

DEP SPECIFICATION

DEEPWATER SUBSEA COMPLETION/WORKOVER SYSTEMS (AMENDMENTS/SUPPLEMENTS TO ISO 13628-7)

DEP 37.80.10.30-Gen.

September 2011

ECCN EAR 99

DESIGN AND ENGINEERING PRACTICE



© 2011 Shell Group of companies

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

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

PREFACE

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

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

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

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

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal typically expect them to follow those design and engineering practices that 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.

TABLE OF CONTENTS

PART I	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	4
1.5	SUMMARY OF MAIN CHANGES.....	5
1.6	COMMENTS ON THIS DEP	5
1.7	DUAL UNITS.....	5
PART II	GENERAL.....	6
PART III	CLARIFICATIONS AND SUPPLEMENTS TO ISO13628-7	7
3.	TERMS, DEFINITIONS, ABBREVIATED TERMS AND SYMBOLS	10
3.1	TERMS AND DEFINITIONS.....	10
3.2	ABBREVIATED TERMS	11
4	SYSTEM REQUIREMENTS	13
4.2	DESCRIPTION OF C/WO RISER SYSTEMS	13
4.4	SYSTEM DEFINITION.....	13
4.5	SYSTEM DESIGN	13
4.7	MODES OF OPERATION.....	14
5.5	WORKOVER CONTROL SYSTEM	19
7	MATERIALS AND FABRICATION	57
7.1	INTRODUCTION	57
7.2	GENERAL MATERIALS REQUIREMENTS	57
8	TESTING.....	58
8.4	HYDRAULIC CLEANLINESS	58
8.5	QUALIFICATION Testing.....	58
8.7	WORKOVER CONTROL SYSTEM AND FAT.....	58
8.8	SYSTEM INTEGRATION TESTS	58
8.9	SYSTEM PRESSURE TESTS.....	59
9.3	WORKOVER CONTROL SYSTEM AND HYDRAULIC EQUIPMENT	59
11.4	DESIGN ANALYSIS.....	59
ANNEX A	(INFORMATIVE) -STANDARDISATION OF C/WO RISER INTERFACE.....	60
ANNEX B	(INFORMATIVE) -OPERATIONAL MODES AND GLOBAL RISER SYSTEM ANALYSIS	60
ANNEX I	(NORMATIVE) QUALIFICATION OF CONNECTORS	60
PART IV	REFERENCES	61

APPENDICES

APPENDIX A	SHELL REFERENCE SCHEMATICS	62
APPENDIX B	LIST OF CHANGES TO DOCUMENT SINCE PREVIOUS ISSUE.....	66

PART I INTRODUCTION

1.1 SCOPE

This new DEP specifies the requirements for deepwater subsea completion/workover systems, and is based on ISO 13628-7, first edition, 2005-11-15.

Part III of this DEP contains text that either clarifies content in the ISO standard or specifies additional requirements and recommendations pertaining to the various sections/clauses of ISO 13628-7. For ease of reference, the clause numbering of ISO 13628-7 has been used throughout Part III of this DEP.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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

This DEP is intended for use in facilities related to 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 should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements 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

See (Part III, 3.2)

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 former Deepwater DEP 37.80.10.30-DWP. A summary of the changes is provided in (Appendix B).

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 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

Part III of this DEP is written as clarifications, amendments and supplements to ISO 13628-7, first edition, 2005-11-15. Wherever reference is made to ISO 13628-7, it shall be understood to mean ISO 13628-7, first edition, 2005-11-15, as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ISO 13628-7 has been used throughout Part III of this DEP.

Clauses in ISO 13628-7, which are not mentioned in this DEP, shall remain valid as written.

PART III CLARIFICATIONS AND SUPPLEMENTS TO ISO13628-7**1. SCOPE**

The purpose of this DEP is to identify and specify the functions and features that a Completion/Workover System shall have in order to meet the Principal's system design requirements.

The modes of operation that the system covers shall be as specified in (Part III, 4.7, Table 1).

The functions and features Completion/Workover System shall include the items detailed in the simplified schematic shown in (Part III, 4.2, Figure 4.1) and the functional schematic shown in (Appendix A, Figure A4).

ISO 13628-7, Figures 2 and 3 describe the industry typical system set-up for performing work in Tubing Hanger and Tree Modes. ISO 13628-7, Figures 4 and 5 are typical examples of the schematics associated with those set-ups.

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.

The basis for the equipment design shall be DEP 37.80.00.36-Gen. A brief note of those requirements is given below to provide a guide to interpreting why and what equipment is to be considered within this document.

