

DEP SPECIFICATION

DEEPWATER SUBSEA VERTICAL TREE SYSTEMS (AMENDMENTS/SUPPLEMENTS TO ISO 13628-4/API 17D)

DEP 37.80.00.36-Gen.

February 2013

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DESIGN AND ENGINEERING PRACTICE



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PREFACE

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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.

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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for deepwater subsea vertical tree systems. It is based on ISO 13628-4, Second Edition, 2010-12-15 and API 17D, Second Edition.

Part III of this DEP amends, supplements and deletes various clauses of ISO 13628-4/API 17D. Part III follows the clause numbering of ISO 13628-4/API 17D for easy reference. All clauses in applicable topics of ISO 13628-4/API 17D not modified by this DEP remain valid as written.

This DEP addresses only deepwater vertical subsea tree systems. Of the topics addressed in ISO 13628-4, this DEP addresses only the following:

- a) Subsea trees
- b) Tubing hanger systems

This DEP also addresses tools and equipment associated with the above.

Where ISO 13628-4 addresses topics for equipment that is not part of a deepwater subsea vertical tree system, for example horizontal tree systems or mudline suspension systems, those topics are not addressed by this DEP and are not applicable to it.

Other items listed in Section 1.2 of ISO 13628-4/API 17D are outside the scope of this DEP.

The intention of this DEP is to complement and align the requirements of the industry standard ISO 13628-4/API 17D with the Principal's specific global requirements for deepwater subsea vertical tree systems.

The ISO document used as the basis for this DEP is part of the ISO 13628 series of documents that are listed under the general title "*Petroleum and natural gas industries — Design and operation of subsea production systems*". For guidance purposes, and in order to identify the general requirements and recommendations, refer to the following API/ISO standard or its equivalent API standard or DEP:

ISO 13628-1:2005	Part 1 General requirements and recommendations
API RP17A:2005	General Requirements and Recommendations (Endorsement of ISO 13628-1)
DEP 37.80.00.30-Gen.	Subsea Systems
ISO 13628-4:2010	Part 4 Subsea Wellhead and Tree Equipment

This is a revision of the DEP of the same number dated September 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in offshore oil and gas production facilities. This DEP may also be applied in other similar facilities.

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 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 Abbreviations

Abbreviations are as given in ISO 13628-4:2010, Section 3, with additions in (Part III, Section 3).

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (Part IV)

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated September 2011. The changes are extensive, and too numerous to list here.

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.
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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 .
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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.

PART II GENERAL REQUIREMENTS

1.1 GENERAL

This DEP shall be used with reference to the following documents:

- a. DEP 37.80.00.30-Gen.
- b. ISO 13628-4:2010 (Part 4: Subsea Wellhead and Tree Equipment)
- c. API 17D, Second Edition (Subsea Wellhead and Christmas Tree Equipment)

Part III of this DEP is written as amendments and supplements to ISO 13628-4 and API 17D, Second Edition, 2010-12-15. Wherever reference is made to ISO 13628-4, it shall be understood to mean ISO 13628-4/API 17D, Second Edition, 2010-12-15, as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ISO 13628-4/API 17D has been used throughout Part III of this DEP.

Clauses in ISO 13628 4/API 17D, which are not mentioned in this DEP, shall remain valid as written.

Any requirements relating to environmental conditions, water depths, pressure/temperature ratings, materials etc. shall be provided within the tender documentation package, basis for design and project equipment specific documentation packages. In (Appendix B) an example data sheet package that can be used to specify project specific information is supplied.

1.2 VERTICAL TREE DESIGN

All deepwater subsea trees shall be a vertical tree (VXT) design.

NOTE: Where the ISO/API document addresses requirements for equipment not part of a deepwater subsea vertical tree system, for example horizontal tree systems or mudline suspension systems, those sections are not addressed by this DEP and are not applicable to it.

PART III AMENDMENTS AND SUPPLEMENTS TO ISO13628-4:2010**2 Normative references**

Add the following:

Refer to (Part IV) of this DEP.

