

DEP SPECIFICATION

GENERAL REQUIREMENTS FOR TOP-TENSIONED RISER, TENDON AND MOORING EQUIPMENT FOR DEEPWATER FLOATING PRODUCTION SYSTEMS

DEP 37.81.21.35-Gen.

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DESIGN AND ENGINEERING PRACTICE



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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 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	5
1.1	SCOPE	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	5
1.4	CROSS-REFERENCES	10
1.5	SUMMARY OF MAIN CHANGES.....	11
1.6	COMMENTS ON THIS DEP	11
1.7	DUAL UNITS.....	11
1.8	NON NORMATIVE TEXT (COMMENTARY).....	11
2.	GENERAL REQUIREMENTS	12
2.1	PRE-JOB "KICKOFF" AND WORK IN PROGRESS MEETINGS	12
2.2	FINAL ACCEPTANCE AND PROTOTYPE AND/OR FACTORY ACCEPTANCE TESTS (FATs).....	12
2.3	DIMENSIONS, DIMENSIONING AND TOLERANCING	13
3.	MATERIALS	13
3.1	MATERIALS SPECIFICATION AND SUPPLIERS.....	13
3.2	MATERIAL HANDLING	13
3.3	MILL CERTIFICATES (MTRS)	14
3.4	MATERIAL SUBSTITUTIONS	15
4.	WELDING	15
5.	NON-DESTRUCTIVE TESTING REQUIREMENTS	17
6.	PAINTING, COATING AND PLATING	17
7.	FASTENERS, FITTINGS AND BOLTING	18
8.	HARDNESS TESTING OF COMPONENTS AND/OR COMPLETED WELDMENTS.....	18
9.	IDENTIFICATION, TRACEABILITY AND MATERIAL CONTROL	19
9.1	GENERAL.....	19
9.2	FINISHED WORK PRODUCTS.....	19
9.3	MATERIAL CONTROL PROCEDURE	19
10.	HANDLING, SHIPPING, STORAGE.....	21
11.	DESIGN FOR CORROSION	21
12.	QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS	21
12.1	QUALITY MANAGEMENT SYSTEM (ISO 9001)	21
12.2	QUALITY ORGANIZATION	22
12.3	CONTRACT QUALITY PLAN	22
12.4	QUALITY ASSURANCE OF SUBCONTRACTORS.....	22
12.5	QUALITY INTERFACE	24
12.6	QUALITY RECORDS.....	25
12.7	WORK SPECIFIC QUALITY ASSURANCE DOCUMENTS.....	25
12.8	NONCONFORMANCES	26
12.9	VERIFICATION INSPECTION.....	27
12.10	NONDESTRUCTIVE TESTING PROCEDURES	28
12.11	DIMENSIONAL CONTROL	29
12.12	PROJECT DOCUMENTATION DELIVERABLES	29
13.	REFERENCES	31

APPENDICES

APPENDIX 1	GENERAL REQUIREMENTS FOR NONDESTRUCTIVE TESTING	33
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APPENDIX 2 GENERAL VISUAL INSPECTION REQUIREMENTS.....37

APPENDIX 3 GENERAL RADIOGRAPHIC INSPECTION REQUIREMENTS 41

APPENDIX 4 GENERAL MAGNETIC PARTICLE INSPECTION REQUIREMENTS 45

APPENDIX 5 GENERAL LIQUID PENETRANT INSPECTION REQUIREMENTS 51

APPENDIX 6 GENERAL ULTRASONIC INSPECTION REQUIREMENTS 58

1. INTRODUCTION

1.1 SCOPE

This DEP provides General Requirements for overall design, fabrication and manufacturing of top-tensioned riser, tendon and mooring equipment (e.g., chain jacks and stoppers, fairleads, tensioning equipment, chain, wire rope) for floating production systems (e.g., FPSs, TLPs).

This DEP is a revision of the DEP of the same number dated February 2012. The following are the main, non-editorial 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 other documents, data or information to which the DEPs may refer.

This DEP is primarily intended for use in the design, fabrication and manufacturing of top-tensioned riser, tendon and mooring equipment exposed to the marine environment for deepwater floating production systems; however, its application to other types of equipment and structures is not precluded and application to other types of equipment and structures shall be as required by Principal.

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 or maintenance 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 materials, 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 will generally specify the technical requirements. 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.