The subsea wellhead (and tubing head) shall have the following features:

- a) 18-3/4 inch fullbore or slimbore body with an H4 profile;
- b) rated for 5,000, 10,000 or 15,000psi working pressure;
- c) the tubing head shall provide a hang off profile with passive orientation for a tubing hanger, a vertical connection for a flowline jumper, downhole annulus access and provide orientation of the Xmas Tree, and;
- d) the tubing head connector hydraulically actuated by an ROV.

The tree and tubing hanger shall have the following features:

- a) dual bore 5 inch x 2 inch (2 inch equivalent annulus diameter) vertical tree with the production bore concentrically aligned to the tubing hanger;
- b) rated for 5,000, 10,000 or 15,000 psi working pressure;
- c) the wellhead connector hydraulically actuated by an ROV;
- d) an 18-3/4 inch H4 profile re-entry mandrel with an internal lockdown profile for tooling intervention;
- e) the tubing hanger shall have a concentric production bore and a minimum of 7 and maximum of 11 radial penetrations for electrical, hydraulic and chemical functions;
- f) the controls requirements and interfaces in accordance with DEP 37.80.00.33-Gen, and;
- g) the ROV related items in accordance with DEP 37.80.30.31-Gen.

The completion/workover system equipment shall comprise:

- a) Riser joints (fully fabricated units c/w riser end connections) for Well completion, TH Installation/Recovery and XT Installation/Recovery and Intervention.
- b) Workover Control System comprising of (but not limited to):
 - i. Hydraulic Power Unit
 - ii. Workover Umbilical (installed on a Umbilical Reeler)
 - iii. Umbilical clamps
 - iv. Remote Control Panels
 - v. Riser Control Station
 - vi. EDP/LRP Mounted Controls package
- c) Surface flow tree
- d) Surface tree tension frame
- e) Lower workover riser package comprising of:
 - i. Lower Riser Package
 - ii. Emergency Disconnect Package
- f) Tubing Hanger Running Assemblies comprising of:
 - Tubing Hanger Running tool
 - BOP Spanner Joint
 - i. THRT Adaptor joint
 - ii. Spacer spool(s)
 - iii. Emergency disconnect Latch (specific for DP Rig)
 - iv. Shear Joint (specific for DP rig)
 - v. Slick Joint(s)
- g) Lubricator valves
- h) Retainer valves
- i) Shear subs
- j) Swivels
- k) Annulus circulation equipment comprising of:
 - Annulus HCR hose (installed on Annulus hose reel)
 - Annulus hose reel
 - Hose clamps
- l) Riser spider
- m) Umbilical clamps used for inside drilling riser and open water work for Well completion, TH Installation/Recovery and XT Installation/Recovery and Intervention.
- n) Handling and test tools

- Notes:
- 1. The above lists have been taken from Section 1 of ISO 13628-7. The list has been revised to show where the Principal's global requirements can be found.
 - 2. Additional comments have been added to identify what the equipment is used for relative to completion and workover activities and where the details of the specific requirements can be found.
 - 3. The activities cover operations from both moored and DP rigs.

The following items are excluded from the scope of this DEP. Details are provided in a separate DEP, as noted, or are not considered to meet the requirements of the Principals Model for Subsea Completion/Workover equipment:

- a) Tubing hanger - refer to DEP 37.80.00.39-Gen.
- b) Internal and external tree cap - refer to DEP 37.80.00.36-Gen.
- c) Subsea test tree for well to rig unloading/clean up and well kill.
- d) Tubing hanger orientation system - refer to DEP 37.80.00.36-Gen.
- e) Surface coiled tubing unit.
- f) Surface wireline unit.
- g) Surface tree kill and production jumper.

3. TERMS, DEFINITIONS, ABBREVIATED TERMS AND SYMBOLS

NOTE: The terms and definitions listed here are common terms and definitions used by industry to describe the equipment being specified in this document. The descriptions are relative to the Principals equipment design parameters and the intended operational modes for Deepwater Subsea applications.

3.1 TERMS AND DEFINITIONS

As per the ISO document but with the following clarifications to align with the Principal's common terms of reference:

3.1.20 Completion riser

This riser may be drill pipe, completion tubing or a "special" riser. It may be used for installation, recovery or completion work but always within the drilling riser.

3.1.21 Completion/workover riser

As 3.1.20 but this riser only be used in open water work.

3.1.77 Landing string

The ISO statement is accepted but for the Principals terms of reference and specific requirements refer to 5.4.3 later.

