

NORSOK STANDARD

DESIGN REQUIREMENTS  
**SUBSEA PRODUCTION SYSTEMS**

U-DP-001  
Rev. 1, January 1995

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## 1 FOREWORD

This standard has been developed by the NORSOK Standardisation Work Group.

All Annexes are informative.

## 2 SCOPE

The Standard covers all phases of a project and sets the overall design requirements for underwater production systems and the interfaces between the subsea system and the surrounding systems. More detailed requirements are formulated in the relevant subsystem standards.

The standard also sets requirements for verification of system performance either by analysis or by testing. The type/extent of verification will be dependant on the content of new and unproven technology in the system.

## 3 NORMATIVE REFERENCES

The latest editions and amendments of the following standards and recommendations shall apply, at the time of order placement:

| API Specifications |                                                   | To be merged/replaced with ISO standards |                                                    |
|--------------------|---------------------------------------------------|------------------------------------------|----------------------------------------------------|
| RP 17A             | Design and Operation of Subsea Production Systems | ISO 13628-1                              | General Requirements                               |
| RP 17B             | Flexible pipe                                     | ISO 13628-2                              | Flexible Pipe                                      |
| Spec. 17D          | Subsea Wellheads and Trees                        | ISO 13 628-4                             | Subsea Wellhead and Christmas Tree Equipment       |
| Spec. 17E          | Subsea Control Umbilicals                         | ISO 13 628-5                             | Subsea Control Umbilicals                          |
| RP 17F             | Subsea Control System Eq.                         | ISO 13 628-6                             | Subsea Production Controls                         |
| RP 17G             | Completion/Workover Riser System                  | ISO 13 628-7                             | Design and Operation of Completion/Workover risers |
| RP 17H             | ROV Interfaces with Subsea Equipment              | ISO 13 628-8                             | ROV Intervention on Subsea hardware                |

Other NORSOK Subsea Standards:

|          |                                      |
|----------|--------------------------------------|
| U-CR-001 | Subsea Structures and Piping System. |
| U-CR-003 | Subsea X-mas Tree System             |
| U-CR-005 | Subsea Production Control System     |
| U-CR-006 | Production Control Umbilical         |
| U-CR-007 | Intervention System                  |
| U-CR-008 | Subsea Colour and Marking            |

Other NORSOK standards:

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| M-DP-001   | Material Selection (with relevant substandards for Surface Preparation, Protective Coating, Cathodic Protection etc). |
| Z- DP- 002 | Coding system.                                                                                                        |
| Z- CR- 001 | Documentation for operation.                                                                                          |
| I- CR- 002 | Safety and automation systems.                                                                                        |
| P- CR- 002 | Life Cycle Cost.                                                                                                      |

## 4 DEFINITIONS AND ABBREVIATIONS

### 4.1 Definitions

The subsea system is divided into typical subsystems as shown in fig. 4.1 and Annex A. The main subsystems are:

Subsea wellhead and x-mas tree equipment: wellhead, tubing hanger, X-mas tree with choke, PGB, completion workover riser, workover control system.

Production Control System: would typically include subsea control module electronics and hydraulics, subsea electrical/hydraulic and chemical injection distribution system, tree instrumentation, misc. tools, and master control-, power/comms- and hydraulic power units on surface.

Umbilical: electrical, hydraulic and chemical lines including terminations.

Intervention system: would typically include tools for pull in and connection of sealines/umbilicals, tools for running of choke, control pod, pig launcher etc., surface control container, umbilical winch, lift wire winch, heave comp. eq. etc.

Subsea structures and piping systems: template and satellite structures, manifold and riser base structures, protection structures, piping modules.

Subsea flowlines: any risers, hard pipes, flexible lines, rigid risers, dynamic risers (not covered in NORSOK).