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

1.3.2 Specific Definitions

Term	Definition
Accept / Accepted / Acceptance	This shall mean Principal's written agreement that the submitted item has been performed in accordance with requirements
APPLICABLE DOCUMENTS	Third party (e.g., industry, government) specifications, standards, and recommended practices which are invoked in whole or in part by the SPECIFICATIONS as requirements for performing the WORK.
APPROVE, APPROVED, APPROVAL	Requirement for the Contractor to submit documentation for written agreement by Principal prior to proceeding with the corresponding activity.
CONCESSION	Written Principal authorisation for the Contractor to use or release materials, components, or methods which do not conform to the requirements of the WORK DOCUMENTS. CONCESSION is the preferred term; the terms "WAIVER" or "WAIVED" are sometimes used in lieu of CONCESSION. The three terms are considered to be synonymous in the context of the SPECIFICATION SYSTEM.
CONTRACT	The specific agreement containing commercial terms and conditions between Principal and Contractor of which these SPECIFICATIONS are an exhibit.
Contract Articles	Contract articles refer to specific sections of contract.
DESIGN VERIFICATION PLAN	That written element of the QUALITY PLAN which specifies the methods and sequences necessary for verification that the design element of WORK, if applicable, conforms to specified requirements. The DESIGN VERIFICATION PLAN is essentially an INSPECTION & TEST PLAN for the design process and in certain SPECIFICATIONS the terms can be used interchangeably.
DRAWINGS	Principal furnished drawings and revisions and/or the APPROVED Contractor drawings and revisions. DRAWINGS can be used to show arrangement, allow for bidding, allow for construction/manufacturing planning, provide sufficient information for material order and provide final requirements for fabrication/manufacture.
ENGINEERING PRODUCTS	The knowledge and documentation resulting from engineering effort related to the final form, fit and function of parts, products, or structures. ENGINEERING PRODUCTS include design and analysis reports; engineering drawings with dimensions, tolerances, surface finishes, layouts, fits, functions.; specifications; and procedures to install, commission, operate, maintain, repair, etc.

Term	Definition
INSPECTION & TEST PLAN	That written element of the QUALITY PLAN which specifies the methods and sequences necessary for verification and testing that the applicable elements of WORK conform to specified requirements. The INSPECTION & TEST PLAN can be one document or a series of individual documents, each defining the inspection and testing necessary for the particular element of WORK it verifies.
MANUFACTURING DETAILS	The Contractor's specific data and documents related to manufacturing techniques or the form of parts or products in an unfinished form.
MASTER DOCUMENT REGISTER (MDR)	Periodically updated and revision controlled listing of Contractor and SUBCONTRACTOR documents submitted to Principal for review, approval or information. In some cases additional documents other than those formally submitted for review/approval/information could be required to be included in the MDR. In some cases the MDR could also be known as the VENDOR DOCUMENT SCHEDULE (VDS), Supplier MASTER DOCUMENT LIST (SMDL), Supplier MASTER DOCUMENT REGISTER (SMDR) or VENDOR DOCUMENT REQUIREMENT LISTING (VDRL).
NONCONFORMANCE, NONCONFORMITY, NONCONFORMING	Nonfulfilment of a specified requirement.
PARTS LIST	An APPROVED list of equipment or components which includes a description of the equipment or component and the material from which the component is manufactured. In certain cases PARTS LISTS are included on DRAWINGS.
PLAN	A written general description of the sequence of activities in performing the WORK. A PLAN references specific PROCEDURES which describe each activity in detail and states the acceptance criteria to be met in each PROCEDURE.
Principal REPRESENTATIVE	The one person, as notified by Principal to the Contractor, who has been identified by Principal as representing Principal in matters relating to the WORK, or any person specifically designated by a Principal REPRESENTATIVE to act on his/her behalf. Principal REPRESENTATIVE is the preferred term; however, in certain SPECIFICATIONS the term SHELL REPRESENTATIVE is used in lieu of Principal REPRESENTATIVE. The two terms are considered to be synonymous in the context of the SPECIFICATION SYSTEM.
PROCEDURE	The APPROVED document setting out the specified way to perform an activity. PROCEDURES contain detailed steps describing specific methods, materials, equipment and activities used to perform WORK.

