TECHNICAL SPECIFICATION

FIELD WELDING OF DUPLEX AND SUPER DUPLEX STAINLESS STEEL PIPELINES (AMENDMENTS/SUPPLEMENTS TO API 1104)

DEP 61.40.20.31-Gen.

July 1999

DESIGN AND ENGINEERING PRACTICE

PREFACE

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Shell International Exploration and Production B.V. (SIEP)
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The Hague, The Netherlands,

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The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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PART I INTRODUCTION

1.1 SCOPE

This new DEP specifies the requirements and gives recommendations for field welding in the construction and maintenance of duplex and super duplex stainless steel pipelines for use in oil and gas operations under both sour and non-sour service conditions. The intended limits of application are as defined for pipeline scope boundaries in Figure 1 of DEP 31.40.00.10-Gen.

Welding on pressurised pipelines and hyperbaric welding are excluded from the scope of this DEP.

Part II of this DEP gives amendments and supplements to clauses of API 1104 which are considered necessary to ensure pipeline integrity in accordance with Shell Group requirements. The clause numbering in Part II of this DEP follows that of API 1104. Where clauses of API 1104 are not amended or supplemented by this DEP, they shall apply in their entirety.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is “F”, as described in DEP 00.00.05.05-Gen.).

This DEP is primarily intended to be used for oil and/or gas pipelines and related facilities. It is intended for use by Exploration and Production, Manufacturing, Chemicals or Supply/Marketing companies which require the use of line pipe.

If national and/or local regulations exist in which some of the requirements may be more stringent than this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Company	Term used in API 1104 which shall be understood to mean Principal.
Defect (in NDT)	An imperfection, or group of imperfections whose indication(s) do not meet specified acceptance criteria.

Elongated slag inclusion (ESI)	Term used in API 1104 which shall be understood to mean linear slag inclusion (reference 3011) as defined in ISO 6520.
Imperfection (in NDT)	An interruption, which may be either intentional or unintentional, in the physical structure or configuration of a pipe or weld.
Indication (in NDT)	Evidence of an imperfection that requires interpretation to determine its significance.
Penetrameter	Term used in API 1104 which shall be taken to mean IQI as used in ISO 1106-3.
Sour service	As defined in DEP 31.22.20.31-Gen.

1.4 ABBREVIATIONS

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BGAS	British Gas Approval Scheme
CSWIP	Certification Scheme for Weld Inspection Personnel
D	Nominal Diameter
FCAW	Flux Cored Arc Welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat-Affected Zone
IQI	Image Quality Indicator
NDT	Non-Destructive Testing
NPS	Nominal Pipe Size
OD	Outside Diameter
PWHT	Post-Weld Heat Treatment
pWPS	Preliminary Welding Procedure Specification which is not qualified
ROL	Run Out Length
SAW	Submerged Arc Welding
SMAW	Shielded Metal Arc Welding
SSCC	Sulphide Stress Corrosion Cracking
WPS	Welding Procedure Specification
WPQR	Welding Procedure Qualification Record

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (Part III). Cross-references to parts of API 1104 give section numbers without brackets.

1.6 INFORMATION TO BE SUPPLIED BY THE PRINCIPAL

The following information should be provided by the Principal at the enquiry stage of the

order.

- nominal OD of linepipe;
- nominal wall thickness of linepipe and fittings;
- grade and designation of the linepipe and component materials;
- the type of external coating and the coating cut back;
- pipeline minimum design temperature;
- pipeline maximum design temperature;
- service environment (fluid composition, pH, chloride, CO_2, H_2S);
- amended or supplementary requirements to this DEP where the pipeline is to be installed by reeling;
- whether specific Contractor quality procedures are to be submitted for agreement (Part II - 11.2);
- whether welding consumables are to be agreed (Part II - 1.5.2.1);
- whether previously qualified welding procedure specifications may be considered for agreement (Part II - 2.1);
- whether ranges of outside diameter and/or wall thickness can be covered by a single welding procedure qualification (Part II - 2.3.2.3);
- whether post-weld heat treatment is acceptable (Part II - 2.3.2.13);
- whether corrosion tests are required for welding procedure qualification and the test procedures to be employed (Part II - 2.6.9);
- specific requirements for weld identification marking (Part II - 4.10);
- whether partial penetration re-repairs can be performed (Part II - 7.1.1);
- whether all NDT indications are to be reported or only those that are evaluated as defects - 8.1.7;
- whether specific radiograph identification requirements are to apply - 8.1.8;
- whether the Contractor's quality plan is to be submitted for agreement (Part II - 11.2);
- the requirements for final documentation (Part II - 11.3); and
- whether alternative acceptance standards for girth welds may be applied and the circumstances under which they are to be applied (Part II – Appendix A).

PART II AMENDMENTS/SUPPLEMENTS TO API 1104

SECTION 1 GENERAL

1.1 SCOPE

Delete this section and replace with the following:

This DEP covers the arc welding of butt and fillet welds in duplex and super duplex stainless steel for pipelines and related facilities.

Welding may be carried out by a SMAW, GTAW, GMAW, SAW, or gas-shielded FCAW process, or a combination of these processes. A manual, semi-automatic, or automatic welding technique, or combination of these techniques may be used. Filler metal shall be used for all passes.

Roll welding may be accepted by the Principal when an automatic welding process is used. GMAW, GTAW, and gas-shielded FCAW shall be restricted to construction areas protected against wind and draught.

This DEP also covers the procedure requirements and acceptance standards to be applied to qualification and production welds destructively tested and/or inspected by radiographic, ultrasonic, or liquid penetrant NDT methods.

1.2 DEFINITION OF TERMS

1.2.2 Definitions

1.2.2.1 Company

Delete this section and replace with the following:

This term shall be understood to mean the Principal.

1.2.2.13 Internal concavity

Replace "internal" with root.

1.3 REFERENCED PUBLICATIONS

Add the following:

See also (Part III) of this DEP.

1.4 EQUIPMENT

Delete this section and replace with the following:

The Contractor shall control welding equipment in accordance with ISO 3834-2. The Contractor shall control inspection and test equipment in accordance with ISO 10012-1.

Pipe handling equipment, rollers, and line-up clamps shall neither damage nor contaminate the pipes and shall achieve the specified fit-up. Direct contact shall be prevented between the duplex and super duplex stainless steel line pipe and carbon steel equipment. Line-up clamps and supports shall have stainless steel inserts or shall be coated with a compatible material. Spacing tools shall be of stainless steel. During preparation for welding, and cleaning or dressing of weld deposits and components, only grinding wheels dedicated to stainless steel work shall be used. Wire brushes shall be of stainless steel.

GTAW power sources shall have a high-frequency starting unit and a crater-eliminating slope-out control.

Gas welding shall not be employed.

1.5 MATERIALS

1.5.1 Pipe and fittings

Delete this section and replace with the following:

This DEP applies to the welding of duplex and super duplex stainless steel pipe, flanges, and fittings.

The Contractor shall check the identity of all materials against the Manufacturer/Supplier's inspection documents. Items without the Manufacturer/Supplier's inspection documents shall not be used unless they are re-certified.

1.5.2 Filler metal

1.5.2.1 Type and size

Delete this section and replace with the following:

The electrodes, filler wires, and wire/flux combinations shall be classified to a national standard and should have type approval from a recognised certifying authority such as DnV or Lloyd's. Where specified by the Principal, the Contractor's filler material selection shall be agreed by the Principal.

Each lot of filler materials shall be tested for deposited weld metal chemical composition and mechanical properties: yield (proof) strength, tensile strength, and elongation. The chromium content shall at least match the parent material and the nickel content shall overmatch the parent material analysis unless the weld is to be subjected to a solution annealing heat treatment.

Fluxes shall be tested and certified in combination with the filler metal.

The certification shall apply to the lot classification in accordance with AWS A5.01 as detailed below:

Consumable Type	Lot Classification
Covered electrodes	C5
Bare solid wire	S3
Flux cored wire	T3
Flux for SAW	F2

NOTE: Unless specified otherwise in the purchase order for filler materials, most Manufacturers/Suppliers will only provide generic certificates that are not directly related to the lot.

If lot certificates are not available, or the certificates are not acceptable, the Contractor shall obtain replacement filler materials or test the filler materials in accordance with this DEP.

Inspection documents for the filler materials shall be in accordance with ISO 10474 3.1.B.

1.5.2.2 Storage and handling of filler metals and fluxes

Delete this section and replace with the following:

Electrodes, filler wires and fluxes shall be stored in a dry storage room in accordance with the Manufacturer's instructions. Filler materials and fluxes shall remain in their original containers which shall be marked with the Manufacturer's name, the consumable trade name and the batch number. Filler materials and fluxes in containers that are not identifiable and traceable shall be removed from the work site. The storage room shall have a maximum relative humidity of 50%.

Filler materials and fluxes that show signs of damage or deterioration, e.g. cracked or flaked coatings, shall be disposed of.

All covered electrodes shall be properly identifiable up to the time of usage, each electrode being distinguishable by a coding marked near the grip end. Electrodes without a code marking shall not be used.

Where necessary, covered electrodes shall be baked and issued to the work place in accordance with the Manufacturer’s instructions.

Wire spools shall be stored in cabinets with the Manufacturer's wrapping in place and shall remain clearly identifiable up to the point of usage. Unidentifiable wire shall not be used.

Flux shall be handled and stored in accordance with the flux Manufacturer's recommendations. Unused flux shall remain identifiable and traceable. Flux shall only be recycled in accordance with the Manufacturer's recommendations.

