

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS EP SPS 019

Subsea production control system

12	11/2016	General technical revision (API STD 17F alignment)
11	05/2015	Organisation change - January 2015
10	10/2014	General technical revision
09	10/2013	General technical revision
00	10/2002	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/TEC	Managing entity: DSO/TEC/SBS
Other Approving entity(ies):	

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 2 of 49

Contents

1. Scope	4
2. Reference documents	4
3. Terms, definitions and abbreviations	5
3.1 Terms and definitions	5
3.2 Abbreviated Terms	6
4. System description	8
5. System requirement	10
5.1 General requirement	10
5.2 Functional requirement	17
5.3 Shutdown philosophy	18
6. Surface equipment	21
6.1 General requirement	21
6.2 Functional requirement	22
6.3 Design requirement	22
7. Subsea equipment	34
7.1 General requirements	34
7.2 Functional requirement	34
7.3 Design requirement	35
8. System interfaces	41
8.1 Interface to ICSS	41
8.2 Interface to Process Data Server (PDS)	42
8.3 Interface to third party equipment	42
8.4 Interfaces to subsea equipment	42
9. Material and fabrication	43
9.1 Material	43
9.2 Fabrication	43
10. Testing	43

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 3 of 49

10.1	Qualification testing.....	43
10.2	Unit Factory Acceptance Test (FAT)	45
10.3	System Extended Factory Acceptance Test (EFAT)	46
10.4	Integrated System test.....	47
11.	Marking, packaging, storage and shipping.....	48
	Bibliography.....	49

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 4 of 49

1. Scope

This document describes minimum requirements of Subsea Production Control System (SPCS) for subsea production system installation.

The following requirement shall be read in conjunction with [API STD 17F](#). This document is written following similar section order as laid out in [API STD 17F](#) in order to ease the cross referencing to the standard and to present clearly different requirements of this document. The requirement on [API STD 17F](#) shall apply except when overruled by additional wording in this document.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
API SPEC 17D	Design and Operation of Subsea Production Systems - Subsea Wellhead and Tree Equipment
API STD 17F	Standard for Subsea Production Control Systems
Directive 2014/34/EU	European Directive 2014/34/EU (26/02/2014) on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
Directive 97/23/EC	European Directive 97/23/EC (29/05/1997) on the approximation of the laws of the Member States concerning pressure equipment
SAE AS 4059 F	Aerospace Fluid Power - Contamination Classification for Hydraulic Fluids

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP INS 101	Instrumentation Design
GS EP INS 110	Instrumentation for package units
GS EP INS 131	Standard Functions and Functional Analysis Development Requirements
GS EP INS 134	Design and supply of integrated control and safety system

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 5 of 49

Reference	Title
GS EP INS 135	Cybersecurity Requirements for Industrial Information Systems (SII)
GS EP INS 146	Generation and Distribution of Hydraulic Energy
GS EP INS 150	Design method for system configuration - Standard functions
GS EP INS 198	Safety and Fire & Gas Standard Functions
GS EP PLR 160	Design, fabrication and testing of Subsea Umbilicals
GS EP SPS 001	Subsea Production Systems General Design Requirements
GS EP SPS 002	Design of Subsea Stations
GS EP SPS 010	Preservation requirements for subsea package
GS EP SPS 016	Subsea Choke Valves
GS EP SPS 021	Subsea mateable electrical/optical connectors
GS EP SPS 023	Cleaning and flushing of hydraulic systems
GS EP SPS 028	Obsolescence Management Plan for Subsea Production Control System
GS EP SPS 029	Metallic Materials for Subsea Production Facilities
GS EP SPS 032	Power Connectors, Penetrators and Jumper assemblies with rated voltage from 3 kV to 30 kV

3. Terms, definitions and abbreviations

3.1 Terms and definitions

For the purpose of this document, the following terms and definitions apply. The terms and definitions shall be as per [API STD 17F](#) with the following additional terms.

Company	Total E&P
Vendor	The party(s) which manufactures and/or supplies materials, equipment, technical documents/drawings and services to perform the duties specified by Company.
Contractor	Contractor appointed by the Company for the supply of the equipment.
'Shall'	'Shall' is used to indicate requirements which are to be strictly followed in order to conform to the specification and acceptance by all parties.
'Should'	'Should' is used to indicate that among several possibilities one is the recommended as particularly suitable without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.
'May'	'May' is used to indicate a course of action permissible within the limits of the specification. An optional course of action.