Term	Definition
PROCESS CONTROL PLAN	That written element of the QUALITY PLAN which specifies the process controls and sequences necessary to control execution of the applicable elements of WORK. The PROCESS CONTROL PLAN can be one document or a series of individual documents, each defining process controls necessary for the particular element of WORK it controls. There can be separate PROCESS CONTROL PLANS for Design, Procurement, Manufacturing, etc. PROCESS CONTROL PLAN is the preferred term; however, in certain SPECIFICATIONS the term MANUFACTURING PROCEDURE SPECIFICATION is used in lieu of PROCESS CONTROL PLAN in order to be specific to the manufacturing element of WORK. The two terms are considered to be synonymous in the context of the SPECIFICATION SYSTEM.
QUALITY ASSURANCE	All planned and systematic activities implemented within the QUALITY SYSTEM, and demonstrated as needed, to provide adequate confidence that WORK complies with requirements.
QUALITY CONTROL	The operational techniques and activities that are used to fulfil requirements. The results of QUALITY CONTROL are the written reports (such as inspection and test results) required by the QUALITY PLANS and PROCEDURES.
QUALITY PLAN	The APPROVED document setting out the specific quality practices, resources and sequence of activities relevant to WORK, or WORK ENTITIES. The QUALITY PLAN can consist of several separate written elements, such as a DESIGN VERIFICATION PLAN, PROCESS CONTROL PLAN and an INSPECTION & TEST PLAN.
QUALITY SYSTEM	The complete embodiment of WORK requirements to include the CONTRACT, WORK SPECIFICATION, DEP, DRAWINGS, TECHNICAL SPECIFICATIONS, and APPLICABLE DOCUMENTS.
REPAIR	Utilisation or performance of additional/new materials or processes other than those that were previously APPROVED to perform the WORK in order to bring non-conforming WORK into conformance or to make it otherwise fit-for-purpose.
REVIEW, REVIEWED	The Principal's right, but not obligation, to comment on a Contractor or SUBCONTRACTOR submitted item and to have access to the associated activity or documentation for the purpose of verifying compliance with requirements of the CONTRACT.
REWORK	Re-performance of previously APPROVED processes in order to bring non-conforming WORK into conformance.
SPECIFICATION	A document stating requirements and including any or all of the sections, paragraphs, appendices, tables, figures or attachments of the SPECIFICATION SYSTEM.

Term	Definition
SPECIFICATION SYSTEM	The complete embodiment of WORK requirements to include the CONTRACT, WORK SPECIFICATION, DEP, DRAWINGS, TECHNICAL SPECIFICATIONS, and APPLICABLE DOCUMENTS.
SUBCONTRACT	Any contract between the Contractor and any party (other than Principal or any employees of the Contractor) for the performance of any part of the WORK.
SUBCONTRACTOR	Any party (other than the Contractor) to a SUBCONTRACT.
TECHNICAL SPECIFICATION	Principal SPECIFICATION which sets the requirements for the specific technical details of fabrication or manufacturing. In certain SPECIFICATIONS the term "Supplement" can be used in lieu of TECHNICAL SPECIFICATION; however, such terminology are considered to be synonymous.
TECHNOLOGY	Patentable or proprietary engineering details, concepts and applications.
WORK	The collective grouping of Contractor or SUBCONTRACTOR activities and products (i.e., entities) directly or indirectly required by CONTRACT and defined by WORK DOCUMENTS. Specifically, elements of WORK could include, as applicable: • Design • Procurement • Manufacturing and/or fabrication • Inspection and testing • Handling, storage, packaging, preservation and delivery • Installation and commissioning • Servicing • Training • Documentation The definition of WORK given herein supplements any definition of WORK, or WORK SCOPE, which might be given in CONTRACT. Definitions of WORK, or WORK SCOPE, given in CONTRACT do not replace the definition of WORK given in this DEP and the definitions are considered to augment one another.
WORK DOCUMENTS	Principal SPECIFICATION SYSTEM and any APPROVED Contractor documents which define WORK requirements.
WORK ENTITY, WORK ENTITIES	Individual pieces or portions of WORK which can be individually described and considered.

Term	Definition
WORK SPECIFICATION	The Principal SPECIFICATION document which describes the scope and requirements for a specific project WORK and references other Principal DRAWINGS and SPECIFICATIONS as necessary to fully describe WORK requirements. WORK SPECIFICATION is the preferred term; however, in certain SPECIFICATIONS the term "TIE SPEC" can be used in lieu of WORK SPECIFICATION. The two terms are considered to be synonymous in the context of the SPECIFICATION SYSTEM.

1.3.3 Abbreviations

Term	Definition
AC	Alternating Current
CP	Cathodic Protection
CRA	Corrosion Resistant Alloy
DGS	Distance-Gain-Size
FAT	Factory Acceptance Test
FBH	Flat Bottom Hole
FSH	Full Screen Height
HWAC	Half wave Alternating Current
MDR	Master Documents Register
MTR	Material Test Reports (Mill Certificates)
NCR	Non-Conformance Report
NDT	Non-Destructive Testing
PMI	Positive Material Identification
RGL	Reference Gain Level
SDH	Side Drilled Holes
TCG	Time-Corrected-Gain

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 (6).