3.1.87 Lower riser package

As ISO but with the clarification that the tree running tool is the LRP connector that also allows the package to connect to a tree for intervention work.

3.1.113 Re-entry spool

In Principals terms of reference this is called the tree re-entry mandrel. In addition to the external profile that is used for handling and LRP re-entry the mandrel is required to have internal profiles. They allow the setting of an ROV tree cap and attachment of a tie-back tool to be used during downhole intervention work.

3.1.133 Slick joint

This term is replaced in Principals terms of reference by cased wear joint (see also section 5.4.16 of the ISO document which states the same).

3.1.165 Tree running tool

Refer to 3.1.87 above.

3.1.168 Tubing Hanger Running Tool (THRT)

Common interface to latch into the tubing hanger, provide production bore access, and hydraulic/chemical/electrical interface to downhole functions.

3.1.169 Tubing riser

This term is replaced in Principals terms of reference by completion riser.

3.1.181 WCT-BOP

This term is replaced in Principals terms of reference by LRP.

The following terms and definitions are used in this DEP and are not listed in the ISO document under those specific headings.

BOP Spanner Joint (BOPSJ)

Intermediate assembly providing interface between the IWOCs umbilical, workstring, and the THRT. The BOPSJ typically does not have isolation valves in the production bore for vertical tree configurations. The BOPSJ spaces-out within the BOP and includes ram spools, shear joints, and annular slick joints.

Tubing Hanger Running Assembly (THRA)

Comprised of the BOPSJ and THRT

Subsea Test Tree (SSTT)

Comprised of the THRT adapter, lower valve module with ram spool, latch module, shear joint, and upper valve module with annular slick joint.

3.2 ABBREVIATED TERMS

As per the ISO document and, with these additions:

AIV(RAIV)	(Riser) Annulus isolation valve
BOPSJ	BOP Spanner Joint
C/WO	Completion/Workover
DHPT	Downhole pressure/ temperature
DP	Dynamic positioning
EAS	EDP Annulus swab
EAM	EDP Annulus master
EPU	Electrical power unit
ESD	Emergency shut down
FSC	Fail safe closed
FSO	Fail safe open
HMI	Human machine interface
HP	High pressure
HPU	Hydraulic power unit
IWOCs	Intervention workover control system
LBSR	Lower blind shear ram
LP	Low pressure
LRP	Lower riser package
LWRP	Lower workover riser package
MCS	Master control station
MODU	Mobile offshore drilling unit
THRA	Tubing hanger running assembly
THRT	Tubing hanger running tool
PRV	Production retainer valve
PSR	Pipe Slip Ram
PXOV	Production crossover valve

RPIV	Production isolation valve
RXOV	Riser crossover valve
SEM	Subsea electronic module
SCM	Subsea control module
UBSR	Upper blind shear ram
VDU	Video display unit
WHPU	Workover hydraulic power unit
WSCM	Workover subsea control module

4 SYSTEM REQUIREMENTS

4.2 DESCRIPTION OF C/WO RISER SYSTEMS

As per ISO document and, with the addition of Figure 4.1 which provides a simple schematic of a Lower workover riser package as defined above

Note: A more explicit diagram is provided in (Appendix A, Figure A4)