## 4.2 Abbreviations

|         |                                             |
|---------|---------------------------------------------|
| BOP     | Blowout Preventer.                          |
| CT      | Coiled Tubing.                              |
| DP      | Dynamic positioning.                        |
| ESP     | Electrical Submersible Pump.                |
| EQDP    | Emergency Quick Disconnect Package.         |
| FAT     | Factory Acceptance Test.                    |
| ICS     | Intervention Control System.                |
| LMRP    | Lower Marine Riser Package.                 |
| LRP     | Lower Riser Package.                        |
| PGB     | Permanent Guide Base                        |
| PICT    | Pull In and Connection Tool.                |
| ROT     | Remotely Operated Tool                      |
| ROV     | Remote Operated Vehicle                     |
| SCSSV   | Surface Controlled Sub-Surface Safety Valve |
| TH      | Tubing Hanger                               |
| WOCS    | Work Over Control Systems                   |
| STT     | Surface Test Tree                           |
| TH/THRT | TH Running Tool                             |
| HPU     | Hydraulic Power Unit                        |

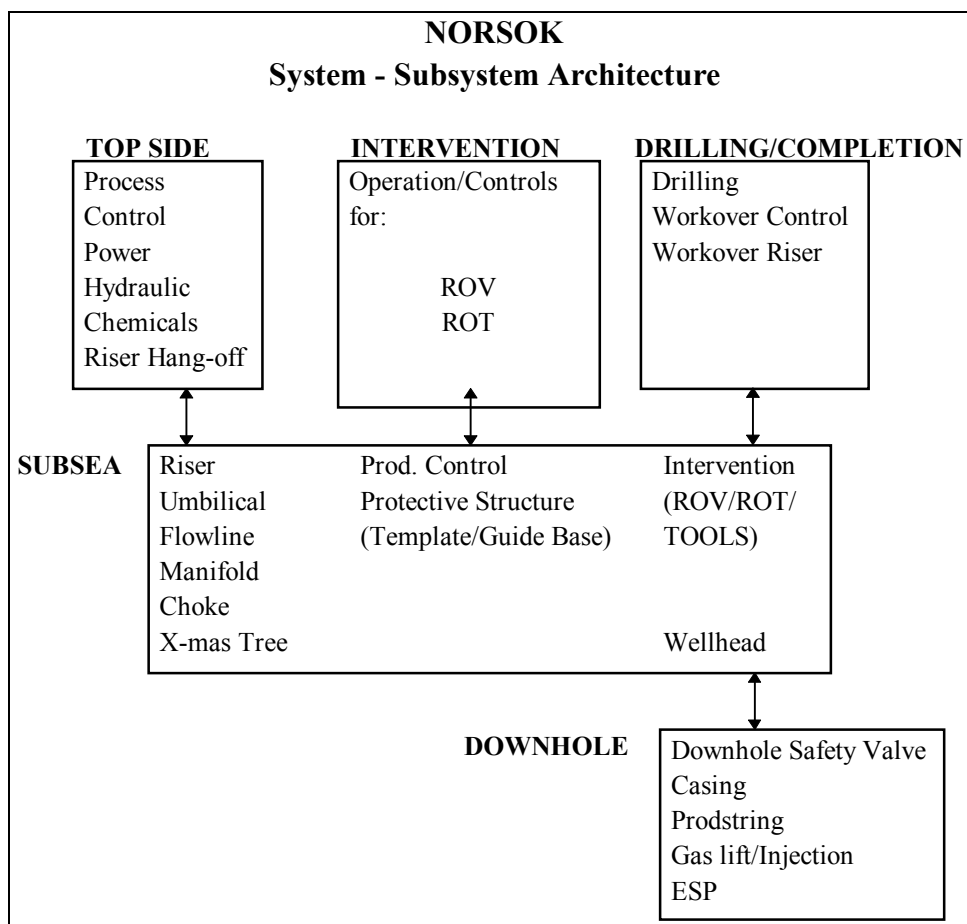


Fig 4.1 Typical Subsea Production System Block Diagram

## **5 DESIGN REQUIREMENTS**

### **5.1 General Design Requirements**

Subsea systems should be designed for diverless installation and intervention.