3 Terms, abbreviated terms, definitions and symbols**3.2 Abbreviated terms and symbols**

Add the following:

HCLS heave compensated landing system

SCM subsea control module

SID subsea isolation device

THS tubing head spool

4 Service conditions and product specification levels**4.1 Service conditions**

Add the following:

Actual project specific service condition details are to be found in the project tender documentation package and/or the supporting specification or data sheet. Appendix B of this document gives an example data sheet package.

4.2 Product specification levels

Add the following:

Apply quality control requirements for PSL3/3G per Table 17 in Section 7.4.2.2.2 of the API 6A/ISO 10423:2009(E) document.

5 Common system requirements**5.1 Design and performance requirements****5.1.1 General****5.1.1.4 Materials**

Add the following:

Details of allowable materials are given in documents under materials and corrosion specifications.

5.1.2 Service conditions**5.1.2.3 Material class ratings**

Add the following:

Material class ratings are per Table 1 of the API 6A/ISO 10423:2009(E) document. Specific project decisions regarding material class ratings are detailed within the tender documentation package either in the project specification or equipment data sheet for subsea trees, tools and equipment.

5.1.4 Miscellaneous design information**5.1.4.7 Coatings (external)**

Add the following:

Details of allowable coatings are given in the documents covering materials and corrosion specifications.

5.1.4.8 Cathodic protection

Add the following:

Details of allowable cathodic protection systems are given in the documents covering cathodic protection specifications.

5.2 Materials

Add the following:

Details of allowable materials are given in documents covering materials and corrosion specifications. All materials shall meet the required material class ratings.

5.2.3 Product specification level

Add the following:

Apply quality control requirements for PSL3/3G per Table 17 in section 7.4.2.2.2 of API 6A/ISO 10423:2009(E).

5.3 Welding**5.3.1 Pressure-containing/controlling components**

Add the following:

Apply quality control requirements for PSL3/3G per Table 17 in section 7.4.2.2.2 of API 6A/ISO 10423:2009(E).

5.4 Quality control**5.4.2 Product specification level**

Add the following:

Apply quality control requirements for PSL3/3G per Table 17 in section 7.4.2.2.2 of API 6A/ISO 10423:2009(E).

5.4.8 Cathodic Protection

Add the following:

Per the ISO document and with details of allowable cathodic protection systems.

6 General design requirements for subsea trees and tubing hangers**6.1 General**

Add the following:

Requirements as per the ISO document with changes and additions to the sections as noted.

Principal requirements are provided in the list below and in the project specification or equipment data sheets:

- a) Each individual wellhead may have a tubing head spool mounted on it. If not, then the wellhead shall be slimbore compatible.
- b) The tree system shall be a conventional dual bore vertical configuration with the

production bore concentrically located and the annulus bore offset.

- c) The tree system and its components shall be suitable for deepwater guidelineless deployment, installation and recovery. Refer to (Part III Annex K), and (Part IV, B1)
- d) Tree system shall be capable of being deployed, installed and recovered using the completion riser, HCLS, downline or drill pipe using ROV support.
- e) The tubing hanger systems shall be compatible with 13-5/8 in BOP drift diameter and surface BOP operations
- f) The tubing hanger and tree systems shall be compatible with wireline and coiled tubing well servicing operations.
- g) All subsea installed equipment shall have a "minimum" operating life of 20 years without the need for planned maintenance. Similarly support and intervention equipment shall be maintained for that 20 year life span.
- h) All items of the completion system shall be designed to be recoverable after installation for maintenance, de-commissioning or abandonment.
- i) The assembled weight of the tree package (ready for shipping and/or installation) shall have the following not to exceed targets:
 - 40.8 Tonnes (90,000 pounds) for 10,000 psi rated systems;
 - 54.4 Tonnes (120,000 pounds) for 15,000 psi rated systems.
- j) Both the subsea control module and choke valve module insert or flow module shall be capable of being recovered and re-installed with the tree still installed subsea.
- k) The tree re-entry mandrel interface shall allow for the attachment of the following:
 - A surface BOP system
 - A tree running and/or handling tool for either drill pipe or wire rope deployment
 - A subsea BOP Package
 - A completion/workover LRP/EDP package
 - An ROV deployable non-orienting tree cap

6.1.3 Orientation and alignment

Add the following:

When using a tubing head spool, all equipment orientation and alignment systems shall be passive and any component of the system that is more damage prone than its mating part shall be the easier of the two to recover and rework. If completing in the wellhead the orientation and alignment system may require a combination of active and passive methodologies, with the focus on minimizing critical path rig activities in setting up the orientation and alignment system.

