

DEP SPECIFICATION

CRA-CLAD AND CRA-LINED STEEL PIPE
(AMENDMENTS/SUPPLEMENTS TO API SPEC 5LD)

DEP 31.40.20.32-Gen.

February 2019

DESIGN AND ENGINEERING PRACTICE

DEM1



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the purchase of seamless and welded corrosion resistant alloy (CRA) clad or lined steel pipe for both sour and non-sour service.

This DEP is based on API SPEC 5LD, 4th Edition, March 2015. Part (III) of this DEP amends, supplements and deletes various clauses of API SPEC 5LD, including June 2017 Errata 1. Part (III) follows the clause numbering of API SPEC 5LD for easy reference.

All clauses of API SPEC 5LD not modified by this DEP remain valid as written.

Circumferential welds are not included in the scope of this DEP. Where circumferential welds (joints) are permitted in production of the line pipe, the requirements are specified in the Project pipeline installation specification; see Part (III).

The material properties, testing and inspection requirements for the carbon steel backing material, together with the overall dimensional tolerances for the finished pipe, are specified in IOGP Document S-616 'Supplementary Requirements to API Specification 5L Line Pipe' this document replaces DEP 31.40.20.37-Gen. CRA Clad and/or lined pipe can also be specified as complying to DNVGL-ST-F101, provided the requirements of this DEP are met, see Appendix 4 for guidance.

The appendices of this DEP give specific requirements for the following:

- Line pipe to be subjected to high strain;
- Weldability testing;
- Linepipe for deepwater projects, including steel catenary riser;
- CRA clad or lined pipe in accordance with DNVGL-ST-F101;
- Inspection of Clad plate.

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 September 2011; 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 authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and/or gas transmission pipelines and related facilities. It is intended for use by Exploration and Production, Manufacturing, Chemicals or Supply/Distribution companies that require the use of line pipe. Application in other facilities may also apply. This DEP may also be applied in other similar facilities.

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 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
Defect (in NDT)	A discontinuity or group of discontinuities whose indication(s) do(es) not meet specified acceptance criteria.
Disbonding	A lack of bond between the base material and the CRA layer, and considered an imperfection.
Flaw/ Discontinuity (in NDT)	An interruption, which could be either intentional or unintentional, in the physical structure or configuration of a pipe.
Indication (in NDT)	Evidence of an imperfection that requires interpretation to determine its significance.
Inspection release note	A document issued by the Principal to authorise shipment (applicable only if the Principal has been involved in monitoring production, inspection and/or documentation).
Minimum operating temperature	The minimum temperature to which the pipeline or section of pipeline can be exposed during normal operational activities, including start-up and shut-down operations and controlled blowdown, but excluding abnormal situations such as pipeline ruptures.
Pipe bevel	The total weld preparation machined on the end of a pipe.
Plate or Coil	The flat starting material for welded pipe before forming into the shape of a pipe.
Purchaser	Term used in API Spec 5LD which has the same meaning as Principal.
Radiological	Term used in API Spec 5LD which has the same meaning as radiographic. The term radiographic is used in this DEP.
Seal weld	Weld performed on the ends of lined pipe to seal the annulus between the CRA liner and carbon steel base pipe.

Term	Definition
Weld overlay clad end	Weld overlay performed on the ends of lined pipe to seal the annulus between the CRA liner and the carbon steel base pipe.

1.3.3 Abbreviations

Term	Definition
AUT	Automated Ultrasonic Testing
BWE	Back Wall Echo
CLA	Centre Line Average
CRA	Corrosion Resistant Alloy
DN	Diameter Nominal
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat Affected Zone
HFW	High Frequency Welded
ID	Inside Diameter
LSAW	Longitudinal Submerged Arc Welding
MUT	Manual Ultrasonic Testing
NDT	Non-destructive Testing (also known as NDE)
OD	Outside Diameter
PAW	Plasma Arc Welding
PREN	Pitting Resistance Equivalent Number
PT	Dye Penetrant Testing
UNS	Universal Numbering System
UT	Ultrasonic Testing
WPS	Welding Procedure Specification