Diving operations shall not be planned in water depths exceeding 180 m.

The subsea production system shall be designed to optimise life cycle cost within the defined safety level.

All pressure containing equipment shall be rated to the highest system operating or test pressure.

For pressure containing equipment placed subsea the design pressure may be adjusted for hydrostatic pressure.

The system shall be designed such that any operation can be terminated leaving the well(s) in a safe state when predefined operational limits are exceeded.

The sub system design work should include the definition of all interfaces between subsystems, typically listed in clause 4.1.

The system shall be designed for easy fault diagnosis without system retrieval.

A high system availability should be obtained through use of simple designs and high quality products (suppliers standard equipment with an in field performance record). Use of redundant designs should only be selected after a cost/benefit analysis.

Operational reliability shall be documented for the subsea systems.

For non critical temporary equipment relaxed requirements may be accepted.

Intervention interfaces shall be implemented according to international standards. (e.g. API 17H)

Connectors with critical functions shall have an arrangement preventing unintentional release.

## 5.2 Procedures/limitations for the operations

The subsea system design work should include the definition of procedures/limitations for major operational modes:

- **Well completion/testing/killing/intervention/workover.** This mode of operation may include simultaneous operations, e.g. one well is controlled from the rig while adjacent wells are producing and are controlled from the process facilities.
- **Pull in and connection of flowlines/umbilicals.** This operation can be performed:
  - as an independent operation from typical installation vessels before the wells are completed
  - after the well is completed
  - from the rig simultaneous with drilling/completion operations.
- **Normal production.** This mode will include regular remote pressure testing of subsea barriers and routine inspection and maintenance by ROV, and well rate testing. (Pipelines may be inspected by instrument pigs or other methods.)
- **Repair of subsea equipment.** Repair is normally done by replacement of components (e.g. valves, inserts) or by replacement of bigger modules carried out by dedicated remotely operated tools. Replacement of equipment may be done while main parts of the system is producing.

## 5.3 Requirements Relating to Barriers

During production activities at least two independent and tested barriers shall be available between reservoir and environment in order to prevent an unintentional flow from the well. The barriers shall be designed to rapidly re-establish a lost barrier. In the event of a barrier failure no activities other than re-establishing two barriers shall be carried out in the well. The position status of the barriers shall be known at all times.

One barrier may be acceptable in the case where the reservoir can not produce to the environment without pressure boosting.

During normal production the X-mas tree, as a complete unit is defined as one of the two barriers. The other barrier is the downhole safety valve.

When a workover vessel has assumed well control via the workover control system, the production control system shall not control the intervened well. It shall be possible to initiate shutdown of the neighbouring wells from the intervention vessel. The system design shall have a fail-safe design.

All hydraulic penetrations through the wellhead connection shall be equipped with isolation valves.

Disconnection of a tree from a pressurised manifold may be performed with one single isolation valve if its pressure containing integrity has been tested. The same would apply when connecting a pig launcher to a pipeline hub.

#### **5.4 Requirements to instrumentation, valve position indicators and valve overrides**

The X-mas tree shall be equipped with pressure monitoring at points necessary for a satisfactory functioning of the system, and for pressure testing of the barrier valves.

The need for temperature monitoring and leak detection systems shall be considered in each individual case.

Mechanically operated valves or valves with mechanical override that are required to pass plugs, tools or pigs through, and where damage may occur if the valve is not fully open, shall have mechanical position indication of fully open and closed position.

All ROV operated valves should have visual position indicators.

All valves in the vertical X-mas tree bores subject to wireline operations shall be equipped with mechanical override.

#### **5.5 Dropped objects and trawlgear protection**

Any special dropped object protection should be evaluated on the basis of probability of drop/hit combined with the hazardous consequence of hit.

In areas with fishing activity two options exist:

- Establish of a restricted zone (no bottom gear fishing is allowed in the area). This will require either continuous surveillance or overtrawlable structures.
- If the establishment of a restricted zone is not allowed, the use of overtrawlables structure is required.

