

DEP SPECIFICATION

GALVANIC ANODES FOR MARINE STRUCTURES AND PIPELINES – SPECIFICATION AND QUALIFICATION – MODIFICATIONS TO ISO 15589-2

DEP 37.81.20.31-Gen.

September 2011

ECCN EAR 99

DESIGN AND ENGINEERING PRACTICE



© 2011 Shell Group of companies

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

This document contains information that is classified as EAR99 and, as a consequence, can neither be exported nor re-exported to any country which is under an embargo of the U.S. government pursuant to Part 746 of the Export Administration Regulations (15 C.F.R. Parts 746) nor can be made available to any national of such country. In addition, the information in this document cannot be exported nor re-exported to an end-user or for an end-use that is prohibited by Part 744 of the Export Administration Regulations (15 C.F.R. Parts 744).

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the recommended standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, Shell GSI disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in Shell GSI.

TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	5
1.5	COMMENTS ON THIS DEP	5
1.6	DUAL UNITS	6
2.	GENERAL	7
2.1	QUALITY REQUIREMENTS, QP AND MPS	7
2.2	MINIMUM ANTICIPATED SERVICE TEMPERATURE (MAST)	7
2.3	ADDITIONAL REQUIREMENTS	7
2.4	UNDERLYING INDUSTRY SPECIFICATION	7
2.5	ANODE MANUFACTURER/SUPPLIER AND ANODE MANUFACTURING FACILITIES PREQUALIFICATION	7
2.6	TRACEABILITY	8
2.7	INFORMATION TO BE CONVEYED TO ANODE MANUFACTURER/SUPPLIER	9
2.8	DOCUMENTS FOR APPROVAL	9
2.9	POST-JOB PRODUCTION HISTOGRAMS	9
2.10	PREPRODUCTION MEETING	10
3.	ANODE CHEMICAL PROPERTIES AND TESTING	11
3.1	ANODE CHEMICAL COMPOSITION	11
3.2	CHEMICAL ANALYSIS METHODS	11
3.3	CHEMICAL ANALYSIS CONTROL STANDARDS	11
3.4	RAW (BULK) ALUMINUM AND ZINC MILL CERTIFICATES	12
3.5	FREQUENCY OF CHEMICAL ANALYSIS	12
3.6	CHEMICAL ANALYSIS DOCUMENTATION	12
4.	ANODE ELECTROCHEMICAL PROPERTIES AND TESTING	13
4.1	ELECTROCHEMICAL TEST METHOD	13
4.2	CLOSED CIRCUIT POTENTIAL TESTS	13
4.3	CURRENT CAPACITY TEST	14
4.4	RETESTS	14
5.	"OFF-THE-SHELF" ANODES	15
6.	ACCEPTANCE	16
7.	ANODE SPECIMENS FOR TESTING BY THE PRINCIPAL OR INDEPENDENT LABORATORY	17
8.	REFERENCES	18

APPENDICES

APPENDIX 1	FLUSH MOUNTED ANODES	20
APPENDIX 2	STAND OFF ANODES	23
APPENDIX 3	BRACELET ANODES	25
APPENDIX 4	ANODE HEAT DATA SHEETS	29
APPENDIX 5	QUALIFICATIONS OF ANODE MANUFACTURERS/SUPPLIERS AND MANUFACTURING FACILITIES	31

1. INTRODUCTION

1.1 SCOPE

This new DEP specifies minimum requirements for manufacture, testing, and inspection of sacrificial anodes. Also included, are requirements for prequalification of sacrificial anode Manufacturers/Suppliers and manufacturing facilities. Typical applications of sacrificial anodes covered by this DEP, as applied to subsea projects are: structures, pipelines, top-tensioned and steel catenary risers, flowline jumpers, sleds, piles, tendons, subsea trees and manifolds, umbilical terminations, hull external surfaces and appurtenances, hull ballast tanks, and mooring equipment.

