



Exploration & Production

## GENERAL SPECIFICATION

### SUBSEA SYSTEMS

#### GS EP SPS 019

#### Subsea production control system

|      |         |                            |
|------|---------|----------------------------|
|      |         |                            |
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## 1. Scope

This document describes the requirements for the Subsea Production Control System (SPCS). Requirements and main equipment for three different subsea layouts are described.

This specification has to be considered in conjunction with other documents describing the total subsea system, interfacing equipment or more details regarding SPCS equipment (see § 2 reference documents). These documents will provide additional input to this specification.

## 2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

This specification and all other equipment specifications referenced herein are based on a set of industry standards identified below.

### Standards

| Reference                 | Title                                                                                                                                |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| API 17D                   | Specification for Subsea Wellhead and Christmas Tree Equipment                                                                       |
| ASME section VIII - Div 1 | Pressure vessels                                                                                                                     |
| ISO 2943                  | Hydraulic Fluid Power - Filter Elements - Verification of Material Compatibility with Fluids                                         |
| ISO 3511                  | Process measurement control functions and instrumentation<br>Symbolic representation                                                 |
| ISO 4406                  | Hydraulic fluid power - Method for coding the level of contamination by solid particle                                               |
| ISO 11898-3               | Road vehicles - Controller area network (CAN) - Part 3: Low-speed, fault-tolerant, medium dependent interface                        |
| ISO 13628-6               | Petroleum and Natural Gas Industries - Design and Operation of Subsea Production Systems - Part 6: Subsea Production Control Systems |
| PED97/23/EG               | Pressure equipment directive                                                                                                         |
| SAE AS4059                | Aerospace Fluid Power - Cleanliness classification for hydraulic systems                                                             |
| 89/336-EEC and 96/98/CE   | EMC Directive                                                                                                                        |

### Professional Documents

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Regulations**

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Codes**

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Other documents**

| Reference      | Title |
|----------------|-------|
| Not applicable |       |

**Total General Specifications**

| Reference     | Title                                                                         |
|---------------|-------------------------------------------------------------------------------|
| GS EP INS 134 | Design and supply of integrated control and safety system                     |
| GS EP INS 135 | Cyber Security requirements for design and supply of ICSS and Package Systems |
| GS EP INS 198 | Safety and Fire & Gas Standard Functions                                      |
| GS EP PLR 160 | Design, fabrication and testing of Subsea Umbilicals                          |
| GS EP SAF 261 | Emergency Shut-Down and Emergency De-Pressurisation (ESD & EDP)               |
| GS EP SPS 001 | Design philosophy and requirements for Subsea Stations                        |
| GS EP SPS 016 | Subsea insert chokes and associated running and retrieval tools               |
| GS EP SPS 021 | Subsea mateable electrical/optical connectors                                 |
| GS EP SPS 022 | Environmental testing of subsea electronics                                   |
| GS EP SPS 023 | Cleaning and Flushing of Hydraulic Systems                                    |
| GS EP SPS 028 | Obsolescence Management Plan for Subsea Production Control System             |



### 3. Abbreviations

|      |                                      |
|------|--------------------------------------|
| CCR  | Central Control Room                 |
| CITV | Chemical Injection Throttle Valve    |
| DIU  | Downhole sensor Interface Unit       |
| DHPT | Downhole Pressure & Temperature      |
| DHSV | Downhole Safety Valve                |
| EFL  | Electrical Flying Leads              |
| ESD  | Emergency ShutDown                   |
| ETU  | Electronic Test Unit                 |
| EWS  | Engineering Work Station             |
| FS   | Full Scale                           |
| FO   | Fibre Optic                          |
| HDU  | Hydraulic Distribution Unit          |
| HP   | Hydraulic High Pressure              |
| HPU  | Hydraulic Power Unit                 |
| HTC  | Hydraulic Test Container             |
| ICSS | Integrated Control and Safety System |
| IWCS | Intelligent Well Completion System   |
| LP   | Hydraulic Low Pressure               |
| MCM  | Manifold Control Module              |
| MCS  | Master Control System                |
| MPFM | Multi-Phase Flow Meter               |
| MWS  | Maintenance Work Station             |
| OFL  | Optical Flying Leads                 |
| OWS  | Operator Work Station                |
| PDS  | Process Data System                  |
| PMV  | Production Master Valve              |
| PWV  | Production Wing Valve                |
| ROV  | Remotely Operated Vehicle            |
| SCM  | Subsea Control Module                |
| SCS  | Subsea Control System                |
| SCU  | Subsea Control Unit                  |
| SDU  | Subsea Distribution Unit             |
| SEM  | Subsea Electronic Module             |