### **6 MANUFACTURING GUIDELINES**

#### **6.1 Verification/Analysis/Testing**

All testing should be performed as normal FATs at the suppliers facilities, by using jigs or other measurement methods to assure that interfacing elements will fit when they are installed subsea.

The valves shall be tested for both function and leakage.

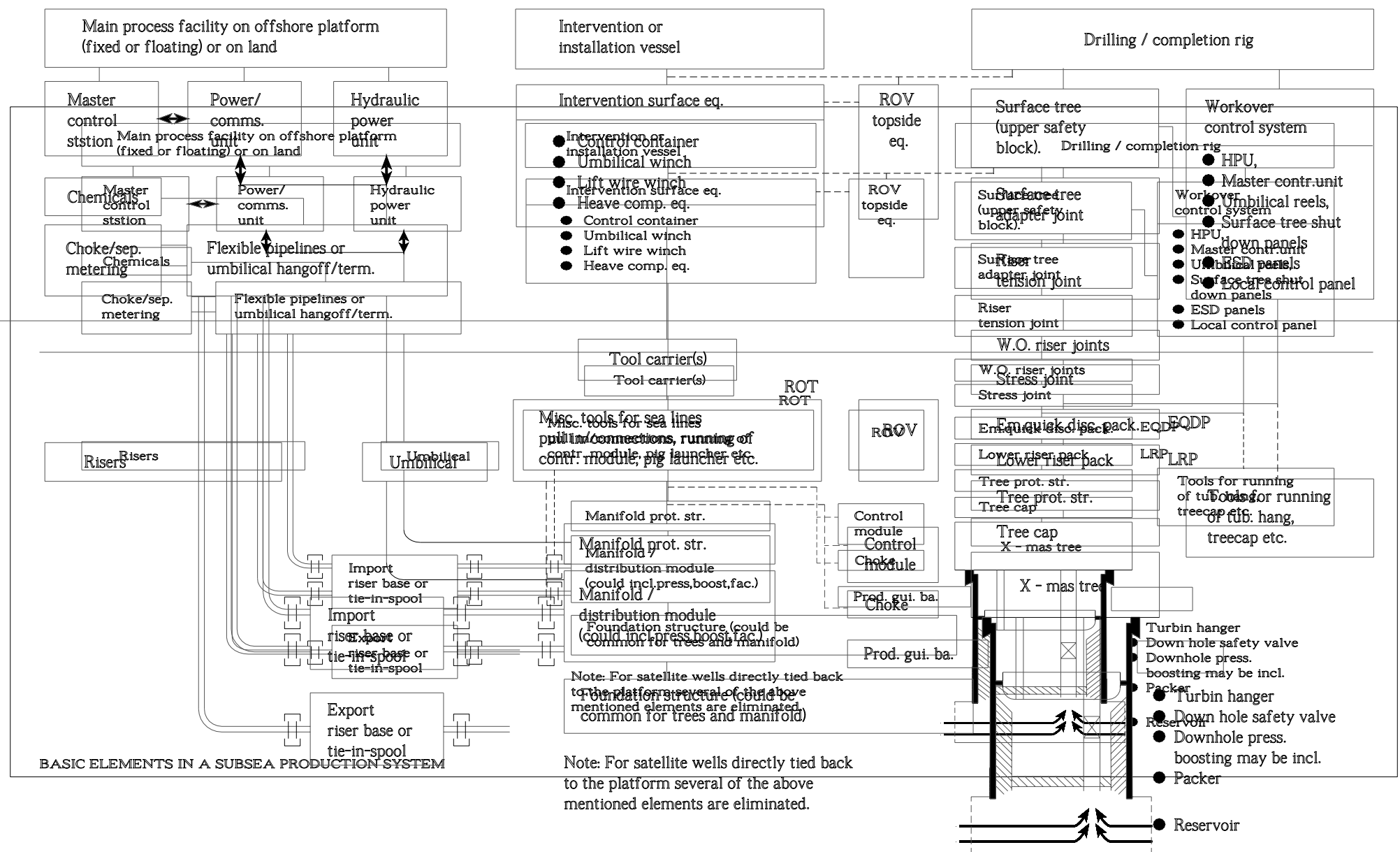
Verification of subsystems and integrated system is required. This can be done by analysis, testing or by documented similarity with field proven equipment with requirements and acceptance criteria for both onshore tests, subsea tests and periodically tests during operational phases.