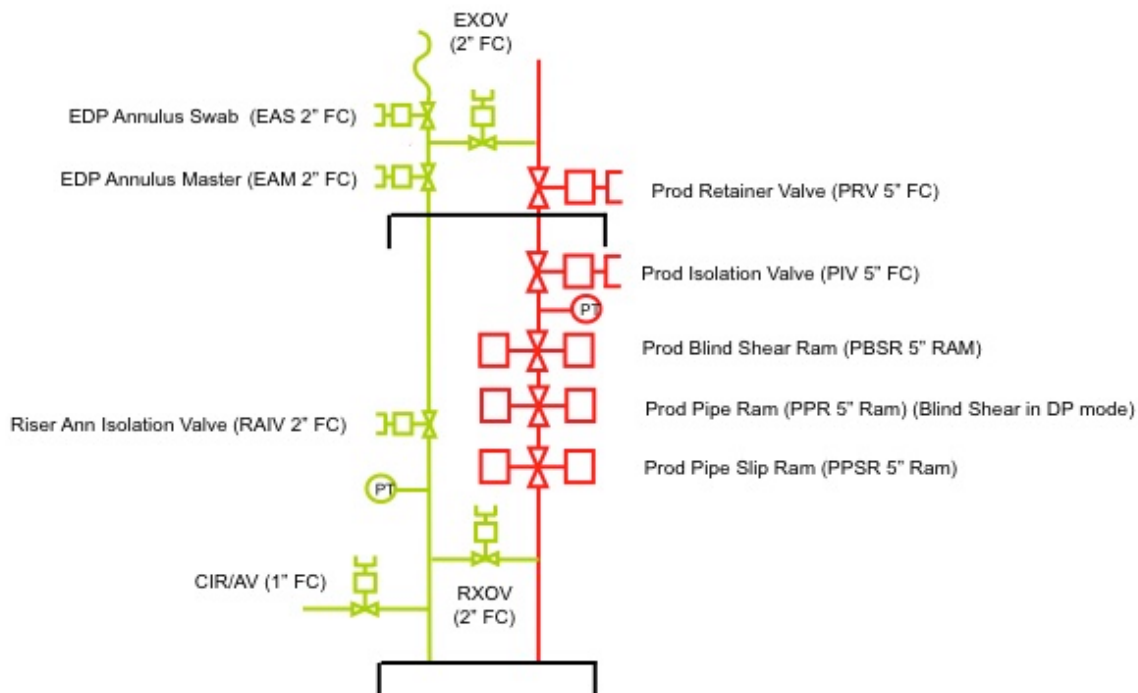


Figure 4.1 EDP/LRP Simplified Schematic

4.4 SYSTEM DEFINITION

As per the ISO document and, with the addition of the following:

DEP 37.80.00.39-Gen. shall be used as the reference document to cover the various systems required during the modes of operation.

4.5 SYSTEM DESIGN

As per the ISO document and, with the addition of the following:

The requirements of DEP 37.80.00.39-Gen. shall be referenced.

The size and weight of the system components shall enable deployment and recovery from/to any of the Principal nominated drilling, installation or workover vessels with a minimum number of lifts. During the course of the design and equipment manufacture Contractor shall provide regular updates of the equipment size and weights and shall ensure that these parameters do not impinge upon the vessels craneage and dynamic lift capabilities. All equipment and system package lifts (both surface and subsea) shall be performed with a maximum half ($\frac{1}{2}$) degree offset. If counterweights or ballasting of equipment is necessary to produce level lifts then the amount of weight used shall be minimised to lessen the impact on the ultimate lifting requirement.

4.7 MODES OF OPERATION**4.7.1 Riser system**

As per the ISO document and, with the addition of the following:

DEP 37.80.00.36-Gen. shall be referenced to define the systems and cover the equipment required during each mode of operation.

From the above document the basic model Tree system shall be dual bore vertical one with the riser being of monobore construction.

The Table 1 below provides a list of the operations the system shall cover to meet the Principals requirements for Completion and workover operations from a DP or Moored rig.

Table 1 List of Operational activities

Mode of Operation	CWOR System	BOP on Tree with SSTT	THRA System
Well completion			X
Well completion (TH) recovery			X
Well Intervention-Open Water	X		
Well Intervention-inside drilling BOP/riser		X	
Well Workover	X	X	

4.9 OPERATIONAL PRINCIPLES

As per the ISO document and, with the addition of the following:

Contractor shall identify from the Design Analysis, the equipment or component that is the designated weak point of the system and how operationally that failure is to be accommodated.

4.12 REGULATIONS, CODES AND STANDARDS

As per the ISO document which lists all the reference documents that cover the equipment and system design, manufacture and testing, with the addition of the following.

In addition the Principal nominated requirements are provided in the Project Basis for Design, the Project Equipment Data Sheets and the documents noted in the Informative companion document.

5.4.2 Common requirements

As per the ISO document and, with this clarification to requirement:

The riser system shall be designed for guidelineless operations only from either a DP or Moored rig.

5.4.3 Landing String

As per the ISO document and, with the addition of the following:

NOTE: Landing string is referred to as the THRA.

The landing string (per the ISO definition in Section 3.1.77) is considered to comprise the THRT and BOPSI assemblies noted in the Figure 5.1 below.