1.5 SUMMARY OF MAIN CHANGES

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

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall / should / may for normative statements

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 REQUIREMENTS

2.1 PRE-JOB "KICKOFF" AND WORK IN PROGRESS MEETINGS

1. Prior to commencement of WORK, and for each separately subcontracted work entity, pre-job "kickoff" meeting(s) shall be held between the Contractor (including appropriate Subcontractors), representatives of Principal and approved 3rd-party inspectors, if applicable.

The purpose of the kickoff meeting is to:

- assure that all parties involved fully understand the WORK and requirements;
 - plan the conduct of WORK;
 - review the Basis of Design and Design Verification Plan if design by the Contractor is included as an element of WORK;
 - initiate, or possibly finalise, the APPROVAL process of Contractor (and subcontractor) documents.
- a. Such pre-job "kickoff" meeting(s) shall be designated hold points in the QUALITY PLAN and a record (minutes) of the meeting (including attendees) maintained as project documentation by the Contractor.
 - b. Pre-job meetings should be held at the location (facility) where the WORK or subcontracted WORK ENTITY is to be accomplished.
2. At the request of Principal, additional Work-in-Progress meetings shall be held at the Contractor's WORK location for discussion with Principal of QUALITY PLANS, PROCESS CONTROL PLANS, INSPECTION & TEST PLANS, WORK progress and schedule status, in relation to the WORK, the TECHNICAL SPECIFICATIONS and codes/standards cited.

2.2 FINAL ACCEPTANCE AND PROTOTYPE AND/OR FACTORY ACCEPTANCE TESTS (FATs)

Final ACCEPTANCE of WORK by COMPANY will not be made until WORK is fully completed, meets the specified requirements of all applicable WORK DOCUMENTS and all final copies of project documentation have been received and ACCEPTED by COMPANY.

1. No unresolved or open NONCONFORMANCE Reports (NCRs) or punch list items shall exist for WORK to be considered finished.
2. Final ACCEPTANCE shall, if required by the WORK SPECIFICATION, applicable TECHNICAL SPECIFICATION or DRAWINGS, include a prototype or a factory acceptance test (FAT).
 - a. If a prototype test or an FAT is required by the WORK SPECIFICATION, applicable TECHNICAL SPECIFICATION or DRAWINGS, then a written PROCEDURE shall be submitted for APPROVAL for each.
 - b. Test results shall be documented in a written report and submitted for ACCEPTANCE within 5 working days of the prototype or FAT test, as applicable.

2.3 DIMENSIONS, DIMENSIONING AND TOLERANCING

1. Dimensions shall be applied to structures, equipment or components based on when the item is at a uniform temperature of 20 °C (68 °F) and no external forces are acting on the item.
 - a. Structures, equipment or components may be inspected at temperatures above or below 20 °C (68 °F) provided gauges and calibration standards are allowed to stabilize to the same temperature as the structure, equipment or component being inspected.
2. Refer to either ANSI Y14.5M or the combination of ISO 129-1, ISO 1101 and ISO 3040 for dimensioning and tolerancing practices as specified in accordance with the Principal.
3. Unless noted otherwise, items shall not be scaled from DRAWINGS.
4. Dimensional acceptance shall be based on SI or USC system of units as specified by the Principal.
 - a. Whichever system is specified by the Principal, that systems shall be the basis of acceptance and documents for inspection shall contain dimensions in those units.
 - b. If units from the other system are contained in the inspection documents then those units shall be shown for information only without any expectation that the Principal will confirm the conversions.

3. MATERIALS

3.1 MATERIALS SPECIFICATION AND SUPPLIERS

1. Material shall conform to the grade designation and testing requirements shown on DRAWINGS or in PARTS LISTS.
2. Materials and material Manufacturer/Suppliers shall be submitted to be APPROVED.
This includes elastomers.

3.2 MATERIAL HANDLING

3.2.1 General

1. Material and equipment, including items furnished by Principal, shall be stored on supports above the ground and any water.
 - a. Materials and equipment shall be kept free from dirt, grease, over-spray or other foreign matter and be protected from corrosion.
2. Chains shall not be used in direct contact with materials.
 - a. Components and plates shall be handled in a manner that avoids permanent deformations and local buckling.
3. Coatings shall be protected from damage.
 - a. Coating damage shall be repaired using APPROVED materials and an APPROVED procedure.

3.2.2 Damaged Materials

1. Damaged materials or components shall be segregated and not be used.
2. Procedures for repair of damaged materials shall be submitted for approval by Principal.
3. The repair of damaged materials shall be subject to APPROVAL by the Principal.