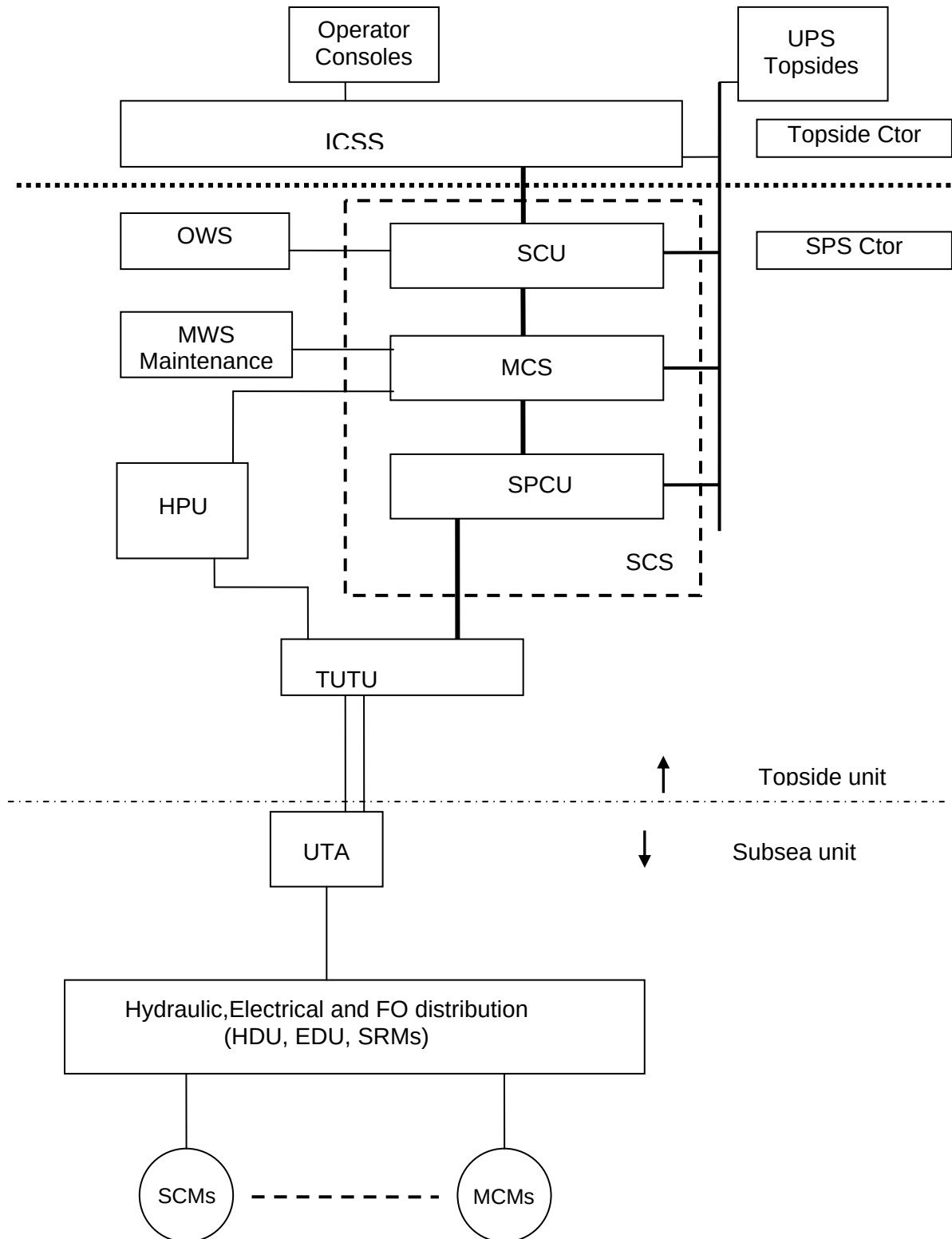


|      |                                     |
|------|-------------------------------------|
| SWS  | Subsea Work Station                 |
| SPCS | Subsea Production Control System    |
| SPCU | Subsea Power and Communication Unit |
| SRM  | Subsea Router Module                |
| THD  | Total Harmonic Distortion           |
| TUTU | Topside Umbilical Termination Unit  |
| UPS  | Un-interruptible Power Supply       |
| UTA  | Umbilical Termination Assembly      |
| USV  | Underwater Safety Valve             |
| VDU  | Visual Display Unit                 |
| XT   | Christmas Tree                      |

## 4. System description

This specification comprises the services and main building blocks for Subsea Production Control Systems (SPCS). A detailed specification for all building blocks shall be issued by Contractor. The building blocks might differ depending on development concept.

The figure shown below indicates how the building blocks are linked. It represents an example to help the understanding of this document but shall not be taken as a specification.



Typical organisation of an electro-hydraulic control system



## 5. Product Requirement

The SPCS shall be optimised for the best availability considering all services required by this specification and interfaces with other equipments and/or packages as described in the project specification.

### 5.1 General

The SPCS shall preferably be of the electro-hydraulic type with optical fibre as the main communication system, selection of hydraulic fluid and use of open or closed control system are to be approved by Company.

The level of redundancy throughout the system will influence cost and reliability, and must be analysed for all parts of the system, i.e.:

- Subsea Control System (SCS)
- Topside modems, umbilical lines and connectors
- Umbilical's
- Hydraulic lines and couplers
- Subsea Electronic Modules (SEM), located in SCM
- Process Sensors - to be redundant
- Housekeeping Sensors
- Control Valve Solenoids
- Subsea hydraulics.

Due consideration shall be given to:

- Production availability requirements
- Standardisation -use "off the shelf"- products, industrial standards