Storage, treatment and handling of all filler materials and fluxes shall be in accordance with the Manufacturer/Supplier's recommendations for achieving minimum hydrogen in the deposited weld metal.

1.5.3 Shielding gases

1.5.3.1 Types

Add the following:

The shielding and purge gas shall be industrial quality complying with ISO 14175 for purity and dewpoint. Hydrogen shall not be added. The component concentrations of the gas shall be as specified on the WPS and shall be the same for procedure qualification and production welding.

1.5.3.2 Storage and handling

Add the following:

Gases in containers that are unidentifiable shall not be used.

Add the following new section:

1.6 QUALITY SYSTEM

The Contractor should maintain and operate a quality system in accordance with ISO 9001 or ISO 9002, or with an alternative standard if agreed by the Principal.

SECTION 2 QUALIFICATION OF WELDING PROCEDURES FOR WELDS CONTAINING FILLER METAL ADDITIVES

2.1 PROCEDURE QUALIFICATION

Add the following:

Only pWPSs agreed by the Principal shall be used for test welding.

When indicated by the Principal in the enquiry document, previously qualified welding procedure specifications may be offered for agreement subject to the following:

- the WPQR is fully in accordance with this DEP;
- the WPS is amended to reflect the project-specific details;
- the welding shall be within the essential variables defined in this DEP; and
- the WPS and WPQR are owned and controlled by the Contractor.

Provisions for the welding and testing of fillet welds, included in API 1104 and this DEP, shall be taken to apply also to full penetration branch welds.

Butt welding procedures, branch welding procedures, fillet welding procedures, and repair welding procedures shall be qualified separately.

Test welding shall be performed under simulated site conditions using pipe nipples with a length of 500 mm or one OD, whichever is the greater. For flange/fitting welds, suitably sized test rings may be used.

2.2 RECORD

Add the following:

Welding parameters should be recorded by means of a calibrated portable arc monitoring system with printout facility.

The procedure qualification record shall include the following:

- printouts from the portable arc monitoring system, or manually recorded parameter data, for each pass;
- original NDT reports;
- original laboratory test reports, including macro and micro photographs showing the microstructure of the weld metal, HAZ, and the base material;
- originals or verified copies of the Manufacturer/Supplier's inspection documents for the test coupon materials; and
- originals or verified copies of the Manufacturer/Supplier's inspection documents for the filler materials and flux employed for test welding.

The WPQR shall be submitted to the Principal with the production WPS for agreement prior to production welding.

2.3 PROCEDURE SPECIFICATION

2.3.1 General

Add the following:

The WPS shall show the following non-technical information:

- date;
- revision number;
- contract number;
- project title;
- Contractor's name; and
- reference to this DEP.

2.3.2 Specification information

2.3.2.2 Pipe and fitting materials

Delete this section and replace with the following:

The materials to which the procedure applies shall be identified. Separate procedures shall be qualified for each specification and grade of pipe or fittings to be welded.

2.3.2.3 Diameters and wall thickness

Delete this section and replace with the following:

Where agreed by the Principal, the allowable ranges shall be as defined in (2.4.2.5) and (2.4.2.18).

2.3.2.4 Joint design

Add the following:

The WPS shall indicate the allowable tolerances on each of the joint design details. Permanent backing bars shall not be used.

Socket welds shall not be permitted for the attachment of branch connections.

2.3.2.5 Filler metal and number of beads

Add the following:

Details of the filler metal sizes, classification, and manufacturer/brand name shall be stated on the WPS for each pass.

2.3.2.6 Electrical characteristics

Add the following:

Where applicable, electrical stickout, contact tube-to-work distance, and wire feed speed shall be specified for each weld pass.

If pulsed welding is used, background current and pulse parameters, e.g. waveform, peak current, duration and frequency, shall be fully specified.

2.3.2.7 Flame characteristics

Delete this section and replace with the following:

Oxyfuel gas welding shall not be used.

2.3.2.11 Type and removal of line-up clamp

Delete the last sentence and replace with the following:

An internal line-up clamp shall not be removed until the root weld pass is 100% complete. An external line-up clamp shall not be removed until the root weld pass is at least 50%

complete, equally distributed around the joint.

The minimum number of weld passes to be deposited before the pipe is lowered off shall be stated.

See also (4.3).

2.3.2.12 Cleaning and/or grinding

Add the following:

The WPS shall state the methods to be used for interpass cleaning, final weld surface treatment, and treatment to the backside of the weld, if any. See also (4.7).

2.3.2.13 Pre- and post-heat treatment

Add the following:

Preheat requirements shall account for welding at low ambient temperatures where sufficient heat to remove surface moisture and prevent condensation may be required.

Post-weld heat treatment (solution anneal) shall only be used when agreed by the Principal.

See also (4.11.1) and (4.11.2).

2.3.2.14 Shielding gas and flow rate

Add the following:

The backing gas composition and flow rate shall also be stated.

The WPS shall include the requirements for backing gas flushing prior to commencement of welding, the number of weld passes for which backing gas flow is maintained, and for monitoring of backing gas oxygen content. See also (4.15).

2.3.2.15 Shielding flux

Add the following:

The AWS flux classification, the Manufacturer, brand name, and the size shall also be specified.

2.3.2.16 Speed of travel

Delete this section and replace with the following:

Speed of travel shall be shown in mm per minute or mm per second.

For manual electrode welding, ROL may be substituted for travel speed.

Add the following new sections:

2.3.2.17 Heat input range

The allowable range of heat input for each welding process and each weld pass shall be specified except when ROL is adopted to define welding speed.

2.3.2.18 Number of welders

The WPS shall designate the number of root pass welders and second pass welders.

2.3.2.19 Partially complete joint

The minimum number of weld passes before the joint is allowed to cool to ambient temperature shall be specified. See also (4.13).

2.3.2.20 Tungsten electrode for GTAW welding

The AWS electrode class shall be specified in the WPS.

2.3.2.21 Welding technique

For automatic welding, the following shall be specified:

- amplitude of weave;
- frequency of weave; and
- dwell time.

2.4 ESSENTIAL VARIABLES

2.4.1 General

Add the following:

If the essential variables are exceeded during production welding, the deposited weld metal shall be removed and the joint re-prepared.

2.4.2 Changes requiring requalification

2.4.2.2 Base material

Delete this section and replace with the following:

Any change in specification, grade or source of supply of pipe and fittings shall constitute an essential variable.

2.4.2.4 Position

Add the following:

Any change in the angle of the axis of the pipe greater than 25° from that used for qualification shall constitute an essential variable.

2.4.2.5 Wall thickness

Delete this section and replace with the following:

Where the use of ranges is agreed by the Principal, any change in wall thickness beyond the qualified ranges given below shall be considered an essential variable.

	Test weld thickness mm	**Qualified range mm**
Butt welds	$t \leq 5$ $t > 5$	t to 1.25t 0.75t to 1.25t
Fillet welds	a	0.75a to 1.25a

where t = nominal wall thickness,

a = theoretical weld throat dimension

The nominal wall thickness shall have the following meanings:

butt joint	Thickness of the parent metal or, if different, thickness of the thinner material
set-on branch connection	Thickness of branch pipe.
set-through branch connection	Thickness of main pipe.

2.4.2.6 Filler metal

Delete this section, including Table 1, and replace with the following:

The following changes shall be considered as essential variables for any given pass in the qualified WPS:

- a change in the diameter of electrode or filler wire;
- a change in filler metal classification;
- a change of filler metal trade name.

2.4.2.10 Shielding gas and flow rate

Delete the second sentence and replace with the following:

A change of flow rate to one beyond the range of ± 10% of that qualified and specified shall also constitute an essential variable.

Add the following:

Any increase in the oxygen content of the effluent backing gas beyond that qualified shall necessitate requalification.

Any decrease in the number of passes before cessation of backing gas flow shall constitute an essential variable.

2.4.2.11 Shielding flux

Delete this section, including Table 1, and replace with the following:

Any change in classification or trade name shall constitute an essential variable.

2.4.2.12 Speed of travel

Add the following:

Any change in the speed of travel, or electrode ROL, outside the range ±10% of that qualified shall constitute an essential variable.

NOTE: Appendix illustrates how ROL can be used in the field to control both welding speed and heat input for SMAW welding.

Add the following new sections:

2.4.2.13 Welding parameters or arc energy

Any change outside the range ± 15% of the single values for volts, amps and wire feed speed determined from the WPQR shall constitute an essential variable. However, the parameters shall be controlled so that the arc energy range is within that shown in the production WPS. The qualified range of arc energy shown in the production WPS shall be based on, per weld pass, the highest instantaneous arc energy measured during qualification welding plus 10% and the lowest instantaneous arc energy minus 10%.

NOTE: The range in the production WPS sets absolute limits and is not subject to variation. If ROL is adopted for SMAW welding, as illustrated in (Appendix 1), arc energy does not require separate controls.

The addition or deletion of pulsed current shall be considered to be an essential variable. Any change in the pulse parameters shall constitute an essential variable.

2.4.2.14 Preheat and interpass temperature

Any decrease in the preheat/minimum interpass temperature, compared to that recorded on the WPQR, or any increase in maximum interpass temperature shall constitute an essential variable.

2.4.2.15 Post-weld heat treatment

The inclusion or omission of PWHT, or any change in PWHT parameters, shall constitute essential variables.

2.4.2.16 Sequence of weld passes

Any change in the sequence of deposition shall constitute an essential variable.

