

DEP SPECIFICATION

CATHODIC PROTECTION SYSTEMS FOR SUBSEA PIPELINES AND HARDWARE (AMENDMENTS/SUPPLEMENTS TO ANSI/NACE SP0607- 2007/ISO 15589-2)

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DESIGN AND ENGINEERING PRACTICE



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies minimum requirements and gives recommendations for the design, installation, electrical continuity verification, commissioning, and surveying of cathodic protection systems for subsea pipelines and hardware and for submerged pipeline sections of on-shore pipelines.

This DEP is based on ANSI/NACE SP0607-2007/ISO 15589-2, hereinafter referred to as ANSI/NACE-ISO.

The sections of ANSI/NACE-ISO included in the scope of this DEP are Sections 1-7, Sections 10-13, Annex A, Annex C, Annex E, Annex F and Annex G. ANSI/NACE-ISO Sections 8 and 9, and Annex D deal with the manufacturing and quality testing of anodes and are covered in DEP 37.81.20.31-Gen. ANSI/NACE-ISO Annex B is not included in the scope of this DEP because it deals with long term chemistry and qualification testing of galvanic anodes, which is outside the scope of this DEP.

This is a revision of the DEP of the same number dated July 1996; 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 gas production, gas handling, distribution and supply/marketing. 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 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 word **should** indicates a recommendation.

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 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

PART II GENERAL REQUIREMENTS**1.1 GENERAL**

Part III of this DEP is written as amendments and supplements to ANSI/NACE-ISO.

Wherever reference is made to ANSI/NACE-ISO, it shall be understood to mean ANSI/NACE-ISO as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ANSI/NACE-ISO has been used throughout (Part III).

Unless specified otherwise in this DEP, all occurrences of the word "should" in ANSI/NACE-ISO shall be replaced with the word "shall".

Clauses in ANSI/NACE-ISO which are not mentioned in this DEP shall remain valid as written.

The cathodic protection systems for offshore pipelines and subsea hardware shall be in accordance with ANSI/NACE-ISO Sections 1-7, Sections 10-13, Annex A, Annex C, Annex E, Annex F, and Annex G with the following amendments/supplements contained herein. Sections 8 and 9 and Annexes B and D of the ANSI/NACE-ISO standard are excluded.

Unless otherwise specified, the references to pipeline(s) in the respective included sections of the ANSI/NACE-ISO standard should be considered as referring to both pipelines and subsea hardware.

Table A provides a summary of the major amendments/supplements to ANSI/NACE-ISO.

Table A: Major Variations to ANSI/NACE-ISO

Topic	DEP Part	DEP Section	Comments
Cathodic Protection Compatibility	III	5.1	Requirements on compatibility between impressed and sacrificial CP systems provided to ensure compatibility between systems.
Design Current Densities	III	6.4	Additional requirements for depths greater than 500m.
Coating Breakdown Factors	III	6.5	Initial coating breakdown factors increased by a factor of 1.75.
Thermal Insulation Coating Breakdown Factors	III	6.5	For thermal insulation systems greater than 50mm a different calculation method is presented for coating breakdown factors.
Electrochemical Properties	III	7.3	Modified electrochemical capacity values presented.
Additional Anodes	III	7.5	Additional anode requirements outlined at various interfaces.
Under Water Installation	III	10.4	Added to provide requirements on retrofit situations.
Subsea Hardware Electrical Continuity Verification	III	10.5	Added to ensure all individual components of the subsea hardware receives CP.

1.2 DESIGN PHILOSOPHY

Subsea pipelines and hardware shall be protected from corrosion using a combination of coatings and CP. The CP system shall be designed to maintain the electrochemical potential of exposed metal surfaces within a range that controls corrosion within acceptable limits and without causing material damage for the specified design life of the asset.

The recommended CP system for newly constructed subsea pipelines features bracelet-type sacrificial anodes. The recommended CP system for newly constructed subsea hardware features either stand-off or flush mounted anodes.

The CP system shall maintain the pipe-to-seawater potential of pipelines between -800 and -1100 mV with respect to an Ag/AgCl reference cell.

CP can have a detrimental effect on duplex stainless steels and some high strength steels if they are susceptible to hydrogen induced stress cracking (HISC). High strength steels that are susceptible to HISC shall not be used in conjunction with CP. For duplex stainless steels the guidance provided in DNV F-112 shall be applied to reduce the risk of HISC. Sacrificial anodes shall not be attached directly to duplex stainless steel components. Only aluminium or zinc sacrificial anodes shall be used with duplex stainless steels. Magnesium anodes or impressed current CP shall not be used.

The CP system shall be designed for the full design life of the subsea pipeline or hardware.