- Fabrication costs
- Operating costs
- Maintenance
- Obsolescence management.

Subsea control systems shall be designed hydraulically fail-safe. All subsea valves related to safety functions shall return to safe position on loss of hydraulic pressure. Loss of electrical power shall at a minimum return the PWV to safe position.

All subsea valves shall start valve operation less than 1 second after operator command is confirmed by SPCU. Updating of subsea measurements shall be every second for all wells; other scan rates should be configurable based on measurement type and communication connectivity.

Hydraulic distribution network shall be fully redundant with 2 HP and 2 LP lines.

Hydraulic analysis shall demonstrate the compatibility of the proposed architecture with operational requirements as defined by the project (Flow Assurance & ESD requirements).

The subsea hydraulic system shall be robust and designed and qualified to tolerate accidental contamination of seawater and particles. It shall be designed to avoid ingress or accumulation of such contamination. All components shall be qualified for operation in fluid contaminated with solid particles and seawater. Vulnerable parts with very low fluid consumption, as control valve pilot stages, shall be protected by dedicated filters separate to LP or HP filters.

The system shall be designed to operate on hydraulic fluid [AS4059](#) Class 12 B-F for one year. If this requirement is qualified by representative cycle testing then the following minimum cycles must be applied: DCVs - 3000 cycles and Choke control valves - 5000 cycles. Other aspects to consider includes filter sizing, filter type and single components tolerance for contamination. This specification applies for the control fluid network and for chemical injection network, should chemical dosing valves be installed subsea.

The HP system shall be designed to cope with pressure increase due to tubing temperature increases caused by the thermal effects of the tubing during well production.

The hydraulic fluid shall be selected with regard to functional specification, operating temperature and resistance to hydrate in case of gas ingress in control lines, particularly the DHSV.