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 6 of 49

‘Can’ ‘Can’ is used for statements of possibility and capability, whether material, physical or capable.

3.2 Abbreviated Terms

AES	All Electric System
CCR	Central Control Room
CITV	Chemical Injection Throttle Valve
DCV	Directional Control Valve
DIU	Down hole sensor Interface Unit
DHPT	Down hole Pressure & Temperature
DHSV	Down hole Safety Valve
DP	Design Pressure
EFAT	Extended Factory Acceptance Test
EFL	Electrical Flying Leads
EPU	Electrical Power Unit
EPTU	Electrical Power Test Unit
ESD	Emergency Shut Down
ESS	Electrical Stress Screening
ETU	Electronic Test Unit
EUT	Equipment Under Test
EWS	Engineering Work Station
FAT	Factory Acceptance Test
FS	Full Scale
FO	Fibre/Fiber Optic
HDU	Hydraulic Distribution Unit
HMI	Human Machine Interface
HP	Hydraulic High Pressure
HPU	Hydraulic Power Unit
ICSS	Integrated Control and Safety System
IWCS	Intelligent Well Completion System
IWIS	Intelligent Well Interface Standard
LAN	Local Area Network
LP	Hydraulic Low Pressure

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 7 of 49

MCM	Manifold Control Module
MCS	Master Control System
MPFM	Multi-Phase Flow Meter
MWS	Maintenance Work Station
OFL	Optical Flying Leads
OS	Operating System
OWS	Operator Work Station
PC	Personal Computer
PDS	Process Data Server
PLC	Programmable Logic Controller
PMV	Production Master Valve
PWV	Production Wing Valve
ROV	Remotely Operated Vehicle
SAM	Subsea Accumulation Module
SCM	Subsea Control Module
SCS	Subsea Control System
SCU	Subsea Control Unit
SDU	Subsea Distribution Unit
SEM	Subsea Electronic Module
SIIS	Subsea Instrument Interface Standard
SPCS	Subsea Production Control System
SPCU	Subsea Power and Communication Unit
SRM	Subsea Router Module
TCP/IP	Transmission Control Protocol/Internet Protocol
TFHPU	Test and Flushing HPU
THD	Total Harmonic Distortion
TUTU	Topside Umbilical Termination Unit
UCP	Unit Control Panel
UPS	Un-interruptible Power Supply
UTA	Umbilical Termination Assembly

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 8 of 49

USV	Underwater Safety Valve
VDU	Visual Display Unit
WI	Water Injection
XT	Christmas Tree

4. System description

The Subsea Production Control Systems (SPCS) shall be provided to ensure safe operation of the subsea production system. The SPCS shall control and monitor various subsea and topside equipment supplied as part of the subsea production system. To fulfil this function, the SPCS shall consist of several building blocks and services.

The SPCS typically consists of the following main equipment.

Topsides equipment:

- Subsea Control Unit ICSS
- Master Control System
- Subsea Power and Communication Unit consisting of Electrical Power Unit and router
- Hydraulic Power Unit
- SSIV Local Control Panel
- Operator Work Station
- Engineering / Maintenance Work Station.