2.4.2.17 Removal of line-up clamp

Removal of the line-up clamp at a stage earlier than stated in the agreed WPS shall constitute an essential variable.

2.4.2.18 Diameter

Where the use of ranges is agreed by the Principal, any change in diameter outside the range 0.5D to 1.5D shall be considered an essential variable.

2.4.2.19 Repair welds

Partial penetration repairs made closer to the inside surface compared to the qualification welding shall be considered an essential variable.

2.5 WELDING OF TEST JOINTS – BUTT WELDS

Delete this section and replace with the following:

Sufficient test welds shall be made to extract all the destructive test specimens required for qualification testing.

2.6 TESTING OF WELDED JOINTS - BUTT WELDS

2.6.1 Preparation

Delete this section and replace with the following:

Prior to removal of test specimens, the test weld shall be subjected to the NDT defined below. If post-weld heat treatment has been agreed, this shall be applied before NDT.

The NDT shall consist of the following:

- visual examination in accordance with EN 970;
- liquid penetrant testing;
- X-ray radiographic testing; and
- ultrasonic testing (for welds made by GMAW, GTAW, and/or FCAW only).

NDT on all test welds shall be performed with the weld at ambient temperature using the equipment and procedures complying with (8).

The acceptance criteria shall be as stated in (6). Any weld which fails to meet the acceptance criteria shall not be offered for destructive testing.

All test welds shall be sectioned at the locations shown in Figure 3 and (Figure A) for the removal of the specimens required by Table 2 and (2.6.6 - 2.6.8).

2.6.3 Nick-break test

Delete this section including 2.6.3.1, 2.6.3.2, and 2.6.3.3.

2.6.4 Root and face-bend test

Delete this section including 2.6.4.1, 2.6.4.2, and 2.6.4.3.

2.6.5 Side-bend test

Delete this section including 2.6.5.1, 2.6.5.2, and 2.6.5.3.

Add the following new sections:

2.6.6 Macroscopic examination and hardness tests

2.6.6.1 Preparation

Specimens shall be extracted from the locations shown in (Figure A) and prepared for macroscopic examination in accordance with ASTM E340.

The sections of the weld taken for macroscopic examination and hardness testing may also be used for ferrite measurement as required in (2.6.7).

2.6.6.2 Method

The prepared sections shall be examined at a magnification of x5 and photomacrographs at the same magnification shall be included in the WPQR.

Hardness testing shall be performed in accordance with EN 1043-1. Hardness indent locations shall be in accordance with BS 4515 and, for the HAZ, EN 1043 -1. The indents shall be visible in the photomacrographs.

2.6.6.3 Acceptance criteria

The prepared sections shall not show any defects as defined in (6).

The maximum individual hardness value shall not exceed the following:

Alloy	Hardness
22Cr	325 HV10
25Cr	350 HV10

2.6.7 Ferrite measurement

2.6.7.1 Method

The ferrite content shall be determined in accordance with Appendix 1 of DEP 31.40.20.34-Gen. The ferrite content shall be measured on all specimens 1 mm from both the inside and outside surfaces and be reported for the parent material, HAZ and weld metal.

2.6.7.2 Acceptance criteria

The ferrite content shall be in the range 40 - 60% for the parent material and 35 - 65% in the weld/HAZ regions.

2.6.8 Charpy V-notch impact testing

2.6.8.1 Preparation

Three sets of three specimens shall be taken from the locations shown in (Figure A). One set of three shall be notched at each of the following positions:

- root weld centre line;
- root fusion line (50% intersection of notch); and
- root fusion line + 2 mm.

If the wall thickness exceeds 20 mm, an additional set of three specimens shall be prepared from the same location for each of the following positions:

- cap weld centre line;
- cap fusion line (50% intersection of notch); and
- cap fusion line + 2 mm.

These requirements are summarised in (Figure B).

Specimens shall, wherever possible, be 10 x 10 mm full size. If these dimensions are not possible, sub-size 10 x 7.5 mm shall be extracted. If the latter are not possible, the specimens shall be 10 x 5 mm. Charpy impact testing may be omitted if a specimen at least 5 mm thick cannot be extracted.

2.6.8.2 Method

Testing shall be conducted in accordance with ASTM A370 at the minimum design temperature of the pipeline.

2.6.8.3 Acceptance criteria

Each set of three specimens shall meet the following requirements:

Specimen Size mm	Charpy Energy Joules	
	Minimum Average	Minimum Single
10 x 10	50	40
10 x 7.5	38	31
10 x 5	25	20

2.6.9 Corrosion tests

2.6.9.1 Pitting tests

When required by the Principal, pitting tests shall be performed in accordance with a procedure advised by the Principal. See also (Appendix 2).

2.6.9.2 SSCC tests

When required by the Principal, SSCC tests shall be performed in accordance with a procedure advised by the Principal. See also (Appendix 2).

2.6.10 Retests

2.6.10.1 General

If the results of destructive testing are unsatisfactory owing to defective specimen preparation or a localised weld defect, the Contractor shall inform the Principal and obtain agreement to proceed with retests.

2.6.10.2 Tensile tests

If a maximum of one tensile specimen does not meet the acceptance criteria, two additional specimens shall be tested. Both of the additional specimens shall meet the acceptance criteria.

2.6.10.3 Charpy V-notch impact tests

If the requirements of (2.6.8.3) are not satisfied, three further specimens shall be tested. The mean value of the six tests shall be at least equal to the average requirement and only two individual values may be lower than the minimum average specified. Only one value may be below the minimum specified value.

2.6.10.4 New pWPS requirement

If the test joint fails to meet the minimum requirements of this DEP, a new pWPS shall be established and qualification welding and testing shall be repeated.

2.7 WELDING OF TEST JOINTS - FILLET WELDS

Change title as follows:

2.7 WELDING OF TEST JOINTS - FILLET WELDS AND BRANCH WELDS

Delete this section and replace with the following:

The configuration of fillet weld test joints shall be in accordance with the weld details to be used in production and the limitations of (2.3).

2.8 TESTING OF WELDED JOINTS – FILLET WELDS

Change title as follows:

2.8 TESTING OF WELDED JOINTS – FILLET WELDS AND BRANCH WELDS

2.8.1 Preparation

Add the following:

Prior to cutting, test welds shall be visually inspected and liquid-penetrant tested. If the weld is deemed acceptable in accordance with (6), it may be offered for destructive testing.

2.8.2 Method

Delete this section and replace with the following:

Macroscopic examination and hardness measurement shall be carried out in accordance with (2.6.6) on each of two macrosections. On full penetration branch welds, ferrite content determination and microstructural evaluation shall also be conducted in accordance with (2.6.7).

2.8.3 Requirements

Delete this section and replace with the following:

The macrosections shall be free from defects. Acceptance criteria for hardness testing shall be as stated in (2.6.6.3). The acceptance criteria for ferrite content and microstructural evaluation shall be as stated in (2.6.7.2).

Add the following new sections:

2.9 WELDING OF TEST REPAIR WELDS

The repair welding procedure shall be qualified in accordance with (2). Partial penetration excavations shall reach a minimum of half the pipe wall thickness.

2.10 TESTING OF REPAIR WELDS

2.10.1 Preparation

Each repair shall be of sufficient length to provide the specified number of specimens for destructive testing. Non-destructive and destructive testing of the repair weld shall be performed as required in (2.6) and (7.1.3).

2.10.2 Method

Destructive tests shall be as follows:

- 1 transverse tensile - 2.6.2;
- 1 macro-hardness test - (2.6.6)
- ferrite measurement for partial penetration repairs (2.6.7) which shall include measurements made in the new HAZ formed in the original weld;
- Charpy testing at the locations shown in Figure 6 of BS 4515;
- when specified by the Principal, corrosion testing for full penetration repairs to include the junction of new and original weld metals.

2.10.3 Requirements

The acceptance criteria shall be as for the original welding procedure qualification.

SECTION 3 QUALIFICATION OF WELDERS

3.1 GENERAL

Delete the last sentence of the second paragraph.

Add the following:

For butt welds, welders shall be qualified by visual examination, radiographic testing and macroexamination. Where automatic welding has been used, ultrasonic testing shall also be undertaken.

For branch welds and fillet welds, welders shall be qualified by visual examination, liquid penetrant testing and macroexamination.

3.2 SINGLE QUALIFICATION

3.2.1 General

Delete the first sentence and replace with the following:

The welder shall make a weld, or portion of a weld, to join pipe nipples simulating the work which will be undertaken in production welding. Segments of pipe nipples shall not be used.

Add the following:

Each of the two pipe nipples used to make the test weld shall have a minimum length of D or long enough to accommodate the alignment device being used, whichever is greater.

3.2.2 Scope

Delete items a, b, c, d, e, f and g and replace with the following:

The limits of welder qualification should be the essential variables of the WPS. Any change which necessitates requalification of the WPS should require requalification of welders to the new, qualified WPS unless the Principal agrees that the variable that has changed has no effect on a welder's performance.

3.3 MULTIPLE QUALIFICATION

3.3.1 General

Delete this section.

3.3.2 Scope

Delete this section.

3.4 VISUAL EXAMINATION

Delete this section and replace with the following:

Visual examination shall be performed in accordance with EN 970. The acceptance criteria shall be as defined in (6).

3.5 DESTRUCTIVE TESTING

3.5.1 Sampling of test butt welds

Delete this section and Table 3 and replace with the following:

After satisfactory radiographic testing, the test weld shall be sectioned for macroexamination in accordance with (2.6.6). Hardness testing may be omitted. The number of macrosections shall be two per welder's portion. The acceptance criteria shall be as defined in (6).

