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ISO 13628 Part 6 Design and Operation of Subsea Production Control Systems- DRAFT

Group Practice

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This Engineering Practice EP GP 78-18 “Supplementary Guidance to ISO 13628 Part 6” is created to compliment the latest 2006 issue of the subject Industry Standard. This Guidance on Industry Standard is not a stand alone document but offers guidance to and qualifies the subject Industry Standard and both documents shall be read in conjunction with each other.

This GP provides assistance in the generation of procurement specifications and/or supplementary project specific technical specifications required for the purchase of Subsea Production Control Systems. It shall be used in accordance with other ETP Documents Series 78 for subsea equipment, which provides further detail necessary to undertake and execute a subsea project.

GP 78-18, does not contain descriptive details of previous “lessons learnt”, but rather contains the resulting clear additions, deletions, replacements or clarifications to the parent Industry Standard.

Full details of previous “lessons learnt” can be found on the BP E&G Segment ‘Exchange’ public folders under the address: Public folders \ How we are organised \ BP Exploration \ BPX Subsea Learning Group \ Focus Areas \ Subsea Lessons Learnt.



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1. Scope

European Standard EN ISO 13628 “Petroleum and Natural Gas Industries – Design and Operation of Subsea Production Systems” represents the European version of a set of harmonised ISO/API standards providing general requirements, recommendations and overall guidance for the development of complete subsea production systems. The standards are produced in separate parts, each typically dealing with a subsystem which together forms a complete subsea production system. Supplementary parts of the standard are added on an ongoing basis.

The current suite of ISO 13628 standards is as follows:

ISO 13628-1 (API 17A)	“General Requirements and Recommendations”.
ISO 13628-2	“Unbonded Flexible Pipe Systems for Subsea and Marine Applications”.
ISO 13628-3 (API 17C)	“Through Flowline (TFL) Systems”.
ISO 13628-4 (API 17D)	“Subsea Wellhead and Tree Equipment”.
ISO 13628-5 (API 17E)	“Subsea Umbilicals”.
ISO 13628-6 (API 17F)	“Subsea Production Control Systems”.
ISO 13628-7 (API 17G)	“Workover/Completion Riser Systems”.
ISO 13628-8 (API 17H)	“Remotely Operated Vehicle (ROV) Interfaces on Subsea Production Systems”.
ISO 13628-9 (API 17J)	“Remotely Operated Tooling (ROT) Intervention Systems”.
ISO 13628-10 (API 17K)	“Specification for Bonded Flexible Pipe”.
ISO 13628-11	“Flexible Pipe Systems for Subsea and Marine Applications”.

- a. This GP 78-18 provides guidance for the design, fabrication, testing, installation and operation of Subsea Production Control Systems specified in accordance with ISO 13628-6 “Subsea Production Control Systems”.
- b. This GP is primarily intended for BP engineering authorities (EAs), technical authorities (TAs), system purchasers and specifiers, designers and operators. It is intended to enhance the information within ISO 13628-6 to make it relevant and applicable within the BP E&P Segment.
- c. This supplementary GP 78-18 is intended to aid this selection process by providing guidance on “additions”, and/or “clarifications” to the relevant paragraph or subject area of ISO 13628-6.
- d. ISO 13628-6 is generally written as an informative narrative with limited prescriptive requirements and is intended to provide “positive guidance for the selection of an optimum solution”. It comprises a diverse listing of prescriptive and optional data that may not be applicable to all control system types.
- e. Note that where a project intends to take a technical path which is in conflict with ISO 13628-6 and/or GP 78-18. The onus is on project / individual do demonstrate the validity of decision.

