all butt welds in pipe of outside diameter greater than 114.3 mm and having a wall thickness greater than or equal to 8.0 mm.

Charpy impact testing shall be carried out in accordance with BS EN ISO 148-1 using a striker with a 2 mm radius and V-notched specimens. The axis of the notch shall be perpendicular to the pipe surface, i.e., through-thickness.

The notch locations shall be as defined in BS EN ISO 9016, namely:

- Weld metal impacts – VWT0
- HAZ impacts – VHT0

The location of the specimens relative to the test weld is specified below.

Each impact test set shall comprise three individual test specimens.

For dissimilar welds (e.g., pipe-to-fitting welds), impact tests shall be carried out on the HAZ of each parent metal.

Charpy impact test sizes and test temperatures shall be accurately recorded on the mechanical test reports.

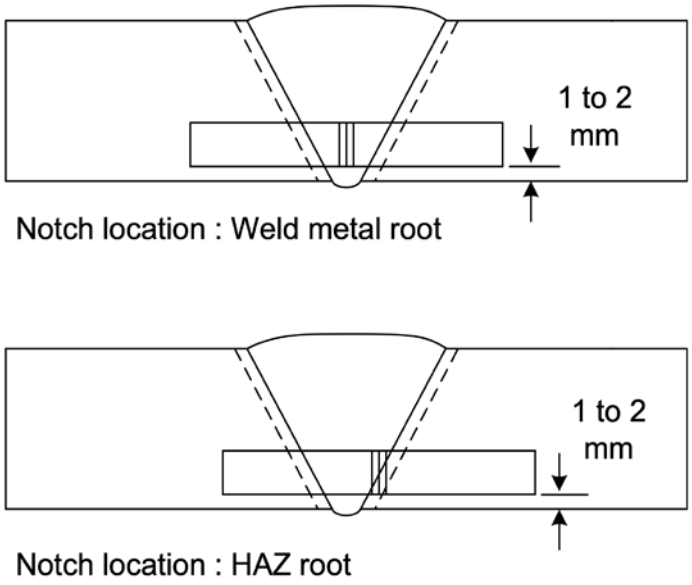


Figure 4. Location of Notch for Charpy Test Specimens.

Specimen Location

The locations for the removal of Charpy impact test specimens is dependent on welding direction (see Figure 2).

Specimens with a V-notch in the through-thickness direction shall be used. They shall be taken from within 1 mm to 2 mm above the inner surface of the parent metal and shall be transverse to the weld (see Figure 4).

When the majority of welding is in the vertical up direction the test specimens shall be taken from the 3 o'clock position. When the majority of welding is in the vertical down direction the test specimens shall be taken from the 6 o'clock position.

When the volume of deposited weld metal in different directions is approximately equal, the root impact specimens shall be taken from the appropriate position corresponding with the direction of the majority of welding in the lower half of the joint. The additional cap impact specimens shall be taken from the position that corresponds with the direction of the majority of welding in the upper half of the joint.

Impact Test Temperature

The impact test temperature shall be minus 10°C, or the minimum design temperature (specified by the

scheme designer), whichever is the lesser. Note however that circumstances may exist that require various minimum impact test temperatures at different pipe work locations. The manufacturer or contractor shall therefore confirm the required minimum weld metal impact test temperature(s) for test welds in discussion with the installation designer and the Gas Transporter prior to testing taking place.

Absorbed Energy Requirements

When tested at minus 10°C, or the minimum design temperature, the absorbed energy requirements for Charpy impact tests are given in Table 5.

Table 5. Charpy Impact Test Requirements.

Pipe Thickness	Charpy V-Notch Specimen Size	Minimum Energy Requirement (J)	
		Individual	Average
≥ 12.5 to < 25 mm	10 x 10 mm	30	40
≥ 10 to < 12.5 mm	10 x 7.5 mm	24	32
≥ 8.0 to < 10 mm	10 x 5.0 mm	21	28

Notes:

a) For pipe thickness ≥ 12.5 mm full size specimens shall be used.

b) The dimensions of sub-sized specimens shall be the largest size specimen possible that can be taken from the available pipe section.

11.5.3 Retests

In the event of failure in any of these mechanical tests, retests shall be allowed only as follows:

a) If there is a pre-existing [weld] defect visible on the fracture face which contributed to the failure of the test, or some deficiency in the preparation of the specimen, a like-for-like replacement may be tested. The test which failed shall be reported, with a reason for the failure given.

b) For other failures not attributable (a) above, no more than one failed test specimen is permitted.

c) The re-test shall comprise two specimens of the same type, dimensions, and test conditions as the failed specimen. The re-test specimens shall be taken from as close as possible to the position of the failed specimen. Both re-tests shall meet the specification requirements for the weld procedure to be approved.

11.6 Testing of Fillet Welds for Procedure Approval

11.6.1 Non-Destructive Testing

The extent of inspection and non-destructive testing of test fillet welds shall be as per Table 6.

All test fillet welds shall be examined in accordance with the requirements of the Gas Transporters version of NDT2 (Non-Destructive Testing of Welded Joints on Construction and Fabrication Projects). Once the GIS version of NDT2 is available then it will take precedence over previous GDN versions. Any supplementary examination methods used shall be as specified by the Gas Transporter.

The results of both visual and non-destructive testing shall be recorded and assessed, according to the appropriate acceptance criteria specified in clause 15.

Table 6. Inspection and Test Requirements for Qualification of Fillet Weld Procedures.

Inspection/Test Method	Extent of Testing	Notes
Visual inspection	100%	
Surface crack detection	100%	MPI
Fracture test	4 specimens	2 specimens for 114.3 mm OD, or less.
Hardness test	3 specimens	Not required for Group 1.1 materials (e.g., Grade B/L245N)
Macroscopic examination	3 specimens	

11.6.2 Destructive Testing

11.6.2.1 Test Specimens

The minimum number of test specimens and the tests to which test fillet welds shall be subjected is given in Table 6.

11.6.2.2 Fracture Test

The fracture specimens shall be taken from the locations shown to have the greatest and the least root gap. Prior to breaking the specimens, a macro examination shall be carried out (see clause 11.6.2.3), on one face of each of the two fracture specimens.

The specimens shall be prepared as shown in Figure 5 and shall be not less than 25 mm wide by 50mm long. The specimens shall be prepared by machine or thermal cutting (if the latter followed by grinding), the sides of the specimens shall be smooth and parallel.

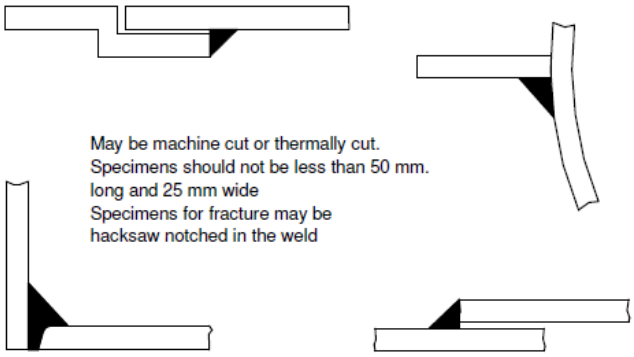


Figure 5. Preparation of Fillet Weld Fracture Test Specimens.

Method

The specimens shall be broken in such a way that the root of the weld is in tension, by either:

a) Supporting both ends and striking the centre of the specimen, or

b) Gripping one end and striking the other end.

Requirements

When tested as specified in 11.6.2.2, the exposed surface of each broken specimen shall be free from lack

of fusion and lack of penetration defects. Other defects in the weld metal shall be within the following limits:

a) Gas pores – The greatest dimension of any pore shall not be greater than 20% of the pipe thickness or 3 mm, whichever is the lesser. The combined area of all pores shall not be greater than 5% of the cross-sectional area.

b) Inclusions – The greatest dimension of any inclusion shall not be greater than 1 mm in depth and 3 mm or 50% of the pipe thickness in length, whichever is the lesser. There shall be not less than 12 mm of sound weld metal between adjacent inclusions.

11.6.2.3 Macro Examination

Method

The specimens shall be prepared and etched as described in BS EN ISO 17639. The polished and etched specimens shall be examined at x5 magnification. A macrograph of each macro shall be provided for record purposes. The degree of photographic magnification shall be clearly shown with a scale marker. After examination, the macro specimen(s) shall be preserved by coating with a suitable clear lacquer.

Requirements

When tested as specified in clause 11.6.2.3, the profile, dimensions, and number of passes of the fillet weld shall be as recorded in the procedure qualification record. The specimen shall be free of cracks, lack of fusion and lack of penetration defects. The total area of any cavities or inclusions shall not be greater than 5% of the fillet weld cross section. The shape/profile of the fillet weld shall meet the requirements of **Table 14**.

11.6.2.4 Hardness Survey

Hardness surveys are not required for Group 1.1 parent materials, as defined in PD CEN ISO/TR 15608 (i.e., Re ≤ 275 N/mm^2, e.g., Grade B/L245N).

Method

A hardness survey shall be carried out on each macro specimen. The specimen shall be tested as described in BS EN ISO 9015-1, using the Vickers method in accordance with BS EN ISO 6507-1 and a 10 kg load. The hardness impression locations shall be as shown in Figure 4 of BS EN ISO 9015-1.

Requirements

When tested as specified in 11.6.2.4 the hardness values shall not be greater than those given in Table 4.

11.6.3 Retests

In the event of failure in any of these mechanical tests, retests shall only be allowed provided that not more than one test specimen fails to meet the requirements.

The retest shall be two specimens identical to the failed specimen taken from as close as possible to the position of the failed specimen.

The procedure shall be acceptable if both retests satisfy the requirements of this specification. The procedure shall be rejected in the event of failure or non-compliance with the above.

11.7 Testing of Butt Weld Repairs for Procedure Approval

11.7.1 Non-Destructive Testing

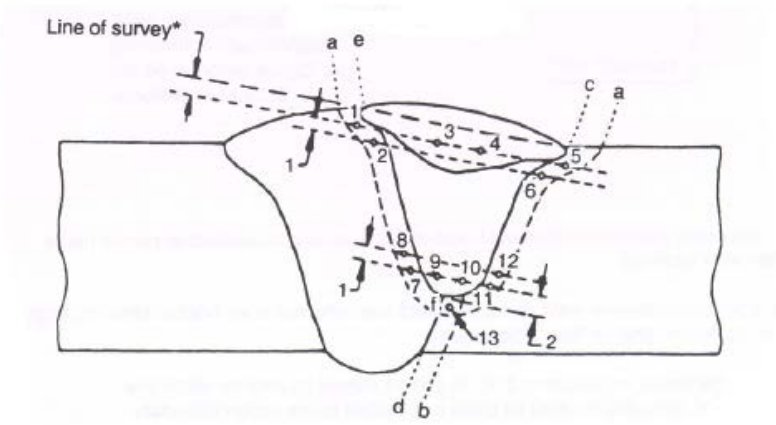
Non-destructive testing shall be carried out as required in clause 14.4.