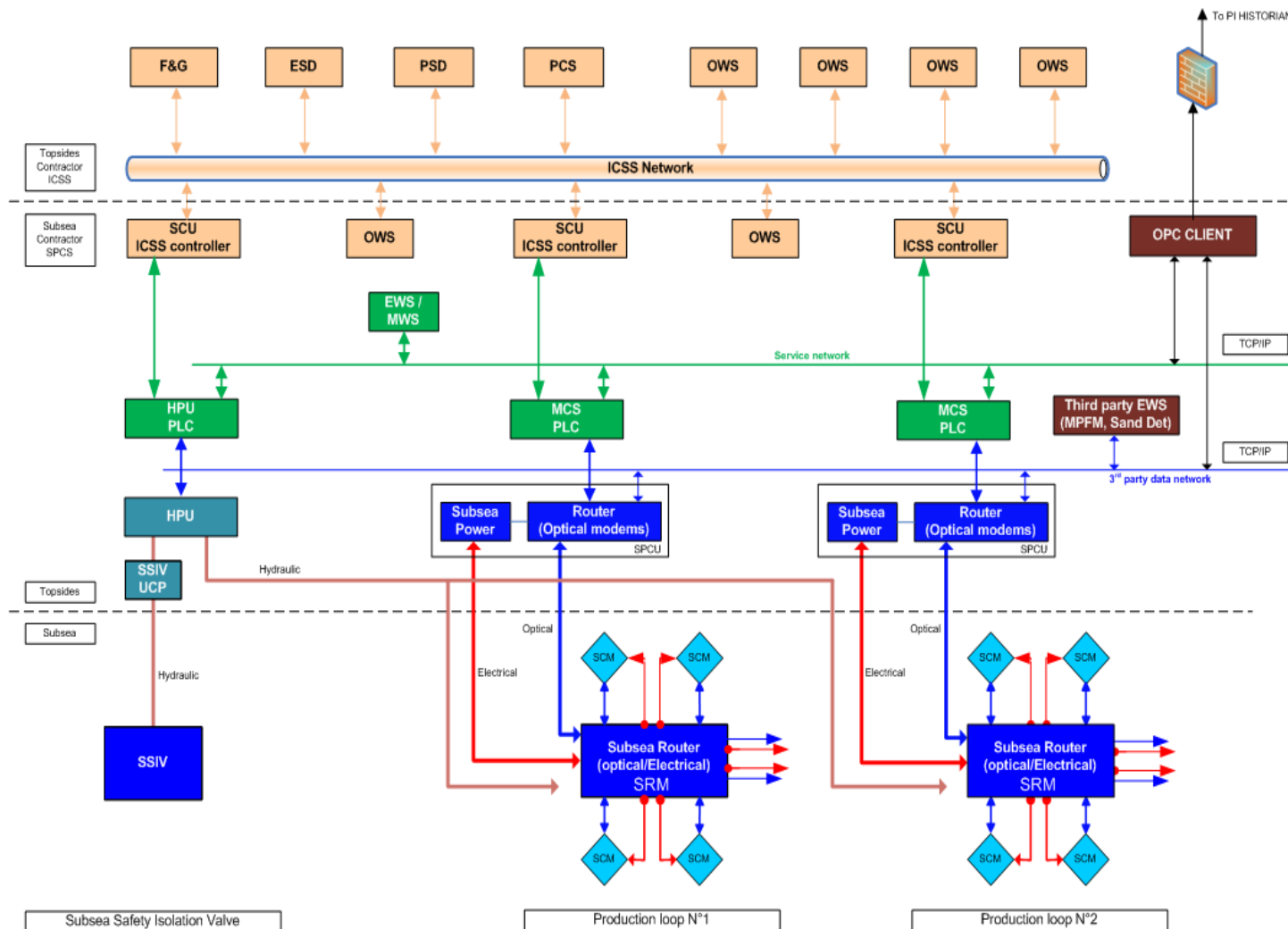
Subsea equipment:

- Subsea Distribution Unit
- Subsea Router Modules
- Subsea Control Modules
- Subsea Instrumentation.

Figure 1 describes the typical Subsea Production Control System architecture. The figure represents an example to help the understanding of how the building blocks are linked but it shall not be taken as a specification. For drawing clarity, redundancy of equipment and connection between SSIV sensors to ESD system are not shown. Quantity of each building block is given only for an example.

A detailed specification for each building block shall be issued by Contractor. The building blocks might differ depending on development concept.

Figure 1 - Typical Subsea Production Control System Block Diagram



General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 10 of 49

5. System requirement

The SPCS shall typically be electro-hydraulic multiplexed system with optical fibre as the main communication link. Use of open or closed control system and selection of hydraulic fluid shall be approved by Company.

An "All Electric System" (AES) may be considered subject to Company approval.

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

5.1 General requirement

All SPCS equipment shall be compliant with Company requirements for obsolescence management defined in [GS EP SPS 028](#) and cyber security rules specified in [GS EP INS 135](#).

Contractor shall issue an obsolescence dossier in accordance with the [GS EP SPS 028](#). The dossier shall describe obsolescence management strategies for identification and mitigation of the effects of obsolescence throughout the product life cycle. This covers the updates of all softwares supplied by Contractor including the Operating System.

5.1.1 Service condition

Product designs shall be capable of withstanding design pressure at rated temperature without degradation, exceeding allowable stress levels, or impairment of other performance requirements for the design life of the system.