3.5.2 Tensile-strength, nick-break and bend test procedures for butt welds

Delete this section.

3.5.3 Tensile-strength test requirements for butt welds

Delete this section.

3.5.6 Sampling of test fillet welds

Change title as follows:

3.5.6 Sampling of test fillet and branch welds

Add the following:

Prior to cutting, the test welds shall be liquid-penetrant tested in accordance with 8.3 and shall meet the requirements of (6).

3.5.7 Test methods and requirements for fillet welds

Delete this section and replace with the following:

3.5.7 Test methods and requirements for fillet and branch welds

After satisfactory liquid penetrant testing, the test weld shall be sectioned for macroexamination in accordance with (2.6.6). Hardness testing may be omitted. The number of macrosections shall be two per welder's portion. The acceptance criteria shall be as defined in (6).

3.6 RADIOGRAPHY – BUTT WELDS ONLY

3.6.1 General

Delete this section and replace with the following:

The qualification butt weld shall be examined by radiography prior to the destructive testing specified in (3.5).

Ultrasonic testing shall also be performed on test welds where any bead has been deposited by automatic welding.

3.6.2 Inspection requirements

Add the following:

The test weld shall also meet the requirements of this DEP.

3.7 RETESTING

Delete this section and replace with the following:

If the test weld does not meet the specified acceptance criteria, the welder may carry out two repeat tests provided that the failure can be attributed to unavoidable conditions and not to lack of training. Both of the repeat welds shall meet the specified acceptance criteria. Failure of one or both repeat welds shall result in disqualification of the welder until such time as the Contractor can demonstrate to the Principal that satisfactory training has been received. After agreement by the Principal, the welder may then be presented for further qualification testing.

3.8 RECORDS

Add the following:

The Contractor shall assign each welder a unique identification number, letter or symbol to ensure traceability to specific welds.

If a welder ceases to work for the Contractor, the unique identification shall not be reassigned to another welder.

SECTION 4 DESIGN AND PREPARATION OF A JOINT FOR PRODUCTION WELDING

Change title as follows:

SECTION 4 PRODUCTION WELDING

4.1 GENERAL

Delete this section and replace with the following:

The preparation and welding of pipeline components shall be in accordance with the qualified and approved WPS.

The approved WPS shall be available at the construction site.

Fusion faces and the surrounding surfaces within a minimum of 25 mm of the joint shall be free from heavy scale, moisture, oil, paint or any other substance which may have a deleterious effect on the weld quality or progress. Prior to welding, the end preparation shall be degreased with a non-chlorinated solvent such as acetone.

Arcs shall be struck only on fusion faces or on striking plates provided as an aid to arc starting. Stray arc strikes shall be removed by grinding. The ground area shall be liquid-penetrant tested and thickness-checked. Where the thickness is below the specified minimum, this section of pipe shall be removed.

The Contractor shall ensure a good earth connection and periodically examine the condition of the earth cables and attachments. Any arcing from a poor connection shall be treated as a stray arc strike. Connections shall be made to the work by stainless steel clamps. Earth cables shall not be welded to pipeline components.

The open ends of the pipe shall be capped when interruptions to work expected to last two or more hours occur. All open ends of pipe strings shall be capped off and sealed when welding is completed.

4.2 ALIGNMENT

Delete this section and replace with the following:

The pipeline components shall be firmly supported in both the vertical and horizontal plane and no welding shall be carried out until the alignment specified in the approved WPS has been achieved.

Any misalignment shall be reduced to a minimum by rotation of the pipe to achieve the best fit. Hammering or heating of the pipe shall not be permitted.

If the offset exceeds 1.6 mm, provided that it is caused by dimensional variations within the specified tolerances, or if alignment of two pipeline components of different nominal thickness and the same outside diameter is required, joint design shall be in accordance with ASME B31.4 or ASME B31.8. Any taper shall not be steeper than 1 in 4.

If a pipe with one longitudinal seam is used, this seam shall be within the top 120° of the circumference. The longitudinal seams of consecutive pipes shall be offset by at least 100 mm.

4.3 USE OF LINE-UP CLAMP FOR BUTT WELDS

Delete this section and replace with the following:

Internal line-up clamps shall be used wherever possible and their design shall be such as to allow the introduction and containment of purging gases. External line-up clamps may be used for line pipe 150 NPS and below, for tie-in welds, and for special welds, such as connections to valves, flanges and fittings.

Pipe shall not be moved or lowered off until the second pass has been completed.

Where an internal or external line-up clamp cannot be used, alignment may be achieved using tack welds. Tack welds shall be temporary bar tacks using suitable duplex stainless steel material. Welding parameters shall be in accordance with the appropriate fill pass.

Tack welding shall be performed only by welders qualified to weld with the WPS. The tack welds shall be removed by grinding as welding progresses around the joint.

Fully penetrating root tacks shall not be allowed.

4.4 BEVEL

4.4.2 Field bevel

Delete this section and replace with the following:

End preparations shall be made by machining and/or grinding with the exception that plasma cutting is permissible provided a machine-guided torch is used. Plasma-cut ends shall be left free of slag and the cut surface shall be ground to a smooth, bright, uniform finish with the removal of a minimum of 0.5 mm of metal.

The new end preparation shall be visually examined and liquid-penetrant tested in accordance with ISO 12095. Burns, small score marks, indentations, other imperfections and linear indications shall be unacceptable and the pipe end shall be re-prepared. Where a cut back has been made as a result of laminations in the pipe, the area for the new end preparation shall be subjected to ultrasonic testing to confirm the absence of laminations. Repair by welding shall not be permitted.

If pipes are cut, pipe markings shall be transferred to the offcut in order to maintain identification.

4.7 CLEANING BETWEEN BEADS

Delete "When automatic or semiautomatic welding is used," and replace with the following:

For all types of welding,

4.8 POSITION WELDING

4.8.2 Filler and finish beads

Delete the last sentence of the first paragraph and replace with the following:

The excess weld metal at the cap for wall thicknesses 6.4 mm and below shall not exceed 1.6 mm. For wall thicknesses greater than 6.4 mm, the excess weld metal at the cap shall not exceed 3.2 mm.

4.9 ROLL WELDING

4.9.2 Filler and finish beads

Delete the last sentence of the first paragraph and replace with the following:

The excess weld metal at the cap for wall thicknesses 6.4 mm and below shall not exceed 1.6 mm. For wall thicknesses greater than 6.4 mm, the excess weld metal at the cap shall not exceed 3.2 mm.

4.10 IDENTIFICATION OF WELDS

Delete this section and replace with the following:

Welds shall be marked, in a manner agreed by the Principal, to maintain traceability of welders to specific welds or parts of welds.

4.11 PRE- AND POST-HEAT TREATMENT

Delete this section and replace with the following:

4.11.1 Preheat and interpass temperature control and measurement

Where preheat is required by the WPS, it shall be applied using electrical resistance heaters, hot air blowers or oxy-propane rosebud torches. Welding or cutting torches shall not be used.

Measurement shall be made in accordance with ISO 13916.

4.11.2 Post-weld heat treatment

PWHT may be specified only in exceptional circumstances. Individual requirements and procedures shall be agreed with the Principal as necessary.

Add the following new sections:

4.12 SEPARATION OF GIRTH WELDS

The minimum allowable distance between girth welds shall be the OD or 500 mm whichever is the larger. In any 3 m length of pipe, a maximum of two welds shall be allowed unless specified otherwise on the agreed construction drawings. Welds of branch connections and attachments should not overlap main seam welds.

4.13 PARTIALLY COMPLETED JOINTS

Interruption of welding should be avoided. If interruption is unavoidable, a minimum of three passes or one-third of the joint thickness, whichever is greater, shall have been deposited. On resumption of welding any preheat requirements specified in the approved WPS shall be applied.

4.14 WELD FINISHING

Welds shall be left as welded and shall not be treated with a flame torch or other mechanical means to change their appearance other than cleaning and dressing operations specified in the WPS. Welds shall not be peened.

When fabrication is completed, all surfaces adjacent to the welds shall be cleaned of spatter, burrs and other imperfections which could interfere with radiographic or ultrasonic inspection.

4.15 SHIELDING AND BACKING GAS

The oxygen content of the backing gas, measured in the effluent gas immediately prior to welding, shall not exceed 0.50%. Measurement shall be made by means of a suitable oxygen meter. The backing gas shall be maintained for the minimum number of weld passes qualified by the WPQR.

SECTION 5 INSPECTION AND TESTING OF PRODUCTION WELDS

5.2 METHODS OF INSPECTION

Delete the first paragraph and replace with the following:

Welds shall be evaluated on the basis of the requirements of (6).

The primary NDT method shall be X-ray radiography. Ultrasonic and liquid-penetrant examination may supplement radiography and shall be used to interpret doubtful indications in the radiographs or for welds inaccessible for radiography.

5.3 QUALIFICATION OF INSPECTION PERSONNEL

Delete the first paragraph and replace with the following:

Welding inspection personnel shall hold a valid welding inspection qualification and certificate from one or more of the following:

- CSWIP
- BGAS
- AWS
- Other certifying body agreed by the Principal.

5.4 CERTIFICATION OF NON-DESTRUCTIVE TESTING PERSONNEL

5.4.1 Procedures

Delete this section and replace with the following:

All personnel shall be qualified and certificated for the method of NDT to be carried out in accordance with ISO 9712. The roles and responsibilities of NDT personnel shall be as defined in the levels of competence in ISO 9712.