2. Normative References

International Electrotechnical Commission (IEC)

IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems.
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IEC 61511 Functional Safety – Safety Instrumented Systems for the Process Industry Sector

BP Engineering Technical Practices (ETP) and related documents

GRP STD 01	BP Group Standard for Integrity Management
GP 30-40	Process Automation Systems
GIS30-401	Process Automation Systems (PAS)
GP 30-70	Control and Instrumentation in Vendor Package Equipment
GP 36-20	Material Selection and Specification for Subsea Equipment.
GP 38-400	Hydraulic Power Supplies
GP 78-03	Achieving Reliability in Subsea Projects
GP 78-04	Reliability Techniques for Subsea Projects
GP 78-05	Guidance on Practice for Testing of Subsea Equipment: FAT, EFAT and SIT.
GP 78-06	Qualification of Technology for Subsea Projects
GP 78-09	Subsea Safety Instrumented Systems.
GP 78-16	Subsea Control Fluid Selection
GP 78-21	Subsea Electrical, Optical Connectors and Cable Assemblies
GP 78-26	Subsea Reliability and Maintenance Data Collection
GP 78-30	Integrated Subsea System Testing / Commissioning / Start-up

The most up to date list of the Series 78 (subsea) documents are available by accessing the BP ETP library website.

3. Terms and Definitions

3.4 Design Pressure

Maximum pressure for which the system or component was designed for continuous usage.

- a. This definition shall be read in conjunction with clarifications made in Clause 5.4.2.2 and viewed in terms of component design pressures and system design pressures.

3.11 Hydrostatic Test Pressure

Maximum test pressure at a level greater than the design pressure”.

The reference to “(rated working pressure)” shall be deleted.

- a. This definition shall be read in conjunction with clarifications made in Clause 5.4.2.2 and viewed in terms of component design pressures and system design pressures.

New Definition – Flying Lead

- b. A single or multiple composite grouping of hydraulic, chemical, electrical power, electrical signal and/or optical signal carrying conduits used to interconnect various items of subsea equipment. Flying Leads may be designed for either ROV or ROT assisted deployment.
- c. Note that the term “Jumper” should be reserved for process carrying interconnections.



- d. Steel tube flying leads or composite flying lead manufactured by an umbilical manufacturer shall be designed to ISO-13628-5; "Subsea Umbilicals".

New Definition - Surface Controlled Sub-Surface Safety Valve

- e. Safety device that is located in the production bore of the well tubing below the subsea wellhead and that will close on loss of hydraulic pressure.

4. Abbreviated Terms

Add the following abbreviations:

BPCS	Basic Production Control System
CP	Cathodic Protection
DBB	Double Block and Bleed
DHG	Downhole Gauge
DIU	Downhole Interface Unit
ETP	Engineering Technical Practice
FMECA	Failure Modes, Effects and Criticality Analysis
FTA	Fault Tree Analysis
GIS	Group Instruction for Supply
GP	Group Practice
HPI	Hydraulic Pressure Intensifier
IWIS	Intelligent Well Interface Standardisation
LIM	Line Insulation Monitor
LVDT	Linear Variable Displacement Transducer
MeOH	Methyl Alcohol (Methanol)
NPT	National Pipe Thread
OLF	Norwegian Oil Industry Association
OSPAR	Oslo/Paris (Convention) on Marine Waste
PLC	Programmable Logic Controller
QM	Quality Management
ROT	Remotely Operated Tooling
SIIS	Subsea Instrumentation Interface Standardisation



SIL	Safety Integrity Level
SIT	Site Integration Testing
SPCS	Subsea Production Control System
SSV	Surface Safety Valve
UKCS	United Kingdom Continental Shelf

5. System Requirements

5.1. General

- a. Add paragraph and comment: “A practical approach to the correct selection of design solutions is the knowledgeable application of proven technology (i.e. equipment or processes that have a track record in identical operating environments)”.

It is essential that the operational and environmental differences between projects are clearly defined. The extrapolation of existing “proven” design solutions for marginally different operating and environmental conditions has often resulted in unexpected failures.

- b. Add paragraph and comment: “Where novel or extrapolated technology is being utilised, or where proven equipment is being applied in unproven or novel applications, appropriate measures to verify the equipment’s integrity shall be taken.

