

DEP SPECIFICATION

WELDING OF PIPELINES AND RELATED FACILITIES

DEP 61.40.20.30-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and give recommendations for the welding of pipeline systems and related facilities. It is intended to be used in conjunction with the industry pipeline welding standard or code, such as API 1104, BS 4515, NEN 3650, or DNV OS F-101, that is applicable in the country of installation.

This DEP specifies the requirements for onshore and offshore welding and inspection of pipelines, flowlines and related facilities. Underwater welding is excluded. This DEP also applies to riser hull piping on floating production facilities that connect the riser to topsides piping.

This DEP covers the following main topics:

- Requirements for welding of carbon steel pipelines including NDE and destructive testing
- Supplemental requirements for welding of 13Cr, duplex stainless steel, and clad or lined pipelines
- Instructions for Engineering Critical Assessment for the above type welds.
- Supplemental requirements for reeled and high strain welds

This DEP specifies requirements and gives recommendations for the use and interpretation of automated ultrasonic inspection (AUT) systems for the inspection of girth welds in carbon steel pipelines, flowlines and catenary risers, as well as CRA welds. Required accuracy of the AUT system and interpretation requirements are defined in this DEP.

Details of production inspection using automated ultrasonic inspection (AUT) systems and inspection procedures are outside the scope of this DEP, but are covered in DEP 37.81.40.32-Gen.

Qualification of automated ultrasonic inspection (AUT) systems and inspection procedures are outside the scope of this DEP, but are covered in DEP 37.81.42.35-Gen.

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 February 2011, amended February 2012; see (1.5) 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. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall 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 could 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 regards 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 equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. 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 capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
AUT-Contractor	The AUT Contractor is the party that carries out the AUT inspection and, if required, manual ultrasonic inspection. The AUT-Contractor can be hired directly by the Principal or subcontracted by the Contractor.
Non-critical pipelines	Pipelines identified as non-critical in accordance with DEP 31.40.00.10-Gen.
Critical pipelines	Pipelines identified as critical in accordance with DEP 31.40.00.10-Gen. and having an operational design maximum axial stress ≤ 90 % SMYS or installation stress ≤ 100 % SMYS. All offshore pipelines and all pipelines designated for sour service that are not already designated as critical - high strain.
Critical high-strain pipelines	Pipelines identified as critical in accordance with DEP 31.40.00.10-Gen. and having an operational maximum axial stress > 90 % SMYS or installation stress > 100 % SMYS.
Cumulative Defect	The combined length or height of defect which interact with one another.
Penetrameter	Term used in applicable industry standard which is to be taken to mean IQI as used in ISO 17636.
O'clock	When a specific clock position is stated in this DEP, it may also include the region of ± 1 hour.
WPQR	WPQR is used to describe both the record of a qualification or the qualification welds and any acts associated with making the qualification welds.

1.3.3 Abbreviations

Term	Definition
AFC	Approved for Construction

Term	Definition
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
AUT	Automated Ultrasonic Testing
AWS	American Welding Society
AYS	Actual Yield Strength
CRA	Corrosion Resistant Alloy
CTOD	Crack Tip Opening Displacement
DWE	Double Wall Exposure
ECA	Engineering Critical Assessment
EFC	European Federation of Corrosion
FBE	Fusion Bonded Epoxy
FCAW	Flux Core Arc Welding
GFCAW	Gas Flux Core Arc Welding
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat Affected Zone
HI	Heat Input
HV₁₀	Vickers Hardness (10 kg load)
ID	Internal Diameter
IQI	Image Quality Indicator
ILUC	Internal Line-Up Clamps
NDE	Non-Destructive Examination
OD	Outside Diameter
Pcm	Carbon Equivalent as defined by Japanese Welding Society
pH₂S	Partial Pressure H ₂ S
POD	Probability of Detection
PWHT	Post Weld Heat Treatment

Term	Definition
Q&T	Quenched and Tempered
SAW	Submerged Arc Welding
SENB	Single Edged Notch Bend
SENT	Single Edged Notch Tensile (fracture toughness specimen)
SMAW	Shielded Metal Arc Welding
SMYS	Specified Minimum Yield Stress
SSC	Sulphide Stress Cracking
SWE	Single Wall Exposure
SWV	Single Wall Viewing
TMCP	Thermo-mechanical Controlled Processing
WPQR	Welding Procedure Qualification Record(s)
WPQT	Welder Performance Qualification Test
WPS	Welding Procedure Specification(s)

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (12).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2011, amended February 2012. The following are the main, non-editorial changes.