The overall system operation shall be verified by testing. If not, practical verification can be based on use of jigs or other test equipment that will verify the interfaces between subsystems.

## **6.2 Cleanliness**

An acceptable cleanliness level for a subsea system can only be obtained if the components are clean before assembly and special precautions are taken during assembly. Qualified suppliers of subsea equipment shall follow predefined procedures and have adequate facilities for assembly of clean products.

ANNEX A  
**BASIC ELEMENTS IN A  
SUBSEA PRODUCTION SYSTEM  
(Informative)**



BASIC ELEMENTS IN A SUBSEA PRODUCTION SYSTEM



ANNEX B

**SUBSEA DATA SHEETS (Informative)**

## **Common Requirements for Subsea Production Systems**

### Subsea Data Sheets

The use of these Data Sheets is optional. They are included to assist the user.

Attached to this cover sheet are the following data sheets:

- Production requirements/Reservoir management
- General Field Data
- Environmental Data

It is felt that in addition to the above the user may want to add data sheets covering the following subject:

- Process Flowcharts
- Operational requirements
- Wellstream composition
- Intervention Strategy
- ROV torque tools
- Simultaneous operations
- Thermal expansion data
- Flowline data
- Control system design data, hydraulic fluids, etc.
- Inspection strategy
- Chemicals needed, corrosion, scale & hydrate inhibitors

| <b>SUBSEA DATA SHEET</b>          |                    | <b>UDS-A01</b> | Rev. |
|-----------------------------------|--------------------|----------------|------|
| <b>TITLE: General Field Data</b>  |                    |                |      |
| Field:                            |                    | Design life:   |      |
| Location( Block/UTM):             |                    | Removal        |      |
| Water depth:                      |                    | Number of      |      |
|                                   |                    | Production:    |      |
|                                   |                    | Injection:     |      |
| Design capacities:                |                    |                |      |
| <b>Field:</b>                     |                    |                |      |
| Oil production                    | (Sm3/SD)           |                |      |
| Water production                  | (Sm3/SD)           |                |      |
| Total liquid production           | (Sm3/SD)           |                |      |
| Water injection                   | (Sm3/SD)           |                |      |
| Gas production                    | (10*6              |                |      |
| Gas injection                     | (10*6              |                |      |
| Initial reservoir pressure        | (Bar(in            |                |      |
| Receiving pressure infrastructure | (Bar)              |                |      |
| <b>Individual wells:</b>          |                    |                |      |
| Production wells:                 | (Sm3/SD)           |                |      |
| Injection wells                   | (Sm3/SD)           |                |      |
| Max flowing wellhead temp         | (deg C)            |                |      |
| Max flowing wellhead temp         | (deg C)            |                |      |
| Max WHP well kill                 | (Bar)              |                |      |
| Max WHP injection                 | (Bar)              |                |      |
| Max WHP during production         | (Bar)              |                |      |
| Min WHP during production         | (Bar)              |                |      |
| Max wellhead shut-in pressure     | (Bar)              |                |      |
| Max WHP bull-heading producers    | (Bar)              |                |      |
| Protection requirements:          |                    |                |      |
|                                   | Fishing activities |                |      |
|                                   | Dropped objects    |                |      |
| Field schematic:                  |                    |                |      |
|                                   |                    |                |      |