This DEP is based upon ISO 15589-2:2004.

This DEP supersedes DEP 37.81.20.31-EPP dated February 2006.

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 procurement and manufacture of sacrificial anodes for subsea projects such as structures, pipelines, top-tensioned and steel catenary risers, flowline jumpers, sleds, piles, tendons, subsea trees and manifolds, umbilical terminations, hull external surfaces and appurtenances, hull ballast tanks, and mooring equipment.

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.

1.3.2 Specific definitions

AFC drawings	Approved for Construction drawings.
AWG	American wire gauge. Standardised nominal diameters and cross-sectional areas sizes of solid round wires, used as electrical conductors expressed as a size i.e. as AWG as defined in ASTM B258.
Cold Water	Refers to projects where the minimum anticipated water temperature is equal to or less than 5°C. When evaluating which anode aluminium anode chemistry to utilize the following factors should also be considered: • Cost of retrofitting. For some applications the cost of retrofitting is outweighed by the increased cost for the higher quality cold water aluminium anodes. • Seasonal accessibility. For some applications the subsea anodes may only be accessible during certain parts of the year. In the event of an anode malfunction this seasonal accessibility may increase the risk to the asset, which can be reduced by utilizing the higher quality cold water aluminium anodes.
DFT	Dry film thickness.
Heat	The product that is cast to a planned procedure in one melting operation in one furnace, without significant interruption. It is also called a melt and defines the molten metal and identifies the anodes cast from it (NACE SP 0387-2006)
HMWPE	High molecular weight polyethylene.
LUGGIN PROBE	Also known as a Luggin-Haber capillary. A device used in measuring the potential of an electrode with a significant current density imposed on its surface. The probe minimizes the IR drop that would otherwise be included in the measurement and without significantly disturbing the current distribution on the specimen. Available as a purchase item from scientific equipment companies specializing in the design and manufacture of electrochemical instrumentation.
MAST	Minimum anticipated service temperature of the anode surface.
MPS	Manufacturing Procedure Specification. Reference ISO 9000 Paragraphs 2.7.2.c, 2.7.2.e, 3.4.5 and 3.7.3.
OES	Optical emission spectroscopy.
QP	Quality Plan. Reference ISO 9000 Paragraphs 2.7.2 b and 3.7.5.
SCE	Saturated calomel electrode.

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 (8).

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.

1.6 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.

2. GENERAL

2.1 QUALITY REQUIREMENTS, QP AND MPS

The anode Manufacturer/Supplier shall implement an ISO 9001 Quality Management System. A QP and an MPS shall be specifically developed for each order.

The QP shall include inspection and test requirements and provide columns or spaces for the Principal to indicate Company inspector inspection activities, e.g. monitor, witness, hold points, etc. for the operations to be undertaken. The QP shall be approved by the Principal.

The MPS shall clearly define the sequence of operations and process controls to be implemented at each manufacturing step as well as specifically annotate any procedures, processing parameters, or requirements that deviate from this DEP. The MPS shall be approved by the Principal

2.2 MINIMUM ANTICIPATED SERVICE TEMPERATURE (MAST)

For projects with a water depth greater than 500 m, the default value for the MAST of the anode surface shall be 4.4°C (40°F) unless otherwise specified in project documents or on AFC drawings.

For non-cold water projects the MAST of the anode surface shall be as specified in the project documents or on AFC drawings.

2.3 ADDITIONAL REQUIREMENTS

Anode alloy type, configuration, i.e. flush-mount (Appendix 1), stand off (Appendix 2) or bracelet (Appendix 3), dimensions, net alloy and gross anode weight and any other requirements not covered specifically by this DEP shall be addressed in project documents or on AFC drawings and subsequently included in the anode procurement documents. If such additional requirements are specified, they shall be included in the MPS.