11.7.2 Destructive Testing

A single macro specimen from the repair weld shall be prepared and tested in accordance with clause 11.5.2.4. A hardness survey shall be carried out in accordance with clause 11.5.2.5.

Repair welding procedures which are not identical to the original approved butt welding procedure shall be subject to full qualification testing (see clause 11.5).

Hardness surveys of partial penetration repair test welds shall be carried out as per Figure 6.



a – b boundary between visible weld heat-affected zone and unaffected parent metal (visible after etching).

c – d boundary between weld metal and weld heat-affected zone (visible after etching); known as ‘fusion line’ or ‘fusion boundary’.

e – f boundary between original weld metal and repair weld metal.

Hardness impression 13 should be entirely within the heat-affected zones of both welds.

The line of survey should be positioned so that impressions 1 and 5 coincide with the heat-affected zone of the final run or change of profile of the fusion line associated with the final run.

Not required for parent metals with Re ≤ 275 N/mm², i.e., Grade B/L245.

Figure 6. Hardness Survey of Partial Penetration Repair Test Welds.

11.8 Testing of Fillet Weld Repairs for Procedure Approval

11.8.1 Non-Destructive Testing

Non-destructive testing shall be carried out as required in clause 11.6.1

11.8.2 Destructive Testing

A single macro specimen from the repair weld shall be prepared and tested in accordance with clause 11.6.2.3. A hardness survey shall be carried out in accordance with clause 11.6.2.4.

Repair welding procedures which are not identical to the original approved fillet welding procedure shall be subject to full qualification testing (see clause 11.6).

12 WELDERS – TESTING, QUALIFICATION AND APPROVAL

12.1 Single Approval for Manual Welding

12.1.1 General

Testing for the approval of manual welders shall be in accordance with BS EN ISO 9606-1. A welder who has successfully welded a procedure approval test is automatically qualified to weld using that procedure.

12.2 Multiple Approval for Manual Welding

12.2.1 General

To reduce the number of welder approval tests, the use of a welder approval from a particular weld procedure may be applied to other joint types, providing the essential variables and other limitation of BS EN ISO 9606-1 and this specification are met.

Subject to the agreement of the Gas Transporter, the use of specific welder approval tests utilising variables that allow the application of the approval to a range of joints (type, size, and configuration etc.) is permitted.

The essential variables for the qualification of manual welders are as follows:

a) Welding process, or combination of processes

b) Plate or pipe test

c) Joint type

d) Material group as per PD CEN ISO/TR 15608

e) Filler material group

f) Filler material type and covering

g) Pipe thickness and diameter as defined in Table 7 and Table 8

h) Welding positions as defined in Table 9 and Table 10

i) Details of test weld including backing, single sided welding, welding from both sides, single layer, multi-layer etc.

12.3 Essential Variables Affecting Approval

12.3.1 Welding Process

Any change in the welding process or combination of processes from that/those used during approval shall be reapproved. Exceptions may be where the approval test was carried out using a solid wire (process 135) and will also approve welding using a metal cored wire (process 138) and vice versa.

12.3.2 Plate or Pipe Test

Welds in pipe will cover welds in plates providing the approval test was carried out on pipe of 33.4 mm OD, or greater.

Welder approval tests carried out in plate shall approve the welder to weld pipes of 168.3 mm OD and greater in positions PA, PB and PC only.

12.3.3 Joint Type

Approval test carried out on butt welds shall qualify all joint types providing other essential variables are satisfied, except for branch connections where a separate test is required.

Where the work predominately involves fillet welds, approval shall be carried out on a fillet weld test.

Types of weld that cannot be qualified by means of a butt or fillet weld shall be qualified separately and cannot be used for multiple approvals.

12.3.4 Material Groups

The material used for welder approval test are covered by the material grouping system of PD CEN ISO/TR 15608 – Groups 1, 2, 3 or 11.

When welding material not covered by the PD CEN ISO/TR 15608 grouping system, a separate approval test is required and this shall not be used to cover the welding of any other materials, including those both covered and not covered by the same grouping system.

12.3.5 Filler Material Group

Approval test shall use a consumable (filler material) specified in Table 2 of BS EN ISO 9606-1, using filler material groups FM1 and/or FM2.

The range of approval of a welder performance test using an FM2 filler material shall allow a welder to weld to a qualified procedure using FM1 filler metal, and vice versa.

For process 141, welding with filler metal will approve welding without filler metal, but not vice versa.

12.3.6 Filler Material Types & Covering

For welding process 111, the range of approval for covered electrodes are shown in Table 4 of ISO 9606-1.

The range of approval for filler material type are shown in Table 5 of ISO 9606-1.

12.3.7 Thickness – Range of Qualification

The range of approval for thickness of pipes and fittings is given in Table 7.

Table 7. Range of Qualification for Thickness of Pipes and Fittings.

Type of Weld	Nominal Thickness of Test Piece, *t*	Range of Qualification
Butt	< 12 mm	3 mm – 2*t*
	≥ 12 mm	≥ 3 mm
Fillet	≥ 3 mm	≥ 3 mm
a) Data summarised from Table 6 and Table 8 of BS EN ISO 9606-1. b) For pipeline and pipework butt welds the deposited thickness (*s*) is usually the same as the nominal thickness of the test piece (*t*). c) Thicknesses less than 3.2 mm are not covered by this specification. d) For branch connection, the thickness is determined by the following: i. Set-on (full penetration butt welds) – thickness of the branch ii. Set-on (partial penetration butt welds) – thickness of the branch iii. Set-through – material thickness of the main (header) pipe		

12.3.8 Diameter – Range of Qualification

The range of approval for pipe and fitting diameters is given in Table 8.

Table 8. Range of Qualification for Diameter of Pipes and Fittings.

Outside Diameter of Test Piece, *D*	Range of Qualification
D ≤ 33.4 mm	*D* – 2*D*
D > 33.4 mm	≥ 0.5*D* (33.4 mm min.)
Note: For both set-on and set-through branch connection, the diameter is determined by the outside pipe diameter of the branch.	

12.3.9 Dissimilar Thickness and Diameter

When the approval test involves test pieces of different pipe diameters and thicknesses the welder carrying out the test will be approved for the approved ranges for both thickness and diameter based upon the thinnest and thickest materials and also the smallest and largest diameters of pipe.

12.3.10 Welding Positions

The range of welder approval for weld positions are summarised in Table 9 and Table 10. Most pipe production welds are performed using PH (5G vertical-up) and PJ (5G vertical-down) positions. PH and PJ welding positions can only be qualified by welding a welder approval test in PH & PJ, respectively.

Test pieces shall have no deviation from the vertical or horizontal direction greater than 25º.

Certain clauses as per BS EN ISO 9606-1 are as follows:

a) Welding positions J-L045 (6G vertical-down) and H-L045 (6G vertical-up) for pipes approves the welding of pipes in all orientations for the respective welding directions.

b) Carrying out an approval test on two pipes of the same outside diameter, one in the PC (2G horizontal-vertical) position and one in the PH (5G vertical-up) position covers the range of approval of a pipe welded in the H-L045 position.

c) Carrying out an approval test on two pipes of the same outside diameter, one in the PC (2G horizontal-vertical) position and one in the PJ (5G vertical-down) position covers the range of approval of a pipe welded in position J-L045.

d) One approval test piece in the form of a pipe welded 2/3 in the PJ or PH position and the remaining 1/3 of the circumference in the PC position will approve the welding of pipes of outside diameters $D \geq 168.3$ mm for all positions in the directions of welding used in the test.

Table 9. Range of Qualification for Welding Positions – Pipe Butt Welds.

Position of Test Piece	Range of Qualification					
	PA	**PC**	**PH**	**PJ**	**H-L045**	**J-L045**
PC	Yes	Yes	—	—	—	—
PH	Yes	—	Yes	—	—	—
PJ	Yes	—	—	Yes	—	—
H-L045	Yes	Yes	Yes	—	Yes	—
J-L045	Yes	Yes	—	Yes	—	Yes
a) Summarised from Table 9 in BS EN ISO 9606-1.						

Table 10. Range of Qualification for Welding Positions – Fillet Welds.

Position of Test Piece	Range of Qualification					
	PA	**PB**	**PF**	**PG**	**PH**	**PJ**
PA	Yes	—	—	—	—	—
PB	Yes	Yes	—	—	—	—
PF	Yes	Yes	Yes	—	—	—
PG	—	—	—	Yes	—	—
PH	Yes	Yes	Yes	—	Yes	—
PJ	Yes	Yes	—	Yes	—	Yes
a) Summarised from Table 10 in BS EN ISO 9606-1.						

12.3.11 Details of Test Weld

Butt Welds

Approval test welding single sided without backing shall approve a welder to also weld single sided with backing and from both sides.

Approval test welding single sided with backing shall approve a welder to also weld from both sides. Approval test welding from both sides shall approve a welder to also weld from one side with backing.

Other test details for butt welds shall have limits of approval as per BS EN ISO 9606-1.

Fillet Welds

A single pass fillet weld approval test does not approve a welder for multi pass fillet welding. A multi pass fillet weld approval test will approve a welder for single pass fillet welding.

12.4 Visual Examination

The test weld shall present a neat workmanlike appearance and shall be assessed by visual examination to BS EN ISO 17637 according to the appropriate acceptance criteria specified in clause 15.1. The results of the examination shall be recorded.

12.5 Non-Destructive Testing

Non-destructive testing shall be carried out on each of the test welds by X-radiography as specified in GIS/NDT2.

The resultant radiograph(s) shall be assessed in accordance with clause 15.1.

12.6 Destructive Testing

12.6.1 General

Destructive testing shall be used for examining butt welds where it is not feasible to carry out non-destructive testing. Destructive testing may be required to confirm interpretation of the results of non-destructive testing.

Fillet welds shall always be subjected to destructive testing.

12.6.2 Butt Welds

The testing of butt welds for welder approval shall comply with the requirements as outlined in BS EN ISO 9606-1. Test piece dimensions and geometries shall be in accordance with BS EN ISO 9606-1 for plates and pipes.