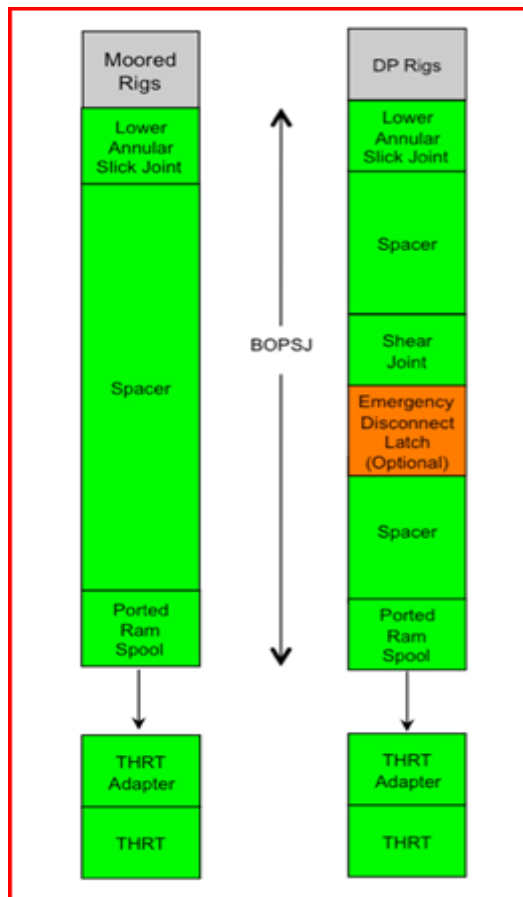


Figure 5.1 Simplified Landing String layouts for DP and Moored rigs

The THRA assembly shall include a BOP Spanner Joint (BOPSJ) which shall have connections that are suitable for making up and disconnecting at the rig floor without the need for any high torque tongs or machinery.

The BOPSJ shall incorporate the means of connection to the completion riser or drill pipe at the top and the THRT adaptor at the bottom.

The length of the BOPSJ shall be set so that a ported ram spool is located across the lower pipe ram of the BOP which can be closed to isolate the annular area between the joint and the inside of stack.

5.4.4 Subsea test tree

As per the ISO document and, with the addition of the following:

The use of a Subsea Test Tree system is not one of the primary concerns for this Shell Global Requirements Document as its use is normally on horizontal tree systems. However consideration needs to be given to at some point in the future using the subsea test tree system to perform these operations:

- Unloading or cleaning up a well back to the completion unit.
- Killing a well prior to recovery of the Tree, TH and completion.
- Well workover and/or intervention utilizing a BOP on tree operation.

5.4.6 Retainer valve

As per the ISO document and, with the addition of the following:

To meet the requirements of the Principal, (Figure 4.1) and (Appendix A, Figure A4) in this DEP show location of the production bore retainer valve (PRV) as an integral part of the EDP assemblies.

5.4.8 Tubing hanger orientation system

As per the ISO document and, with the addition of the following:

The requirements of DEP 37.80.00.36-Gen. shall be addressed. Those requirements stipulate that a tubing head shall be used to support the tubing hanger and that the orientation system provided shall be "passive" in nature.

The following requirements are those that relate to the actual operation of TH installation:

- a) The system shall allow the TH to be installed and tested in a single trip and shall be highly tolerant to debris.
- b) The system shall exhibit control over these operations:
 - Initial interface of the TH seal within the tubing head
 - Re-entry of the THRT into the installed TH
- c) The installation procedure shall not require the engagement of a pack-off within the tubing head more than once.
- d) The system shall provide clear indication at the drill floor as to the status of the installation operation, in particular relating to orientation, lockdown and tie-back.
- e) The installation procedures shall be compatible with the Completions group procedures for the setting of packers.
- f) Throughout the installation procedure, it shall be possible to monitor the downhole electrical line integrity and communicate with the hydraulic and chemical line functions.
- g) The TH installation procedure shall not be limited by vessel heading.
- h) The TH installation system shall be designed to be capable of accommodating an external test pressure of the Equipment Design Pressure + the hydrostatic head of fluid within the drilling riser with the completion riser bore at ambient surface pressure.
- i) It shall not be necessary to apply torque to any running string in order to achieve alignment of the TH or to activate any seals.
- j) The running system shall include a temporary stabbing funnel guide that fits onto the THRT and facilitates free stabbing of the tool onto a TH in the correct attitude at the drill floor.

5.4.9 Lower workover riser package

As per the ISO document but with the following changes:

The text states the package contains a wireline coiled tubing BOP (WCT-BOP) assembly which in the Principals terms of reference is known as the lower riser package (LRP).

The LRP package shall contain the following valves which shall be located as shown in (Figure 4.1) and (Appendix A, Figure A4) in this DEP. This configuration meets the Principal's requirements. Typical specification details may be provided by the Principal in a sample equipment data sheet. Project may elect to make up their own layout which would be referenced with the Project specific data sheets or specification.

The LRP package shall be capable of isolating the production bore by closing either the lower or upper shear ram. Both shear rams shall be sealing and capable of shearing coiled tubing, braided wire, slickline, and electrical cable. A pipe slip ram below the LBSR shall capture the coil tubing string prior to shear closure.