2.4 UNDERLYING INDUSTRY SPECIFICATION

Anodes shall be manufactured and tested in accordance with ISO 15589-2:2004. Some statements and/or required values in ISO 15589-2:2004 are repeated in this DEP for clarity or special emphasis; however, unless specifically deleted/waived by this DEP, all provisions of ISO 15589-2:2004 shall be complied with. In cases where there are conflicting requirements between this DEP and referenced industry specifications, the requirements of this DEP shall supersede. The underlying industry specification(s) shall be identified in the MPS.

2.5 ANODE MANUFACTURER/SUPPLIER AND ANODE MANUFACTURING FACILITIES PREQUALIFICATION

Unless otherwise specified in project documents or on AFC drawings, the anode Manufacturer/Supplier and manufacturing facilities shall successfully complete a prequalification process in accordance with (Appendix 5) and obtain approval from the Principal, prior to full-scale anode production commencement for an actual order.

Additionally, unless otherwise specified in project documents or on AFC drawings, the anode Manufacturer/Supplier shall produce a test anode for approval by the Principal prior to commencement of full production when the casting is to take place using a new mould design or size. The test anode shall be manufactured utilizing the same anode alloy type, manufacturing process, moulds, furnaces, etc. as to be used for production anodes. The anode Manufacturer/Supplier shall verify the dimension and weight requirements of the anode produced from the new mould design or size. Additionally, the test anode shall be sectioned and examined for internal defects in compliance with ISO 15589-2, Section 9.9. Approval by the Principal shall then be obtained prior to commencement of full production.

2.6 TRACEABILITY

Traceability of each anode and piece of anode core material shall be maintained with respect to heat number and Manufacturer/Supplier. Failure to provide verification of anode or core material traceability shall result in anode rejection.

2.7 INFORMATION TO BE CONVEYED TO ANODE MANUFACTURER/SUPPLIER

(Table 1) provides a summary of information to be conveyed to the anode Manufacturer/Supplier in the anode procurement documents in order for the anode Manufacturer/Supplier to be able to properly supply product in compliance with this DEP.

Table 1 Information to be conveyed to anode Manufacturer/Supplier

MAST
Anode alloy type
Anode configuration type, i.e. flush-mount, stand-off, bracelet
Anode dimensions or AFC drawing
Anode net alloy and gross anode weight
Inspection requirements
If, for bracelet anodes, bonding cables are required and whether they <u>shall</u> be attached to the anode core by the anode Manufacturer/Supplier
Any other requirements not covered specifically by this DEP

2.8 DOCUMENTS FOR APPROVAL

As a minimum documents as listed in (Table 2) shall be submitted to the Principal for approval.

Table 2 Document submittals requiring approval by the Principal.

Anode Manufacturer/Supplier's Quality Plan (QP)
Anode Manufacturer/Supplier's Manufacturing Procedure Specification (MPS)
Contractor's procurement specification, if applicable
Anode drawing (unless AFC Drawing supplied by Principal or Contractor is to be used)
Core welding procedure specifications (WPSs)
Written procedure for conducting chemical analysis
Electrochemical test sample configuration (drawing) and dimensions
Electrochemical test procedure describing the specific test set-up, method of making the required measurements, and sample cleaning methods
Data sheet form
Written dimensional inspection plan
Written procedure for the determination of anode-to-core electrical resistance
Written procedure for the surface preparation and painting process, including repairs (for flush-mount and bracelet anodes only)
Written bonding cable attachment procedure, if applicable
Control standards certificate of analysis (for non-cold water anodes only).

2.9 POST-JOB PRODUCTION HISTOGRAMS

A summary report of results containing histograms of chemical, electrochemical and dimensional properties measured and recorded shall be provided at the completion of the order.

2.10 PREPRODUCTION MEETING

If required by the Principal or Contractor, as applicable, a preproduction meeting shall be held at the anode Manufacturer/Supplier's manufacturing facility prior to commencement of manufacturing in order to discuss and assure common understanding of the QP and MPS in relation to the order. This preproduction meeting, when required, shall be a designated Hold Point in the QP.