Add the following new section:

5.5 EXTENT OF INSPECTION AND TESTING

Prior to welding, the Contractor shall examine free-issue materials for damage and compliance with the relevant materials specification. All damage and discrepancies shall be reported immediately to the Principal.

During production welding, the welding parameters shall be checked against the production WPS at intervals defined in the Contractor's quality plan. All butt welds shall be subject to 100% visual examination in accordance with EN 970 and 100% radiographic testing in accordance with (8). If the physical configuration prevents radiographic testing, all welds shall be inspected by ultrasonic testing in accordance with (8), where feasible, or alternative methods agreed with the Principal. Fillet welds shall be subject to 100% visual inspection in accordance with EN 970 and 100% liquid-penetrant testing in accordance with (8).

Welds containing defects, as defined in this DEP, shall be rectified in accordance with (7).

SECTION 6 ACCEPTANCE STANDARDS FOR NON-DESTRUCTIVE TESTING

6.1 GENERAL

Add the following:

All welds shall be visually inspected and all cracks, crater cracks, surface pores, spatter, residual slag or stray arc strikes shall be considered as defects. Weld root oxidation, where visual examination can be performed, shall not exceed the limits shown in DEP 30.10.60.31-Gen.

Imperfections shall be classified in accordance with ISO 6520. Classification of defects from radiographs shall be performed using the IIW Reference Radiographs where indicated in ISO 6520.

6.3 RADIOGRAPHIC TESTING

6.3.1 Inadequate penetration

Change title as follows:

6.3.1 Lack of penetration (reference 402)

Delete this section, including Figure 13, and replace with the following:

Any lack of penetration shall be considered a defect.

6.3.2 Inadequate penetration due to high-low

Change the title as follows:

6.3.2 Lack of fusion (reference 4013)

Delete this section, including Figure 14, and replace with the following:

Any lack of fusion (reference 4013) shall be considered a defect.

6.3.3 Incomplete fusion

Change the title as follows:

6.3.3 Lack of fusion

Delete this section and replace with the following:

Lack of fusion which is open to the surface shall be considered a defect.

6.3.4 Incomplete fusion due to cold lap

Change the title as follows:

6.3.4 Lack of fusion (reference 4011, 4012)

Delete the first two sentences of the first paragraph, including Figure 16.

Replace 'IFD' with: lack of fusion (reference 4011, 4012).

6.3.5 Internal concavity

Change the title as follows:

6.3.5 Root concavity

Delete this section and replace with the following:

The length of root concavity, determined using an image contrast graph, shall not exceed 25% of the total length of the weld. The depth of root concavity shall not exceed 10% of the pipe wall thickness or 1.5 mm whichever is the smaller. The weld metal, including cap, shall

not be thinner than the parent material thickness.

6.3.6 Burn-through

6.3.6.1 Definition

Delete this section and replace with the following:

Burn-through shall be defined as stated in ISO 6520.

6.3.6.2 Acceptance criteria

Delete this section and replace with the following:

Any amount of burn-through shall be considered to be a defect.

6.3.6.3 Acceptance criteria - pipe less than 60.3 mm OD

Delete this section and replace with the following:

Any amount of burn-through shall be considered to be a defect.

6.3.9 Cracks

Delete this section and replace with the following:

Cracks of any type shall be considered to be defects.

Add the following new section:

6.3.13 Excess weld metal/excessive penetration

Weld metal when measured from the adjacent parent material outer surface shall not exceed 1.6 mm for wall thicknesses 6.4 mm and below and 3.2 mm for wall thicknesses greater than 6.4 mm.

Excessive penetration, determined using an image contrast graph, shall not exceed 1.6 mm.

6.4 MAGNETIC PARTICLE TESTING

Delete this section.

6.5 LIQUID-PENETRANT TESTING

6.5.2 Acceptance standards

Delete this section and replace with the following:

Indications shall be considered as defects when they exceed the dimensional and/or numerical limits for imperfections specified in (6.1 and 6.3).

6.6 ULTRASONIC TESTING

6.6.2 Linear indications

Delete item a. and replace with the following:

All linear indications interpreted as cracks shall be considered as defects.

Delete item b. and replace with the following:

All linear indications (other than cracks) interpreted to be open to the surface shall be considered as defects.

SECTION 7 REPAIR AND REMOVAL OF DEFECTS

7.1 DEFECTS OTHER THAN CRACKS

7.1.1 Authorisation for repair

Delete this section and replace with the following:

Welds containing defects shall be repaired only if approved by the Principal. A weld with defects should be repaired only once. After further NDT, if the repair is unacceptable then the complete weld and HAZ should be removed. Full penetration repairs shall not be repeated.

Single weld pass repairs and root-sealing weld passes shall not be performed. SMAW shall not be used for the root pass in a full penetration repair.

7.1.2 Removal and preparation for repair

Delete this section and replace with the following:

Defects necessitating repair shall be entirely removed to sound metal.

The removal of weld metal, or portions of the parent material, shall be by machining or grinding. Thermal gouging methods shall not be used. Repair excavations shall be smoothly contoured and tapered, having a minimum included groove angle of 50°. Visual and liquid-penetrant testing of the repair weld grooves shall be carried out prior to rewelding to confirm complete removal of the defects.

The total repair length shall not exceed 40% of the total weld length. The maximum length of a single repair portion shall be 30% of the total weld length. Groove taper shall be included in the measurements.

7.1.3 Testing of repairs

Add the following:

All repairs which require excavation and rewelding shall be re-radiographed. The radiograph shall extend for a minimum distance of 50 mm beyond either end of the repaired area measured on the face of the weld.

7.2 AUTHORISATION AND PROCEDURE FOR REPAIR OF CRACKS

Delete this section, including items a., b., c., d., e., and replace with the following:

For cracks, other than crater cracks, the complete weld and HAZ shall be removed.

SECTION 8 PROCEDURES FOR NON-DESTRUCTIVE TESTING

8.1 RADIOGRAPHIC TEST METHODS

8.1.1 General

Delete this section and replace with the following:

Radiographic testing shall be performed in accordance with ISO 1106-3 Class B. The radiation shall be X-ray. The technique shall be film outside, source of radiation inside. Where the source of radiation cannot be located inside the pipe, the Principal may agree to use of the film and source of radiation outside: double wall, single image technique.

The Contractor shall qualify a radiographic testing procedure prior to testing production welds by producing radiographs that comply with this DEP.

NOTE: Radiographic testing procedure qualification may be undertaken on test welds produced for welding procedure qualification.

8.1.2.3 Other imaging media

Delete this section.

8.1.3 Exposure geometry

8.1.3.1 Film radiography

Delete the third paragraph, including the formula and definitions, and replace with the following:

The minimum source-to-specimen distance shall be calculated in accordance with ISO 1106-3 for Class B radiographic testing.

8.1.3.2 Other imaging media

Delete this section.

8.1.4 Type of penetrameters

Delete this section and replace with the following:

IQIs shall be wire type.

8.1.5 Selection of penetrameters

8.1.5.1 Hole type penetrameters

Delete this section and replace with the following:

Wire-type IQIs shall be used.

8.1.5.2 Wire-type penetrameters

Delete this section and replace with the following:

For production radiographic testing, IQI selection, number, location and appearance in radiographic images shall be in accordance with ISO 1106-3 and ISO 1027.

For radiographic procedure qualification, IQIs shall also be placed on the surface facing the source of radiation. The specified sensitivity requirement shall be achieved on the source side IQIs. The sensitivity achieved on the film side IQIs shall be recorded for comparison and used for evaluating production radiographs.

8.1.6 Placement of penetrameters

8.1.6.2 Other imaging media

Delete this section.

8.1.9 Storage of film and other imaging media

8.1.9.2 Other imaging media

Delete this section.

8.1.10 Film density

Change title to:

8.1.10 Film density and sensitivity

8.1.10.1 Film density

Delete this section and replace with the following:

The minimum density shall be 2.0. The maximum density shall be 3.5 where adequate interpretation can be achieved with the viewing screen.

8.1.10.2 Film viewing equipment

Delete this section and replace with the following:

Illuminators shall comply with the requirements of ISO 5580.

Add the following new section:

8.1.10.4 Sensitivity

The sensitivity shall be 2% or better.

8.1.11 Image processing

Delete this section and replace with the following:

Film shall be processed, handled and stored so that the images are interpretable for at least 5 years after they are produced.

8.2 MAGNETIC PARTICLE TEST METHOD

Delete this section.

8.4 ULTRASONIC TEST METHOD

Add the following:

NOTE: Special techniques are required for ultrasonic testing of duplex and super duplex stainless steels. These shall be developed by the Contractor and agreed by the Principal prior to use.

SECTION 9 AUTOMATIC WELDING

Delete this section and replace with the following:

Requirements for automatic welding are addressed in the preceding sections of this DEP.

SECTION 10 AUTOMATIC WELDING WITHOUT FILLER-METAL ADDITIONS

Delete this section and replace with the following:

Welding without filler-metal addition shall not be permitted.

Add the following new section:

SECTION 11 DOCUMENTATION

11.1 GENERAL

All required documentation shall be in the English language unless otherwise specified by the Principal.

11.2 PRE-WELDING DOCUMENTATION

Where required by the Principal, the Contractor's contract-specific quality plan shall be submitted for agreement prior to the commencement of welding.