Pressure definition for subsea control equipment shall be as specified in [API STD 17F](#).

Temperature ratings shall be extended ratings as defined in [API STD 17F](#), unless otherwise specified by the project.

The design shall conform to the applicable local regulations regarding EMC for the environment in which the equipment is used.

5.1.2 Hydraulic system

5.1.2.1 General

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

Minimum cleanliness level of the hydraulic system shall be [SAE AS 4059 F](#) Class 6. Reference is made to [GS EP SPS 023](#) for cleaning and flushing of hydraulic systems.

Hydraulic analysis shall be performed to demonstrate the performance of the proposed network in fulfilling the operational requirements (flow assurance & ESD requirements) as defined by the project.

The subsea hydraulic system shall be designed to prevent or minimize ingress of sea water and solid particles in all operational scenarios. The design shall be robust and qualified to tolerate accidental contamination. All fluid-wetted components shall be qualified for operation in fluid contaminated with solid particles and seawater. Vulnerable parts with very low fluid consumption, such as control valve pilot stage, shall be protected by dedicated filters.

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 11 of 49

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

The hydraulic system shall be designed to operate on hydraulic fluid [SAE AS 4059 F](#) Class 12 B-F for one year. This requirement shall be qualified by representative cycle testing as defined in section 10.

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.

Components integrated into a system shall not be subjected to a system hydrostatic pressure test in excess of their component qualification or factory acceptance test (FAT) hydrostatic test pressure.

5.1.2.2 System Pressure Ratings and Performance Requirements

Hydraulic system design and operating pressures are illustrated in Figure 2 and Figure 3:

- System design pressure (DP) class should conform to one of the recommended classes defined in [API STD 17F](#). The pressure classes refer to the nominal pressure differential between internal and external pressures.
- The design pressures of components that form the system shall be equal to or greater than the system design pressure (DP).
- In the case of SCSSVs and other hydraulically actuated downhole completion equipment, water depth and downhole setting depth shall be considered when establishing the appropriate system design pressure (DP) class.

Note: SCSSV and downhole equipment functional pressure requirements are typically defined as absolute pressure values in recognition that downhole valve performance normally correlates with downhole process pressure, which is also defined in absolute pressure terms.

- A system pressure-relieving device, normally a system pressure-relief valve, shall be fitted at the HPU with a set pressure no higher than the system design pressure (DP).
- The system pressure-relieving device shall limit the HPU maximum relieving pressure to no higher than 110% of system design pressure (DP).
- The system maximum operating pressure (MOP) should be set no higher than 5% below the lowest pressure relieving device reseal pressure.

Note: The purpose is to ensure that the relieving device fully seals after operation. The specific pressure relieving device operating characteristics will define the reseal pressure, the resulting margin, and consequently the maximum operating pressure (MOP).

- The system maximum operating pressure (MOP) shall be set such that the highest subsea hydraulic differential pressure resulting from control fluid/seawater static head differences does not exceed the system design pressure (DP).
- The selected SCSSV hydraulic supply maximum operating pressure (MOP) shall not over-pressurize the SCSSV during well life.

Note: The pressure required to open an SCSSV is a function of well pressure, which is itself typically a time-dependent variable as the well depletes. A lower actuation pressure is