6.1.4 Rating

Add the following:

Per the ISO document and the project specification or equipment data sheet.

6.1.5 Interchangeability

Add the following:

Major items of equipment within the systems shall be designed to meet as a minimum the following interchangeability requirements. Per the definition contained in the project scope of work, the Contractor may achieve the desired level of interchangeability by using actual equipment or by providing and maintaining tools or jigs that can achieve the same.

- a) Any subsea tree with any tubing head spool assembly
- b) Any tubing head spool with any wellhead

- c) Any tubing hanger with any subsea tree and with any tubing head spool assembly
- d) Any SCM on any subsea tree or manifold SCM mounting base
- e) Any controls jumper to any subsea tree stab plate and test plate
- f) Any tree cap and LRP assembly with any subsea tree, and any LRP with any EDP
- g) Tree deployment tool with any tree
- h) Any choke insert with any choke body
- i) All running tools and riser joints
- j) All test equipment
- k) Any tie-in connector with any hub
- l) All sets of ROV tools with all ROV interfaces on the equipment
- m) ROV tool systems with the proposed drilling and installation vessel ROVs
- n) Retrievable sensors

Add the following new section:

6.1.7 Protection philosophy

The protection philosophy used in the design of the tree system is required to meet the following Principal requirements in the stated order of importance:

- a) Avoidance of hazard to human life
- b) No release of hydrocarbons to the environment
- c) Loss of control over tree system functions
- d) Rendering well impossible to kill or re-enter by direct vertical means

The tree system shall be provided with protection against the risk of damage due to accidental loads.

Installed subsea tree equipment shall possess local protection against dragged objects such as installation equipment, but not fishing trawls. Loads resulting from such snagging shall be transmitted into the well conductor. The provision of such protection shall not restrict the ability to re-enter and service the well and perform maintenance activities.

Special consideration shall be given to equipment protection during transportation and handling when undertaking offshore operations. Additional protection equipment shall be included where necessary to minimize damage to equipment during offshore loading from supply boat to rig and vice versa.

Designs shall minimize the risks of ROV tethers and installations lines snagging during installation, operation, maintenance and intervention activities.

At a detail level, sensitive components shall be located in non-exposed, or suitably protected positions provided that access for remote intervention, where necessary, is not compromised.

Add the following new section:

6.1.8 Installation, maintenance and repair philosophy

Installation activities and the requirements for ROVs and tooling are given in, (Part IV, B1).

The general Installation, maintenance and repair (IMR) philosophy is stated as follows:

- a) All installation and intervention operations shall therefore be achieved by guidelineless means with the assistance where necessary of a standard deepwater work class ROV

- b) The tubing head spools and trees shall be run and installed either on wire, by HCLS, by drill pipe, by the surface BOP and marine riser system, or by the completion riser system.
- c) In all cases it shall be possible to lock the tree to the tubing head spool, and to verify the connection and performance of the seal arrangements with an ROV.
- d) All subsea valves shall have the facility for ROV override, unless specified otherwise. During ROV operation the hydraulic control system shall not allow the ingress of seawater, with or without the controls flying lead made-up to the manifold, or the forming of a hydraulic lock.
- e) All minor tree components shall be assessed for in-situ ROV repair and the tree design shall maximize the possibility for unplanned maintenance by this means. The Contractor shall prepare a summary report of all contingency ROV intervention and repair tasks for Principal review.
- f) The sensitivity of equipment during installation and retrieval to adverse weather conditions and/or vessel motions shall be considered during the equipment design phase.
- g) The equipment Contractor is required to liaise with the Principal and installation Contractor to agree the requirements for, location of, and items needed to mount transponders on equipment during installation and metrology operations.

