

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

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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 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.

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1. INTRODUCTION

1.1 SCOPE

This new 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, etc.) for floating production systems (e.g., FPSs, TLPs, etc).

This DEP is a revision of, and supercedes, SIEP General Requirements Specification GR-MOOR Revision 0 dated September 2000; see (1.5) for a summary of the main changes.

Users of this document are cautioned that there may be product specific Technical Specifications that have requirements that supersede the requirements contained herein. Conversely, this DEP may be part of a larger Project Document or Contract which also supercedes the requirements contained herein.

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.

References to Contractor in this DEP also include Subcontractors.

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.

1.3.2 Specific Definitions

Term	Definition
ACCEPT, ACCEPTED, ACCEPTANCE	Principal's written agreement that a submitted item has been performed in accordance with requirements.
APPLICABLE DOCUMENTS	Third party (e.g., industry, government, etc.) specifications, standards, recommended practices, etc. which are invoked in whole or in part by the SPECIFICATIONS as requirements for performing the WORK.
APPROVE, APPROVED, APPROVAL	Mandatory requirement for the Contractor to submit documentation for written agreement by Principal prior to proceeding with the corresponding activity.
Principal	Shell International Exploration and Production Inc. (SIEP Inc.) and any company other than SIEP Inc. which is for the time being directly or indirectly affiliated with SIEP Inc. or a joint venture partner working with SIEP Inc. on a project for which the CONTRACT is issued. Note: Principal is the preferred term; however, in certain SPECIFICATIONS the term SHELL is used in lieu of Principal. The two terms shall be considered to be synonymous in the context of the SPECIFICATION SYSTEM.
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. Note: Principal REPRESENTATIVE is the preferred term; however, in certain SPECIFICATIONS the term SHELL REPRESENTATIVE is used in lieu of Principal REPRESENTATIVE. The two terms shall be considered to be synonymous in the context of the SPECIFICATION SYSTEM.
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. Note: CONCESSION is the preferred term; however, in certain SPECIFICATIONS the terms "WAIVER" or "WAIVED" are used in lieu of CONCESSION. The three terms shall be 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	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. Note: The DESIGN VERIFICATION PLAN is essentially an INSPECTION & TEST PLAN for the design process and in certain SPECIFICATIONS the terms may be used interchangeably.

Term	Definition
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, etc.; specifications; and procedures to install, commission, operate, maintain, repair, etc.
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 may 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 may be required to be included in the MDR. In some cases the MDR may 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). Note: The MDR shall include: 1. Document title 2. Document control number 3. Document revision level 4. Date and purpose, i.e. for approval by Principal or for information only, the document was submitted to Principal for review/approval/information. 5. Principal REPRESENTATIVE the document was submitted to. 6. Principal approval, approval with comments, rejection or otherwise return date. 7. Principal REPRESENTATIVE approving, approving with comments, rejecting or otherwise returning the document.
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.

Term	Definition
PLAN	A written general description of the sequence of activities in performing the WORK. A PLAN shall reference specific PROCEDURES which describe each activity in detail and shall state the acceptance criteria to be met in each PROCEDURE.
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.
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 may be one document or a series of individual documents, each defining process controls necessary for the particular element of WORK it controls. There may be separate PROCESS CONTROL PLANS for Design, Procurement, Manufacturing, etc. Note: 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 shall be 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 may 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.

Term	Definition
SPECIFICATION	A document stating requirements and shall include any or all of the sections, paragraphs, appendices, tables, figures or attachments of the SPECIFICATION SYSTEM.
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" may be used in lieu of TECHNICAL SPECIFICATION; however, such terminology shall be considered to have synonymy.
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 shall include, as applicable: 1. Design 2. Procurement 3. Manufacturing and/or fabrication 4. Inspection and testing 5. Handling, storage, packaging, preservation and delivery 6. Installation and commissioning 7. Servicing 8. Training 9. Documentation Note: 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 shall be 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.
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. Note: WORK SPECIFICATION is the preferred term; however, in certain SPECIFICATIONS the term "TIE SPEC" may be used in lieu of WORK SPECIFICATION. The two terms shall be considered to be synonymous in the context of the SPECIFICATION SYSTEM.

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 and supercedes SIEP General Requirements Specification GR-MOOR Revision 0 dated September 2000. Due to massive reformatting required to convert SIEP General Requirements Specification GR-MOOR Revision 0 dated September 2000 into the DEP format, as well as bring it up to date with changes to requirements and referenced documents, the entire document should be considered as “changed”. Hence, no effort is made in this section to identify the main, non-editorial changes.

1.6 COMMENTS ON THIS DEP

The custodian of this DEP is the Shell Civil, Structures and Offshore (CSO) Engineering Discipline.