Subsea production control system

Rev.: 12

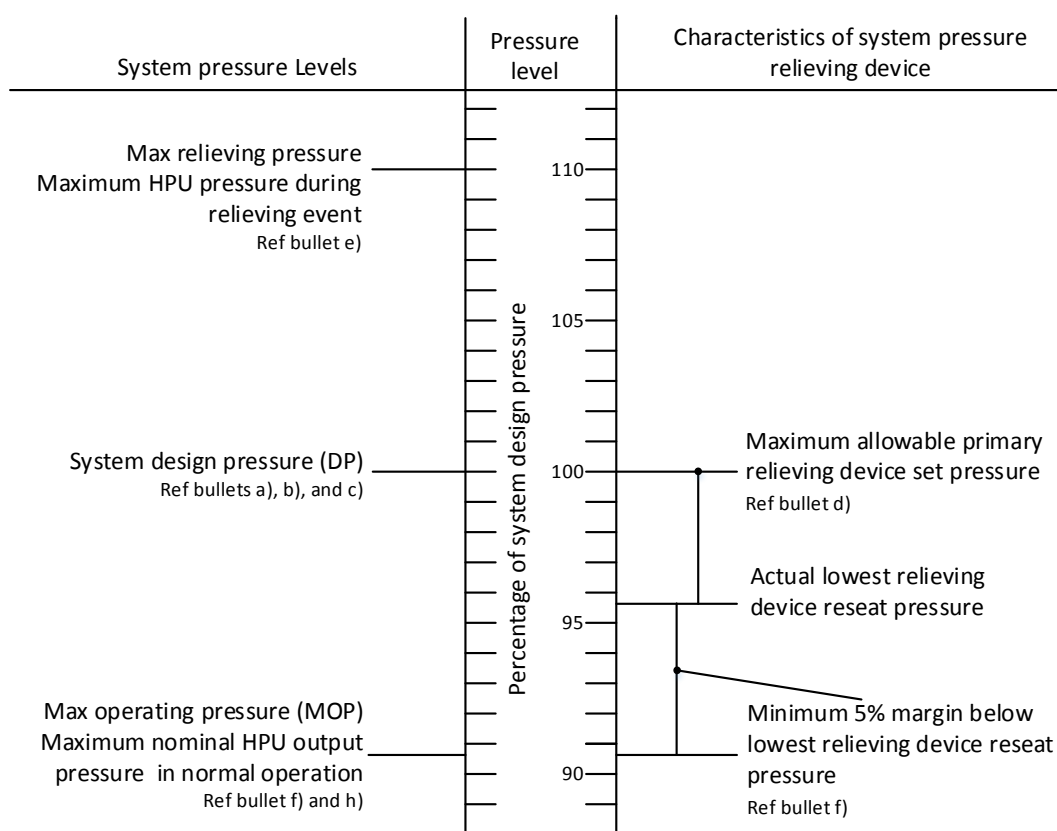
Effective date: 11/2016

Page: 12 of 49

therefore required as the well depletes. The maximum and minimum recommended SCSSV hydraulic supply pressure limits are defined by the SCSSV manufacturer. Provision of an operator-controlled, variable SCSSV hydraulic pressure facility at the HPU can mitigate SCSSV over-pressurization over well life.

- i) The hydraulic system shall provide sufficient system capacity (reference Figure 3) to supply control fluid at a pressure and average flowrate required to actuate subsea valves using operational frequencies as defined in the project specification.
- j) Local subsea transient hydraulic supply differential pressure (referenced against relevant DCV and actuator return side pressures) experienced during valve or choke actuation shall not be lower than the minimum operating pressure defined as the higher of:
 1. 150% of the highest delatching pressure of any DCV
 2. 115% of the highest start-to-close pressure of any spring return actuator.

Note: Hydraulic system capacity (reference Figure 3) is often limited by the actuator start-to-close pressure. Actuators exhibiting a lower start-to-close pressure whilst still conforming to other [API SPEC 17D](#) performance requirements will improve hydraulic system performance.

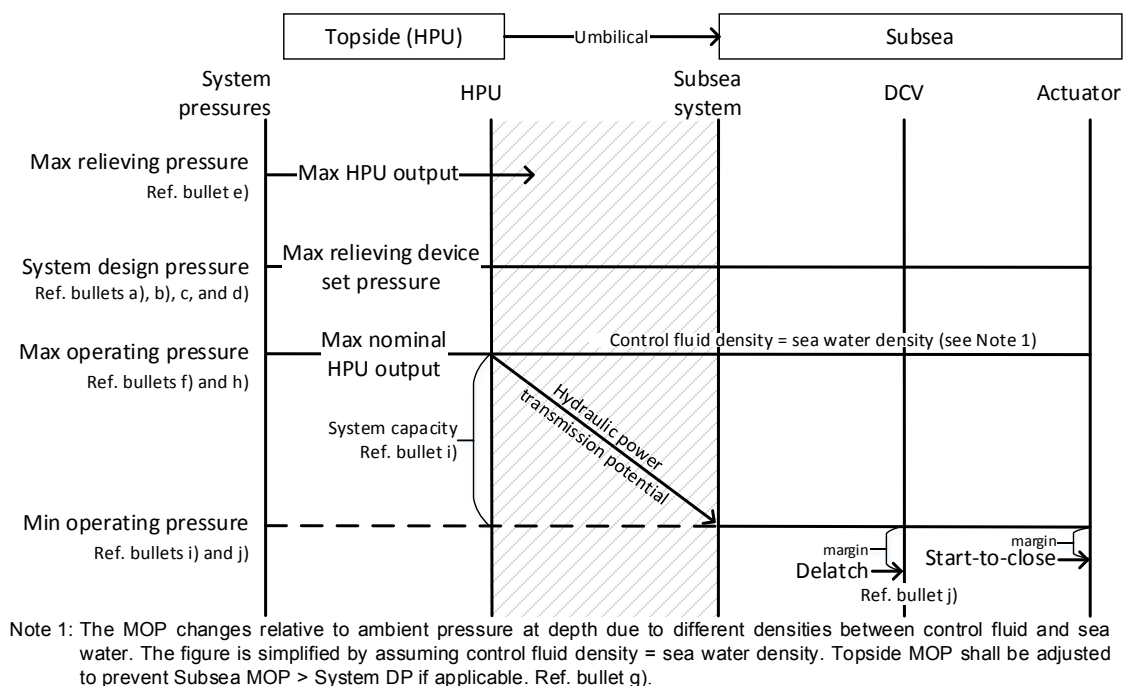
Figure 2 - HPU pressure specification overview