This is a completely revised DEP with modified title and scope which covers welding of carbon steel, CRA and CRA clad pipelines and related facilities and gives additional requirements to common industry welding standards.

Section/Clause	Change
All	Title change
All	This DEP is a compilation of requirements from DEPs: DEP 61.40.20.30-Gen., DEP 30.10.60.30-Gen., DEP 37.81.40.31-Gen., DEP 61.40.20.31-Gen.(to be withdrawn) and DEP 61.40.20.36-Gen (to be withdrawn).
	This DEP also includes new requirements for welding Super Martensitic Stainless Steel pipelines.

1.6 COMMENTS ON THIS DEP

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://swwww.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.

1.7 DUAL UNITS

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.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL

2.1 INFORMATION TO BE SUPPLIED BY THE PRINCIPAL

1. Project specific information provided by the Principal shall be applied in conjunction with this DEP and applicable welding standard.
2. The project specific information may include the following:
 - a. nominal OD of line pipe(s);
 - b. nominal wall thickness of line pipe(s) and appurtenance material(s);
 - c. grade and designation of the line pipe(s) and component material(s);
 - d. the type of external coating;
 - e. pipeline minimum design temperature;
 - f. pipeline maximum design temperature;
 - g. service environment (e.g., fluid composition, pH, chloride, CO₂, H₂S);
 - h. whether specific Contractor quality procedures to be submitted for agreement;
 - i. whether previously qualified welding procedure specifications may be considered for agreement;
 - j. whether post-weld heat treatment is acceptable / required;
 - k. specific requirements for weld identification marking and weld map;
 - l. whether partial penetration re-repairs can be performed;
 - m. whether all NDE indications are to be reported or only those that are evaluated as defects;
 - n. whether specific radiograph identification requirements are to apply;
 - o. the requirements for final documentation;
 - p. whether alternative acceptance standards for girth welds may be applied and the circumstances under which they are to be applied;
 - q. test temperature for CTOD tests;
 - r. test temperature for Charpy tests;
 - s. if any additional Charpy tests, at other temperatures are required due to special service conditions;
 - t. pipe sizes that require fatigue testing, if different than the default in this DEP;
 - u. sour service requirements, including pH₂S;
 - v. appendices to be invoked;
 - w. listing of AUT contractors who are approved to inspect flow line/pipeline and riser weld inspection;
 - x. acceptance criteria for welds, if different from the criteria in (APPENDIX B);
 - y. acceptance criteria and NDE methodology for (APPENDIX A) CRA weld overlay and clad pipe near the weld bevel, prior to welding;
 - z. whether end dimensioning will be conducted by the Contractor;
 - aa. whether counter boring will be conducted by the Contractor.