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.

1.7 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.

2. GENERAL REQUIREMENTS

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

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 shall be to:

1. assure that all parties involved fully understand the WORK and requirements
2. plan the conduct of WORK
3. review the Basis of Design and Design Verification Plan if design by the Contractor is included as an element of WORK
4. initiate, or possibly finalise, the APPROVAL process of Contractor (and subcontractor) documents

Such pre-job "kickoff" meeting(s) shall be designated hold points in the QUALITY PLAN and a record (minutes) of the meeting, including attendees, shall be maintained as project documentation by the Contractor. Pre-job meetings should be held at the location (facility) where the WORK or subcontracted WORK ENTITY is to be accomplished.

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, etc. 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. No unresolved or open NONCONFORMANCE Reports (NCRs) or punch list items shall exist for WORK to be considered finished.

Final ACCEPTANCE shall, if required by the WORK SPECIFICATION, applicable TECHNICAL SPECIFICATION or DRAWINGS, include a prototype and/or a factory acceptance test (FAT). If a prototype test and/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, as applicable, and test results shall be documented in a written report and submitted for ACCEPTANCE within 5 working days of the prototype and/or FAT test, as applicable.

2.3 DIMENSIONS, DIMENSIONING AND TOLERANCING

Dimensions shall be applied to structures, equipment or components when the item is at a uniform temperature of 20°C (68°F) and no external forces are acting on the item.

Dimensioning and tolerancing practices shall comply with either ANSI Y14.5M or the combination of ISO 129-1, ISO 1101 and ISO 3040.

Unless noted otherwise, items shall not be scaled from DRAWINGS.

3 MATERIALS

3.1 MATERIALS SPECIFICATION AND SUPPLIERS

Material shall conform to the grade designation and testing requirements shown on DRAWINGS or in PARTS LISTS.

Materials and material Manufacturer/Suppliers shall be APPROVED by Principal.

3.2 MATERIAL HANDLING

3.2.1 General

Material and equipment, including items furnished by Principal, shall be stored on suitable supports above the ground and any water. Materials and equipment shall be kept free from dirt, grease, over-spray or other foreign matter and shall be protected from corrosion.

Chains shall not be used in direct contact with materials. Components and plates shall be handled in a manner that avoids permanent deformations and/or local buckling.

Care shall be taken to avoid damage to coatings. Coating damage shall be repaired using APPROVED materials and an APPROVED procedure.

3.2.2 Damaged Materials

Damaged materials or components shall be segregated and shall not be used. Procedures for repair of damaged materials shall be submitted for approval by Principal; however, the repair of damaged materials shall be APPROVED on a case-by-case basis.

3.2.3 Anodes

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.

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)

Classification of materials furnished by the Contractor shall be supported by the material Manufacturer/Supplier's Material Test Reports (MTRs; e.g., mill certificates, etc.).

Unless otherwise required in this DEP, all MTRs shall comply with ISO 10474 Test Report Type 3.1.B or 3.2. MTRs shall be legible and shall 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.

MTR's shall be submitted by Contractor for REVIEW before incorporating material into WORK. Third-party, reformatted or other substitutes for original or certified copies of original, MTR's shall not be accepted.

The MTR shall show the results of testing required by both the material specification and this DEP. MTRs without a complete reporting of elements, as required by this DEP, shall not be submitted and such material shall be physically segregated and clearly marked as NONCONFORMING.

In addition to the requirements of the material specification and this DEP, 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 given below, Nitrogen (N), Aluminium (Al) and Titanium (Ti) contents, and any elements intentionally added.
- b) Pcm shall be calculated on the basis of heat analysis using the following formula and reported on the MTR:

$$Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B$$

- c) The following values (wt %) shall be assumed for unreported, unintentional elements: Si = 0.35; Mn = 1.2; Cu = 0.25; Cr = 0.10; Ni = 0.10; Mo = 0.05; V = 0.08; B = 0.0008
- d) Manufacturing process used (e.g., TMCP, Normalised, Quench and Tempered, etc.)

3.4 MATERIAL SUBSTITUTIONS

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.