Butt weld approval testing shall be in accordance with the visual method as described in BS EN ISO 9606-1 and either radiographic examination or bend testing or fracture testing.

Bend Testing

Bend tests shall be carried out in accordance with BS EN ISO 5173. Former and inner roll details are defined in BS EN ISO 9606-1 section 6.5.2.3.

For pipes of outside diameter 33.4 mm and less, bend tests may be replaced by a notched tensile test of the entire approval test piece as defined in Figure 9 of BS EN ISO 9606-1.

For thicknesses of 12 mm and greater, root and face bend test specimens may be replaced by side bends.

For welding processes 131, 135 and 138, additional bend or fracture tests shall be carried out to complement the radiographic testing.

Fracture Testing

Fracture tests shall be carried out in accordance with BS EN ISO 9017.

For pipes of outside diameter 33.4 mm and less, fracture tests may be replaced by a notched tensile test of the entire approval test piece as defined Figure 9 of BS EN ISO 9606-1.

The examination length of each test specimen shall be at least 40 mm, or greater.

12.6.3 Fillet Welds

The testing of fillet welds for welder approval shall comply with the requirements as outlined in BS EN ISO 9606-1. Test piece dimensions and geometries shall be in accordance with BS EN ISO 9606-1 of this specification for plates and pipes.

Fillet weld approval testing shall be in accordance with the visual method as described above and either fracture testing, macroscopic examination or when the approval has been carried out on pipe, radiographic testing.

Fracture Testing

Fracture tests shall be carried out in accordance with BS EN ISO 9017.

For fracture testing of pipe, the test piece shall be cut into at least four (or more if possible) separate specimens and each specimen shall be individually fractured.

Macroscopic examination may be used to replace the use of fracture tests with the testing of at least two sections in accordance with BS EN ISO 17639, or clause 11.5.2.4 of this specification, with the omitting of the hardness testing. One macroscopic specimen shall be taken from a stop start area.

12.6.4 Acceptance Criteria for Tests

The results of tests outlined in clause 12.6 shall satisfy the acceptance criteria in clause 15.1 and the following:

- The welder approval test need not be assessed for angular misalignment.
- Any flaws appearing at the edges of the bend test specimens shall be ignored and will not be classed as a failure unless the resultant cracking is attributable to incomplete penetration, slag, or another type of flaw.

12.7 Retests

In the event of a test failing to meet the requirements of BS EN ISO 9606-1, the welder may be allowed one opportunity to repeat the approval test.

When the contracting parties agree that the failure was due to conditions beyond the welder's control, then an additional test is required to verify the quality and integrity of the new test material and /or new test conditions.

12.8 Records

The details of each welder's approval test and test results shall be recorded. All documentation relating to welder approval tests shall be submitted to the Gas Transporter for approval prior to the welder commencing production work.

Record forms similar to the example shown in Annex A of BS EN ISO 9606-1 should be used. The period for which records should be kept should be specified by the Gas Transporter.

12.9 Period of Validity

The welder's qualification shall remain valid for two years from the date of successful testing of the test piece. Every six months the welder's production performance shall be reviewed to confirm that the welder

has been satisfactorily working within the initial range of qualification. Providing that evidence (see BS EN ISO 9606-1) is available to confirm this, the welder's qualification remains valid. If the required evidence is not available to confirm validity the welder shall be re-tested.

12.10 Mechanised Welding

For mechanised welding, each welder shall be approved for all parts of the operation of making a weld. A change in the type of welding equipment or system shall require re-approval of the welder.

13 PRODUCTION WELDING

13.1 Proximity of Welds

The clearance between the toe of any set-on welded attachment and the toe of any other weld shall not be less than 25 mm.

Unless agreed by the Gas Transporter, adjacent circumferential welds should be separated at least by a distance equivalent to the diameter of the pipe.

13.2 Pipe End Preparation

The pipe ends shall be bevelled to the dimensions specified in the approved welding procedure. The pipe bevel and any bevel transition shall be in accordance with the dimensions given in GIS/P16 specification.

All pipe which is to be cut back shall be examined visually prior to and after cutting. Pipe with a wall thickness greater than 6.3 mm shall be ultrasonically examined in accordance with GIS/NDT2 for 100 mm each side of the proposed cut line to ensure freedom from unacceptable lamination defects.

When pipe ends require cutting and bevelling in the field, this shall be carried out by machine or by machine thermal cutting, manually or mechanically operated. After thermal cutting, the bevel shall be dressed to remove oxidised surfaces. A facing plate shall be available, if required, to check the pipe ends are square.

Minor imperfections (burrs, small score marks etc.) occurring within the weld preparation area shall be blended out by grinding providing that the joint configuration remains within the permitted tolerances.

For socket welds the pipe ends shall be cut square and internal or external burrs removed by filing. The pipe ends shall be cleaned to a bright finish for a distance from the end of the pipe equal to the depth of the socket plus 25 mm. The socket shall also be cleaned, internally and externally, to a bright finish. Cleaning by grinding is not allowed. Surface cleanliness shall comply with clause 13.3.

13.3 Fusion Faces

Immediately prior to welding, all fusion faces and adjacent material shall be free from notches, fins, tears, moisture, scale, rust, paint, grease, or other extraneous matter. Any planar defects found shall comply with clause 15.1. Cleaning to base material shall extend for not less than 25 mm from the edge of the fusion faces on both internal and external faces of the parts to be welded.

Polyethylene coatings shall be cut back not less than 150 mm from the pipe end.

Fumes from coating removal and welding can be particularly hazardous in confined spaces. Where there is the potential for polyethylene or polyurethane coatings to become heated to temperatures, which may cause the emission of toxic fumes, consideration shall be given to the effective collection and disposal of such fumes. Personnel shall be provided with protective clothing and equipment, which is adequate to allow the operation to be completed safely. Due cognisance of the Control of Environment and Waste Act shall be taken.

Polyethylene coatings and their adhesive mastics shall be prevented from attaining temperatures that cause the emission of toxic fumes. Where a polyethylene coating has been cut-back, all traces of adhesive mastic shall be removed. Scraping, blast cleaning or a suitable stripping agent may be acceptable for removing the mastic. Flame heating shall not be used.

13.4 Alignment

Weld preparations between pipes and fittings of the same nominal wall thickness shall be aligned so as to minimise the internal offset between surfaces. This may be achieved by rotation of the pipes or the use of external clamps.

The maximum internal misalignment shall not exceed 3 mm, or 15% of the nominal pipe wall thickness, whichever is the lesser.

For pipes and fittings of different nominal wall thicknesses and the same outside diameter, alignment shall be achieved by transitioning in accordance with GIS/P16 specification.

Angular misalignment at the weld of less than 3° is acceptable provided that the misalignment is equally distributed on both sides of the weld up to a maximum of 1.5° per side.

All components that are to be welded together shall be positioned, aligned and set-up, in such a way that prevents the need to force, spring or superimpose additional stresses on any component during construction.

External or internal clamps shall be capable of independently maintaining pipe or component alignment.

13.5 Tack Welds

The work shall be set up, properly supported and where line-up clamps are not used, tack welded using the root run parameters and variables from the approved/qualified welding procedure.

Tack welding shall only be carried out by qualified welders.

Root tacks are not permitted for butt welds made using slag-forming welding processes.

'Bullet' tack welds shall be used for MMA welds. The 'bullets' shall be of metallurgically compatible material, and fusion shall be on the bevel face – not the root face. Bullet tack welds shall be made using agree parameters. Each bullet tack shall be removed (by grinding) as the root pass progresses.

Bridge tacks are not permitted.

Note: A bridge tack is made using weld metal to connect the two sides of a joint. Unlike a bullet tack, no additional material is added.

All tack welds shall be spaced equally around the weld circumference. The minimum number of tack welds shall be as follows:

< 88.9 mm OD	— a minimum of three tack welds each not less than 15 mm long.
88.9 – 323.9 mm OD	— a minimum of four tack welds each not less than 25 mm long.
> 323.9 mm OD	— a minimum of four tack welds each not less than 50 mm long.

All weld preparations shall be dry prior to tack welding. Pre-heating requirements shall be as specified in the qualified welding procedure.

Defective tack welds shall be removed by grinding ensuring that no damage to the adjacent preparation arises and that the permitted tolerances of the joint configuration are still obtained.

The workpiece shall not be left in the tacked condition for a prolonged period of time.

13.6 Line-Up Clamps and Pipe Supports

13.6.1 External Clamps

External line-up clamps shall be used to hold pipes firmly in position. On no account shall straps, cleats, brackets or similar plate sections be attached to the pipe by welding for the purposes of alignment.

Where it is agreed between the contracting parties that the use of an external line-up clamp is impracticable, then the weld shall be set-up, spaced, supported and tack welded in accordance with clause 13.5.

13.6.2 Lowering Off

For pipelines, the stage during the welding cycle at which the pipe is lowered on to skids, or support is removed in the case of fittings, shall be agreed between the contracting parties, and clearly stated in the welding procedure.

13.7 Working Clearance

The working clearance around the joint shall be not less than 600 mm. This working clearance shall be maintained until all welding, inspection and protective coating application operations are completed.

When the weld is to be made in a trench or confined space, the excavation shall be of sufficient size to provide the welders, inspector, and other operators with ready access to the joint.

All excavations shall be made safe, and where necessary, supported in accordance with the appropriate the Company safety requirements and statutory regulations.

13.8 Stray Arcs

Arcs shall only be struck on fusion faces. Contact of the electrode, or of non-insulated parts of the electrode holder, with the surface of the pipe shall be avoided.

Where it is necessary for removing slag from the tip of the electrode, or to facilitate the starting of the arc, an earth saddle or starting plate which makes good electrical contact with the pipe, should be placed conveniently near to the weld for striking the electrode. Electrode holders shall be of the fully insulated type.

Damage due to stray arcs shall either be repaired or rejected as sanctioned by the Gas Transporter. Where permission to repair an arc strike has been given by the Gas Transporter, the procedure shall include, but not necessarily be limited to, the mechanical removal of the defective material by blending, checking by MPI and confirmation that the thickness of the pipe or fitting is within permitted thickness tolerances. Where permission is not given to repair an arc strike, the affected component shall be removed from the system.

If the thickness, after dressing, is less than the minimum specified on the purchaser’s order, repairs may only be carried out in accordance with a procedure which has been approved by the Gas Transporter. The repaired area will then be subjected to further non-destructive testing, which shall include radiography, MPI and ultrasonic examination.