The sizes and materials of the tubing, line and cable shall be provided in the Project Tender Document Package.

The LRP package shall have an annulus through path that allows access to the Tree and the Annulus Circulation Hose. The Path shall incorporate a fail-safe close riser isolation valve (AIV) and a fail-safe close crossover valve (PXOV) between the annulus and production bore. The crossover porting shall be below the pipe slip ram and the riser annulus isolation valve (RPIV).

The LRP package structure shall attach to the connector and provide these features:

- Have a funnel down re-entry arrangement and if required a system of passive orientation.
- The structure shall be capable of supporting the weight of the LRP, EDP and Stress joint in free standing and test stand configurations.

5.4.10 Emergency disconnect package

As per the ISO document and, with the addition of the following:

The package shall be capable of use as an emergency disconnect connector set in the landing string above the LRP. The connector shall incorporate a ROV override facility for emergency release/disconnection.

The package shall be capable of accepting a workover control module and the connection of the workover umbilical and the annulus circulation line.

The interface with the EDP/LRP shall be made with metal to metal seals that can be replaced subsea by ROV.

The package shall contain the following valves which are to be located as shown in (Figure 4.1) and (Appendix A, Figure B4). The production bore valve (PRV) shall be fail safe close gate valve suitable for isolating the production bore prior to disconnection. The EDP shall have a fail safe close annulus master valve (EAM) and a fail safe close annulus swab valve (EAS) arrangement as well as a fail safe close crossover gate valve (EXOV) located between the two aforementioned valves for inter bore communication, circulation and clean out.

5.4.11 Subsea wireline/coiled tubing BOPs (WCT-BOP) and shearing valves

As per the ISO document and, with this comment:

To meet Principals requirements, the WCT-BOP package shall be known as the LRP. The functional requirements for the LRP have been defined previously in (5.4.9).

The valve configuration to meet Principals requirements is given in (Figure 4.1) and (Appendix A, Figure B4).

5.4.12.2 Emergency disconnect package connectors

As per the ISO document and, with the addition of the following:

The primary hydraulic actuation of the connector (and the LRP package connector/tree running tool) shall be performed through the Workover Control system and the C/WO umbilical. The connectors shall be provided with secondary operating and emergency override features that are operable with an ROV.

5.4.12.3 C/WO Riser Joint Connectors

As per the ISO document and, with these additions and exception:

The riser joint connectors proposed shall be proven high strength deepwater designs and they should have pre-loaded quick make up break out capability at assembly. The connection design shall be robust and durable in order to maximise their use offshore, full interchangeability of connections is required. Shell requirements are that the connection be made up or broken out without the use of sophisticated and specialised torque or tension machinery.

Contractor is required to establish for each connection a data base of their operational use and all performed maintenance throughout their working lifetime.

Contractor is to provide with the bid any details of preliminary analysis work on open water use and the effects of vortex shedding on the riser profile with a control umbilical attached and with and without an annular line in place also.

Suspended riser string weight is to include the LRP and EDP package weights and the Annulus Circulation Hose.

The paragraph relating to Connector torque resistance does not apply as the TH assembly shall not be run through this riser.

5.4.13 Stress joint

As per the ISO document and, with the addition of the following:

The stress joint shall transmit stresses induced by the riser system during all modes of operation and in all year weather conditions without imposing any restrictions on the operations resulting from the weather conditions.

The stress joint shall have an upper connection compatible to the riser joint connections and a lower connection that allows quick make up and break out. In addition the stress joint shall have a top connection saver sub in addition to the pup joints provided with the riser system.

5.4.14 Riser joints

As per the ISO document and, with the addition of the following:

A means of maintaining pre-load and make up shall be provided to prevent loss of seal integrity and connector back off and rotation during normal operations.

Any lubricants or greases required for the joint make up shall be compatible with operations both inside the drilling riser, in open water and from the internal mediums.

5.4.18 Surface tree

As per the ISO document and, with the addition of the following:

The main bore valves may be manual operated but should operating safety become an issue then they shall be hydraulically actuated.

5.4.20 Surface tree tension frame

As per the ISO document and, with the addition of the following:

With respect to lift capability the statement should read "the entire C/WO riser string, including the LRP/EDP assembly".

5.4.22 Annulus circulation line

As per the ISO document and, with the addition of the following:

- It shall be equivalent in length to the Workover umbilical.