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. Tendon and top-tensioned riser girth welds shall also comply with DEP 39.01.20.36-Gen.
3. Pressure containing welds shall also comply with ASME BPV Section IX.
4. Corrosion resistant and hard facing (wear resistant) overlays need only be in compliance with ASME BPV Section IX Section Article 2 for procedure and procedure qualification and Article 3 for welders and welding operators.
5. All welding procedure specifications (WPS's) and procedure qualification records (PQR's) shall be APPROVED.
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. If compliance with other DEP's is stipulated then the requirements of those DEP's shall supercede the requirements of this DEP. 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 across their cross section. For carbon and low alloy steel weldments, maximum hardness measured in the traverse shall be 325 HV10. For carbon and low alloy steel weldments with potential for exposure to H₂S environments, maximum hardness shall be as specified by ISO 15156-2. Weldments of other alloys shall have their hardness requirements APPROVED.
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. 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 EN 1043-1. Hardness test indentation locations shall be as recommended by EN 1043-1. All hardness values obtained shall be within the specified hardness ranges for the base material.
10. In addition to (8) and (9) above, 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. The length of the deposited bead shall not exceed the minimum permissible bead length for the WPS. This pass shall be made with the lowest permissible heat input and preheat temperature applicable to the WPS being qualified. 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. 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. Number, location and orientation of toughness test specimens shall be APPROVED; however, in general, 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. 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. 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. The weld map shall show in drawing/sketch format:
 - a) each weld,
 - b) the base materials to be joined,
 - c) weld quality level,
 - d) calculated fatigue life and fatigue curve that was used (if design has been performed by Contractor or SUBCONTRACTOR),
 - e) WPS number and revision level,
 - f) base material(s) size, weight and grade (for tubulars),
 - g) nondestructive testing (NDT) method, procedure number and revision level
 - h) notations to indicate welds requiring special fatigue enhancement conditioning and for those welds, the conditioning procedure number and revision level.

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. All NDT shall comply with (Appendix 1) through (Appendix 6) of this DEP.
4. At a minimum, 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 final post-weld heat treatment, if applicable, nor prior to 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 applied as soon as possible after finish machining to prevent flash rusting.
4. Unless otherwise approved by Principal, Jet-Lube ALCO-EP-73 PLUS® or Cortec VCI-369® or APPROVED equivalent, inhibited grease shall be lightly applied to bolts, nuts, washers, fittings, flange faces, etc. prior to make-up.

Note: Jet-Lube ALCO-EP-73 PLUS® is available from Jet-Lube, Inc.; Phone = (800)538-5823 or (713)674-7617; fax = (713)678-4604; Address = 4849 Homestead Rd., Houston, TX 77028. Cortec VCI-369® is available from Century Corrosion Technologies; Phone = (800)828-2368 or (281)858-1000; fax = (281)858-9000; Address = 9710 Telge Rd., Houston, TX 77095.

5. Unless otherwise specified by Principal, carbon, low alloy or alloy steel fasteners and fittings exposed to the marine atmosphere on a long-term basis shall be coated in accordance with DEP 30.48.00.32-Gen.
6. Unless otherwise specified by Principal, 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, unless they will be electrically continuous with the cathodic protection system, in which case they may be 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, etc.) and fittings shall have hardness $\leq$ HRC 35 unless otherwise APPROVED.
3. Usage of stainless steel or corrosion resistant alloy (CRA) fasteners or fittings shall require specific APPROVAL; however, the following shall generally apply, unless specified otherwise by Principal:
 - Austenitic stainless steels and CRAs exposed to the marine atmosphere or subsea conditions shall have have PREN / 43.0 [note: $\text{PREN} = \% \text{Cr} + 3.3(\% \text{Mo}) + 16(\% \text{N})$] and the following compositional requirements:
 - o Mo /6.0 wt. %
 - o N /0.2 wt. %
 - Duplex stainless steels exposed to the marine atmosphere or subsea conditions shall have PREN / 40.0 and the following compositional requirements:
 - o Cr /25.0 wt. %
 - o Ni /5.0 wt. %
 - o Mo /3.0 wt. %
 - o N /0.15 wt. %

8 HARDNESS TESTING OF COMPONENTS AND/OR COMPLETED WELDMENTS

1. Components and/or completed weldments in contact with environments that may cause cracking (e.g., seawater exposure under cathodic protection, sour gas exposure, etc.) shall be subjected to special hardness controls as required by WORK DOCUMENTS.
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 shall have their maximum hardness criteria APPROVED.
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 as shown on DRAWINGS, for finished components; otherwise, hardness testing may be performed on raw material prior to finish machining. These hardness tests shall be performed only after all heat treatments, including post weld heat treatment or stress relieving, have been performed.
5. 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.
6. 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. Otherwise, such test shall consist of a total of three (3) readings; (1) base metal, (1) heat affected zone and (1) weld overlay deposit.
7. All hardness testing shall be performed in accordance with ASTM standards and reported in values obtained in the test method utilized. Should converted hardness values be required, ASTM E140 shall be used and the converted values reported in parentheses next to the tested value.
8. For special circumstances where the hardness testing methods in ASTM are impossible to perform due to location or configuration or where hardness testing is deemed detrimental to the part, the use of alternative methods shall be APPROVED on a case-by-case basis.