13.9 Weather Conditions

Welding shall not be carried out when the quality of the completed weld would be impaired by airborne moisture, blowing sands or high winds.

Components shall not be welded when they are at a temperature below 5°C, or when the weld area is damp. Pre-heating may be used to dry or raise the temperature of the components see clause 13.10.

All practicable measures shall be taken to shield the weld area immediately prior to and during welding. This is particularly important where gas shielded welding processes are used. Upon completion of welding the joint shall be wrapped in a dry, insulating, heat resistant (asbestos free) material blanket, with a waterproof backing. The weld shall be allowed to cool to ambient temperature in a slow and uniform manner before removal of the blanket.

The Gas Transporter or his representative shall have the right to suspend welding until adequate protection from the weather can be provided by the contractor or until weather conditions improve.

13.10 Pre-Heating

13.10.1 General

The pre-heating requirements shall be as specified in Table 11 and shall be stated on the welding

procedure.

Pre-heating is not normally required for steels covered by this specification. However, all components forming the weld shall be dry and free of moisture immediately prior to welding. Pre-heating may be used to raise the temperature of the components or to dry the weld bevel areas.

The carbon equivalent value of the parts to be joined shall be established. Where fittings of higher chemistry and specified minimum yield strengths equal to or greater than 290 N/mm^2 and the materials standards referred to in clause 8 are used then pre-heating and welding shall be in accordance with GIS/P2 or GIS/P8.

Table 11. Preheat Temperature Requirements.

Carbon Equivalent Value (CE Value, or CE_{IIW}) (1)	**Minimum Preheat Temperature for Pipes and Fittings (3, 4)**		
	When: SMYS < 290 N/mm^2 (2) Diameter ≤ 457.1 mm and/or Thickness ≤ 8 mm	**When: SMYS < 290 N/mm^2 (2) Diameter > 457.1 mm and/or Thickness > 8 mm**	**When: SMYS > 290 N/mm^2 (2)**
< 0.45%	5ºC	P2 / P8	P2 / P8
0.45% – 0.50%	50ºC		
> 0.50%	100ºC		

Notes:

1. Carbon equivalent value calculated using the International Institute of Welding formula:

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

2. SMYS – Specified minimum yield strength (N/mm^2, or MPa)
3. Where the chemical composition of materials to be welded is unknown, a minimum preheat of 50ºC and 100ºC shall be used for pipe-to-pipe welds and pipe-to-fitting welds, respectively.
4. Where the ambient temperature is less than 5ºC the parent metal (i.e., bevels) shall be preheated to dispel any moisture.

13.10.2 Method and Extent of Pre-Heating

The area of pipe that is pre-heated shall extend around the entire periphery of the pipe or part being joined. In each case the area 75 mm of pipe each side of the weld shall be heated and maintained at the required temperature.

Pre-heating shall be applied by propane gas/air torch by such means that maintain a satisfactory temperature distribution around the weld. Care shall be taken to avoid damage to the pipe coating. Where a minimum pre-heat temperature is specified in the welding procedure, the temperature attained shall be measured by temperature-indicating crayons (which melt when the required temperature is reached) or by a suitable contact thermometer.

Crayons which indicate temperature by colour change are not permitted.

Infrared pyrometers are not permitted.

The pre-heating temperature actually attained shall reach the minimum required by the approved procedure, but shall not exceed it by more than 50°C.

13.11 Branches

13.11.1 General

All branches shall be made with specialised fittings (e.g., forged or pressed tees, forged set-on components or manufactured fittings), or fabricated from pipe as appropriate.

Where a sloping branch pipe is to be connected directly to the main pipe, the angle between the centre line of the main pipe and that of the branch pipe shall not be less than 60°, and special precautions shall be taken locally, at the acute crotch, to ensure a sound weld.

13.11.2 Spacing of Branches

The minimum spacing of branches shall be equivalent to one main pipe diameter. The length of flanged branches shall be such that there is adequate access for welding and inspection (see clause 13.1 and 13.7).

13.11.3 Joint Preparation

Branch connections and branch openings in the main pipe shall be cut by machining or by thermal cutting ensuring the complete removal of the hardened layer by grinding. The cut edges shall then be dressed by filing or grinding to the dimensions given in the approved welding procedure (see clauses 13.2 and 15.1).

13.11.4 Welding

13.11.4.1 General

All welding shall be carried out in accordance with the approved welding procedure. The root gap shall be maintained during the deposition of the first weld pass. Tack welding shall only be used in accordance with the requirements of clause 13.5.

Copies of the approved welding procedures shall be available at the work location. Welders and Welding Inspectors shall be fully familiar with the appropriate procedures.

13.11.4.2 Internal Welds

Internal welding shall only be carried out as specified in the approved welding procedure.

13.11.4.3 Fittings

All fittings shall be welded in one complete heat cycle.

13.11.4.4 Branch Reinforcement (Compensation)

When the reinforcement is thermally cut to shape, the cut edges shall be dressed by filing, grinding, or machining.

The reinforcement shall be securely held in position by tack welds, which shall be of sound quality, as required in clause 13.5.

13.12 Inter-Run Cleaning

Each run of weld metal shall be thoroughly cleaned, by hand or power tools, before a further run is applied.

All visible defects, e.g., slag, cavities, cluster porosity and other deposition faults such as convexity shall be removed by grinding. Particular attention shall be paid to the cleanliness of junctions between the weld metal, fusion faces and stop/starts before deposition of further weld metal.

13.13 Partially Completed Joints

Where practicable, welds shall not be left partially completed. For pipes up to and including 219.1 mm outside diameter, all welds shall be completed in one welding cycle. Where production conditions are such

that pipe-to-pipe welds (on pipes greater than 219.1 mm OD) have to be left partially completed, the following conditions shall apply:

a) The weld shall have a minimum of three runs deposited.

b) Upon discontinuation of welding, the weld shall be wrapped in a dry, insulating, heat resistant material with a waterproof backing. The weld shall be allowed to cool in a slow uniform manner (see 13.9).

c) Prior to recommencement of welding, the joint shall be dry and reheated to the specified inter-pass temperature stated in the welding procedure.

14 EXAMINATION AND TESTING OF PRODUCTION WELDS

14.1 General

Attention is drawn to the Confined Spaces Regulations with regard to pipe entry (if personnel are required to enter and work in gas pipelines) and excavations.

The extent of examination and non-destructive testing (NDT) testing of production welds shall be as specified in Table 12.

Table 12. Extent of Inspection and Non-Destructive Testing of Production Welds.

Type of Weld and Location	Visual Inspection	Radiographic or Ultrasonic Testing	Surface Crack Detection (MPI)
Girth Welds at Non-Critical Locations	100%	10% (b)	—
Girth Welds at Critical Locations (a)	100%	100%	100%
Fillet Welds at All Locations	100%	—	100%

Notes:

a.) Critical locations are typically crossings associated with bridges, railways, major roads and motorways, navigable waterways, and welded joints not included in the hydrostatic pressure test.

b.) If the radiography or ultrasonic inspection reveals a defective weld, another two welds made by the same welder, or two welds on either side of the defective weld, shall be examined by radiography or ultrasonic methods. If the additional welds inspected meet the quality requirements of this specification, further inspection can return to the minimum specified requirements. However, if either of the additional welds inspected contain unacceptable weld defects the level of girth weld NDT shall be increased to 100% of completed welds. This level of NDT shall be maintained until the cause(s) of the defect(s) are identified and corrective action taken to prevent further occurrence. At such time, the standard level of inspection may be re-instated.

c.) The Gas Transporter shall reserve the option to have any production weld inspected by NDT.

d.) Welds subject to percentage inspection shall be selected by the Gas Transporter or their representative.

14.2 Qualification of Inspection & NDT Personnel

All inspection and NDT personnel shall be qualified to the appropriate level or discipline of the BGAS Inspector approval scheme. The validity of an inspector's approval may be checked by the Gas Transporter at any time. Therefore, it is required that proof of qualification, i.e., the BGAS approval identity card be available for scrutiny.

At the discretion of the Gas Transporter personnel qualified to an equivalent level or discipline in an alternative scheme may be approved (see GIS/NDT2).

14.3 Visual Examination of Welds

Each weld shall be examined visually during production and upon completion. This is to ensure compliance with the approved welding procedure specification, to detect unacceptable defects (see clause 15) and permit remedial work to be carried out while the joint is still within the original weld cycle inter-pass temperature range.

14.4 Non-Destructive Testing of Welds

Upon completion of welding and subject to any agreed time delay, each weld shall be examined by an NDT method approved by the Gas Transporter (see Table 12). All NDT shall be in accordance with the requirements of GIS/NDT2. When datum points are required, the method of marking shall be approved by the Gas Transporter.

Note: If the Gas Transporter requires an alternative time delay prior to the NDT of qualification test welds or production welds this shall be agreed with the manufacturer or contractor prior to welding commencing.

14.5 Destructive Testing of Welds

The Gas Transporter shall have the option to require the removal of completed welds for the purpose of destructive testing. Destructive testing shall consist of the removal of completed welds, the sectioning of the welds into specimens and the testing of the specimens. The specimens shall be prepared and tested to check compliance with the requirements specified in clauses 11.7 and/or 11.8.

14.6 Inspection and NDT Records

The results of all inspection and NDT examinations and any observed defects shall be recorded as specified in GIS/NDT2. As a minimum, these records shall be retained for the life of the pipeline or installation or as directed by the Gas Transporter.

15 WELD ACCEPTANCE CRITERIA

15.1 Acceptance Criteria Based on Quality Control

This section provides the acceptance criteria for weld imperfection where visual inspection and radiography are the main inspection techniques. All weld imperfections found on butt welds and fillet welds shall be assessed against the acceptance criteria in Table 13 and Table 14 respectively.

The dimensional limitations of weld flaws subject to rejection specified in Table 13 and Table 14 by their location and disposition, a factor that should be borne in mind when considering the rejection of welds that appear to be borderline in quality as assessed by the limitation of flaws specified in Table 13 and Table 14.

If imperfections are found on the pipe ends, fusion faces and branches prior to welding (see clauses 13.2, 13.3 and 13.11), any planar defect found shall not be greater than 25 mm in any direction.

Table 13. Acceptance Criteria for Girth Weld Imperfections.