3.2.3 Anodes

1. For temporary storage, anodes with their shipping pallets shall be stacked on wooden timbers or nonmetallic supports, minimum 150mm (6 in) high, so that anodes are free of any contact with each other, the ground or any standing water.
2. Any accumulation of aluminium oxide (white powder) on the anode surface or between anodes shall be removed by rinsing with fresh water.

3.3 MILL CERTIFICATES (MTRS)

1. Classification of materials furnished by the Contractor shall be supported by the material Manufacturer/Supplier's Material Test Reports (MTRs; e.g., mill certificates).
2. MTRs shall meet all of the following:
 - a. comply with ISO 10474 Test Inspection Certificate Type 3.1 or 3.2;
 - b. be legible and define the Manufacturer/Supplier, manufacturing location, type, grade, steelmaking process, chemical composition and mechanical test results of the material on a specific testing basis as a minimum;
 - c. be submitted by Contractor for REVIEW before incorporating material into WORK;
 - i. third-party, reformatted or other substitutes for original or certified copies of original, MTR's shall not be accepted.
 - d. show the results of testing required by both the material specification and this DEP;
 - i. MTRs without a complete reporting of elements, as required by this DEP, shall not be submitted;
 - ii. material from MTRs without a complete reporting of elements shall be physically segregated and clearly marked as NONCONFORMING.
3. MTRs for pieces to be fabrication welded shall include the following:
 - a. complete composition, showing all elements per the material specification, elements in the Pcm formula (Equation 1), Nitrogen (N), Aluminium (Al) and Titanium (Ti) contents, and any elements intentionally added;
 - i. Pcm shall be calculated on the basis of heat analysis using the formula (Equation 1) and reported on the MTR:
$$\text{Pcm} = \text{C} + \text{Si}/30 + (\text{Mn} + \text{Cu} + \text{Cr})/20 + \text{Ni}/60 + \text{Mo}/15 + \text{V}/10 + 5\text{B} \quad - \text{Equation 1}$$
 - b. the following values (wt %) shall be assumed for unreported, unintentional elements;
 - i. Si = 0.35;
 - ii. Mn = 1.2;
 - iii. Cu = 0.25;
 - iv. Cr = 0.10;
 - v. Ni = 0.10;
 - vi. Mo = 0.05;
 - vii. V = 0.08;
 - viii. B = 0.0008.
 - c. manufacturing process used (e.g., TMCP, Normalised, Quench and Tempered).

3.4 MATERIAL SUBSTITUTIONS

1. If material substitutions are requested by Contractor during fabrication and/or manufacturing, the new and old size, weight, material grade, DRAWING and piece number shall be provided in writing for APPROVAL.
2. MTR's shall be submitted to COMPANY with a copy of the material substitution request.

4. WELDING

1. All welding, welding procedures, welding procedure qualifications and welder and welding operators' qualifications shall be in compliance with AWS D1.1.
2. Refer to DEP 39.01.20.36-Gen. for tendon and top-tensioned riser girth welds.
3. Pressure containing welds shall comply with ASME BPV Section IX.
4. Corrosion resistant and hard facing (wear resistant) overlays shall be in compliance with ASME BPV Section IX Article 2 for procedure and procedure qualification (to include hardness traverse as specified in this section) and Article 3 for welders and welding operators.
5. All welding procedure specifications (WPS's) and procedure qualification records (PQR's) shall be subject to APPROVAL.
6. Unless specifically addressed in this DEP, all applicable requirements of AWS D1.1 shall be applied.
7. If mandatory compliance with ASME Section IX is stipulated, then Contractor shall apply the requirements of that code in addition to the requirements specified by this DEP.
 - a. If compliance with other DEPs' welding criteria is stipulated then the requirements of those DEP's shall supersede the requirements of this DEP.
 - b. In case of conflicting welding code requirements, the more stringent shall generally govern, as reflected in the APPROVED WPS's and PQR's.
8. Welding procedure qualifications shall include a hardness traverse across the cross section.
 - a. For carbon and low alloy steel weldments, maximum hardness measured in the traverse shall be 325 HV10.
 - b. For carbon and low alloy steel weldments with potential for exposure to H₂S environments, maximum hardness shall be as specified by ISO 15156-2.
 - c. Weldments of other alloys shall have their hardness requirements subject to APPROVAL.
9. Hardness testing described in (8) shall be performed on a cross section of the procedure qualification weld that has been macroetched to reveal the Heat Affected Zones (HAZ) and weld deposit.
 - a. As a minimum, a Vickers microhardness survey utilizing an applied load of 10 kgf (i.e., HV10) shall be performed on the macrosection from the test weld in accordance with ISO 9015-1.
 - b. Hardness test indentation locations shall be as recommended by ISO 9015-1.
 - c. All hardness values obtained shall be within the specified hardness ranges for the base material.