NOTE: Review by the Principal of a preliminary quality plan at the enquiry stage may assist the process.

11.2.1 Content of the quality plan

The format and issue of the quality plan shall be consistent with the document control element of the Contractor's quality system.

The content of the quality plan should be based on ISO 10005 and shall include the following:

1. Identification of the contract to which the plan is to be applied.
2. Reference to API Standard 1104 and this DEP.
3. Location of the work.
4. Identification of the individuals responsible for controlling the activities defined in the plan.
5. Identification of the individuals with the authority to interface directly with the Principal.
6. Identification of all subcontractors.
7. The quality plans of all subcontractors.
8. All sequenced activities for the contract and references to the quality system procedures and the work instructions which will be applied to these activities.
9. Where requested by the Principal, copies of specific quality system procedures.
10. Test and inspection frequency and acceptance criteria.
11. The location of each inspection and test point in the activity sequence.
12. Points where the Principal has established witnessing or verification requirements.

NOTE: Further guidance on quality plans may be obtained from DEP 82.00.10.10-Gen.

11.3 FINAL DOCUMENTATION

The Principal shall specify the final documentation requirements in the contract document.

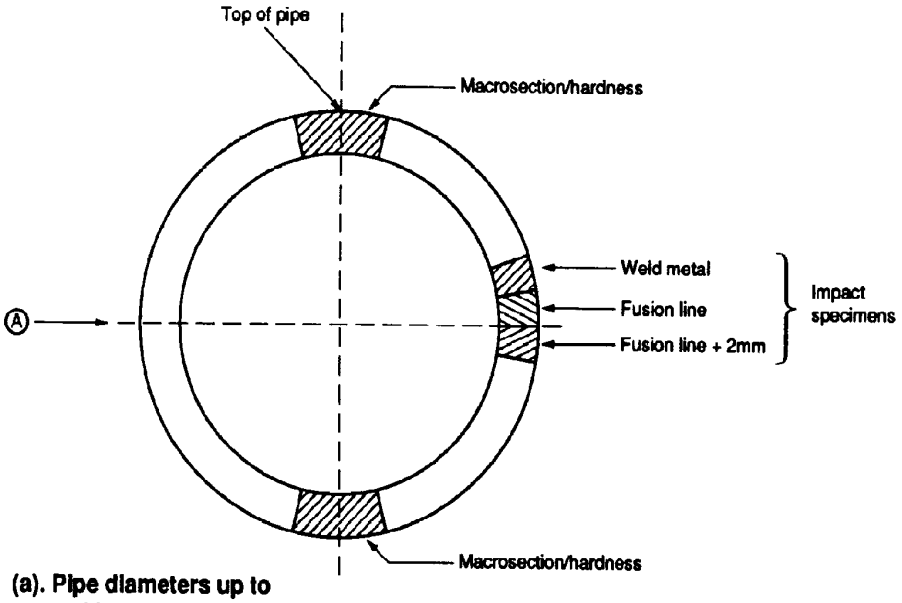
APPENDIX A ALTERNATIVE ACCEPTANCE STANDARDS FOR GIRTH WELDS

A.1 GENERAL

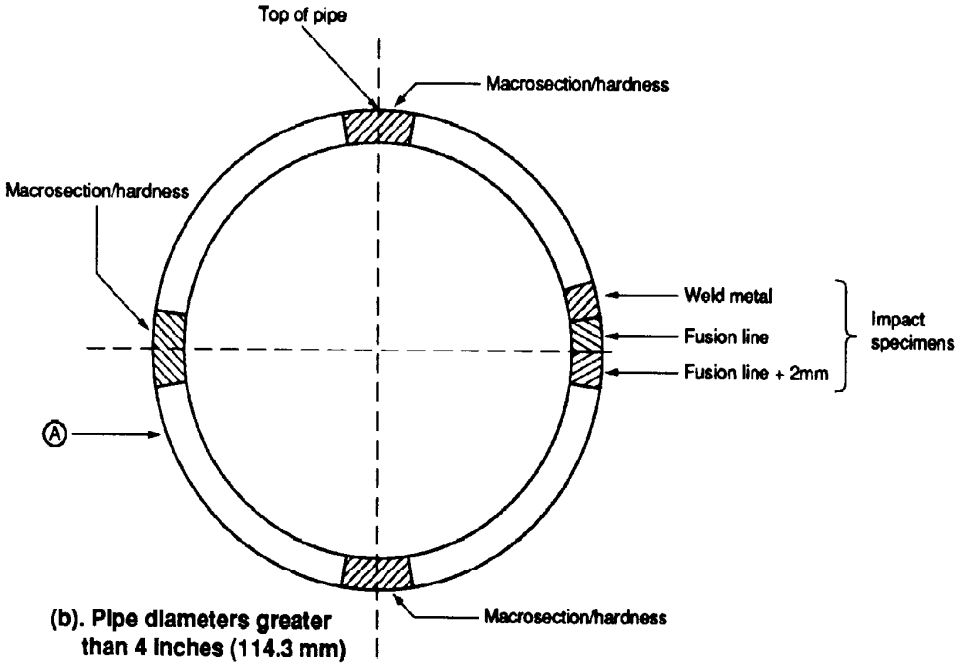
Add the following:

Alternative acceptance criteria in accordance with this Appendix shall only be allowed if specified by the Principal.

FIGURE A Location of sampling for macrosection and impact test specimens procedure qualification of butt welds



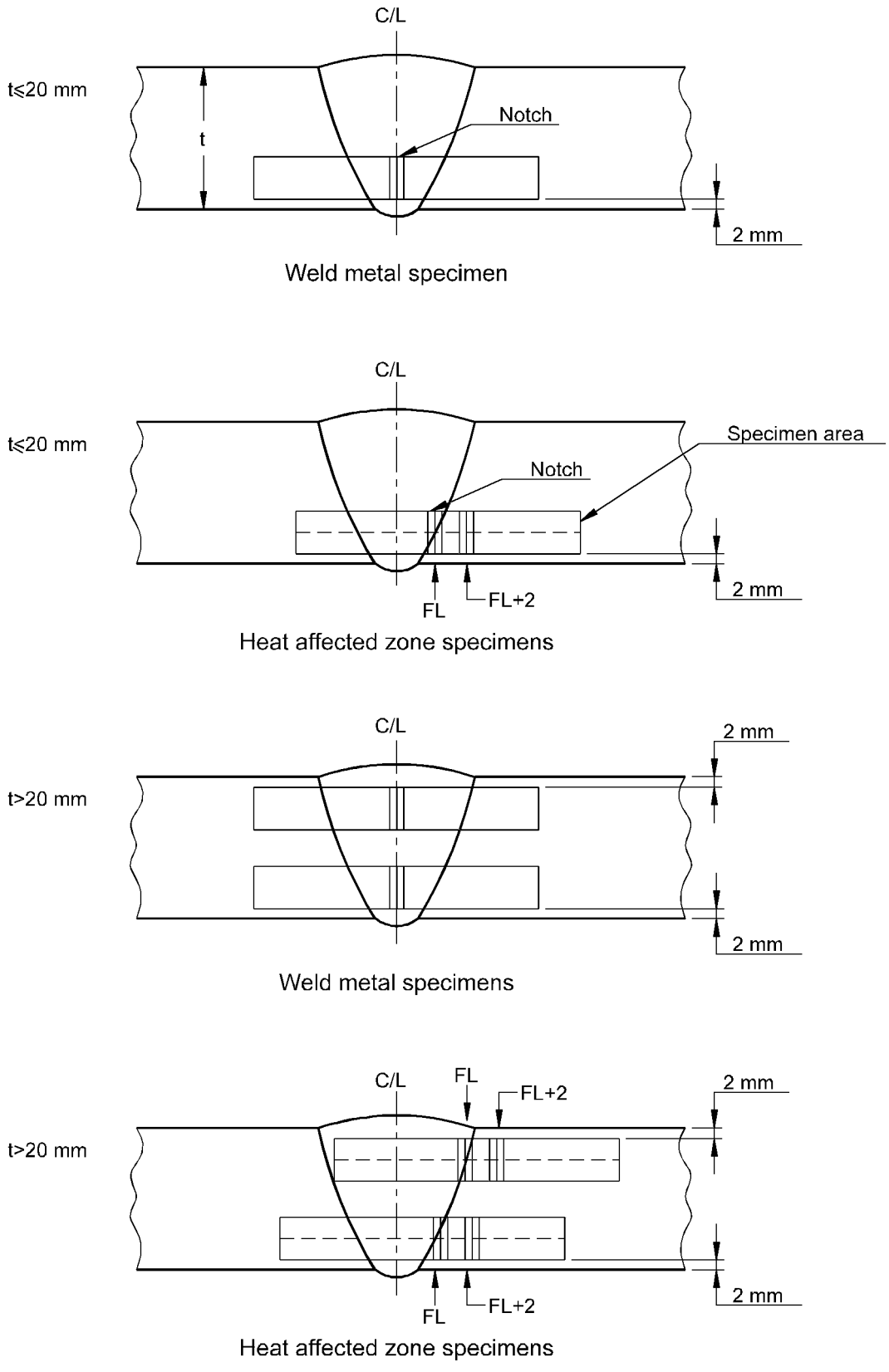
(a). Pipe diameters up to and including 4 inches (114.3 mm)



(b). Pipe diameters greater than 4 inches (114.3 mm)

Note: If additional impact specimens are required due to the wall thickness exceeding 20 mm these shall be taken from location Ⓐ

Figure B Location of impact test specimens for procedure qualification of butt welds



PART III REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used together with any amendments.