Weld Defect Type (Ref. ISO 6520-1)	**Allowable Limit**
Cracks (100)	Not permitted. Weld shall be cut out.
Crater cracks (104)	Crater cracks which are positively identified and measure less than 4 mm in any direction shall be repaired. Welds containing crater cracks larger than 4 mm shall be cut out.
Arc strike / Stray arc (601)	Not permitted.
Axial misalignment (5071)	The maximum internal misalignment shall not exceed 3 mm, or 15% of the nominal pipe wall thickness, whichever is the lesser. For external misalignment, the weld shall be tapered between the two surfaces with a slope not steeper than 1:4.
Cap profile (502)	The weld metal shall be of smooth contour. The external weld reinforcement shall be between 1.5 mm and 3 mm high measured from the outer surface of the parent metal. The weld face shall be substantially symmetrical about the centre line of the joint.
Cap undercut (5011 & 5012)	The length of cap undercut shall be less than 50 mm in any continuous weld length of 300 mm, or 15% of the weld circumference when this is less than 300 mm. The depth of cap undercut shall be less than 1 mm, or 10% of the pipe thickness, whichever is smaller.
Lack of fusion, cap (401)	Not permitted.
Surface-breaking defects (2017)	The surface of the weld shall be free from porosity, exposed slag, cavities and loose or excessive scale.
Internal (root) profile	The root bead shall merge smoothly into the adjacent surfaces. At no point shall the weld be thinner than the pipe thickness.
Excess penetration, root (504)	The root penetration shall not exceed 3 mm.
Root concavity (515)	The root concavity shall merge smoothly into the adjacent surfaces. Total length shall not exceed 25% of the circumferential length. Depth ≤ 1.5 mm or 10% of wall thickness.
Root undercut (5011 & 5012)	The length of root undercut shall be less than 25 mm in any continuous weld length of 300 mm, (or 8% of the weld circumference when this is less than 300 mm). The depth of root undercut shall be less than 1 mm, or 10% of the pipe thickness, whichever is smaller.

Weld Defect Type (Ref. ISO 6520-1)	**Allowable Limit**
Incomplete root penetration (4021)	The length of incomplete root penetration or incomplete root fusion shall be less than 25 mm in any continuous weld length of 300 mm, (or 8% of the weld circumference when this is less than 300 mm).
Lack of root fusion (4013)	The length of incomplete root penetration or incomplete root fusion shall be less than 25 mm in any continuous weld length of 300 mm, (or 8% of the weld circumference when this is less than 300 mm).
Hollow bead 2015 & 2016	Not to exceed 50 mm in any 300 mm length of weld, or 1/6 of total length of the weld when this is less than 300 mm.
Burn-through (510)	Not greater than 6 mm in any direction. Maximum of two burn-throughs in any 300 mm of weld length.
Lack of inter-run fusion Lack of side-wall fusion (401)	The length of incomplete side-wall fusion, incomplete inter-run fusion, or slag lines shall be less than 50 mm in any continuous weld length of 300 mm, or 15% of the weld circumference when this is less than 300 mm.
Slag inclusions (301)	The total length of inclusions shall be less than 50mm in a length of 300 mm, or 15% of the weld circumference when this is less than 300 mm.
Other inclusions Copper (3042), Tungsten (304), Flux (302), Oxides (303) etc	The total length of inclusions shall be less than 12 mm in a length of 300 mm, or 15% of the weld circumference when this is less than 300 mm. Individual inclusions shall not exceed 3 mm or 50% of the pipe thickness, whichever is smaller.
Isolated gas pores (2011)	Any individual spherical gas pore whose maximum diameter exceeds 25% of the wall thickness or 3 mm, whichever is smaller.
Uniformly distributed porosity (2012)	Smaller than those permitted as isolated pores the diameters of which in aggregate exceed 10 mm in any 25 mm length of weld. The distance between any two adjacent pores must not be less than five times the diameter of the largest pore.
Clustered porosity (2013)	Any circle 10 mm in diameter in which the total area of individually acceptable randomly distributed gas pores exceeds the equivalent area of six pores of 1 mm diameter. Figure 6 attached for comparison.
Elongated cavity (2015), Wormholes (2016)	Not to exceed 6 mm in length or 1.5 mm in diameter for pipe thickness not exceeding 25 mm. Not to exceed 12 mm in length or 25% of the pipe thickness whichever is the smaller or 3 mm in diameter for pipe thickness greater than 25 mm.
Accumulation of defects	Any accumulation of defects, except porosity, having a total length equal to or greater than 100 mm on any continuous weld length of 300 mm, or a total length equal to or greater than 15% of the weld length must not be accepted. Where the pipe wall thickness is ≤ 10 mm, no other defects shall be permitted coincidental to any acceptable defect.

Table 14. Acceptance Criteria for Fillet Weld Imperfections.

Weld Defect Type (Ref. ISO 6520-1)	**Allowable Limit** [a, b]
Crack (100)	Not permitted. Weld shall be cut out.
Crater crack (104)	Crater cracks which are positively identified and measure less than 4 mm in any direction shall be repaired. Welds containing crater cracks larger than 4 mm shall be cut out.
Surface pore (2017)	Max. dimension for a single pore.
Lack of fusion (incomplete fusion) (401)	Not permitted.
Undercut (5011 & 5012)	Individual length ≤ 50 mm, Total length 15% of circumferential length. Length 50 mm in every 300 mm. Depth ≤ 1 mm or 10% of wall thickness.
Excessive convexity (503)	Max. 4 mm
Incorrect weld toe angle (505)	Alpha ≥ 100º
Unequal leg length (512)	When leg length, z = 6 mm — Difference, h = 2.5 mm max. z = 10 mm, h = 3 mm max. z = 15 mm, h = 3.5 mm max.
Insufficient throat thickness (5213)	h = 1 mm max.
Excessive throat thickness (5214)	h = 4 mm max.
Stray arc (601)	Not permitted.
Spatter (602)	Not permitted.
Lack of penetration (402)	Not permitted.
Incorrect root gap (617)	Gap between the parts to be joined. Gaps exceeding the appropriate limit may, in certain cases, be compensated for by a corresponding increase in the throat thickness.
Multiple imperfections in any cross-section. (e.g., macro-sections)	

a) Acceptance limits are a mixture of Quality Level B and C taken from BS EN ISO 5817.

b) Notation as per BS EN ISO 5817.

15.2 Weld Acceptance Criteria – Ultrasonic Examination

When primary inspection is by ultrasonic test methods, the criteria for weld defect acceptance shall be agreed with Gas Transporter prior to construction.

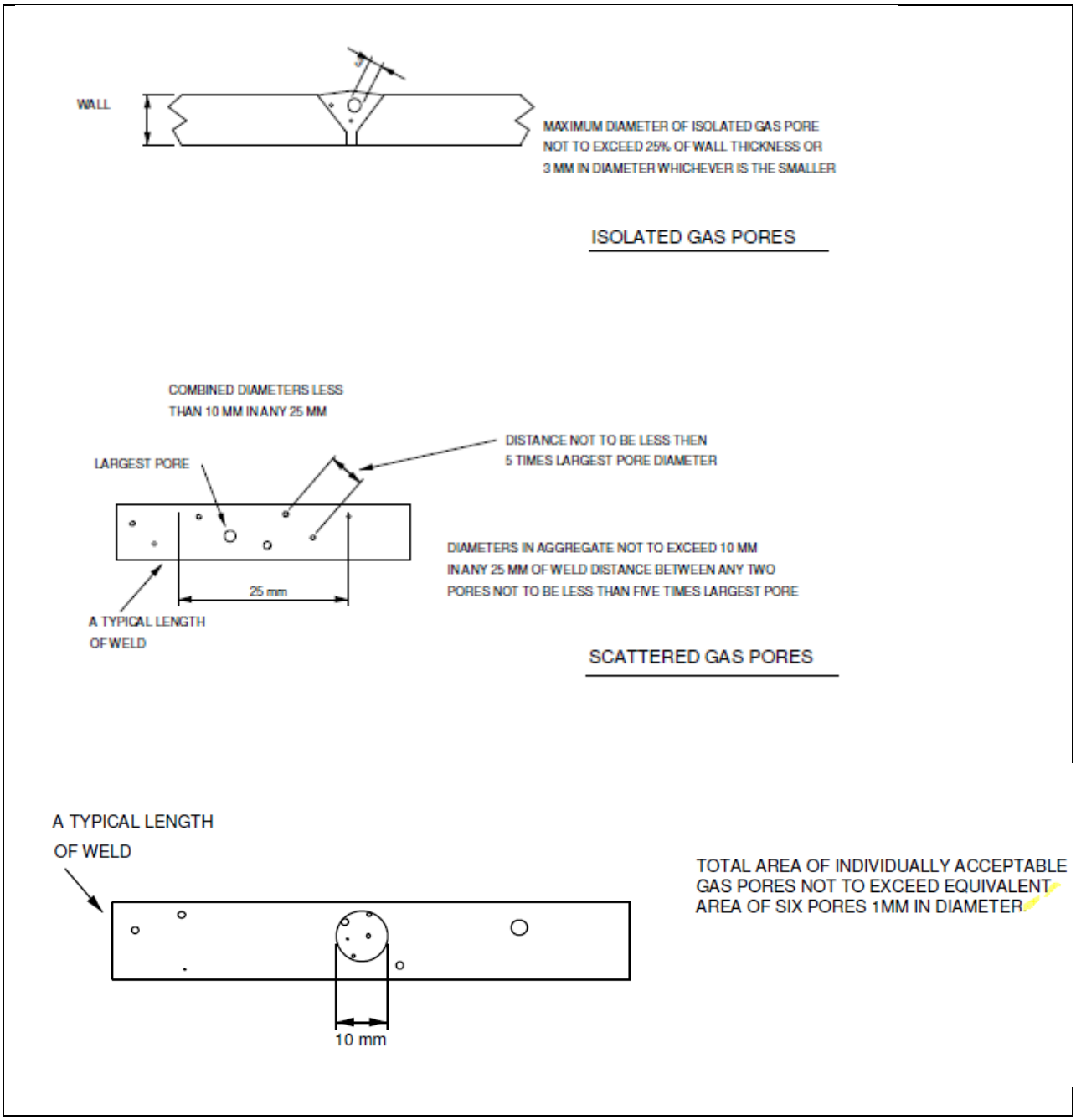


Figure 7. Porosity Distribution Chart (When Inspected by Radiography).

16 RECTIFICATION OF WELDS

16.1 Removal of Defects

When welds fail to comply wholly or in part with the requirements of clause 15, either the weld shall be repaired locally, or the weld shall be cut-out. Repairs shall not be made before full non-destructive testing and inspection has been carried out according to the relevant specification, except as specified in clause 14.