|                                      |                      |                        |                         |                        |                      |
|--------------------------------------|----------------------|------------------------|-------------------------|------------------------|----------------------|
| <b>SUBSE</b>                         |                      | <b>UDS-A02</b>         |                         | Rev. A                 |                      |
| <b>TITLE: Production</b>             |                      |                        |                         |                        |                      |
| Field:                               | <input type="text"/> | Design life:           | <input type="text"/>    |                        |                      |
| Location(                            | <input type="text"/> | Water depth:           | <input type="text"/>    |                        |                      |
|                                      |                      | Number of              | <input type="text"/>    |                        |                      |
|                                      |                      | Production:            | <input type="text"/>    |                        |                      |
|                                      |                      | Injection:             | <input type="text"/>    |                        |                      |
| Chemical Injection                   |                      |                        |                         |                        |                      |
| <b>Chemical</b>                      | <b>Rate</b>          | <b>Injection lines</b> | <b>Injection points</b> | <b>Design pressure</b> | <b>Reference</b>     |
| Methanol                             | <input type="text"/> | <input type="text"/>   | <input type="text"/>    | <input type="text"/>   | <input type="text"/> |
| Corrosion inhibitor                  | <input type="text"/> | <input type="text"/>   | <input type="text"/>    | <input type="text"/>   | <input type="text"/> |
| Scale inhibitor                      | <input type="text"/> | <input type="text"/>   | <input type="text"/>    | <input type="text"/>   | <input type="text"/> |
| <input type="text"/>                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    | <input type="text"/>   | <input type="text"/> |
| <input type="text"/>                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    | <input type="text"/>   | <input type="text"/> |
| <input type="text"/>                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    | <input type="text"/>   | <input type="text"/> |
| Data acquisition and                 |                      |                        |                         |                        |                      |
| <b>Sensor</b>                        | <b>Producers</b>     | <b>Injectors</b>       | <b>Remarks</b>          |                        |                      |
| Wellhead pressure                    | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| Wellhead temperature                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| Downhole pressure                    | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| Downhole temperature                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| Hydrocarbon detection                | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| Sand sensor                          | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| 3-phase meter                        | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| <input type="text"/>                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| <input type="text"/>                 | <input type="text"/> | <input type="text"/>   | <input type="text"/>    |                        |                      |
| Well testing                         |                      |                        |                         |                        |                      |
| Well testing                         |                      |                        |                         |                        |                      |
| Well testing                         |                      |                        |                         |                        |                      |
| Wellstream sampling                  |                      |                        |                         |                        |                      |
| Adjustable chokes                    |                      |                        |                         |                        |                      |
| Production logging(PLT) freq         |                      |                        |                         |                        |                      |
| Cased hole logging (Saturation) freq |                      |                        |                         |                        |                      |
| Coring:                              |                      |                        |                         |                        |                      |

| <b>SUBSEA DATA SHEET</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       | <b>UDS-A04</b> | Rev.      |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------|-----------|------------------------|-----|--|--|----------------------------|-------|--|--|------------------------------|-------|--|--|--------------------------------------------|-------|--|--|
| <b>TITLE: Environmental Data</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Field:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       | Design life:   |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Location( Block/UTM):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       | Water          |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Transportation:<br><div style="margin-left: 100px;">Storm return period</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Installation, removal:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |                | Reference |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Significant waveheight                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | (m)   | 2,5            |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Spectral peak period range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (sec) | 6,0 - 10,0     |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Current velocity (mean over draft)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | (m/s) | 0,3            |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Wind speed, one hour mean, 10 m<br>above sealevel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | (m/s) | 15             |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Operation: <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">    Significant waveheight</td> <td style="padding: 5px;">(m)</td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> </tr> <tr> <td style="padding: 5px;">    Spectral peak period range</td> <td style="padding: 5px;">(sec)</td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> </tr> <tr> <td style="padding: 5px;">    Current velocity (at seabed)</td> <td style="padding: 5px;">(m/s)</td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> </tr> <tr> <td style="padding: 5px;">    Current velocity (operation of<br/>        hatches)</td> <td style="padding: 5px;">(m/s)</td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> <td style="border: 1px solid black; width: 150px; height: 20px;"></td> </tr> </table> |       |                |           | Significant waveheight | (m) |  |  | Spectral peak period range | (sec) |  |  | Current velocity (at seabed) | (m/s) |  |  | Current velocity (operation of<br>hatches) | (m/s) |  |  |
| Significant waveheight                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | (m)   |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Spectral peak period range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (sec) |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Current velocity (at seabed)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | (m/s) |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Current velocity (operation of<br>hatches)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (m/s) |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |
| Soil conditions: <div style="height: 150px; border: 1px solid black; margin-top: 10px;"></div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |                |           |                        |     |  |  |                            |       |  |  |                              |       |  |  |                                            |       |  |  |