10. A Bead-on-Plate (BOP) weld pass and Vickers microhardness survey shall be made on each base-metal with each consumable to be permitted by the WPS in accordance with BS 7363 Type 2.
 - a. The length of the deposited bead shall not exceed the minimum permissible bead length for the WPS.
 - b. This pass shall be made with the lowest permissible heat input and preheat temperature applicable to the WPS being qualified.
 - c. Location of hardness readings shall be as shown in Figure 9 of BS 7363 except that an additional all-weld-metal hardness reading shall be obtained.
 - d. Hardness measurements shall be HV10 and maximum hardness requirements shall be as per (8) above.
11. When toughness testing for welds is required, the welding procedure qualification shall include testing to insure that the specified toughness will be met on production welds.
 - a. Number, location and orientation of toughness test specimens shall be subject to APPROVAL.
 - i. Specimens shall be extracted from locations so that specified toughness is confirmed for the weld metal, HAZ and base metal at weld root and near-cap locations.
 - ii. If dissimilar metals are welded, then both HAZ's and base metals shall be tested.
12. Contractor shall establish a system for recording individual welder and welding operator repair rates and a welder evaluation programme that establishes criteria for retraining, requalification and removal from WORK.
13. Welding symbols on DRAWINGS shall comply with AWS A2.4.
 - a. Welds shall be complete joint penetration groove welds except where specifically noted on DRAWINGS.
14. Contractor (or SUBCONTRACTOR, as applicable), shall submit a fabricated assembly weld map to COMPANY for review, approval or information when requested by Principal.
 - a. The weld map shall show the following in drawing/sketch format:
 - i. each weld;
 - ii. the base materials to be joined;
 - iii. weld quality level;
 - iv. calculated fatigue life and fatigue curve that was used (if design has been performed by Contractor or SUBCONTRACTOR);
 - v. WPS number and revision level;
 - vi. base material(s) size, weight and grade (for tubulars);
 - vii. nondestructive testing (NDT) method, procedure number and revision level;
 - viii. notations to indicate welds requiring special fatigue enhancement conditioning and for those welds, the conditioning procedure number and revision level.
15. Post-weld heat treat or stress relief temperature shall be no higher than 28 °C (50 °F) below previous tempering temperature for steels which have been tempered.
16. Welding procedure qualification is limited to no higher than + 0.02 for Pcm or CEV relative to the steel used in the procedure qualification test.

5. NON-DESTRUCTIVE TESTING REQUIREMENTS

1. Visual, radiographic, magnetic particle, liquid penetrant, ultrasonic, and other NDT inspection methods shall be performed by the Contractor as required by DRAWINGS or this DEP to ensure that structures, equipment and components are free from defects exceeding the acceptance criteria for the specified NDT method applied.
2. For those NDT procedures which have acceptance criteria based on thickness, the thickness used for determination of the acceptance criteria shall be the nominal finished machined thickness.
3. Refer to (Appendix 1) through (Appendix 6).
4. All structures, equipment and components shall receive visual inspection (VT) with 100% surface coverage.
5. Final NDT of structural weldments shall not occur prior to both of the following:
 - a. final post-weld heat treatment, if applicable;
 - b. 48 hours after completion of the weld.

6. PAINTING, COATING AND PLATING

1. Components shall be painted, coated or plated as specified by Principal.
2. All Contractor painting, coating or plating PROCEDURES applicable to WORK shall be submitted for APPROVAL.
3. Finished machined carbon steel surfaces shall have an APPROVED corrosion inhibiting compound.

This is typically done by application as soon as possible after finish machining to prevent flash rusting.
4. An APPROVED inhibited grease shall be lightly applied to bolts, nuts, washers, fittings, and flange faces prior to make-up.
5. Carbon, low alloy or alloy steel fasteners and fittings exposed to the marine atmosphere on a long-term basis shall be coated.
 - a. Refer to DEP 37.81.21.32-Gen. for coating requirements
6. Carbon, low alloy or alloy steel fasteners and fittings exposed to the subsea environment on a long-term basis shall be galvanised in accordance with ASTM A153 or ASTM B695, Class 50 and greased as specified above or coated in accordance with DEP 37.81.21.32-Gen., unless they will be electrically continuous with the cathodic protection system.
 - a. If protected by a cathodic protection system they may be coated as in (6) or left uncoated except for aforementioned coating of grease.