No welds shall be repaired without the approval of the Gas Transporter's Inspector and then only under their personal supervision. If the repair is carried out because defects were revealed by non-destructive testing, the records showing these defects shall be made available.

Defects shall be removed by chipping, grinding, machining or thermal gouging. Entire welds shall be removed by thermal cutting, cold cutting, grinding or machining.

16.2 Preparation for Re-Welding

16.2.1 Partial Removal of Weld Metal

The excavated portion of the weld shall be sufficiently deep and long to remove the defect. The excavation shall match the original joint design with a gradual 'boat-shaped' taper from the base of the cut to the weld surface.

When the root of the weld is accessible from the bore of the pipe, a repair to the root may be carried out from that position using a minimum of two passes. Weld procedures for back weld repairs shall be separately qualified.

16.2.2 Complete Removal of the Weld

Where a weld has been removed (i.e., cut out) and there is no serious loss of pipe length, the weld preparation shall be re-made in accordance with the approved welding procedure. Care shall be taken to remove all traces of the heat affected zone from the previous weld. Typically, removal of 3 mm parent metal is sufficient.

Where a length of pipe containing a weld has been removed, a new length of pipe shall be inserted, and the two welds shall be prepared in accordance with the requirements of the approved welding procedure.

16.3 Re-Welding

All repair welding shall be carried out in accordance with an approved welding procedure. Repairs shall be limited to 30% of the weld length for a partial penetration repair, or 20% of the weld length for a full penetration repair. No more than two attempts at a repair of any region are permitted.

Full penetration repairs shall be implemented only under constant supervision. Vertical down welding shall not be used for the root run in full penetration repairs. If repairs cannot be carried out within these limitations, or are not affected successfully, the weld shall be cut out. Full records of all repairs shall be maintained.

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

17 PROJECT WELDING RECORDS

As a minimum the following records pertaining to welding shall be prepared and submitted to the Gas Transporter on completion of the pipeline or installation:

a) Pipe/fitting material and consumable test certificates.

b) Approved welding procedure sheets.

c) Welding procedure and welder qualification test records.

d) NDT test records and inspection reports.

e) Inspector approval records.

f) Pressure test records.

APPENDIX A – REFERENCES

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

A.1 British Standards

BS 499-1	Welding terms and symbols Part 1: Glossary for welding, brazing and thermal cutting
BS EN 1011-2	Welding. Recommendations for welding of metallic materials – Arc welding of ferritic steels
BS EN 10025-2	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels
BS EN ISO 636	Welding consumables – Rods, wires and deposits for tungsten inert gas welding of non-alloy fine grain steels – Classification
BS EN ISO 2560	Welding consumables – Covered electrodes for manual metal arc welding of non-alloy and fine grain steels
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 4063	Welding and allied processes. Nomenclature of processes and reference numbers
BS EN ISO 4136	Destructive tests on welds in metallic materials – Transverse tensile test
BS EN ISO 5173	Destructive tests on welds in metallic materials. Bend tests
BS EN ISO 5817	Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
BS EN ISO 6507-1	Metallic materials – Vickers hardness test part 1: Test method
BS EN ISO 6520-1	Welding and allied processes. Classification of geometric imperfections in metallic materials - Fusion welding
BS EN ISO 6892-1	Metallic materials. Tensile testing. Method of test at ambient temperature
BS EN ISO 9001	Quality management systems. Requirements
BS EN ISO 9015-1	Destructive tests on welds in metallic materials – Hardness testing Part 1: Hardness test on arc welded joints
BS EN ISO 9017	Destructive tests on welds in metallic materials. Fracture test
BS EN ISO 9606-1	Qualification testing of welders. Fusion welding – Steels
BS EN ISO 14175	Welding consumables – Gases and gas mixtures for fusion welding and allied processes

BS EN ISO 14341	Welding consumables – Wire electrodes and deposits for gas shielded metal arc welding of non-alloy fine grain steels – Classification
BS EN ISO 15609-1	Specification and qualification of welding procedures for metallic materials. Welding procedure specification – Arc welding
BS EN ISO 15614-1	Specification and qualification of welding procedures for metallic materials. Welding procedure test – Arc and gas welding of steels and arc welding of nickel and nickel alloys
BS EN ISO 17632	Welding consumables. Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels. Classification
BS EN ISO 17637	Non-destructive testing of welds – Visual testing of fusion-welded joints
BS EN ISO 17639	Destructive tests on welds in metallic materials. Macroscopic and microscopic examination of welds
BS EN 50525-1	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U) – General requirements
BS EN IEC 60974-14	Arc welding equipment – Part 1: Welding power sources
PD CEN ISO/TR 15608	Welding. Guidelines for a metallic materials grouping system.

A.2 Gas Industry Standards

GIS/L2	Steel pipe 21.3 mm to 1219 mm outside diameter up to 7 bar (supplementary)
GIS/F7	Specification for steel welding pipe fittings 15mm to 450mm inclusive nominal size for operating pressures not greater than 7 bar
GIS/P16	Specification for the dimensions and applications of standard weld end preparations for steel pipe, fittings and valves
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/NDT2	Specification for non-destructive testing of welded joints in steel pipelines and pipework

APPENDIX B – DEFINITIONS

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

Approved Welder	A welder who has demonstrated their ability to produce welds meeting the requirements of this specification.
Attachment	Weld-on service tees, nipples, slip-on flanges, cathodic protection plates, etc. Weldoflanges, weldolets and threadolets are classed as full-penetration butt welds.
Contractor	Persons, firm, company, or authority carrying out work on behalf of the Gas Transporter
Dressing	The removal of metal by grinding or filing to produce a smooth contoured surface free of defects.
Inspector	The body, association or employee that ensures that the materials and construction are in accordance with this specification.
Installation	The fabricated assembly of pipe, fitting and equipment normally situated within a fenced enclosure excluding that part which form part of a pipeline.
Pipeline	The extent of all fabrication up to and including block valve assemblies terminating at the attachment weld to a pig-trap or as defined by the Gas Transporter.
Positional Welding	Welding wherein the pipe or assembly is held in a fixed position.
Socket Weld	A fillet weld made with the end of the pipe slips into a sleeve, the inside diameter of which conforms approximately to the outside diameter of the pipe.

APPENDIX C – PRE-QUALIFIED PROCEDURES FOR FILLET WELDING

The following pre-qualified weld procedures are provided for use on Company projects. For each application the Contractor shall generate their own WPS, which can reference one of the procedures in this standard.

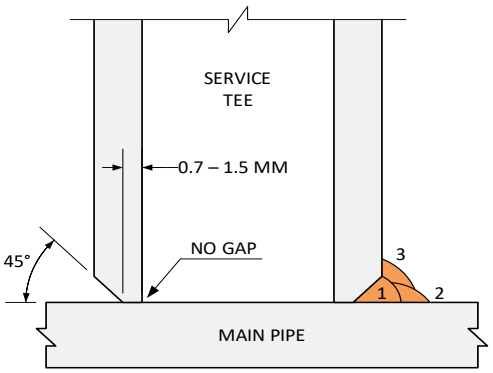
WPS No.	Scope of Application
ST1	Service tee onto main pipe, 60.3 – 457.1 mm OD
ST1A	Service branch onto main pipe, 60.3 – 219.1 mm OD
ST2	Service pipe to service tee outlet, 21.3 mm, 26.7 mm, and 33.4 mm OD
ST3	Service pipe to service tee outlet, 42.2 mm, 48.3 mm, and 60.3 mm OD
SP1	Service pipe to coupling joint, 21.3 mm, 26.7 mm, and 33.4 mm OD
SP2	Service pipe to coupling joint, 42.2 mm, 48.3 mm, and 60.3 mm OD
FL1	Slip-on flange, vertical pipe pup (PB weld position), 88.9 – 457.1 mm OD
FL2	Slip-on flange, horizontal main pipe (PJ weld position), 21.3, 26.7 and 33.4 mm OD
FL3	Slip-on flange, horizontal main pipe (PJ weld position), 42.2, 48.3 and 60.3 mm OD
FL4	Slip-on flange, horizontal main pipe (PJ weld position), 88.9 – 457.1 mm OD
DP1	Dip pipe onto main pipe, 60.3 – 457.1 mm OD
CP1	Cathodic protection (CP) plate onto main pipe, 60.3 – 457.1 mm OD

Electrode Types

The following electrode types are suitable for welding in accordance with this engineering standard, as specified in the welding procedures listed above:

- Type-X Bohler Fox OHV BS EN ISO 2560-A: E38 0 RC 1 1 (AWS A5.1 E6013)
  Oerlikon Supercord R14
- Type-Y Filarc Type 68
  Bohler Thyssen Phoenix Blau BS EN ISO 2560-A: E42 0 RC 1 1 (AWS A5.1 E6013)

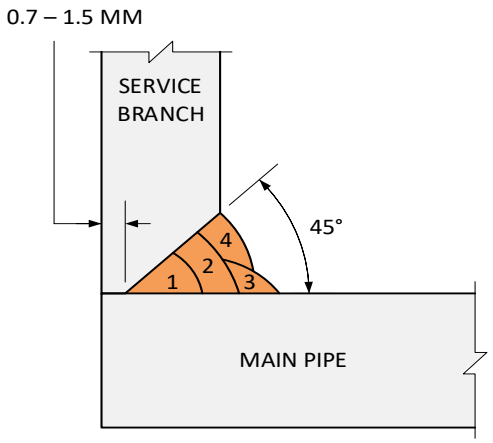
The Company should be consulted about the suitability of other electrodes, and for the names of suitable electrodes which may become available after the publication of this standard.

WPS No.	**ST1**	
Scope of application:	Service tee onto main pipe	
Service tee: – Diameter (d): – Wall thickness: – Grade:	 21.3, 26.7, 33.4 42.2, 48.3 & 60.3 mm {normal} TBA	Joint Fit-Up & Pass Sequence 
Main pipe: – Diameter (D): – Wall thickness: – Grade:	 60.3 – 457.1 mm {normal} Up to L360/X52	
Size ratio (d/D):	0.4 max.	
Pipe orientation:	Horizontal	
Position of tee:	Top dead centre	
Welding position:	PB	
Joint type:	Partial penetration branch	
Current type:	DC EN	
Preparation:	Grind base of tee where necessary to give a good fit onto the main pipe. Drill hole at top dead centre (*aka* crown) of main pipe. Position tee over hole on main pipe and align outlet. Screw punch to top of tee before welding.	
Alignment & Welding:	Fix tee with one tack, tap side of tee above tack to close gap between tee and main pipe. Deposit weld run #1 starting at the opposite side to the tack. The tack is to form part of weld run #1. Complete the run sequence as shown.	

Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-X	2.5	90 – 115	18 – 22	—
2 – 3	PB	Type-X	2.5	85 – 115	20 – 24	—

WPS No.	**ST1A**
Scope of application:	Service branch onto main pipe, 60.3 – 219.1 mm OD
Service branch: – Diameter (d): – Wall thickness: – Grade:	 21.3, 26.7, 33.4 42.2, 48.3 & 60.3 mm {normal} TBA
Main pipe: – Diameter (D): – Wall thickness: – Grade:	 60.3 – 219.1 mm {normal} Up to L360/X52
Size ratio (d/D):	0.4 max.
Pipe orientation:	Horizontal
Position of tee:	Top dead centre
Welding position:	PB
Joint type:	Partial penetration branch
Current type:	DC EN
Preparation:	Grind base of tee where necessary to give a good fit onto the main pipe. Drill hole at top dead centre (*aka* crown) of main pipe. Position tee over hole on main pipe and align outlet. Screw punch to top of tee before welding.
Alignment & Welding:	Fix branch with one tack, close gap between branch and main pipe. Deposit weld run #1 starting at the opposite side to the tack. The tack is to form part of weld run #1. Complete the run sequence as shown.

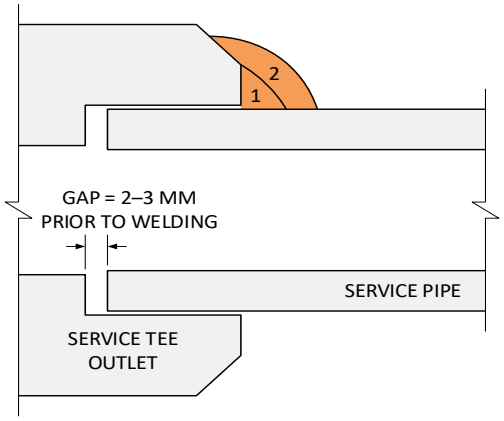
Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-X	2.5	80 – 115	18 – 22	—
2	PB	Type-X	3.2	130 – 160	18 – 22	—
3 – 4	PB	Type-X	4.0	160 – 200	18 – 22	—

WPS No.	**ST2**
Scope of application:	Service pipe to service tee outlet, 21.3, 26.7 and 33.4 mm OD
Service tee: – Diameter (d): – Wall thickness: – Grade:	 21.3, 26.7, 33.4 mm {normal} TBA
Service pipe: – Diameter (D): – Wall thickness: – Grade:	 21.3, 26.7, 33.4 mm {normal} TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PB
Joint type:	Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on service pipe and clean to bright metal. Insert service pipe fully into socket fitting and scribe a line where pipe emerges from fitting. Withdraw pipe approximately 2.5 mm, using scribe line as a guide, before tacking in place.
Alignment & Welding:	Tack at two positions around the socket. The tack is to form part of weld run #1. Complete the run sequence as shown.

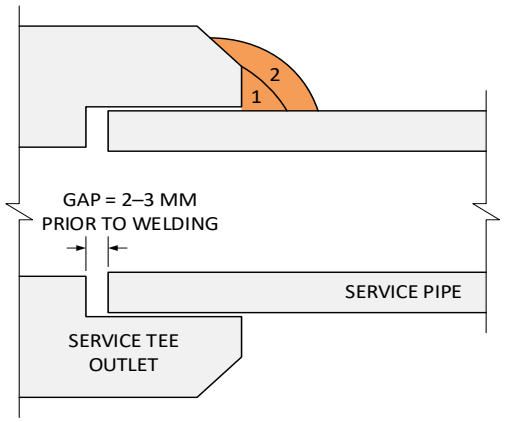
Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-X	2.5	75 – 100	18 – 24	—
2	PB	Type-X	2.5	75 – 100	18 – 24	—

WPS No.	**ST3**
Scope of application:	Service pipe to service tee outlet, 42.2, 48.3 and 60.3 mm OD
Service tee: – Diameter (d): – Wall thickness: – Grade:	 42.2, 48.3, 60.3 mm {normal} TBA
Service pipe: – Diameter (D): – Wall thickness: – Grade:	 42.2, 48.3, 60.3 mm {normal} TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PB
Joint type:	Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on service pipe and clean to bright metal. Insert service pipe fully into socket fitting and scribe a line where pipe emerges from fitting. Withdraw pipe approximately 2.5 mm, using scribe line as a guide, before tacking in place.
Alignment & Welding:	Tack at two positions around the socket. The tack is to form part of weld run #1. Complete the run sequence as shown.

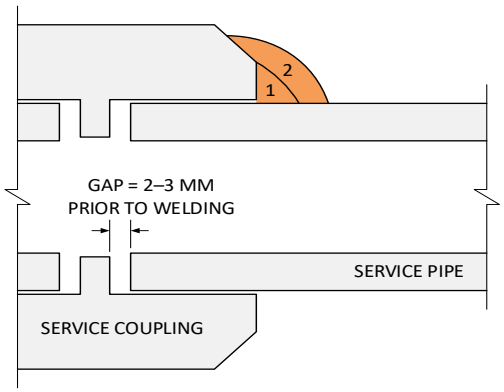
Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-Y	3.2	115 – 140	24 – 30	—
2	PB	Type-Y	3.2	115 – 140	24 – 30	—

WPS No.	**SP1**
Scope of application:	Service pipe to coupling joint, 21.3, 26.7 and 33.4 mm OD
Coupling joint: – Diameter (d): – Wall thickness: – Grade:	 21.3, 26.7, 33.4 mm {normal} TBA
Service pipe: – Diameter (D): – Wall thickness: – Grade:	 21.3, 26.7, 33.4 mm {normal} TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PB
Joint type:	Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on service pipe and clean to bright metal. Insert service pipe fully into socket fitting and scribe a line where pipe emerges from fitting. Withdraw pipe approximately 2.5 mm, using scribe line as a guide, before tacking in place.
Alignment & Welding:	Tack at two positions around the socket. The tack is to form part of weld run #1. Complete the run sequence as shown.

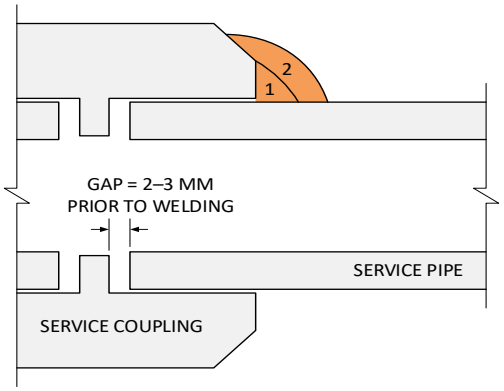
Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-X	2.5	75 – 100	18 – 24	—
2	PB	Type-X	2.5	75 – 100	18 – 24	—

WPS No.	**SP2**
Scope of application:	Service pipe to coupling joint, 42.2, 48.3 and 60.3 mm OD
Coupling joint: – Diameter (d): – Wall thickness: – Grade:	 42.2, 48.3, 60.3 mm {normal} TBA
Service pipe: – Diameter (D): – Wall thickness: – Grade:	 42.2, 48.3, 60.3 mm {normal} TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PB
Joint type:	Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on service pipe and clean to bright metal. Insert service pipe fully into socket fitting and scribe a line where pipe emerges from fitting. Withdraw pipe approximately 2.5 mm, using scribe line as a guide, before tacking in place.
Alignment & Welding:	Tack at two positions around the socket. The tack is to form part of weld run #1. Complete the run sequence as shown.

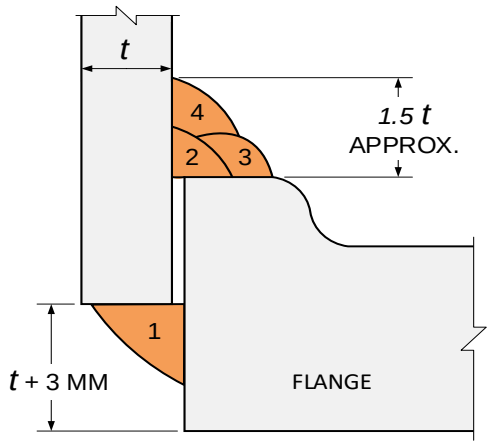
Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-Y	3.2	115 – 140	24 – 30	—
2	PB	Type-Y	3.2	115 – 140	24 – 30	—

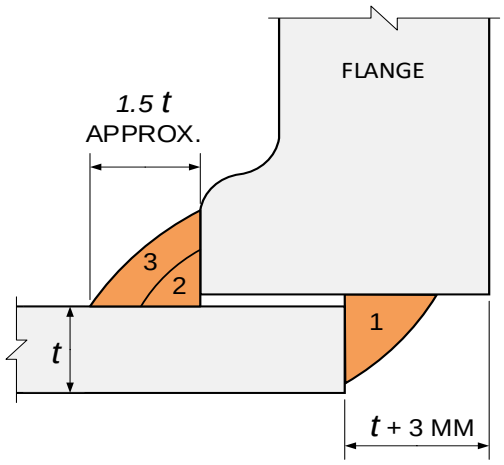
WPS No.	**FL1**
Scope of application:	Slip-on flange, vertical pipe pup (PB weld position), 88.9 – 457.1 mm OD
Slip-on flange: – Specification: – Diameter: – Type: – Grade:	 GIS/F7 88.9 – 457.1 mm TBA TBA
Main pipe [pup]: – Diameter (D): – Wall thickness (t): – Grade:	 88.9 – 457.1 mm (1) 4.5 – 12.7 mm (2) TBA
Size ratio (d/D):	N/A
Pipe [pup] orientation:	Vertical
Position of fitting:	N/A
Welding position:	PB
Joint type:	1: Single run circ. fillet 2–4: Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on pipe (no bevel) and clean to bright metal. Support pipe on spacers of thickness t + 3 mm. Slip flange over pipe pup, adjust clearance evenly around circumference. Square flange with respect to axis of pipe pup.
Alignment & Welding:	Deposit two evenly spaced tack at the back of the flange (i.e., external). De-slag the tack welds and grind to smooth profile. The tack is to form part of weld run #2. Complete the run sequence as shown, turning the assembly as appropriate to achieve the correct welding position. A weld positioner, or rotary table may be used.

Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1 (Int.)	PB	Type-X	3.2 or 4.0	115 – 140 180 – 220	18 – 24	—
2 – 4 (Ext.)	PB	Type-X	4.0	180 – 220	18 – 24	—

Notes:
1. Larger diameters may be welded. However, attention must be paid to welding the first run in four opposite quadrants to control distortion and residual stresses.
2. For pipe wall thicknesses greater than 8.0 mm, the internal weld shall be multi-run.
3. Slip-on flanges may be welded onto certain types of fitting. However, the bevel on the fitting must be removed, and appropriate alignment/gaps must be achievable.

WPS No.	**FL2**
Scope of application:	Slip-on flange, horizontal main pipe (PJ weld position), 21.3, 26.7 and 33.4 mm OD
Slip-on flange: – Specification: – Diameter: – Type: – Grade:	 GIS/F7 21.3, 26.7, 33.4 mm TBA TBA
Main pipe [pup]: – Diameter (D): – Wall thickness (t): – Grade:	 21.3, 26.7, 33.4 mm 3.4 – 5.5 mm TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PJ
Joint type:	1: Single run circ. fillet 2–3: Multi-run circ. fillet
Current type:	DC EN
Joint Fit-Up & Pass Sequence	
Preparation:	Cut square end on pipe (no bevel) and clean to bright metal. Slip flange over pipe end, adjust clearance evenly around circumference. Square flange with respect to axis of pipe pup. Allow flange to project over the pipe end by a distance of t + 3 mm.
Alignment & Welding:	Deposit two tacks, 6 & 12 o'clock, at the back of the flange (i.e., external). De-slag the tack welds and grind to smooth profile. The tack is to form part of weld run #2. Complete the run sequence as shown. A weld positioner may be used, if appropriate.

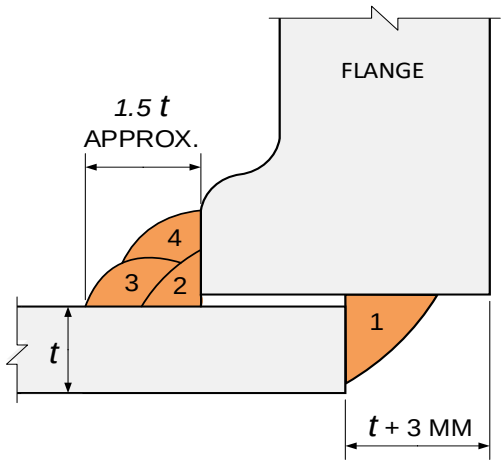
Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1 (Int.)	PJ	Type-X	2.5	85 – 120	20 – 24	—
2 – 3 (Ext.)	PJ	Type-X	2.5	90 – 120	20 – 24	—

Notes:

1. Slip-on flanges may be welded onto certain types of fitting. However, the bevel on the fitting must be removed, and appropriate alignment/gaps must be achievable.

WPS No.	**FL3**
Scope of application:	Slip-on flange, horizontal main pipe (PJ weld position), 42.2, 48.3 and 60.3 mm OD
Slip-on flange: – Specification: – Diameter: – Type: – Grade:	 GIS/F7 42.2, 48.3, 60.3 mm TBA TBA
Main pipe [pup]: – Diameter (D): – Wall thickness (t): – Grade:	 42.2, 48.3, 60.3 mm 3.4 – 5.5 mm TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PJ
Joint type:	1: Single run circ. fillet 2–4: Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on pipe (no bevel) and clean to bright metal. Slip flange over pipe end, adjust clearance evenly around circumference. Square flange with respect to axis of pipe pup. Allow flange to project over the pipe end by a distance of t + 3 mm.
Alignment & Welding:	Deposit two tacks, 6 & 12 o'clock, at the back of the flange (i.e., external). De-slag the tack welds and grind to smooth profile. The tack is to form part of weld run #2. Complete the run sequence as shown. A weld positioner may be used, if appropriate.

Joint Fit-Up & Pass Sequence

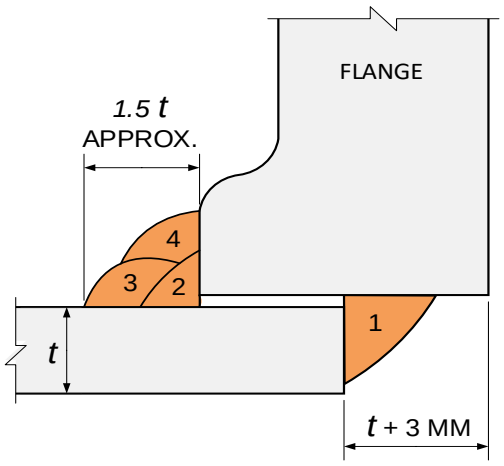


Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1 (Int.)	PJ	Type-Y	3.2	110 – 130	20 – 26	—
2 – 4 (Ext.)	PJ	Type-Y	3.2	110 – 130	20 – 26	—

Notes:
1. Slip-on flanges may be welded onto certain types of fitting. However, the bevel on the fitting must be removed, and appropriate alignment/gaps must be achievable.

WPS No.	**FL4**
Scope of application:	Slip-on flange, horizontal main pipe (PJ weld position), 88.9 – 457.1 mm OD
Slip-on flange: – Specification: – Diameter: – Type: – Grade:	 GIS/F7 88.9 – 457.1 mm TBA TBA
Main pipe [pup]: – Diameter (D): – Wall thickness (t): – Grade:	 88.9 – 457.1 mm (1) 4.5 – 12.7 mm (2) TBA
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of fitting:	N/A
Welding position:	PJ
Joint type:	1: Single run circ. fillet 2–4: Multi-run circ. fillet
Current type:	DC EN
Preparation:	Cut square end on pipe (no bevel) and clean to bright metal. Slip flange over pipe end, adjust clearance evenly around circumference. Square flange with respect to axis of pipe pup. Allow flange to project over the pipe end by a distance of t + 3 mm.
Alignment & Welding:	Deposit two tacks, 6 & 12 o'clock, at the back of the flange (i.e., external). De-slag the tack welds and grind to smooth profile. The tack is to form part of weld run #2. Complete the run sequence as shown. A weld positioner may be used, if appropriate.

Joint Fit-Up & Pass Sequence

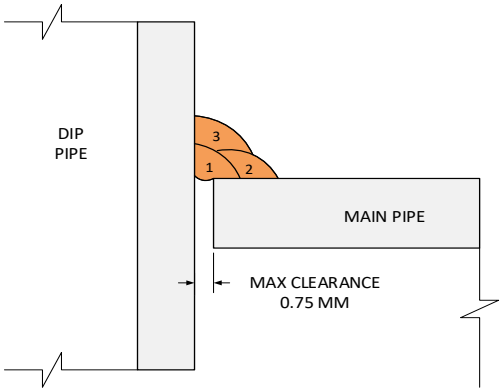


Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1 (Int.)	PJ	Type-Y	3.2 4.0	115 – 140 155 – 190	18 – 24 22 – 26	—
2 – 4 (Ext.)	PJ	Type-Y	4.0	155 – 190	22 – 26	—

Notes:
1. Larger diameters may be welded. However, attention must be paid to welding the first run in four opposite quadrants to control distortion and residual stresses.
2. For pipe wall thicknesses greater than 8.0 mm, the internal weld shall be multi-run.
3. Slip-on flanges may be welded onto certain types of fitting. However, the bevel on the fitting must be removed, and appropriate alignment/gaps must be achievable.

WPS No.	**DP1**
Scope of application:	Dip pipe onto main pipe, 60.3 – 457.1 mm OD
Dip pipe: – Diameter (d): – Wall thickness: – Grade:	 33.4 mm {normal} TBA
Main pipe: – Diameter (D): – Wall thickness: – Grade:	 60.3 – 457.1 mm 4.5 – 12.7 mm Up to L360/X52
Size ratio (d/D):	0.4 max.
Pipe orientation:	Horizontal
Position of tee:	Top dead centre
Welding position:	PB
Joint type:	Full penetration branch
Current type:	DC EN
Preparation:	Drill a Ø35 mm plain hole through the crown of the main pipe. Insert dip pipe fully into main pipe and scribe a line on the dip pipe at the point where it emerges from the main pipe. Withdraw dip pipe 12 mm using the scribe line as a reference.
Alignment & Welding:	Tack the dip pipe to the main pipe at one position and de-slag. Deposit run #1, starting at the opposite side from the tack weld. The tack is to form part of weld run #1. Complete the run sequence as shown.

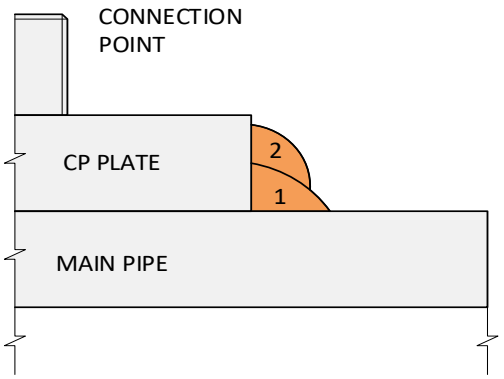
Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1	PB	Type-X	2.5	80 – 110	18 – 24	—
2 – 3	PB	Type-X	2.5	90 – 115	18 – 24	—

WPS No.	**CP1**
Scope of application:	Cathodic protection (CP) plate onto main pipe, 60.3 – 457.1 mm
CP plate: – Plate Diameter: – Wall thickness: – Grade:	 60 x 80 mm oval shaped 10 mm S275 typ.
Main pipe: – Diameter (D): – Wall thickness: – Grade:	 60.3 – 457.1 mm 4.5 – 12.7 mm Up to L360/X52
Size ratio (d/D):	N/A
Pipe orientation:	Horizontal
Position of tee:	Top dead centre
Welding position:	PB
Joint type:	Multi-run fillet
Current type:	DC EN
Preparation:	Clean main pipe to bright metal without compromising wall thickness. Position CP plate on top dead centre (*aka* crown) of main pipe.
Alignment & Welding:	Tack weld at two positions and de-slag. Deposit run #1, all round. The tacks are to form part of weld run #1. Deposit run #2, all round, as close as possible to the extremity (toe) of run #1 without touching the pipe wall.

Joint Fit-Up & Pass Sequence



Weld Run	Welding Direction	Electrode	Electrode Diameter (mm)	Arc Current (A)	Arc Voltage (V)	Heat Input (kJ/mm)
1 – 2	PB	Type-X	2.5	75 – 100	18 – 24	—

Notes:
1. Ideally, the CP plates will be pre-shaped to suit the contour of the main pipe.
2. Other shapes of CP plate may be used. However, the principles of welding shall be the same.
3. CP plates may be welded onto larger diameter pipes, and/or pipes with heavier wall thickness subject to agreement.

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