Add the following new section:

6.1.9 Load criteria

The Contractor shall design all the equipment covered by this specification to withstand the load conditions given in the ISO document in addition to the following:

- a) Permanent loads
- b) Operational loads
- c) Accidental loads - these loads are diverse in nature, but shall include the following:
 - Dropped objects of 100 mm (4 in) or greater diameter with an energy of up to 10 kJ (7,375 foot pounds) force.
 - A snag load of 45 Tonnes (99,200 pounds) applied at a height of 1.5 m (59 in) above the wellhead connector.
 - Loss of vessel position while connected to the subsea tubing head spool or tree by:
- d) Drillpipe / running system
- e) Completion riser system and umbilicals
- f) Surface BOP, SID and high pressure marine riser system
- g) Subsea BOP and drilling riser system
- h) Tugger wire snagging loads of 5 Tonnes (11,000 pounds) on tree accessory items.
- i) Impact loads resulting from guidelineless operations (e.g. impacts by the SID, subsea BOP and other items of deployed equipment).
- j) Impact loads resulting from ROV collisions.

Factors applied to basic loads for load combinations shall be in accordance with the recommendations of the governing design codes and regulations. Where a component is not covered by a suitable code, the engineering assumptions used in selecting load cases and factors shall be clearly presented to the Principal for review and approval.

The Contractor shall determine the ultimate bending capacity of the wellhead, spool and tree stack for all relevant installation and workover configurations and vessel options for Principal review and approval. These shall show that the ultimate failure point is above the

tubing hanger in tubing hanger installation and workover modes (i.e. in completion riser system) and above the tree in tree installation and workover modes.

Equipment shall be designed to enable year round installation and replacement and equipment strength shall not impose onerous operational limitations. The Contractor shall advise equipment limitations in the form of calculation packages incorporating operational envelopes submitted for Principal review and approval making specific mention of:

- a) Tensile and bending capacities of connectors and tools
- b) Bending capacities of the completion/workover riser systems and tree stack up relative to corresponding vessel offsets, and operating conditions for all relevant installation and workover configurations
- c) Shock loading sensitivities (thermal, impact, etc.)
- d) Expected subsea equipment deployment limitations and vessel offsets
- e) Fatigue life limitations

It is the responsibility of the Contractor to design equipment such that it is fit for the intended service. The Contractor shall perform specific analysis to ensure that equipment supplied is fully compatible with the effects of the water depth at the Principal nominated offshore site.

6.2 Tree valving

Add the following:

Tree valving shall be per the items relating to vertical tree systems defined in the ISO document and the project specification or equipment data sheets and the system schematics in (Appendix A).

In addition the following general requirements apply.

All tree system valves shall either be hydraulically or ROV actuated. Where valves are hydraulically actuated they shall be fitted with an ROV override device. During the override action there shall be no seawater ingress into the valve or cavity or hydraulic locking due to chamber displacement. All valves shall have position indicators that meet the accessibility/visibility requirements given in the ROV interfaces specification (Part IV, B1).

Similarly all the operating or override buckets shall meet the functional and dimensional requirements contained within the same document.

The Contractor is to ensure the design of the valve/actuator and hydraulic system allows operation of the override without damaging any of those components. The project equipment data sheets will provide the detailed requirements of each valve within the system.

Figure B1 in (Appendix A) of this DEP illustrates a typical model for a production tree system. Figure B2 in (Appendix A) shows a fully populated tree layout with respect to valves, functions and penetrations. Figure B3 shows the different available configurations of choke/flow modules.

The Contractor shall refer to the subsea tree data sheet and the project specific schematics or process and instrumentation diagrams for the project specific requirements.

6.2.13 Compensating barrier

Add the following:

A common valve actuator discharge fluid compensating system shall be designed into the Tree system.

