

DEP SPECIFICATION

CATHODIC PROTECTION SYSTEMS FOR FIXED OFFSHORE STEEL STRUCTURES (AMENDMENTS/SUPPLEMENTS TO NACE SP0176-2007)

DEP 37.19.30.30-Gen.

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DESIGN AND ENGINEERING PRACTICE



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the number, mass, dimensions, type, and distribution of anodes for the cathodic protection (CP) of new fixed offshore steel structures.

This DEP is based on NACE Standard SP0176-2007. Part III of this DEP amends, supplements and deletes various clauses of NACE SP0176-2007. Part III follows the clause numbering of NACE SP0176-2007 for easy reference.

All clauses of NACE SP0176-2007 not modified by this DEP remain valid as written.

This DEP may also serve as a guideline if in situ replacement of a CP system is required.

This DEP is a revision of the DEP of the same number dated December 1995; 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, oil refining, chemical processing, gasification, 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 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

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 clause number is shown in brackets (). Other documents referenced in this DEP are listed in (Part IV).

1.5 GUIDANCE FOR USE

Part I of this DEP provides an introduction, Part II discusses CP philosophy, and Part III contains amendments/supplements to NACE Standard SP0176-2007.

For clarity, the clause numbering of NACE Standard SP0176-2007 has been used. Clauses in NACE Standard SP0176-2007 that are not amended/supplemented by this DEP shall remain valid as written.

1.6 SUMMARY OF MAIN CHANGES

Due to the change in the base document from DNV to NACE, there are significant changes in the organization of this DEP from the 1995 version, but no change in the design methods other than incorporating the slope intercept method as an optional design method. This is in Appendix E of the NACE standard.

There is one potentially significant change in source of design data. [Appendix A] in the NACE standard contains two sources of data for determining the design current density [Table A1 and Figure A1], where the previous version of the DEP only had the Figure A1. While preserving the need for the Principal to provide or approve all design data, Appendix A of this DEP states that, unless agreed to by the Principal, the design shall be based on data from Figure A1. Table A1 shall be considered for reference, e.g. in cases where water velocity or other factors may require higher values. In practice, the Principal generally provides this type of data as actually measured, so there is little practical change in the process.

Prequalification testing of anodes as covered in Appendix 3 of the previous DEP is deleted here and incorporated instead in DEP Informative 37.81.20.31-Gen.

1.7 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 NACE SP0176-2007. Wherever reference is made to NACE SP0176-2007, it shall be understood to mean NACE SP0176-2007 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of NACE SP0176-2007 has been used throughout Part III of this DEP.

Unless specified otherwise in this DEP, all occurrences of the word "should" in NACE SP0176-2007 shall be replaced with the word "shall".

Clauses in NACE SP0176-2007 which are not mentioned in this DEP shall remain valid as written.

1.2 DESIGN PHILOSOPHY

CP systems shall be designed to maintain the submerged metal surfaces of offshore structures within a specified electrochemical potential range that prevents sub-sea corrosion and material damage. Maintaining the potential is normally achieved by supplying cathodic protection current from a sacrificial anode system. Impressed current systems shall not be used for new installations unless specified by the Principal.

Impressed current CP systems are typically used in brackish waters or if high currents mitigate the formation of calcareous film. An impressed current system may also be considered for an offshore structure that is to serve beyond its original design life and in which the sacrificial anodes are depleted.

As a minimum, a CP system shall be designed for the full design life of the structure. However, the possibility of a prolonged field life requiring an extended structure life shall be given due consideration.

CP systems specified in this DEP shall be used only in seawater with a salinity range of 3.3 to 3.8%, and a temperature range of 4 to 30°C.

CP systems shall be designed to maintain the submerged steel surfaces within an electrochemical potential range of -0.800 to -1.050 volts versus Ag/AgCl/seawater.

Traditionally the Principal has relied solely on sacrificial anodes to prevent subsea corrosion of its offshore structures. Nevertheless, if circumstances result in very high current demand or anode weights, and if the use of sacrificial anodes alone is not considered effective or feasible, coatings shall be used in conjunction with sacrificial anodes.

1.3 DESIGN TEMPLATE

A design sheet that may be helpful to designers with the design and calculation sequence is presented in (Appendix F). An example of its use is presented in (Appendix G).

PART III AMENDMENTS/SUPPLEMENTS TO NACE SP0176-2007**FOREWORD**

*Delete **Foreword**.*

SECTION 1 GENERAL**1.2** *Replace this clause by:*

Corrosion on structures is divided into three zones, submerged, splash, and atmospheric.

1.6 *Replace this clause by:*

No deviations from the requirements of this DEP are permitted without explicit approval of the Principal

SECTION 2 DEFINITIONS, SYMBOLS, AND ABBREVIATIONS

Add new term:

MAST: Mean Anticipated Service Temperature

SECTION 3 STRUCTURAL DESIGN FOR CORROSION CONTROL**3.1** INTRODUCTION**3.1.1** *Replace this clause by:*

This **clause** recommends design features that simplify corrosion control of structural steel in the submerged zone of offshore structures.

3.2 SPLASH ZONE**3.2.2** *Replace 2nd sentence with:*

Coating for splash zone shall be addressed by DEP 31.40.30.36-Gen.