ANNEX C

**NATIONAL REGULATIONS (Informative)**

## **ANNEX C NATIONAL REGULATIONS**

The latest edition and current amendments of the following standard shall apply.

Norwegian Petroleum Directorate (NPD):

- Regulations for productions- and auxillary systems on production installations etc.

ANNEX D

**ADDITIONAL TEST REQUIREMENTS FOR  
CONVENTIONAL SUBSEA X-MAS TREES  
(Informative)**

## **ANNEX D ADDITIONAL TEST REQUIREMENTS FOR CONVENTIONAL SUBSEA X-MAS TREES**

In addition to the requirements set forth in section 10.6 the following applies:

- A test of the orientation system including running and installation of the TH using a dummy BOP shall be included as a part of the FAT.
- Interface and function testing of TH and THRT with the riser simulator and WOCS shall be performed as a part of the total FAT. Also other items such as XT, LRP and SFT shall be function and interface tested with the use of the WOCS as a part of the total FAT.
- The THRT with THRT Adapter Joint/Orientation Joint shall undergo an offshore orientation check with the drilling BOP to be used during well completion. The TH test stand shall simulate the wellhead/TH as installed. The BOP shall be prepared with the orientation feature and located on the test stand during the test.

### Additional test requirements for all types of subsea production x-mas trees and workover systems

Testing of actuators are defined in API Spec. 6A.

The second pressure-holding period for hydrostatic testing shall not be less than fifteen minutes. For actuator seal testing an additional test with a pressure-holding period of one hour shall be included at both steps after reducing pressure to zero.

First fully assembled x-mas tree shall be submerged into a purpose-built tank filled with fresh water and undergo a pressure test with nitrogen as a part of the FAT testing. The duration of the test shall be 24 hours. Valves should be cycled at two hours intervals during the test period. Company to specify if more trees shall undergo this test.

During test of the stack up according to API 6A including XTERT, LRP and x-mas tree, the drift mandrel shall completely pass through the vertical bore of x-mas tree system including subs down to the nipple profile of the tubing hanger.

ANNEX E

**WORKOVER CONTROL SYSTEMS (Preliminary  
) (Informative)**

## **ANNEX E**

### **WORKOVER CONTROL SYSTEMS**

The workover control system shall be further developed and be included in the NORSOK Subsea Christmas Trees Systems specification (U-CR-003).

- D1**    The WOCS (Workover Control System) shall be used to run the following modules: STT, EQDP; LRP, X-mas tree, X-mas tree cap, X-mas tree cap running tool, Tubing Hanger Running Tool and Tubing Hanger.

The WOCS HPU container including main control panel shall be designed for operation in hazardous area zone 2, while the remote control panels and reels shall be classified for operation in zone 1 area.

The WOCS shall include all necessary equipment required for control of X-mas Tree and related equipment and the Tubing hanger and Related equipment, with respect to number of functions, flow, pressure and response time. It shall be designed to provide safe and efficient operation of all relevant equipment functions during all modes of operation on live wells. It shall be capable of performing a complete ESD/EQD sequence within 60 seconds. It shall include all necessary equipment.

The overall arrangement of the vessel with regard to area classification and the total safety philosophy shall be taken into consideration in design, fabrication, installation and operation of the WOCS.