SHELL STANDARDS

Index to DEPs and standard specifications	DEP 00.00.05.05-Gen.
Acceptance criteria for oxidation of stainless steel weldments	DEP 30.10.60.31-Gen.
Pressure vessels (amendments/supplements to ASME Section VIII Division 1 and Division 2)	DEP 31.22.20.31-Gen.
Pipeline engineering	DEP 31.40.00.10-Gen.
Welded and seamless duplex and super duplex stainless steel line pipe (Amendments/supplements to API Spec. 5LC)	DEP 31.40.20.34-Gen.
Project quality assurance	DEP 82.00.10.10-Gen.

AMERICAN STANDARDS

Welding of pipelines and related facilities	API 1104 Eighteenth edition, May 1994

Issued by:
American National Standards Institute
11 West 42nd Street
New York, NY 10036
USA

Pipeline transportation systems for liquid hydrocarbons and other liquids	ASME B31.4
Gas transmission and distribution piping systems	ASME B31.8

Issued by:
American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017
USA

Mechanical testing of steel products	ASTM A 370
Standard specification for reagent water	ASTM D 1193
Macroetching metals and alloys	ASTM E 340
Standard practice for preparing, cleaning, and evaluating corrosion test specimens	ASTM G 1
Standard practice for preparation and use of bent-beam stress-corrosion test specimens	ASTM G 39
Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution	ASTM G 48

Issued by:
American Society for Testing and Materials
100 Bar Harbor Dr,
West Conshohocken PA 19426,
USA

Filler metal procurement guidelines	AWS A5.01

Issued by:
American Welding Society
550 N.W. LeJeune Road, P.O. Box 351040
Miami, Florida 33135
USA

BRITISH STANDARDS

Welding of steel pipelines on land and offshore	BS 4515

Issued by:
British Standards Institute
389 Chiswick High Road
London W4 4AL
United Kingdom

Corrosion resistant alloys for oil and gas production: Guidance on general requirements and test methods for H_2S service	EFC 17

Issued by:
The Institute Of Materials
1, Carlton House Terrace
London SW1Y 5DB
United Kingdom

EUROPEAN STANDARDS

Non-destructive examination of fusion welds - Visual examination	EN 970
Destructive tests on welds in metallic materials - Hardness testing - Part 1: Hardness test on arc welded joints	EN 1043-1

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CEN Central Secretariat
36, rue de Stassart
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APPENDIX 1 EXAMPLE OF USING RUN OUT LENGTH (ROL) TO MONITOR SHIELDED MANUAL ARC WELDING

This option is based on the recognition that ROL is really the only feature that the welder can directly control.

In practice ROL also provides the simplest and most easily checked parameter available to both the welder and the inspector. This requires no measurement of voltage or amperage.

The actual ROL achieved for any weld bead in the production weld should be measured and assessed as a RATIO of the deposited weld length to the length of weld rod consumed.

It is considered acceptable if the RATIO is within +/- 10% of the average value recorded during welding procedure qualification as specified on the approved WPS.

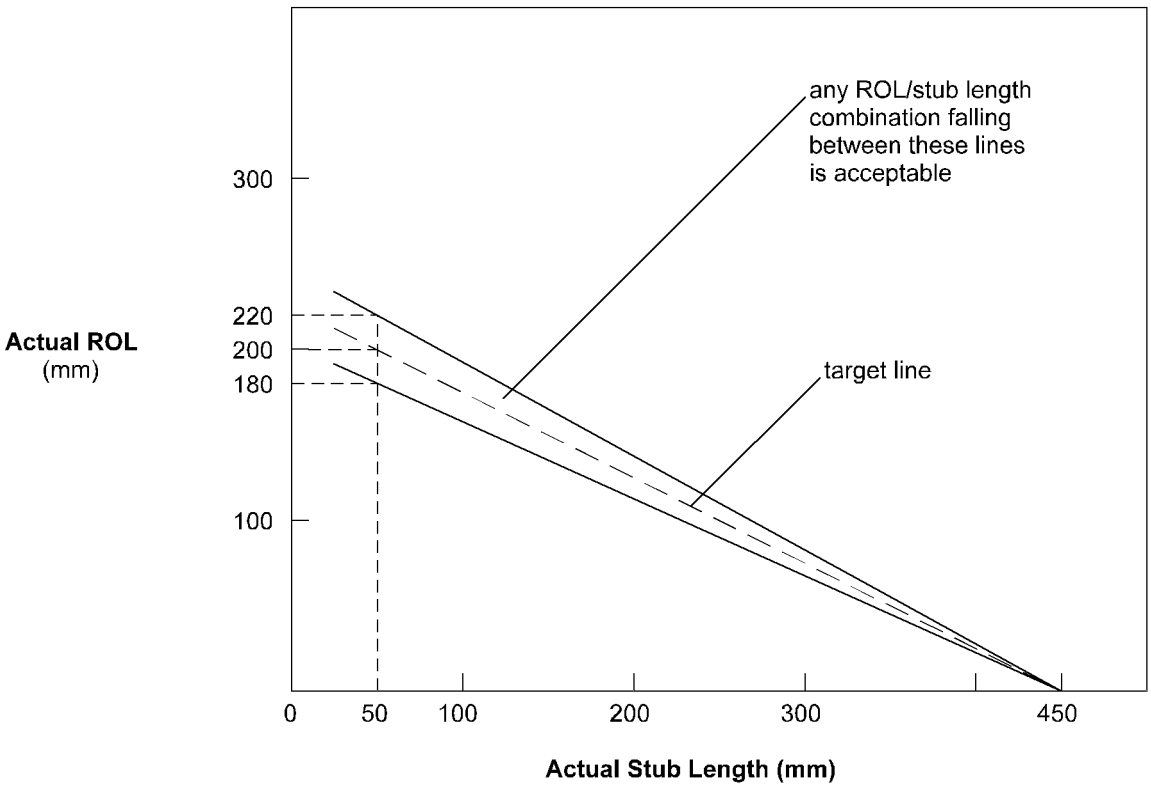
An inspection chart can be very easily constructed based on the ROL recorded on the WPS.

For example:

Average ROL recorded during welding procedure qualification	=	200 mm
Welding rod length	=	450 mm
Stub length (length of welding rod remaining)	=	50 mm
The approved RATIO	=	200/400 or 0.5

The allowable range of the RATIO is therefore 0.45 to 0.55.

In chart form:



APPENDIX 2 POSSIBLE CORROSION TESTS FOR WELDING PROCEDURE QUALIFICATION

Several corrosion tests which may be specified by the Principal are described for information. They shall only be mandatory when specified by the Principal. Guidance on corrosion testing can also be found in EFC Publication Number 17.

A2.1 FERRIC CHLORIDE PITTING CORROSION TEST

A2.1.1 Scope

This procedure describes a simple accelerated test technique for assessing the pitting corrosion resistance of duplex stainless steel in chloride containing environments. This procedure is a specific interpretation of ASTM G48 Method A which should be referenced for background information.

A2.1.2 Basis of method

The test involves total immersion of a test specimen in an aqueous solution of ferric chloride at a constant temperature for a 24-hour period and assesses whether the specimen has passed or failed on the basis of weight loss. The temperature of exposure shall be specified by the Principal.

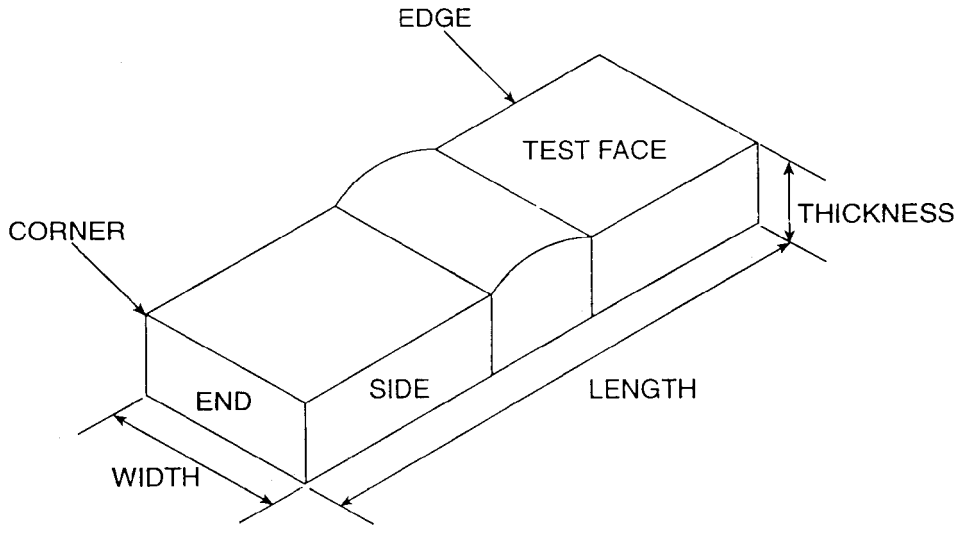
A2.1.3 Terminology

The nomenclature to be used to describe various aspects of the testpiece is given in (Figure A2.1).

(i) The face including the area of weld to be tested shall be called the 'test face'. If there are two 'test faces' these should be unambiguously named e.g. the 'root test face' and 'cap test face'.

(ii) If there is only one 'test face', the face opposite shall be called the 'reverse face'.

Figure A2.1 General layout of test specimen showing the test face uppermost



NOTE: The underside may be either a second test face or simply ground flat and referred to as the reverse face.