7. FASTENERS, FITTINGS AND BOLTING

1. Requirements for all fasteners, fittings and bolting shall be included on a DRAWING or in a PARTS LIST.
2. All carbon, low alloy and alloy steel fasteners (bolts, studs, nuts) and fittings shall have hardness $\leq$ HRC 35.
3. Usage of stainless steel or corrosion resistant alloy (CRA) fasteners or fittings shall be subject to APPROVAL.
 - a. The following shall apply for CRA fasteners, fittings and bolting:
 - i. austenitic stainless steels and CRAs exposed to the marine atmosphere or subsea conditions shall have PREN / 43.0 (Equation 2) and the following compositional requirements;
 - 1). Mo /6.0 wt. %
 - 2). N /0.2 wt. %
$$\text{PREN} = \% \text{Cr} + 3.3(\% \text{Mo}) + 16(\% \text{N})$$

-Equation 2
 - ii. duplex stainless steels exposed to the marine atmosphere or subsea conditions shall have PREN / 40.0 (Equation 2) and the following compositional requirements;
 - 1). Cr /25.0 wt. %
 - 2). Ni /5.0 wt. %
 - 3). Mo /3.0 wt. %
 - 4). N /0.15 wt. %

8. HARDNESS TESTING OF COMPONENTS AND/OR COMPLETED WELDMENTS

1. Hardness controls for Components or completed weldments in contact with environments that may cause cracking (e.g., seawater exposure under cathodic protection, sour gas exposure) shall APPROVED.
2. In the case of seawater or marine atmospheric exposure, carbon, low alloy and steels shall be limited to a maximum hardness of 35 HRC, while other alloys are to have their maximum hardness criteria subject to APPROVAL.
3. In the case of H₂S environmental exposure, component hardness maximums shall be in accordance with NACE MR0175/ISO15156 for the particular alloy and condition.
4. Locations for hardness measurements shall be APPROVED.
5. The hardness tests shall be performed only after all heat treatments, including post weld heat treatment or stress relieving, have been performed.
6. When hardness testing of completed weldments has been specified by WORK DOCUMENTS, one hardness test of a weld shall consist of a total of five (5) readings; (2) base metal on each side of the weld, (2) heat affected zone on each side of weld and (1) weld deposit.
7. When hardness testing of completed weld overlay has been specified by WORK DOCUMENTS, one hardness test of a weld overlay shall be as above if base metal is accessible from both sides.
 - a. This test shall consist of a total of three (3) readings; (1) base metal, (1) heat affected zone and (1) weld overlay deposit.

8. All hardness testing shall be performed in accordance with ASTM standards and reported in values obtained in the test method utilized.
 - a. Should converted hardness values be required, ASTM E140 shall be used and the converted values reported in parentheses next to the tested value.

9. IDENTIFICATION, TRACEABILITY AND MATERIAL CONTROL

9.1 GENERAL

1. Contractor shall develop and implement a written Positive Material Identification (PMI) program for all pressure containing/pressurized components and welding consumables.
 - a. Approval by Principal is required of the PMI program for pressure containing/pressurized components.
 - b. Refer to DEP 31.10.00.10-Gen.
2. Materials and WORK products (welds, components, subassemblies, assemblies,) shall be distinctly identified, marked and traceable.
 - a. Contractor shall establish an identification system that uniquely identifies materials, interim WORK products and final WORK products.
 - b. The identification system shall reference DRAWINGS and PARTS LISTS, as applicable.

9.2 FINISHED WORK PRODUCTS

1. Finished WORK products shall be marked, with their part number and serial number in locations APPROVED by COMPANY.
 - a. Marks shall be applied with low stress dot stamps to a bare metal surface.
 - b. If the stamped surface is subsequently coated, then the mark shall also be painted onto a coated surface in a contrasting colour with at least 25mm (1 in) high letters.

9.3 MATERIAL CONTROL PROCEDURE

1. Contractor shall establish, submit for REVIEW, implement and audit a written Material Control Procedure.

9.3.1 Steel Manufacturer/Supplier's Markings

1. Contractor shall transfer the material Manufacturer/Supplier's material identification mark (e.g., heat/plate number/forging serial number/casting serial number) or, alternatively, a unique reference number onto cut pieces and remnants that may be used for WORK by Contractor, including any COMPANY supplied materials.
2. Low stress die stamps or other APPROVED means shall be used.
3. When used, in lieu of actual heat/plate numbers, forging serial numbers, casting serial numbers, unique reference numbers shall be identified on each mill certificate or be traceable through an APPROVED cross reference list.
4. Material which does not have original or verifiable markings as required by this DEP shall be physically segregated and clearly marked as nonconforming.
 - a. For use of such materials, a sample from each piece shall be removed and the chemical composition and mechanical properties required by the applicable material specification obtained.
 - b. These materials shall be subject to APPROVAL on a case by case basis.

