

DEP SPECIFICATION

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

DEP 61.40.20.31-Gen.

February 2011

(DEP Circular 65/12 has been incorporated)

(Amendment A02 has been incorporated – February 2013)

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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PART I INTRODUCTION

1.1 SCOPE

This 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.

This DEP is based on API 1104, Twentieth Edition, October 2005, with Errata/Addendum of July 2007 and December 2008.

The intended limits of application are as defined for pipeline scope boundaries in Figure 1 of ISO 13623.

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

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated January 2010; see (1.7) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This DEP is intended for use in facilities related to oil and gas production. Application in other facilities may also apply.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in 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 with regard to the 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, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

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

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

The **Principal** is the party that 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 lower-case word **shall** indicate a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
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 17636.

Amendment A02

Sour service	As defined in DEP 31.22.00.31-Gen.
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1.4 ABBREVIATIONS

Term	Definition
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
PRE	Pitting Resistance Equivalent
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
WPQR	Welding Procedure Qualification Record
WPS	Welding Procedure Specification

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 SUMMARY OF CHANGES

The previous edition of this DEP was dated January 2010.

For this revision a companion document called a “DEP Informative” has been created containing background information and which is accessible from the Shell Standards web page.

Other than editorial revisions, the following are the main changes to this document:

Old section	New Section	Change
General		The Process Safety table in the companion Informative provides RAM rankings of the Process Safety requirements in this DEP and further background information.
1.1	1.1	The general requirements that were contained in the Scope section have been moved to Part II General Requirements.
-	Part II	Added general requirements in-line with the standard structure for amendment DEPs.
Part II	Part III	Part II renumbered to Part III in-line with the standard structure for amendment DEPs.
4.2.3.1	4.2.3.1	Backing gas requirements have been added.
5.1	5.1	Modified fourth bullet under second paragraph to include sub-contractors.
5.3.2.6	5.3.2.6	Added requirement to specify specific machine programs tied to power supplies.
5.3.2.15	5.3.2.15	Added EN and ISO as flux classification bodies.
6.7	6.7	Modified first sentence of the replacement clause.
7.14	7.14	Added last sentence.
7.15	7.15	Added onto last sentence mock-up testing.
A2.1.4	A2.1.4	Added second sentence onto second paragraph.
Part III	Part IV	Renumbered.

Amendment A02

PART I, 1.3.2	PART I, 1.3.2	Reference to pressure vessel DEPs have been updated to the new pressure vessel DEP 31.22.00.31-Gen.
PART I, 1.7	PART I, 1.7	Updated DEP feedback process.

PART IV	PART IV	Reference to pressure vessel DEPs have been updated to the new pressure vessel DEP 31.22.00.31-Gen.
PART IV	PART IV	Added DEP feedback form - DEP 00.00.05.80-Gen.

1.7 COMMENTS ON THIS DEP

Amendment A02

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://sws.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.8 DUAL UNITS

Amended per Circular 65/12

Dual units have been incorporated throughout this DEP.

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

PART II GENERAL REQUIREMENTS

1.1 GENERAL

Part III of this DEP amends, supplements and deletes various clauses of API 1104, Twentieth edition, October 2005 with Errata/Addendum of July 2007 and December 2008.

Wherever reference is made to of API 1104, it shall be understood to mean of API 1104, Twentieth edition, October 2005 with Errata/Addendum of July 2007 and December 2008, as amended/supplemented by this DEP.

For ease of reference, the clause numbering of of API 1104 has been used throughout Part III of this DEP.

Clauses in of API 1104 that are not mentioned in this DEP shall remain valid as written.

1.2 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, CO₂, H₂S);
- 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 - 14.2);
- whether welding consumables are to be agreed (Part II - 4.2.2.1);
- whether previously qualified welding procedure specifications may be considered for agreement (Part II - 5.1);
- whether ranges of outside diameter and/or wall thickness can be covered by a single welding procedure qualification (Part II - 5.3.2.3);
- whether post-weld heat treatment is acceptable (Part II - 5.3.2.13);
- whether corrosion tests are required for welding procedure qualification and the test procedures to be employed (Part II - 5.6.9);
- specific requirements for weld identification marking (Part II - 7.10);
- whether partial penetration re-repairs can be performed (Part II - 10.1.);
- whether all NDT indications are to be reported or only those that are evaluated as defects - 11.1.7;
- whether specific radiograph identification requirements are to apply - 11.1.8;
- whether the Contractor's quality plan is to be submitted for agreement (Part II - 14.2);
- the requirements for final documentation (Part II - 14.3); 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 III AMENDMENTS/SUPPLEMENTS TO API 1104**(Twentieth edition, October 2005 with Errata/Addendum of July 2007 and December 2008)****SECTION 1 GENERAL****1.1 SCOPE**

Delete this subsection 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 Plasma arc, or a combination of these processes.

Unless agreed otherwise by the Principal, the GTAW process shall be used for the root and second passes.

A manual, semi-automatic, or automatic welding technique, or combination of these techniques may be used. Filler metal SHALL [PS] 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.

DEP clauses that do not satisfy the local regulations will be addressed in specific amendments to this DEP as project specific specifications.

SECTION 2 REFERENCED PUBLICATIONS

Add the following:

See also (Part III) of this DEP.

SECTION 3 DEFINITION OF TERMS**3.2 DEFINITIONS****3.2.3 company**

Delete this subsection and replace with the following:

This term shall be understood to mean the Principal as defined in 1.3.1.

3.2.6 imperfection

Delete this subsection and replace with the following:

This term shall be understood to mean 'Imperfection (in NDT)' as described in PART I of this DEP.