If thermal analysis shows that temperature increase within the fixed volumes of a connector increases the contained pressure, compensation shall be included to capture any excess fluid volume. This requirement is for all the tree system connectors which include tree connector, the tree flowline connector, and the flow module connectors.

6.3 Testing of subsea tree assemblies

6.3.2 Factory acceptance testing

Add the following:

For the purposes of definition of responsibility, both the factory acceptance test (FAT) and the extended factory acceptance test (EFAT) shall be performed by the Contractor as part of their contract scope of supply. Any system integration testing shall be kept separate from those tests.

Equipment shall be tested in accordance with the requirements of the ISO document, PSL3, PSL3G and PR2, or as specified in the project specification or equipment data sheets, plus the additional test requirements detailed below. Proof of previous testing and compliance of similar valves to PR2 requirements may be accepted by the Principal in lieu of further testing.

Any other equipment that falls outside the scope of the above noted standards shall be tested in accordance with procedures to be generated by the Contractor and issued for general review and approval by the Principal. Such procedures shall be set at a similar level of content and thoroughness as the equivalent noted standards.

Tree system equipment testing shall include, but not be limited to, the following:

- a) Component level tests: pressure
- b) Sub-assembly tests: pressure & function
- c) Assembly tests: pressure & function
drifting and any qualification testing of new equipment
- d) Stack-up tests: pressure & function
drift and interface check
interchangeability (to an extent agreed with Principal)

The above tests shall be performed for all equipment in the scope of supply and stack-up tests shall prove equipment performance and operation in all operational combinations of equipment.

- a) Contractors shall submit such test procedures to the Principal for review and approval and each and every functional feature and interface with adjacent equipment shall be tested at component level prior to integration testing.
- b) All new equipment designs or reconfigurations of existing proven equipment shall be subjected to thorough qualification test programs, which shall include hyperbaric testing.
- c) Design and test procedures shall be submitted for the Principal's review and approval prior to commencement of equipment development programs beginning.

Each element of the subsea completion system shall be tested according to the above philosophy. The Contractor shall prepare a summary document detailing the test plan for the complete tree system, including all ancillary items of equipment. In addition the Contractor shall also prepare a comprehensive testing matrix listing the entire scope of supply and showing all interface testing to be performed for the Principal's review and approval.

The Principal requires that equipment interchangeability is adequately demonstrated with reference to the requirements previously stated. The Contractor shall prepare an interchangeability testing program for the Principal's review and approval.

Equipment that is to be insulated shall have the insulation materials applied after component level testing is completed and prior to any integration testing activities taking place.

Hydraulic cleanliness shall be monitored throughout equipment test programs to verify that cleanliness is being maintained during equipment operation. The levels of tolerable cleanliness are given in the document covering Control Specifications listed in (Part IV, B1).

System integration testing with other elements of the subsea system shall be carried out in accordance with the requirements of the documents covering SITs listed in (Part IV, B1) and the Project Specification or equipment data sheets.

The Contractor shall consider all aspects of equipment testing and submit a comprehensive and logical test strategy and program that meets both the ISO and requirements detailed in the Project Specification or equipment data sheets. The following requirements are in addition to those given in the ISO document:

- a) All completed tree assemblies to be used for gas service shall be subjected to a submerged PSL3G open body gas test. In accordance with API 6A/ISO 10423 requirements, testing shall exclude the VX gasket, TH seal, and the tree cap seals. Gas testing of completed tree assemblies is not required for trees not designated for gas service.
- b) Equipment and ambient temperatures shall be recorded during testing.
- c) Pressure testing of completed sub-assemblies may be conducted in the painted condition if agreed with the Principal and approved by the appropriate regulatory authorities.
- d) All valves shall be tested in both directions.
- e) The residual capacity available in hydraulic valve actuators shall be determined under worst case conditions.
- f) Valves shall be capable of being repeatedly overridden without the additional hydraulic control fluid being supplied to the actuator.
- g) All wireline plug profiles shall be tested from above and below with the plugs installed. Specialist personnel only shall be used to install and retrieve proprietary tools and plugs.
- h) All gauges and chart recorders shall be calibrated against a calibration gauge with a traceability record prior to being used for testing.
- i) The Principal or nominated third party shall be given the opportunity to review and approve all test plans and mark what testing they wish to witness.
- j) Prior to manufacture of equipment the Contractor shall prepare a chart defining minimum drift diameters for all equipment. The chart shall be submitted to the Principal for review and approval.
- k) Potable water with an added corrosion inhibitor and anti-freeze if necessary shall be used for testing purposes. The Contractor shall submit details of the contents of such test medium to the Principal for review and approval.
- l) All hydraulic and chemical injection control lines with threaded couplers/connectors shall be tested to 1.1 x working pressure on reconnection after any disconnection.
- m) The first ROV intervention point of each size, rating, design, or type (whether for primary or contingency operation) shall be tested at maximum loading with the appropriate tools. These tests shall prove the integrity of the ROV interface and torque feedback system without causing any damage to any valve or actuator components. Should the equipment be fitted with safety devices, e.g., shear pins or other, then single items of each size, rating, design, or type shall again be tested to prove their suitability.
- n) The Contractor shall provide any specialist manpower and services to operate and maintain any ROV equipment supplied by them. Typically these tests shall verify that the equipment meets the specified operating criteria such as calculated operation torques, pressures and number of turns information.

- o) The Contractor shall provide the Principal with documented and witnessed test reports for all hyperbaric testing performed on the pressure containing equipment designs to be supplied. Any design changes from "as tested" configurations incorporated into the proposed equipment shall meet the requirements of section 5.1.7 in the ISO standard.
- p) With the exception of reconfigured depth proven equipment, one item of every design of equipment supplied shall be fully qualified (including hyperbaric tests) to at least 1.1 x design water depth. The Contractor shall submit to the Principal test procedures and program for review and approval prior to any testing or test equipment procurement beginning.
- q) Any equipment to be supplied that is insulated shall be pressure tested to working pressure a further time after the application of the insulation material is complete. The Contractor shall be required to develop a test procedure with acceptance criteria for this test for review and approval by the Principal.

6.4 Marking

Add the following:

All subsea and surface equipment shall be marked with specific performance criteria such as pressure rating, size, torque etc. in accordance with the design data sheet details.

All subsea installed equipment shall have markings that are clearly visible to an ROV camera. Where motion or movement is to be determined, markings shall be of contrasting colours.

Choke and valve actuators or effectors shall be clearly marked with all relevant operational data, e.g. direction of rotation, number of turns, open/closed position.

All ROV docking and grab points and any access routes shall be clearly identified according to the requirements of the ROV Interfaces document listed in (Part IV, B1).

Equipment that is to be handled or lifted shall have weight in both air and water marked on a surface that is clearly visible.

All lift points should be clearly labelled with their rated capacities.

6.5 Storing and shipping

Add the following:

The requirements for packaging, storage and shipment will be detailed within the Project scope of supply and tender documentation packages.

All parts and equipment shall have exposed metallic surfaces protected against rust.

Loose components shall be separately packed and have clear identifiable markings.

Any non-metallics shall be stored in packages that prevent any deterioration due to exposure to the environment, light, moisture etc.

All hydraulic and chemical injection lines shall be flushed and filled or drained per the requirements of the project documentation and documents listed in, (Part IV, B2).

All/any exposed hydraulic end fittings or lines without dedicated pressure containing assemblies shall be provided with temporary caps for transit. These caps shall be removed prior to deploying any equipment subsea.

Units and assemblies shall be securely crated or mounted on skids to suit the proposed shipment method. The skids shall be designed to prevent damage and to facilitate safe handling. Lift points shall be clearly marked with the load rating and any "pinch" points marked with clearly visible warning or danger notices.

Exposed seals, seal surfaces, threads and operating parts shall be protected from mechanical damage during shipping.

7. Specific requirements – subsea-tree-related equipment and sub-assemblies**7.3 Threaded connections**

Add the following:

All threaded hydraulic and chemical injection pressure connections shall be of an anti-vibration, anti-rotation type. Tapered threaded connections are not allowed.