Subsea production control system

Rev.: 12

Effective date: 11/2016

Page: 13 of 49

Figure 3 - Hydraulic system operating pressures overview


5.1.3 Electrical system

The electrical power for subsea production control system equipment installed on topsides shall be supplied by redundant power lines from an UPS with minimum of 30 min autonomy period for subsea operation. Loss of one power supply from UPS shall not have any effects on Topside SPCS equipment functionality.

If batteries are used subsea for local power storage, the charging status of the batteries shall be monitored to ensure continued operation and relevant safety valve closure. 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 (Quad) 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.

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 14 of 49

A fault in or downstream of each SRM output bulkhead electrical connector 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.

5.1.4 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 shall 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). Further optimization may be considered through the use of hybrid electrical/fibre optic flying leads with Company approval.

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 (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 to communicate with each other such that each SEM can utilize either the "A" or "B" primary communication networks.

5.1.5 Interfaces and software

5.1.5.1 General

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

All subsea modules containing software shall have hardware/firmware facilitating upgrade or download of new application program/software and configuration from topside. Complete or

General Specification		GS EP SPS 019
Subsea production control system		
Rev.: 12	Effective date: 11/2016	Page: 15 of 49

partial download of application program to SEM shall be possible without interrupting normal operation of the redundant SEM. Should the downloading operation fail, it shall be possible to maintain the original application code already downloaded and retry the downloading operation. The total time for downloading new parameters / software shall not exceed 2 hours per well.

Complete information on software and hardware version shall be retrievable from the EWS/MWS.

5.1.5.2 Subsea Process Control

A subsea processing system may have active control functions which are time critical. The active control functionality can be level control or pressure control. Time constants for all active control loops shall be established. The control system shall meet all requirements driven from the respective time constants. In addition to level and pressure control, control of anti-surge valves can in certain applications be a time critical control loop.

Control loops can be closed through application software at host facility or through application software locally at the processing facility. In case of local control special emphasis shall be taken regarding shut down functionality and safety integrity level of the control loop.

Sensors shall be considered, that will enable early warning of impending failure of subsea rotating machinery.

A subsea processing system may comprise of one or several closed control loops. A study shall be made to identify and describe the control loops. A strategy shall be developed addressing whether such loops should be closed subsea or topsides. If possible wrt response time and bandwidth closing of control loops in a topside located computer is default case. Exception could typically be for magnetic bearing systems with a requirement for very high response.

5.1.5.3 Condition Monitoring

The SPCS shall be capable of acquiring all diagnostic data from the subsea control system and connected monitoring and control equipment. Data acquisition rates for specific diagnostic data points may be determined on a case by case basis depending on available bandwidth.

All data from SPCS shall be made available topside for remote trending and analysis through an external data interface.

5.1.6 Redundancy

Dual redundancy shall be provided for electrical supplies, communication links and hydraulic lines as described in the previous sections.

Redundancy requirement of other equipment are specified in different sections of this document.

General guidelines on redundancy defined by [API STD 17F](#) are applicable and must be analysed for all parts of the system, i.e.

- Subsea Power and Communication Unit
- Umbilical lines, connectors and flying leads
- Subsea electronic modules