3.2.7 indication

Delete this subsection and replace with the following:

This term shall be understood to mean 'Indication (in NDT)' as described in PART I of this DEP.

3.2.8 internal concavity

Replace "internal" with root.

SECTION 4 SPECIFICATIONS**4.1 EQUIPMENT**

Delete this subsection 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.

4.2 MATERIALS**4.2.1 Pipe and fittings**

Delete this subsection and replace with the following:

This DEP applies to the welding of duplex (for example grades such as UNS S31803, S32205, etc, in which PRE is less than 40 but more than 34) and super duplex stainless steel (for example grades such as UNS S32750, S32760, etc, in which PRE is 40 or greater) 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.

4.2.2 Filler metal**4.2.2.1 Type and size**

Delete this subsection and replace with the following:

The electrodes, filler wires, and wire/flux combinations shall be classified to a national standard and should have 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 certificates for the filler materials shall be in accordance with ISO 10474 Type 3.1.B.

4.2.2.2 Storage and handling of filler metals and fluxes

Delete this subsection 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.

4.2.3 Shielding and Backing gas

4.2.3.1 Types

Add the following:

The shielding and back purge gas shall be classified in accordance with ISO 14175. Purity and dew point shall be selected by the contractor in order to achieve the requirements in this DEP. Hydrogen shall not be added. The shielding gas for the root and second passes shall be Ar/2-3 %N. Backing gas may be 100% Nitrogen. Backing gas shall be maintained during welding operations until 10 mm (3/8 in) of weld metal is deposited. The component concentrations of the gas shall be as specified on the WPS and shall be the same for procedure qualification and production welding.

4.2.3.2 Storage and handling

Add the following:

Gases in containers that are unidentifiable shall not be used.

Add the following new subsection:

4.3 QUALITY SYSTEM

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

SECTION 5 QUALIFICATION OF WELDING PROCEDURES FOR WELDS CONTAINING FILLER METAL ADDITIVES

5.1 PROCEDURE QUALIFICATION

Add the following:

All welding SHALL [PS] be qualified using a Welding Procedure Specification (WPS) and corresponding Procedure Qualification Record (PQR), as detailed in Section 5 of this document.

Qualification of welding procedures shall include testing as referenced in Appendix (A2.1) in addition to those as defined below. Separate procedure qualification shall be done simulating partial penetration repairs. Weld root repairs are not allowed and will require a cut out and re-weld. Only WPSs 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 or sub-contractors under direct control of the principal contractor.
- Mechanical and metallographic testing for WPQR has been witnessed by an independent body

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 (20 in) or one OD, whichever is the greater. For flange/fitting welds, suitably sized test rings may be used.

The use of historical reeling data may be permitted subject to meeting the requirements detailed below and being acceptable to the PRINCIPAL. Where acceptable, mechanical test specimens shall be artificially strained 5% (or at level that is representative of the installation and operational conditions) aged at 250°C (482°F) for one hour and be conducted in accordance with Section 8.5.2 of this specification, unless otherwise agreed with the PRINCIPAL.

For pipeline girth welds subjected to plastic deformation during installation (i.e. reeling), fracture toughness testing and ECA should be conducted by the CONTRACTOR in accordance with DNV-OS-F101 and DNV-RP-F108. The proposed philosophy and methodology shall be approved by the PRINCIPAL prior to testing.

A selection of the procedure qualification welds shall be subjected to full-scale simulation bending at the maximum strain predicted during installation. Cognizance shall also be taken of potential high strains and the effect of fatigue during operation and should be assessed if deemed significant by the PRINCIPAL the number of cycles shall be determined from the number of cycles required for installation, plus any contingency operations and agreed with the PRINCIPAL. These strained welds shall then be aged for 1 h at 250°C (482°F).

Weld repair procedures shall be included in the full-scale trial and shall be located to undergo maximum strain. The test welds shall be fabricated into the test string in a manner that ensures that the 12 o'clock welding position of one weld and the 3 or 9 o'clock welding position of the second weld is located at the point of maximum bending strain, i.e. the outside of the bend. The number of welds within the test string shall be sufficient to account for WPQ mechanical test requirements.

5.2 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.
- original NDT reports;
- original laboratory test reports, including macro and micro photographs clearly showing the microstructure of the weld metal, HAZ, and the base material;
- originals or verified copies of the Manufacturer/Supplier's certification documents for the test coupon materials; and
- originals or verified copies of the Manufacturer/Supplier's certification documents for the filler materials and flux employed for test welding.
- The WPQR shall be submitted to the Principal with the production WPS for approval prior to production welding.

5.3 PROCEDURE SPECIFICATION

5.3.1 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.

5.3.2 Specification information

5.3.2.2 Pipe and fitting materials

Delete this subsection 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.

5.3.2.3 Diameters and wall thickness

Delete this subsection and replace with the following:

Where agreed by the Principal, the allowable ranges shall be as defined in (5.4.2.5) and (5.4.2.18).

5.3.2.4 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.

5.3.2.5 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.

5.3.2.6 Electrical characteristics

Add the following:

Where applicable, electrical stick out, 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. Specific machine programs tied to specific models of power supply shall be specified where applicable.

5.3.2.7 Flame characteristics

Delete this subsection.

5.3.2.11 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 second 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 (7.3).

5.3.2.12 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 (7.7).

5.3.2.13 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 (7.11.1) and (7.11.2).

5.3.2.14 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 (7.15).

5.3.2.15 Shielding flux

Add the following:

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