This shall include the rigorous application of qualification testing which shall fully explore and quantify the equipments ultimate operational limits”.

It is often the case that the inherent “safety margin” of a specific equipment design or technology is not clearly understood nor is sufficiently well defined.

GP 78 03, 04 and 06 should be used to drive reliability in design for any new or unproven design solutions

5.2. Concept Development

5.3. Production Control System Functionality Requirement

5.3.1. General

5.3.2. Intelligent Well Application

- a. Add Paragraph and comment: Implementation of intelligent well control within the tree-mounted subsea control module is not the preferred method and should be avoided.

For new development intelligent well control shall be implemented in a separate control module e.g. Downhole flow Control Module (DCM).

Intelligent well control within the SCM can introduce a significant risk of hydrocarbon ingress that can compromise SCM operability and well control. In addition, intelligent well control technology is relatively immature and consequently subject to change. Embedding this technology within a SCM can be a barrier to standardization.

Where hydraulically actuated isolation valves are installed on intelligent well hydraulic function lines, these valves require automatic shutdown functionality. Control of these valves should be from the tree mounted SCM, not DCM.



5.3.3. Flexibility with Respect to Electrical Load Situations**5.3.4. Robustness of Hydraulic System****5.3.5. Seawater Ingress in Hydraulic System**

- a. Add paragraph and comment: "All SCM functional components that can come into contact with seawater (either by design or by component failure) and, in particular, all hydraulic control fluid wetted components in the Subsea Production Control System, shall be fully seawater compatible".
- b. Add paragraph and comment: "It should be recognised that seawater ingress into subsea equipment hydraulic control fluid lines will almost certainly occur during equipment installation and recovery. The Subsea Production Control System should be "exercised" as soon as possible to displace all such seawater ingress".
- c. Add paragraph: "Relative density differences between seawater and internally constrained fluid volumes (i.e. hydraulic control fluids, lubricants, insulating dielectric oils etc) can provide a driving force resulting in significant and continuous fluid transfer mechanisms. These effects shall be carefully considered with respect to all potential leakage paths".
- d. Add paragraph and comment: "Suitable methods of avoiding continuous fluid transfer mechanisms caused by differential fluid densities shall be used where appropriate (i.e. anti-siphon techniques, U-Tubes etc.)".

For example the location of elastomeric joints at high locations on dielectric filled enclosures, without the use of an internal sealing tube to a low point in the enclosure, should be avoided where possible.

- e. Add paragraph: "The use of single seals shall be avoided".
- f. Add paragraph: "Dual seal barrier designs shall facilitate individual seal testing where possible".

5.3.6. Subsea Intervention**5.3.7. Increased Scope with respect to Number of Wells****5.3.8. Increased Scope with respect to Number of Umbilicals****5.3.9. Interface toward Subsea Separation/Subsea Boosting System****5.3.10. Subsea Chemical Injection**

- a. Add paragraph and comment: "The implication of Subsea Chemical Injection System (and hydrate inhibition system) redundancy and availability shall be considered during system design".

5.3.11. Downhole Instrumentation System Interfaces

- a. Add paragraph and comment: "The use of an externally mounted Downhole Interface Unit (DIU) designed in general accordance with Annex E.1.2 Option 2 – "Subsea Control Module (SCM) Interface", should be considered as the preferred Downhole Instrumentation System Interface".



5.3.12. Downhole Chemical Injection**5.4. General Requirements****5.4.1. General****5.4.2. Service Condition****5.4.2.1. Suitability for Working Environment**

- a. Add paragraph and comment: "Reference shall also be made to Clause 5.4.2.6".

Unit or System Integration Tests (SIT) in outdoor winter environments can expose equipment to low ambient temperatures. The viscosity and stability of many water-based control fluids may become problematic at such temperatures and this should be recognised.