3.3 ATMOSPHERIC ZONE**3.3.2** *Replace this clause by:*

Corrosion in this zone is typically controlled by the application of a protective coating system.

3.5 SUBMERGED ZONE – INTERNAL AREAS**3.5.1** *Add at the end of this clause:*

Where there is surface access to flooded compartments, provisions for entry or venting shall consider the potential presence of toxic and/or flammable gasses.

SECTION 4 CRITERIA FOR CP**4.2 GENERAL**

4.2.2 *Delete 2nd sentence.*

4.4 ALTERNATIVE REFERENCE ELECTRODES

4.4.1.1 *Add at the end of the clause:*

Cu/CuSO₄ should not be used in seawater except as a check to the Ag/AgCl reference. If CSE is used it shall be frequently checked and CuSO₄ solution replaced if contaminated (milky) and copper electrode cleaned.

4.5 METHODS OF MEASURING AND EVALUATING cp

4.5.1 *Add at the end of this clause:*

The Contractor shall prepare a plan for an initial cathodic protection commissioning survey to be performed after installation of the jacket and prior to connection of the pipelines, for approval by the Principal. The survey plan shall also include at least the following:

- Number and location of structure-to-electrolyte measurements
- Method of performing the survey
- Proposed timing of the survey
- Equipment and procedures to be used to carry out the survey

Upon approval by the Principal, the Contractor shall carry out the survey.

Add new clause:

4.8 DETRIMENTAL EFFECTS OF CATHODIC PROTECTION

4.8.1 Low-alloy steels with minimum yield stress ranging from 275 to 450 MPa are specified for substructures for fixed offshore platforms (see DEP 37.19.00.30-Gen.). If the use of higher strength steels is considered, particularly those with minimum yield stress above 400 MPa, special attention shall be given to:

- Weldability and requirements for special welding procedures
- Fatigue problems that may result from the use of higher working stresses
- Toughness requirements in relation to other elements of fracture control, such as fabrication specifications, inspection procedures, service stress, and service temperature
- Potential effect of seawater and corrosion protection system performance on fatigue characteristics
- Reduced strain hardening associated with higher ratio of yield strength to ultimate strength

4.8.2 Quenched and tempered low-alloy steels, cold worked austenitic steels, duplex steel, and precipitation hardened ferrous and non-ferrous alloys that are not intended for welding may be susceptible to various types of hydrogen embrittlement, such as hydrogen induced stress cracking (HISC) and sulphide stress cracking (SSC). These alloys shall be proven compatible, by the Manufacturer/Supplier, with CP systems utilising aluminium-based sacrificial anodes. If impressed current CP is used, the suitability of materials of construction shall be reviewed by the Principal.

SECTION 5 DESIGN OF CATHODIC PROTECTION SYSTEMS

5.1 INTRODUCTION

5.1.1 *Add at the end of this clause:*

The objective of the design calculations shall be to compute by iteration the number of anodes and anode dimensions that (1) fulfil the initial current, maintenance current, current capacity, and current distribution requirements of the structure, and (2) provide the lowest installed cost for the CP system, including cost of anode materials, moulds, installation and coating systems (if used). The design calculations shall be adequately detailed and documented to allow checking and verification by the Principal.

Add new clause:

- 5.1.1.1 The CP system shall be designed such that no planned retrofitting is required during the design life of the protected structure. The Principal shall specify the required design life. The design parameters as specified in this DEP shall be used by the Contractor for the design of a CP system.

5.4 TYPES OF CP SYSTEMS

5.4.1 **Galvanic anode systems**

5.4.1.1 *Replace this clause by:*

Unless otherwise approved by the Principal, all sacrificial anodes shall be aluminium-indium-zinc, meeting the compositional requirements of DEP 37.81.20.31-Gen. Tin, mercury, or cadmium activated aluminium alloys shall not be used. Aluminium activators other than indium may be used only if approved by the Principal. If approved by the Principal, magnesium anodes may be used for a very short design life or to assist in developing the initial current required for polarization and if the resulting structure potential is compatible with alloys per clause [4.8].

Add new clause:

- 5.4.1.5 Anodes shall be manufactured in accordance with DEP 37.81.20.31-Gen.

- Anodes shall only be manufactured of chemistries and in foundries that are pre-qualified for the application and approved by the Principal.
- Anode and foundry pre-qualification shall be in accordance with DEP 37.81.20.31-Gen.
- The Principal shall specify anode chemistry and approved foundries for the application.
- If the Contractor proposes an alternate chemistry or foundry, the relevant information and requirements of DEP 37.81.20.31-Gen. shall be provided to the Principal for consideration and approval.

Add new clause:

- 5.4.1.6 Anode core material shall be carbon steel and shall comply with the requirements for tubular structure secondary members as specified in DEP 37.81.20.31-Gen. The core diameter and wall thickness shall be agreed with the Principal. Anode core attachment shall be by welding as specified in the applicable drawings. Welding shall conform to the welding specification for the associated structure.

Add new clause:

- 5.4.1.7 Anodes shall be the "slender stand-off" type, with a minimum stand-off (i.e. the closest distance between the aluminium alloy and the cathode structure member) of 150 mm. Anodes shall have a cylindrical or trapezoidal shape. The anode core shall exit at the anode ends.