2.2 GENERAL AMENDMENTS/ADDITIONS TO INDUSTRY STANDARDS

2.2.1 Equipment

1. The Contractor shall control welding equipment in accordance with ISO 3834-2.
2. The Contractor shall control inspection and test equipment in accordance with ISO 10012 or equivalent local standard.
3. Welding shall not be carried out by plasma arc welding, oxyacetylene welding, self-shielded FCAW or flash butt welding processes.
4. Contractor shall utilise all welding and data logging equipment, of the same type to be used in production, and prepare all spools used in WPQR testing.
5. Welding machines shall not be operated beyond their rated capacity.
 - a. Instruments shall be installed on the machines to accurately measure voltage and amperage.
 - b. The machines shall be maintained in good working order and promptly repaired or replaced if deemed defective.
6. Welding equipment with internal weld data logging capabilities that is outside of current calibration shall have their accuracy demonstrated prior to WPQR welds using an external secondary calibrated weld data logger or calibrated ammeters/voltmeters.
 - a. Welding equipment with internal weld data logging capabilities should be calibrated every 6 months.
 - b. Periodic performance checks of weld data logging equipment, wire feed speed, travel speed, and gas flow rate should be verified during production welding where required by the Principal.
7. Welding machine leads shall be fastened to the base metal securely by means of clamps or other mechanical means (not by welding) as follows:
 - a. Connections do not cause notch damage to the pipe.
 - b. Arcing does not occur between the leads and the pipe.
 - c. Any leads with insulation damaged shall be discarded or safely repaired to meet applicable safety standards.
8. The length of leads and their gauge shall be documented during WPQR welding and not changed more than 10 % from that qualified.
9. GMAW, GTAW, and gas-shielded FCAW shall be restricted to construction areas protected against wind and draught.
10. GTAW power sources shall have a high-frequency starting unit and a crater-eliminating slope-out control.
11. All mechanized welding equipment shall be capable of being connected to a data logging system that can record all parameters relevant to the applied heat input including wire feed speed.
12. For semi-automatic and mechanised / automatic welding, the welding power supply and welding bugs used in production shall be of the same type, model and software version as those used for welding procedure qualification.
13. The Contractor or Manufacturer/Supplier shall have demagnetisation equipment available to reduce or eliminate magnetization of the carbon steel pipe that could interfere with the welding activities.
14. All instruments used for monitoring the welding parameters shall be calibrated in accordance with Manufacturer/Supplier's recommendations and the Contractor's calibration procedure.

2.2.2 Handling of base materials

1. Pipe storage and handling facilities shall be subject to approval by the Principal.
2. Bare wire slings shall not be used to lift coated pipe.
3. Pipes and fittings shall be stored in segregated area(s) dedicated to one material type.
4. The Contractor's procedures for the avoidance of contamination shall be subject to approval by the Principal prior to the commencement of any CRA welding related activities.
5. Pipe handling equipment, rollers, racks, line-up clamps, steelwork and any equipment that could come into contact with CRA pipe, cladding/liner surfaces, or other CRA components shall be padded or covered with stainless steel or non-metallic material to prevent contamination.
6. Pipe handling equipment, rollers, racks, line-up clamps, steelwork and any equipment that could come into contact with CRA pipe, cladding/liner surfaces, or other CRA components shall not be used for handling ferritic steels.
7. Brushes, grinding discs and other tools that have been in contact with ferritic steels shall not be used with CRAs.

2.2.3 Quality system requirements

1. The Contractor shall operate a quality system in accordance with and ISO 9001 as supplemented by ISO 3834-1 and ISO 3834-2, or an alternative system approved by the Principal.
2. A contract-specific quality plan shall be submitted by the Contractor to the Principal for approval prior to the commencement of welding.
Review by the Principal of a preliminary quality plan at the enquiry stage may assist the process.
3. The verification activities carried out on behalf of the Principal shall be defined on the quality plan.

2.2.4 Qualification of NDE personnel

1. NDE personnel shall hold a valid qualification to ISO 9712 for the relevant technique (or to an equivalent standard approved by the Principal).
2. The roles and responsibilities of NDE personnel shall be as defined in the levels of competence in ISO 9712 or local equivalent standard (e.g., ASNT)
3. The Contractor shall have a Level 3 qualified NDE practitioner available for supervision and assistance in the interpretation of ambiguous indications.
The Level 3 NDE practitioner does not need to be present continuously at the NDE inspection point but made available when required.
4. Ultrasonic operators shall be subject to approval of the Principal.
5. For CRA materials ultrasonic operators shall demonstrate through examination, experience and practical testing that they are competent in the use of UT for detecting defects.
6. If NDE personnel fail to meet performance requirements, they shall be disqualified from the work until it can be demonstrated by the Contractor that they have achieved a satisfactory standard by undertaking a test by a third party agency approved by the Principal.
7. The competence assurance system for qualification of AUT personnel shall be subject to the approval of the Principal.

2.2.5 Qualification of inspection personnel

1. Welding inspection personnel shall hold a valid welding inspection qualification and certificate in accordance with Table 1 or an alternative qualification approved by the Principal.