- It shall be rated for the working pressure available selected by project.
- It shall be installed on a reeler similar in design and function to the Workover umbilical.
- The end fittings shall be designed to interface with the rig choke and kill (directly or through adapters) and EDP connection. As a minimum the connecting assemblies shall be similar in design, rating, construction and operation to those interfaces.

The other additional considerations are that the equipment shall be supplied as a fully operational system and come complete with crossovers, subs, running sheave assemblies, running clamps and any surface jumpers that interface with other equipment on the unit.

5.5 WORKOVER CONTROL SYSTEM

5.5.1 General

As per the ISO document and, with this note added:

Assume that the source for the provision of methanol shall be available from injection units held onboard the vessel. If such facilities are not available then the contractor shall source suitable equipment to meet the requirements of the operation.

For the Principals operational scenarios, all Completion, Installation and workover operations be performed from either a moored or DP MODU. If the DP option applies then an Emergency Quick Disconnect Connector (EQDC) for the riser shall be required.

5.5.3 Safety measures

As per the ISO document and, with the following clarification:

The statement reads "It should be possible to initiate shutdown of the neighbouring wells from the Workover Vessel".

The clarification is that the system should be capable of "informing or relaying to" the production control master unit of the need to shut in production from the adjacent wells but not to actually function the valves from the vessel.

5.5.5 Shutdown and disconnect functions

As per the ISO document and, with the addition of the following:

5.5.5.1 ESD Levels

The ESD system shall be comprised of three levels of emergency shutdown. The operator may chose the level of ESD based on the environmental and hazard conditions at the time.

Valve commands are to be issued in accordance with ESD Matrix table. Production SCM and Workover SCM ESD valve commands shall be executed in parallel.

The total time for execution of the tree SCM ESD valve commands should be equal to or less than the total time for execution of the workover SCM ESD valve commands(not inclusive of EDP connector commands). This is required to ensure that all tree SCM valves commands are transmitted prior to denenergization of the tree channel circuits. This may be accomplished by means of a permissive triggered by the transmission of the last production SCM valve command.

All valves commands to the production SCM shall be sent by the topside system prior to de-energization of the tree channel circuits.

ESD shutdown logic shall have a configurable delay timer to optimize valve issue commands.

The topside system shall give priority to the ESD signals over all other communication and data acquisition tasks until the ESD sequence has been completed.

The topside system shall monitor each valve command returned from subsea for an acknowledgment (ACK) response. If the topside system receives a Negative

Acknowledgment (NACK), the topside system shall ignore the NACK from the SCM and proceed with the next valve command.

The topside system shall send each valve command to both SEMs simultaneously for redundancy.

The Figure 5.1 below is a Matrix that provides typical details of those ESD Levels.

Abbreviation	ESD I Open mode	ESD II Open mode	ESD III Open mode	ESD I Wireline Mode	ESD II Wireline Mode (Above SCSSV)	ESD II Wireline Mode (Below SCSSV)	ESD III Wireline Mode (Above SCSSV)	ESD III Wireline Mode (Below SCSSV)	ESD I Coil Mode	ESD II Coil Mode (Above SCSSV)	ESD II Coil Mode (Below SCSSV)	ESD III Coil Mode (Above SCSSV)	ESD III Coil Mode (Below SCSSV)
SPWV	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close	Close
SPMV	Close	Close	Close	As Is	As Is	As Is	As is	As is	As Is	As Is	As Is	As is	As is
SPSV	As Is	As Is	As Is	As Is	As Is	As Is	As is	As is	As Is	As Is	As Is	As is	As is
SKV	As Is	As Is	As Is	As Is	As Is	As Is	As is	As is	As Is	As Is	As Is	As is	As is
EDPCL	As Is	As Is	Vent	As Is	As Is	As Is	Vent	Vent	As Is	As Is	As Is	Vent	Vent
EDPCUL	As Is	As Is	Disconnect	As Is	As Is	As Is	Disconnect	Disconnect	As Is	As Is	As Is	Disconnect	Disconnect
EDPSUL	As Is	As Is	Disconnect	As Is	As Is	As Is	Disconnect	Disconnect	As Is	As Is	As Is	Disconnect	Disconnect
PRV	As Is	As Is	Close	As Is	As Is	As Is	As is	As is	As Is	As Is	As Is	As is	As is
EAM	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
EAS	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
EXOV	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
RAIV	As Is	Close	Close	As Is	Close	Close	Close	Close	As Is	Close	Close	Close	Close
UBSR	As Is	As Is	As Is	As Is	Close	Close	Close	Close	As Is	As Is	As Is	Close	Close
LBSR	As Is	As Is	As Is	As Is	Close	Close	Close	Close	As Is	As Is	As Is	Close	Close
CIR/AV	As Is	Close	Close	As Is	Close	Close	Close	Close	As Is	Close	Close	Close	Close
PIV	As Is	Close	Close	As Is	As Is	As Is	As is	As is	As Is	As Is	As Is	As is	As is
PPSR	As Is	As Is	As is	As Is	As Is	As Is	As is	As is	As Is	Close	Close	Close	Close
RXOV	As Is	Close	Close	As Is	Close	Close	Close	Close	As Is	Close	Close	Close	Close
PWV	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
AMV	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
XOV	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
PSDV	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
CIT1	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
CIT2	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
CIT3	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
CIT4	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
CID1	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
CID2	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
PMV	As Is	As Is	Close	As Is	As Is	As Is	As is	As is	As Is	As Is	As Is	As is	As is
AWV	As Is	As Is	Close	As Is	As Is	As Is	Close	Close	As Is	As Is	As Is	Close	Close
PC	As Is	As Is	Stop	As Is	As Is	As Is	Stop	Stop	As Is	As Is	As Is	Stop	Stop
SV1	As Is	Close	Close	As Is	Close	As Is	Close	As is	As Is	Close	As Is	Close	As is
SV2	As Is	Close	Close	As Is	Close	As Is	Close	As is	As Is	Close	As Is	Close	As is