The design shall be such that trapped air as far as possible is avoided, and can be removed, either by design, flushing or venting prior to subsea installation.

The hydraulic system shall be designed to minimize seawater ingress in all operational scenarios, including installation and retrieval of individual units. If seawater ingress prevention cannot be guaranteed or if there is a credible risk of seawater ingress, SCM fluid-wetted components should be considered along with procedures to flush out contaminated fluid.

All user interfaces, including both hardware and software, shall be agreed with Company in all project phases.

All subsea components containing software shall have hardware/firmware facilitating downloading of new application software and configuration from topside. Complete or partial download of application program to SEM's shall be possible without interrupting normal operation of the redundant SEM. Complete information on software and hardware version shall be retrievable from the ETU. Should the downloading operation fail, it shall be possible to keep the data already downloaded and start again the operation. The total time for downloading new parameters / software shall not exceed 2 hours per well.

Temperature ratings are to be according to [ISO 13628-6](#) extended ratings, unless otherwise specified by the project.

## 5.2 Subsea Communication Philosophy

Company philosophy for SPCS Communications shall be that optical fibres are used, where possible, to provide primary communications to subsea systems.

Dedicated communication channels should be provided to all Manifolds and Water Injection distribution units.

Dual redundant fibre optic communication channels ("A" & "B") shall be provided to each Manifold and WI distribution unit. Redundant optical fibres shall run in separate gel filled steel tubes (in an "A" & "B" channel configuration) within the static umbilicals.



Dedicated Optical Flying Leads (OFL), terminated with ROV mateable optical connectors, shall be used to connect the incoming optical fibres from the incoming Umbilical UTA direct to the local manifold distribution equipment (Subsea Router Modules - SRM).

In the case of daisy chained manifold systems, dedicated OFL terminated with ROV mateable optical connectors shall be used within the manifold to interconnect any incoming optical fibres from the incoming UTA to the outgoing UTA directly without passing through any intermediate on-manifold equipment.

Communications distribution within each local manifold (or future well cluster) shall be facilitated by dual redundant retrievable distribution units (SRMs). Within each SRM, incoming optical communications shall be converted into an electrical format and routed via an electrical Local Area Network (LAN) used in a star configuration to each SCM. To take advantage of this distribution network, electrical power and communication signals shall be distributed from the SRM to each SCM using separate conductors within common EFLs. FO alternatives may be considered on a case by case basis when extended lengths make electrical means less effective.

Routing of communication traffic around the overall subsea communication network(s) shall be controlled using the TCP/IP Protocol Suite (Open Network Standards).

Each SEM shall have dual redundant communication paths to the surface equipment. The preferred configuration is to allow "A" and "B" SEMs (inside a single SCM) to communicate with each other such that each SEM can utilize either the "A" or "B" primary communication networks.

### 5.3 Subsea Electrical Power Philosophy

Dedicated electrical power channels should be provided to each manifold and WI distribution. Depending on field architecture, multi-dropped power to remote WI locations may be considered.

Dual redundant electrical power channels ("A" & "B") shall be provided for each manifold and WI distribution. Redundant power channels shall be run in separate cables within the static umbilicals.

Each umbilical electrical cable shall be directly connected to a single UTA Bulkhead Electrical Connector.

EFLs, terminated with ROV mateable electrical connectors, shall be used to connect individual power channels from the incoming UTA direct to the local distribution equipment.

Power distribution within each local manifold or WI distribution shall be performed by dual redundant retrievable units also used to distribute the local electrical communications channels (SRM). Within each SRM, the incoming power channel shall be split and routed in a star configuration to each SCM. To take advantage of this distribution network, electrical power and communication signals shall be distributed from the SRM to each SCM using separate conductors within common EFLs.

A fault in or downstream of each SRM output bulkhead electrical connector (supplying an on template tree SCM) shall not affect operation of any other SCM. This feature may be achieved by use of an autonomous or remotely controlled "Electrical Fault Isolation" system in the SRM location that isolates the output line on detection of a fault condition. This facility shall allow an electrical fault downstream of each SRM to be isolated allowing the remaining system to continue operation.