Table 1 Competence levels for welding inspection personnel

Competence Level	Country/Region	Applicable Standard	Inspector Position	Designation
1	UK / Europe	ISO 17637	Visual Welding Inspector	3.0
	Netherlands / Europe	ISO 17637 / ISO 14731	International Welding inspector, Basic	IWI-B
	USA	AWS	Certified Associate Welding Inspector	CAWI-
2	UK / Europe	ISO 17637	Welding Inspector	3.1
	Netherlands / Europe	ISO 17637 / ISO 14731	International Welding inspector, Standard	IWI-S
	USA	AWS	Certified Welding Inspector	CWI
3	UK / Europe	ISO 17637	Senior Welding Inspector	3.2
	Netherlands / Europe	ISO 17637 / ISO 14731	International Welding inspector, Comprehensive	IWI-C
	USA	AWS	Senior Certified Welding Inspector	SCWI-

2.2.6 Documentation

1. All required documentation shall be in the English language.

3. WELDING PROCEDURE QUALIFICATION**3.1 GENERAL**

1. All WPS SHALL [PS] be qualified with the results documented on a WPQR and approved by Mechanical, Materials & Integrity (MMI) technical authority of the Principal and available for all production welds.
2. Filler metal shall be used for all passes.
3. When indicated by the Principal in the enquiry document, previously qualified welding procedure specifications may be offered for agreement subject to the following:
 - a. The WPQR is fully in accordance with this DEP.
 - b. The WPS is amended to reflect the project-specific details.
 - c. The welding is within the essential variables defined in this DEP.
 - d. The WPS and WPQR are owned and controlled by the Fabricator.
4. The proposed welding procedure specifications (p-WPSs), for all welding procedures including repair welding, shall be submitted to the Principal for review a minimum of two weeks prior to the proposed date of welding qualification.
 - a. The p-WPS shall be endorsed and signed by the Contractor's authorised representative prior to submission.

- b. After acceptance by the Principal, each WPS shall be qualified in accordance with this DEP.
- 5. If the test joint fails to meet the minimum requirements of this DEP, a new WPS shall be established, qualified and subject to approval by the Principal.

3.2 WELDING OF TEST PIECE

- 1. To qualify mechanised/automatic welding procedures, three test welds shall be made for each welding procedure.
 - a. All three shall be subjected to non-destructive testing and at least one subject to mechanical testing.
- 2. All qualification welds shall be subjected to volumetric NDE using the approved production NDE method.
- 3. The NDE acceptance criteria for welding procedure qualification shall be the same as for production welding.
- 4. Any weld which fails to meet the acceptance criteria shall not be offered for destructive testing.
- 5. Test welding shall be performed using pipe sections with a minimum length of 250 mm (10 in).

A minimum length of 500 mm (20 in) might be required if fatigue testing is specified.
- 6. For flange/fitting welds, suitably sized test rings at least 300 mm (12 in) in length shall be used.

3.3 WELDING PROCEDURE QUALIFICATION RECORD

- 1. The procedure qualification record (WPQR) shall include the following:
 - a. Printouts or electronic data files from the weld data logging system.
 - b. Original NDE reports.
 - c. Original laboratory test reports, including macro and micro photographs with scale, clearly showing the microstructure of the weld metal, HAZ, and the base material.
 - d. Originals or verified copies of the Manufacturer/Supplier's certification documents for the test coupon materials.
 - e. Original or verified copies of the Manufacturer/Supplier's certification documents or lab test results for the welding consumables.
- 2. The final WPQR shall be submitted along with the WPS to the Principal for approval two weeks prior to production welding.

3.4 INFORMATION TO BE INCLUDED IN WPS

- 1. The WPS shall incorporate the technical contents specified in ISO 15609-1, and, if applicable, the following:
 - a. steel grade and delivery condition in accordance with recognized industry welding standard;
 - b. number of welders for the specific weld passes;
 - c. maximum time lapse between start of root pass and start of second (hot) pass;
 - d. type of line-up clamp or tack welding;
 - e. preheating procedure;
 - f. minimum interpass temperature if different from the preheat temperature;