The use of thread sealant tape and sealant compounds is not allowed.

Upon completion of all testing and prior to shipping, all connections shall be checked for integrity and, if called for in the project specification or data sheets, fitted with wire locking security devices.

7.5 Studs, nuts and bolting

Add the following:

Refer to the specification for materials as noted in (Part IV, B4).

7.5.4 Anti-corrosion coating/plating

Add the following:

In addition to the documents noted above the requirements for coating/plating are also covered in the specification for the painting of offshore components noted in (Part IV, B4).

Any Coating damage shall be repaired to meet the requirements of the above upon completion of all testing, prior to shipping.

7.5.5 Make up torque requirements

Add the following:

All non-API type wing blocks that are to be secured to the main valve block shall be secured with integral torque indicator studs. The Contractor is to provide to the Principal a report defining the torque levels, stud materials, torque equipment and joint integrity expectations for review and approval.

7.6 Ring gaskets**7.6.1 General**

Add the following:

Per the ISO document and in addition to the specifications listed in (Part IV, B4) covering Materials and Corrosion Specifications.

7.6.3 Materials**7.6.3.1 Ring gasket materials**

Add the following:

Per the ISO document and in addition the specifications listed in (Part IV, B4) covering Materials and Corrosion Specification.

7.8 Tree connectors and tubing heads**7.8.1 General**

Add the following:

Per the ISO document and, in addition the specifications listed in (Part IV, B4) covering materials and corrosion specifications.

- a) A tubing head spool assembly shall be installed on each wellhead at a pre-set orientation.

- b) All connection systems shall be designed to enable any permanently installed hydraulic system used to retain or lock the connector to be pressurised before conducting any pressure test of the system. All hydraulic functions shall be vented prior to operational use of the equipment. All pressure testing shall be conducted with pressure vented in the function lines.
- c) Connectors shall also be provided with position indicators accessible to the ROV cameras.
- d) Connectors shall have a secondary lockdown device or design feature to prevent accidental connector unlock during operations.
- e) The flowline connector shall be part of the tree assembly with the hub (fabricated into a retrievable loop) on the tubing head assembly. That connector shall be hydraulically actuated by ROV on both the lock and unlock cycle and also be provided with an ROV accessible mechanically actuated secondary unlock feature. In addition the connector shall also be provided with position indicators accessible to the ROV cameras, and secondary lockdown devices or design features to prevent accidental connector unlock during operations.
- f) Flowline connectors are not required to retain the seal assemblies. The seals shall be installed by ROV prior to the tree landing and after installation. The seals shall be capable of being tested externally to prove pressure integrity. Testing shall be performed at 1000 psi above ambient pressure.

7.8.1.2 Tree/tubing head spool connectors

Add the following:

- a) All XT/THS connectors should be hydraulically actuated by ROV on both the lock and unlock cycle and also be provided with a mechanically actuated secondary unlock feature.
- b) The XT/THS connectors shall be capable of securely holding on to and deploying the main gasket, and shall also be compatible with ROV deployment and installation of the gasket directly in the wellhead or spool. The project shall decide the deployment methodology and define in the tree data sheet. If the gasket is to be deployed with the connector the replacement of the gasket on the deck shall be accomplished utilizing a remotely operated gasket retention/release system.
- c) A seal sleeve arrangement shall also be provided in the tree/connector and tubing spool interface. This shall seal on a suitable profile inside the tubing head spool assembly and serve two purposes: 1) provide means to internally test the tree connector gasket, and 2) serve as a secondary annulus barrier internal to the primary connector gasket seal, which will be internally rated to full working pressure and externally rated to full hydrostatic differential.
- d) The pressure containing part of the tree connector body shall be integral with the tree valve block. The preferred connection method is with load bearing screw threads.
- e) The tubing head and tree connectors shall incorporate a low pressure seal arrangement to prevent/divert the accumulation of any gas within the internal components of the connector that could lead to non-operation of the connector through hydrate formation. The design of the connector skirt and guide cone area shall be specifically designed to deflect/release hydrocarbons venting up from the seabed around the conductor.