1.4 CROSS-REFERENCES

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

1.5 SUMMARY OF MAIN CHANGES

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

Section/Clause	Change
Various	Reference to DEP 31.40.20.37-Gen has been replaced by IOGP S-616 'Supplementary Requirements to API Specification 5L Line Pipe.
5.2	Seal welds are no longer allowable in lined pipe
5.2	309Mo is recommended but not mandatory for welds in 316L clad/lined pipe
5.5	Add New section on allowable welding processes
6.3	Allowable iron content in 625 overlay increased from 5 to 8%. 5% was not practically achievable.
8.2	In sour service the backing steel shall comply with the requirements for carbon steel in sour service (annex H of IOGP S-616) with the exception that HIC and SSC testing is not required, unless specified for individual projects.
9.1	Maximum allowable chloride content in hydrotest water changed from 50 mg/kg to 200 mg/kg to align with DEP 31.40.20.34-Gen. and DEP 31.40.40.38-Gen.
11.5	Add New section on AUT systems
11.6	Add New section on ultrasonic and electromagnetic inspection reference standards
Appendix 4	Add New appendix for pipe in accordance with DNVGL-ST-F101
Appendix 5	Add New appendix on inspection of clad plate

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.
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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.

PART II GENERAL REQUIREMENTS

1.1 GENERAL

Part (III) of this DEP is written as amendments and supplements to API Specification 5LD 4th Edition, March 2015.

1. Wherever reference is made to API SPEC 5LD, it shall be understood to mean API Specification 5LD 4th Edition, March 2015, as amended/supplemented by this DEP.
2. Appendix 1 of this DEP and Appendix 3 of this DEP address specialized applications and shall be used in cases of high strain (Appendix 1) or deepwater (Appendix 3) design.
3. Appendix 2 (weldability) of this DEP shall be applied in all cases.
4. Appendix 5 (inspection of clad plates) shall be applied in the case of clad pipe manufactured from clad plate
5. Prior to purchase orders being awarded the pipe mill shall be listed as approved on the current Shell TAMAP (Technically Approved Manufacturers and Products) list for linepipe.
6. For ease of reference, the clause numbering of API SPEC 5LD has been used throughout Part (III) of this DEP.
7. Clauses in API SPEC 5LD, which are not mentioned in this DEP, shall remain valid as written.
8. Where circumferential welds (jointers) are permitted in production of the line pipe, the requirements for the circumferential welds shall be included in the Project pipeline installation specification and, be included in the Purchase Order.

Rationale: To ensure circumferential weld requirements are documented and communicated.

9. Unless otherwise stated in this DEP, the material properties, testing and inspection requirements for the carbon steel backing material, together with the overall dimensional tolerances for the finished pipe, shall be as specified in IOGP S- 616., amending API 5L 46th Edition, May 2018 and ISO 3183, 2019 (PSL 2).
ISO 3183:2019 references API 5L 46th Edition as the primary standard.
10. The format of LPMDS (Line Pipe Materials Data Sheet) as required for IOGP S-616 shall be used as the basis for initial enquiries for CRA pipe.

PART III AMENDMENTS/SUPPLEMENTS TO API SPEC 5LD

1 Scope

1.1 Coverage

Replace the third paragraph with the following:

Grades of base metal covered by this specification are L360, L390, L415, L450 and L485 (X52, X56, X60, X65 and X70). Grades of the CRA layer covered are Grades S31603, N08904, N08825, N06625 and any other alloy specified by the Principal in the purchase order.

Add new section:

1.3 Quality System

1. The Manufacturer/Supplier shall establish and maintain a quality assurance system in accordance with ISO 9001, or an approved equivalent, and furnish a quality plan specific to the items stated in the purchase order to the Principal.

2 Normative References

Add the following:

1. Refer to (Part IV) of this DEP.

3 Terms, Definitions and Abbreviations

Add the following:

1. Refer to (Part I, 1.3) of this DEP.

5 Manufacturing of Clad and Lined Steel Pipe

5.2 Description of Clad and Lined Steel Pipe

Replace all instances of API 5L PSL 2 with the following in Item 1:

1. IOGP S-616, including Annex H, with the exception of the HIC and SSC testing, except where specified on individual purchase orders.

Add the following clauses:

2. During all stages of manufacture, including grit blasting and cutting, contamination of the CRA layer with carbon steel shall be avoided, taking the following precautions:
 - a. Direct contact of the CRA layer with carbon steel handling equipment (e.g., hooks) shall not be done;
 - b. The hand tools used for CRA shall be separate from the hand tools used for carbon steel.
3. For the overlay of the longitudinal seam in the case of welded, clad pipe and for the pipe end overlay in the case of lined pipe, the following shall be satisfied:
 - a. The use of consumables other than 309 MoL consumables in the welding of 316L clad/lined pipe shall be subject to Principal approval.
 - b. The Mo content of 309 MoL weld metal shall be at least equal to that of the cladding/lining.