- D2**    The surface HPU container shall allow easy access to all components for maintenance and repair. Removable hinged side panels shall be included for protection and maintainability during onshore/offshore operations and transportation. The return reservoir shall have sufficient capacity above the high level switch to drain down the complete accumulator system. Separate purifier drain and fill connections shall be fitted to the reservoirs.

The pump system shall be capable to pressurise the topside accumulators within 15 minutes, and maintain the system pressure during all operational modes.

Alarms shall be provided, both visible and audible upon critical low accumulator pressure. Pressure regulators shall be of high flow type. The return line system shall be equipped with an overpressure system to prevent seawater ingress due to difference density of hydraulic fluid and sea water.

- D3**    The master control panel shall be display the general arrangements for the system. All tree and running tool functions shall be available together with signals for verifications of pressure output on each function provided by pressure switches located downstream of the control valves.

All functions related to pressure testing shall be provided with manual needle valves for isolation of external connections. The test lines shall be vented to a dedicated waste sump with accessible drain, and not returned back to the supply tank.

Unintended operation of connectors during running shall not be possible. Critical functions as opening of connectors and closing of shear ram shall be protected by interlock or protective covers. PSD, ESD and EQD function buttons shall be located at main control-, remote control- and drillers shut down panels. PSD function buttons shall be located at supervisor shut down panel, test area shut down panel and rig control room shut down panel. EQD function button shall be provided at escape route shut down panel.

- D4**    The manual surface shut in system should be by pneumatics. The circuit shall be hardpiped and designed as an open (fail as is) system. Air supply shall be provided from a common source at the WOCS container. In the event of air failure on the rig, back up air bottles shall be provided, locally on each station and in the WOCS, to ensure normal control for 30 minutes and successful ESD/EQD within 1 hr. from loss of power.
- D5**    The shut down panels shall be designed to operate PSD, ESD and EQD function. One to be located inside drillers cabin control room or on the frill floor.
- D6**    The umbilical reels shall be equipped with a mobile remote operation control in addition to local control at the reels. The length of remote control cables shall be 20 m. The reel system shall provide constant tension and sufficient torque and speed for efficient running of equipment. An interlock shall prevent winches from being operated while the jumpers are connected.
- D7**    The workover control system shall be supplied with all necessary test and auxiliary equipment.

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| <b>SUBSEA DATA SHEET</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  | <b>UDS-A07 REV. A</b> |  |
| Page 1 of 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |                       |  |
| <b>TITLE: Design against fishing gear/overtrawlability</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |                       |  |
| Field:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  | Design Life:          |  |
| Location (Block/UTM):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  | Water Depth:          |  |
| <p><b>DESIGN FOR OVERTRAWLABILITY</b></p> <p>Overtrawlability design will have to be done with due consideration to access requirements.</p> <p>For overtrawlable structures the following requirements shall apply:</p> <ul style="list-style-type: none"> <li>The protective structure shall deflect all fishing equipment.</li> <li>The structure shall include corners, with the maximum true angle of 58° from the horizontal optimised to assist trawl and trawl wire deflection.</li> <li>Corners, ramps and equivalent structures shall penetrate the seabed to avoid snagging from trawl warp lines and ground rope. Effects from installation tolerances and expected scouring shall be accommodated.</li> <li>The size of openings shall be such that trawl doors are prevented from entering into the structure.</li> <li>If vertical side bracings are included, these shall be spaced to prevent intrusion and rotation of trawl equipment, without restricting subsea structure access for the intervention systems.</li> </ul> <p>Notice should be taken to the following comments:</p> <ul style="list-style-type: none"> <li>All protuberances shall be minimised to prevent snagging of nets.</li> <li>The lower the structure the less effect the trawl gear will have in friction, pullover and snagging.</li> <li>Advantage can be gained by having a continuous top ring to the structure.</li> <li>The pullover/snagging force of a trawlboard will be reduced if the top hat affect is continued either with close spaced tubulars, plated in steel a other suitable materials.</li> <li>All external edges/members shall have a minimum radius of 250 mm.</li> </ul> |  |                       |  |