Electrical isolation between compatible sacrificial anode CP systems on platforms and pipelines is not required from a CP standpoint but other factors such as future asset sales and tie-ins may mandate electrical isolation. Subsea pipelines can be electrically isolated from an onshore section by using an isolation joint at the beach. The isolation joint may be omitted if the onshore impressed current CP system is designed to ensure that there is no current drain from the offshore pipeline sacrificial anodes to onshore. This should include the installation of potential monitoring coupons close to the onshore pipeline to allow potentials to be accurately measured during service.

The design of the CP system shall be carried out by Contractor approved by the Principal.

1.3 CONCEPTUAL DESIGN

The Contractor shall submit to the Principal a conceptual design of the CP system for review and approval. Only after such approval, shall the Contractor commence detailed design.

In some cases (e.g. on small projects or standard projects) the Principal may request the Contractor to carry out both conceptual design and detailed design in one operation.

PART III ANSI/NACE-ISO**1 SCOPE**

Delete this section and refer to (Part I, clause 1.1).

2 NORMATIVE REFERENCES

Add to this section the references listed in (Part IV).

3 TERMS AND DEFINITIONS

Add new terms:

hardware

subsea infrastructure used to aid in the gathering of hydrocarbons, excluding pipelines, flowlines, and risers. Typical examples include pipeline end terminations/manifolds, manifolds and trees. Any piping contained in the structure shall be considered as part of the hardware. Fixed offshore structures such as jackets and floating offshore structures are not included.

jumper

static or flexible piping utilized to transport the pipe contents between manifolds, pipeline end terminations/manifolds and trees.

4 SYMBOLS AND ABBREVIATED TERMS

Add new terms:

AFC approved for construction

HRC Rockwell Hardness C

5 CP SYSTEM REQUIREMENTS**5.1 GENERAL**

Replace 1st sentence of 4th paragraph by:

Subsea pipelines can be electrically isolated from an onshore section by using an isolation joint at the beach. The isolation joint may be omitted if the onshore impressed current CP system is designed to ensure that there is no current drain from the offshore pipeline sacrificial anodes to onshore. This should include the installation of potential monitoring coupons close to the onshore pipeline to allow potentials to be accurately measured during service.

Add new clause:

5.1.1 Requirements for subsea hardware

Subsea hardware shall be protected from external corrosion using a combination of coatings and CP.

The CP system shall be designed, fabricated, and installed by a Contactor approved by the Principal.

The CP system shall be designed so that exposed hardware metal surfaces are maintained within an electrochemical potential range that protects them from external corrosion for the design life of the system.

As specified in clause 12.2.2, subsea hardware shall contain CP test points to provide an accessible location for potential measurements.

Electrical continuity and its verification conform to clause 10.5.

If electrical continuity cannot be guaranteed (by permanent metal to metal contact) CP shall be designed discretely.

Electrical isolation between proven compatible sacrificial anode CP systems is not required unless specified by the Principal. Compatible systems are those with anodes of the same chemistry.

Anodes shall be distributed as widely as possible with consideration to movement during the installation process and movement from thermal expansion. Effect of the anode placement on the centre of gravity of the hardware shall be considered.

In certain cases, electrical isolation between hardware protected by an impressed current CP system and hardware protected by a sacrificial anode system may not be practical or desirable. For these cases the impressed current CP system should operated between – 0.950V (vs. Ag/AgCl) and –1.050V (vs. Ag/AgCl) for aluminium anodes and between – 0.950V (vs. Ag/AgCl) and –1.030V (vs. Ag/AgCl) for zinc anodes to increase compatibility between the two systems. With Principal approval, impressed systems can be utilized for initial polarization with the galvanic system designed to sustain the subsea equipment for the remaining life. In this case special care shall be given to the impacts of the polarizing potentials on any material susceptible to hydrogen damage.

In cases where compatibility is deemed critical, and if specified by the Principal, advanced computer modelling shall be used to ensure that the impressed current system and the sacrificial anode system are compatible and that the impressed current system is capable of supplying sufficient current to current drains.

6 DESIGN PARAMETERS

6.1 GENERAL

Add new clause:

6.1.1 Requirements for subsea hardware

Design of the CP system for subsea hardware shall be based on:

- materials, exposed surface area, temperature, type and thickness of corrosion coating, type and thickness of insulation coatings, confidence of electrical continuity, and installation requirements,
- all possible current drains including control tubing, half of all possible jumpers (assuming the other half of the jumper is protected from the subsea hardware at the other end), pig receivers, flying leads...etc.
- environmental conditions, such as seawater composition, temperature, and resistivity at the seabed,
- the design life of the subsea hardware,
- applicable local regulations,
- performance data on CP systems in the same environment.