A2.1.4 Sample preparation

The test surface of the weld (unless instructed otherwise this is the root of a single-sided weld or the internal cap of a two-sided weld) shall be "as prepared for service". No

additional preparation of the weld surface shall be allowed.

A minimum of two samples shall be prepared from the weld under test and tested as described below.

An approximately cuboidal specimen, i.e. with six nominally rectangular faces, shall be used, with a test face size of 50 x 25 mm. If the material thickness is greater than 20 mm, the specimen shall be machined on the reverse face until it is no more than 20 mm thick. It is most convenient to test specimens of 5 mm to 10 mm thickness. The weld direction shall be approximately parallel to the shorter edge of the test face, and the weld shall be positioned equidistant from the two ends of the specimen.

If a weld width exceeds one third of the specimen length, the length shall be increased to a value equal to at least three times the weld width. When comparisons are made between a series of specimens, they shall all be of the same size.

It should be noted that the need to weigh the specimens to ± 1 mg requires the weight to be within the range of a balance with the required accuracy. Consequently, it is recommended that the specimen weight should be no more than 200 g. This may require the specimen thickness to be reduced to less than 20 mm, particularly for specimens with a non-standard test face size. Dimensions within ± 10% of those stated shall be considered acceptable. All corners of the test face should be 90° ± 10°.

All cutting and machining operations must be carried out avoiding undue contamination of the test face, and with no overheating or "bluing" of the sample.

Specimens from pipe material shall be removed by cutting either radially or along appropriate parallel chords.

The sides and ends of the specimens shall be ground to remove machining marks, using a suitable range of grit sizes, to produce a 1200 grit finish by standard metallographic procedures. If the reverse face requires machining to achieve the desired specimen thickness, it shall also be ground to a 1200 grit finish; otherwise the reverse face may be left as-welded, although it should be noted that attack may occur on this face also. If 1200 grit abrasive is not available, 1000 grit, or any finer abrasive, may be used. All corners and edges shall be rounded off and have any burrs removed during the grinding process.

Specimens shall not be marked either by stamping or with ink/paint. Vibro-etching is allowed for identification purposes but only in parent material outside of the test face and well away from the fusion zone and HAZ, i.e. on the ends or sides of the specimen.

NOTE: Corrosion or pitting at these locations may render the test invalid.

A2.1.5 Test solution

The test solution shall be made up from 100 g of Analar grade ferric chloride hexahydrate ($FeCl_3.6H_20$) and 20 g of disodium ethylenediamine tetra-acetate di-hydrate ($Na_2EDTA.2H_20$) per 900 ml of distilled water, or other water meeting ASTM D1193 type IV.

A2.1.6 Apparatus

(i) The solution and specimen shall be contained in a tall-form glass beaker or a wide neck, Erlenmeyer flask. A capacity of 1000 ml should be sufficient for standard specimens, but larger capacity, e.g. 2000 ml may be necessary for non-standard specimens. Each specimen shall be placed in a separate container.

(ii) The specimens shall sit at approximately 45° on a cradle designed to allow easy passage in and out of the container and ensure minimum contact with the specimen, so as to reduce the likelihood of crevice corrosion.

(iii) The containers shall be held within a constant temperature water bath, capable of maintaining a specified temperature to within ± 0.5 °C. The temperature of the bath shall be monitored throughout the test with a thermometer or a calibrated thermocouple.

(iv) Specimens shall be weighed before and after testing using a balance capable of ± 1 mg accuracy.

A2.1.7 Procedure

(i) The specimens shall be decontaminated with clean acetone or methanol and air dried, then weighed to the nearest 1 mg, immediately prior to testing. If the specimens are to be stored, they shall be kept in a desiccator, and then weighed prior to testing.

(ii) A minimum of 20 ml of test solution per 100 mm^2 of total specimen surface area shall be placed in the test container.

(iii) The container and solution shall then be covered with a watchglass and placed in a water bath pre-heated to within ± 0.5 °C of the specified test temperature.

(iv) The temperature of the solution shall be monitored. When it has reached ± 0.5 °C of the test temperature, the specimens shall be placed on a cradle and immersed in the test solution and the container recovered with a watch glass. The specimens shall be oriented with the test face uppermost at an angle of approximately 45° to the vertical. The test temperature must be maintained within ± 0.5 °C of the required value throughout the exposure period.

(v) The specimens shall be removed from the test solution after 24 hours, rinsed and scrubbed with a nylon bristle brush under running water and finally immersed in acetone or methanol and dried thoroughly. The scrubbing process should remove any loose corrosion product and staining from the specimen surface.

(vi) When dry, the specimens shall be re-weighed to $\pm$1 mg or better.

(vii) After weighing, the specimens shall be observed under a binocular microscope in order to identify the location of any pitting and/or general corrosion. A steel pin may be used to probe the surface of the specimens in an attempt to open up covered pits.

A2.1.8 Acceptance criteria

If the specimen has gained weight or lost no more than 20 mg it shall be considered to have passed the test.

If the weight loss is more than 20 mg, the specimen shall be considered to have failed the test, unless pitting can be positively identified only on areas outside of the test face.

For acceptance both samples shall meet these criteria.

If one or both specimens fail as a result of pitting on any face other than the test face, a re-test may be carried out on new specimens.

If a test weld has been cleaned after welding, e.g. by pickling, as part of its preparation for service, the specimen shall be considered to have failed if any pitting is visible on the test face, regardless of weight loss.

If the fill passes of the test weld are deposited with a consumable having lower pitting resistance than that used for the root, pitting in the weld metal on the specimen sides is acceptable. In such cases the pass/fail assessment must be performed visually if the weight is > 20 mg. The specimen will be considered to have failed if pitting is visible on the test face.

A2.1.9 Reporting

The following shall be included in the test report for each specimen:

(i) A brief description of the weld condition, i.e. details of all post-weld heat treatment and surface preparation.

(ii) The specimen dimensions.

(iii) A brief description of any feature observed on the test face prior to testing which identifies notable features, in particular any which might be mistaken for pits after exposure.

(iv) The volume of test solution to the nearest 50 ml.

(v) The actual test temperature, including any variation noted during the test exposure.

(vi) The weight of the specimen immediately prior to testing.

(vii) The weight of the specimen after cleaning and drying at the completion of the test.

(viii) The weight change during testing.

(ix) The location of any pits discovered shall be recorded on a sketch of photo of the specimen. If no pits are observed, this shall be stated. The use of probing shall be reported, with the observed results.

(x) Whether the specimen has passed or failed the test.

NOTE: This should record if a failure was due to attack outside the test face and is therefore eligible subject to a re-test in accordance with (A2.1.8).

A2.2 PITTING CORROSION TEST

A2.2.1 Procedure

The test procedure shall be in accordance with ASTM G1 with the following additional requirements.

A2.2.2 Test specimens

The tests should be performed on triplicate specimens. The specimen size should be 20 mm x 50 mm x 2 mm (plus weld root) with the weld located centrally.

A2.2.3 Specimen preparation

The root face of the general/pitting corrosion test specimens should be left in the as-welded condition and should only be degreased.

A2.2.4 Test solution

The specific test solution and conditions shall be advised by the Principal. The following procedure should be used when autoclave testing with CO_2 and/or H_2S is required:

- N_2/CO_2 deaeration at a flow rate of >100 ml/min per litre of solution for 1 hour (to achieve less than 0.01 ml/m^3 oxygen);

- Purged at test temperature with a gas mixture containing H_2S until the required partial pressure is reached. Alternatively, the solution may be purged at ambient temperature such that the required H_2S partial pressure is achieved when heated to test temperature;

- Exit valve closed and autoclave pressurised with CO_2/N_2 to required level after autoclave has been heated to the required temperature;

- Gas should be replenished once/twice weekly under these testing environments;
- Specimens should be electrically isolated from dissimilar metals and the autoclave.

A2.2.5 Test duration

The test duration should be a minimum of thirty days.

A2.2.6 Post-test evaluation

The cleaned specimens shall be subject to an optical (x30) examination, followed by sectioning and scanning electron microscopy (SEM) examination of suspect areas.

A2.2.7 Acceptance criteria

No pitting on any surface of all tested samples and the general weight loss corrosion rate should be less than 0.1 mm/yr.

A.2.3 SULPHIDE STRESS CRACKING (SSC) TESTS

A2.3.1 Four point bend tests

The test procedure shall be in accordance with ASTM G39 with the following additional requirements:

A2.3.2 Test specimens

The test should be conducted on triplicate specimens of dimensions:110 mm to 250 mm long, 15 mm to 50 mm wide, thickness such that $y^1/h < 0.1$, with the weld located in the centre. The root weld zone and as much adjacent parent material as possible should be left in the as-welded/received condition.

The specimen surfaces should be cleaned in detergent with a nylon brush, followed by degreasing with acetone and rinsing with de-ionised water.

A2.3.3 Specimen loading

Each specimen shall be loaded such that the strain achieved is equivalent to 100% of the actual proof stress of the parent material. The strain should be measured using strain gauges.

A2.3.4 Test solution

See (A2.2.4) above.

A2.3.5 Test duration

The test duration shall be a minimum of 30 days.

A2.4.5 Post-test evaluation

The cleaned specimens shall be subject to an optical (x30) examination of the surface, followed by sectioning and scanning electron microscopy (SEM) examination of suspect areas.

A2.4.6 Acceptance criteria

No cracking or corrosion attack on any tested specimen.