9.3.2 Contractor's Steel Marking System

1. A unique marking system for the different steel grades shall be applied to each piece of steel.
 - a. The marking system shall also uniquely identify steel with through-thickness (Z) properties.
 - b. Low stress die stamps or other APPROVED means shall be used.
 - c. Painted material identification or metal markers, tags or bands may also be used to facilitate material control, provided the marks are legible at the time of the final "in-place" Material Quality Control verification.

9.3.3 Materials Verification and Traceability – All Materials

1. All material shall have the following material verification checks performed by Contractor:
 - a. material identification as specified in Contractor's procurement documents or COMPANY TECHNICAL SPECIFICATIONS, as applicable;
 - b. check of mill certificates to verify that the chemical composition and mechanical properties meet the applicable specification;
 - c. transfer of identification markings to each cut piece, if applicable;
 - d. material grade and applicable dimensions (e.g., thickness);
 - e. positive material identification (PMI) on all Level 1 and Level 2 components and welding consumables or when WORK involves stainless steels and corrosion resistant alloys;
 - i. refer to ASTM E1916, as a minimum.
2. Material grade and applicable dimensions shall be verified by Contractor's Quality Control personnel to be in accordance with the drawings during the fit-up phase of fabrication and during assembly.
3. PMI shall include checks at all phases of fabrication, including material receipt, prior to welding and after welding.
4. The PMI plan shall be submitted by Contractor for COMPANY APPROVAL.

9.3.4 Materials Verification and Traceability – Materials Identified for Full Traceability

1. Traceability shall exist without having to physically locate the material identification mark(s) on the pieces by Contractor's maintenance.
 - a. Tracibility shall include usage of a material traceability database.
2. Traceability shall exist between mill certificates (e.g., heat/plate number, forging serial number, casting serial number) and the Contractor's piece identification scheme.
3. Using the original plate heat/plate number, forging serial number, casting serial number, as the starting reference data, all pieces shall be traceable to their respective final locations in the structure or component.
4. Using the final location of the piece in the structure as the starting reference data, pieces shall be traceable to their original plate heat/plate number, forging serial number, and casting serial number.

10. HANDLING, SHIPPING, STORAGE

1. Contractor shall be responsible to protect WORK products from environmental, handling and shipping damage or deterioration until the products have been received by Principal.
2. Packaging and protection plans shall be APPROVED by the Principal which assure that equipment will not be damaged by the environment for specified storage conditions if not put into service within one year.

11. DESIGN FOR CORROSION

1. When corrosion protection design has been included in Contractor's scope, it shall be provided by a combination of coatings and sacrificial anodes to meet the design service life.
2. The CP design shall be submitted for APPROVAL by Principal.
3. Coating systems shall be as specified by Principal.
4. Refer to DEP 30.10.73.32-Gen. for design, installation, commissioning of manufactured sacrificial protection systems and for anode manufacture and Quality Control of Cathodic protection (CP) systems.
 - a. The temperature of the component shall be considered in proper design of the anodes.
5. Each system shall be provided with CP test points for verification of in-service cathodic protection levels.
 - a. Location and number of CP test points shall be submitted for APPROVAL by Principal.
6. Each system shall be designed to be capable of being retrofitted subsea with ROVs.
There are devices available on the market with imbedded CP systems.
7. Refer to DEP 30.10.73.32-Gen. for anode installation and CP test points.
8. Electrical continuity between the sacrificial anodes and all items requiring cathodic protection shall be verified during FAT of each system.
 - a. Refer to 30.10.73.32-Gen.

12. QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS**12.1 QUALITY MANAGEMENT SYSTEM (ISO 9001)**

1. Contractor shall establish, implement and maintain an effective, documented QUALITY SYSTEM covering all elements of WORK.
2. The QUALITY SYSTEM shall be certified by a 3rd-party agency in compliance with ISO 9001, or APPROVED equivalents, as applicable for the Contractor's WORK scope.
 - a. All applicable guidelines presented in ISO 9001, shall be considered as mandatory requirements for the Contractor's QUALITY SYSTEM.

Some statements and/or issues addressed in ISO 9001 could have been repeated or clarified in this DEP for clarity or special emphasis.