## 5.4 Shutdown Philosophy

### 5.4.1 No Flow Requirement

In order to improve reliability and robustness of subsea well isolation the PWV shall be electrically fail safe close by using an electrically held DCV. This will permit the wells to be placed in a "NO Flow" condition before unlatching DHSV and PMV safety barriers.

On removal of electrical power the PWV (Electrically Held Directional Control Valve EH - DCV) will immediately close (20-40 seconds through the return spring and the bleed of LP supply on the actuator). This action will result in a no flow status of the subsea well.

### 5.4.2 Closing sequence on a subsea well

This closing sequence description is performed through the standard logic for production stop or safety shutdown sequence managed by the SCU.

Close PWV

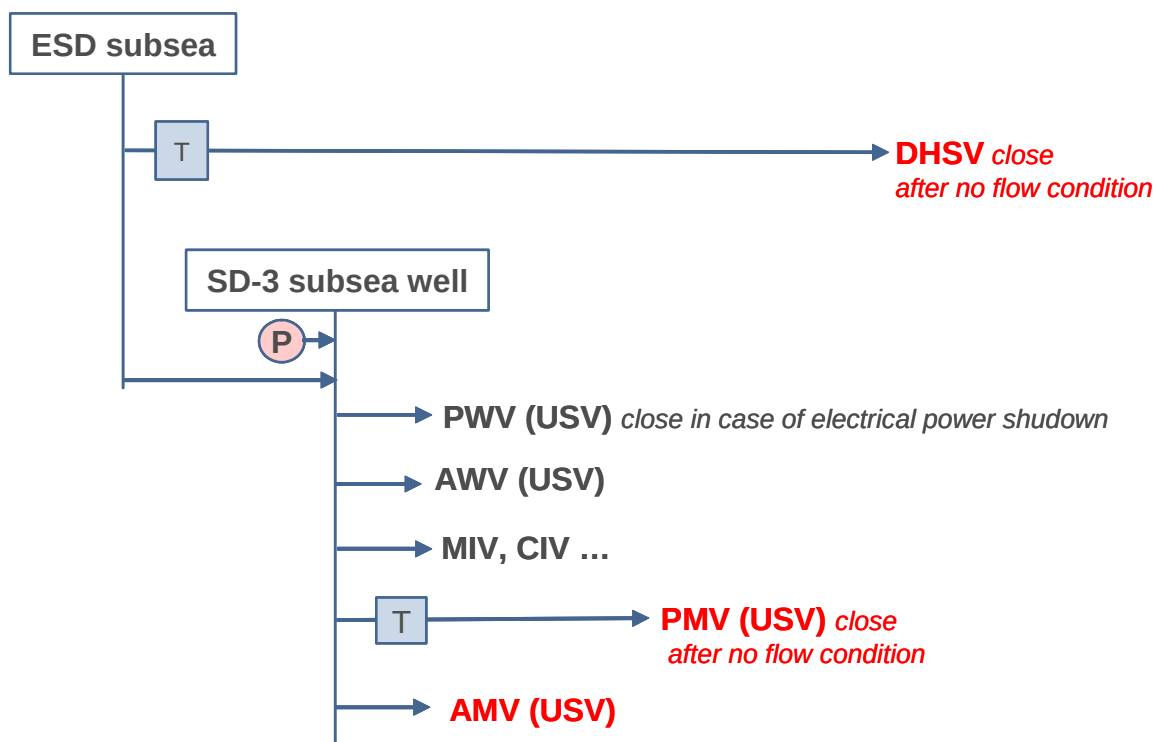
Timer delay (*To allow the well to reach "No Flow" condition*)

Close PMV + CIV + MeOH valves

Timer delay (*To allow the valves to close before closing the downhole safety barrier*)

Close DHSV

The following sequence is provided to illustrate the valve shutdown order and associated timer requirements:



T Adjustable timer

**Note:** In all cases the PWV will close first.