Figure 5.1 ESD Levels Matrix

5.5.5.1.1 Level 1

The ESD Level 1 shutdown is a surface only shutdown that results in closure of the Surface flow tree based on the selected operational mode.

5.5.5.1.2 Level 2

The ESD level 2 shutdown is a sequenced surface and subsea shutdown. The closure sequence of surface flow tree, EDP, and LRP valves is based on the operational mode. The level 2 shutdown is sequenced such that surface flow tree valves are closed first, and then followed with the closure of the EDP and LRP valves.

5.5.5.1.3 Level 3

The ESD level 3 shutdown is a sequenced surface and subsea shutdown followed by disconnect of the EDP from the LRP. The closure sequence of surface flow tree, EDP, and LRP valves is based on the operational mode. The level 3 shutdown is sequenced such

that surface flow tree valves are closed first, and then followed with the closure of the EDP and LRP valves. The EDP unlock is sent once all valve commands have been processed.

In order to prevent arcing damage and possible failure of the stab plate electrical connectors between the EDP and LRP, ESD III operation shall incorporate a routine to power down both channel A and channel B tree SCM circuits prior to unlock of the EDP connector.

The primary permissive for initiation of the de-energization of the production SCM channel circuits shall be receipt of a response from the production SCM for the last tree ESD valve command. A response includes both 'ACK' and 'NACK' type messages.

In the event that no response is received by the topside system from the production SCM after the last tree ESD valve command, the transmission of the EDP unlock command by the topside system shall serve a secondary trigger for de-energization of the production SCM channel circuits. The topside system shall process both actions (EDP unlock and tree channel de-energization) in parallel.

5.5.5.2 Operational Modes ESD Impacts

The Workover Riser be operated in one of three following operational modes:

- Open Hole Mode: The production bore is open without wireline or coil tubing present in the production bore.
- Wire Line Mode: Wireline is present in the production bore.
- Coil Tubing Mode: Coil tubing is present in the production bore.

Each operational mode shall have a specific valve and ram closure sequence.

In addition, the wireline and coil tubing workover riser modes shall be subdivided into above or below SCSSV categories:

- Above SCSSV: The total depth of the wireline or coil tubing run is above the set depth of the SCSSV.
- Below SCSSV: The total depth of the wireline or coil tubing run is above the set depth of the SCSSV.

Each above or below SCSSV subdivision shall have a specific valve and ram closure sequence.

5.5.5.3 EDP Connector Logic

The ESD system shall allow the operator to abort the unlock command for the EDP connector during the specified time period. Once an ESD level 3 command is acknowledged, the HMI application shall display a countdown timer in a display window. The operator may abort the EDP unlock during this time window only. The only command affected by this abort feature is EDP connector unlock command.

- When operator triggers an ESD Level 3, a timer is activated and the operator station screens display a count down and request confirmation to unlock the EDP.
- If the operator chooses 'YES', the EDP unlock after the timer expires.
- If operator chooses 'NO', the timer expires and the EDP not unlock.
- If operator takes no action, the timer expires and the EDP unlock.

5.5.5.4 ESD Initiation Sites

The ESD may be initiated from multiple sites on the RIG or vessel. The location of equipment shall be determined during rig interface engineering.