- c. Alloy 625 or other Nickel-based consumables approved by the Principal shall be used in the welding of alloy 825 and alloy 625 clad/lined pipe.
- d. The PREN* of the deposited weld (weld cladding) material shall exceed that of the cladding/lining material, except in the case of 625 lining/cladding material.

$$*PREN = \% Cr + 3.3 \% Mo + 16 \% N$$

5.2.2 Lined Pipe

Add to first paragraph:

1. The carbon steel base material for lined pipe shall be produced by the seamless process or, with the approval of the Principal, either welded HFW or LSAW pipe.
 - a. IOGP S-616, including Annex H shall apply, with the exception that HIC and SSC testing is not required unless specified on individual purchase orders.
2. In the case of welded pipe used for CRA mechanically lined pipe, the height of the internal reinforcement shall be not more than 1 mm (0.04 in), and blend smoothly, unless otherwise specified by the Principal.
3. Immediately prior to the introduction of the liner, the internal surface of the base pipe (or, in the case of lined pipe manufactured from plate and sheet, the surface of the steel plate which becomes the internal pipe surface) shall be internally blasted to a surface finish of SA 2½, ISO 8501-1.

5.3 Cold Sizing and Cold Expansion

Add new section:

5.3.5 Circumferential Welds

1. Circumferential welding, where permitted, shall not take place before expansion.

Add new section:

5.5 Welding Processes

1. Use of welding processes without filler metal shall be subject to approval by the Principal.
2. The longitudinal seam welds for clad pipe SHALL [PS] be full penetration and double sided welded using a qualified welding procedure specification applicable to one or more of the following welding processes:
 - a. Gas Tungsten Arc Welding (GTAW);
 - b. Plasma Arc Welding (PAW);
 - c. Submerged Arc Welding (SAW);
 - d. Gas Metal Arc Welding (GMAW).
3. For internal weld passes on clad pipe, electroslag welding may be used.
4. The longitudinal seam welds in the CRA liner for lined pipe shall be full penetration and be welded using a qualified welding procedure specification applicable to one of the following welding processes:
 - a. GTAW welding;
 - b. PAW welding.

6 Chemical Properties and Tests

6.1 Composition

Add the following clause:

1. The Molybdenum content of 316L shall not be less than 2.5 wt%.

6.3 Product Analyses of Backing Steel, Welds, and CRA

Replace the third sentence in this section with the following:

1. Samples for analyses shall be taken from finished pipe (i.e., pipe which has been formed, welded (if applicable) and expanded (if applicable) but not necessarily before trimming to final pipe length).

a). *Seamless Clad or Lined Pipe.*

Delete this section.

b). *Welded Clad or Lined Pipe.*

Delete the first sentence of this section.

Add the following section:

c). *Chemical Analysis of Weld Overlay.*

- i. A check of the chemical analysis of the weld overlay shall be made on two pipes per heat.
 - ii. The chemical analysis shall be done on a point located in the middle of the overlay bead, at least 1 mm (0.04 in) below the surface and at a distance of at least (tc-1 mm) from the overlay/backing material interface where tc is the minimum specified overlay thickness.
 - iii. The elements to be analysed shall include Mn, Cr, Ni, Mo and Fe.
2. The values measured shall be consistent with a dilution of the filler metal composition by less than 10 %.
 3. In the case of Inconel 625 overlay, the iron content shall not exceed 8 %.
 4. Where the cladding or liner is specified as N06625, the iron content of the weld overlay shall not exceed 8 %.
 5. For the weld overlay end of lined pipe, the use of an NDT method such as X-Ray Fluorescence Spectroscopy (XRF) as a substitute shall be subject to approval by the Principal.

Delete the 7th paragraph of this section "The product analyses of..."

6.6 Backing Material

Replace this section with the following:

1. The chemical composition of the backing material (heat and product analysis) shall conform to the requirements of IOGP S-616 Section H.4.1.
2. All Elements as listed in API 5L table H.1 shall be reported.

7 Mechanical Properties and Tests

Add the following clause:

1. The number of test pieces, per weld, test methods and acceptance criteria for all tests shall be as specified in IOGP S-616, Section 10.2., Annex H.7.2 and Annex J.8.1.