Conversely tests in outdoor summer environments can expose equipment to high ambient temperatures and considerably higher surface temperatures cause by continuous exposure to sunlight. The internal temperatures of electrical and electronic equipment may be significantly raised and this should be recognised.

5.4.2.2. Pressure Ratings**5.4.2.2.1. General.**

- a. Add sub-clause: and comment: "Components integrated into a system shall not be subjected to a System Proof Pressure Test in excess of their Component Qualification or FAT Hydrostatic Test Pressure".
- b. Add sub-clause: "The low pressure portion of the control equipment, including, if applicable, atmospheric fluid reservoirs, pump suction filters, pump suction lines, system return lines etc, shall be tested in accordance with manufacturer's written specifications. (Clause 11.2.2)".
- c. Add sub-clause: "The setting of the primary pressure safety relief device shall not be greater than the System Design Pressure (Clause 5.4.3.4)".

5.4.2.2.2. Hydraulic Control Components.

- a. Add paragraph: "Hydraulic components for the SCSSV circuit shall have individual design pressures meeting or exceeding the System Design Pressure".

5.4.2.2.3. Other Equipment.**5.4.2.3. Temperature Ratings (Host Facility Equipment)****5.4.2.3.1. Without Controlled Environment.****5.4.2.3.2. Controlled Environment.****5.4.2.4. Temperature Ratings (Subsea Installed Equipment)**

- a. Add paragraph: "Special consideration shall be given to the minimum design and operational temperature ratings of subsea control system equipment that may be exposed to significant Joules-Thompson cooling effects in service (i.e. sensors positioned immediately downstream of production chokes)".



5.4.2.5. Electromagnetic Compatibility**5.4.2.6. Storage/Test Temperature Recommendations****5.4.2.7. External Hydrostatic Pressure****5.4.2.8. Fluid Compatibility**

- a. Add paragraph: for more specific detail on BP fluid compatibility reference should be made to GP 78-20, Subsea Control Fluid Selection

5.4.3. Hydraulic System**5.4.3.1. Hydraulic Control Fluid****5.4.3.2. Cleanliness****5.4.3.3. Seawater Ingress and Compensation**

- a. Add paragraph: “A pressure compensator used to prevent seawater ingress during deployment shall be sized for the maximum calculated fluid volume change plus an additional 100% allowance”.
- b. Add paragraph: “The pressure compensator maximum calculated fluid volume shall consider the following situations both individually and in worst case combinations:
 - Pressure compensation effects required during storage of equipment in extreme environmental conditions including the potential effects of direct exposure to sunlight (solar heat gain).
 - Pressure compensation effects required during subsea retrieval or deployment of individual equipment items (e.g. an individual SCM).
 - Pressure compensation effects required during subsea retrieval and deployment of equipment combinations (e.g. an SCM/Xmas Tree assembly).
- c. Add paragraph: “Fluid compensation systems shall not require replenishment immediately prior to deployment to cater for possible previous exposure to high storage temperatures. However, pre-deployment replenishment should normally be performed as a precautionary practice”.
- d. Add paragraph and comment: “Care shall be taken to ensure that combinations of individual pressure compensation systems do not adversely interact. Specifically a hydraulic system pressure compensator should operate independently of an associated enclosure oil-fill volume compensation system.”

An example of this is where an SCM internal hydraulic system pressure compensator is located within the SCM enclosure which itself has an independent enclosure oil-fill pressure compensation system.
- e. Add paragraph and comment: “The use of pressure compensation systems to prevent hydraulic lock when subsea mating or de-mating of hydraulic couplings during all intermediate stages of subsea system infrastructure construction shall be considered”.

This is of particular relevance for hard-piped hydraulic systems when combined with remote tooling. Extremely high internal pressures can be generated during mating and, conversely, significant coupling separation forces will be generated in deepwater applications.



5.4.3.4. Overpressure Protection**5.4.3.5. Vibration and Pressure Pulses****5.4.4. Electrical System**

- a. Add sentence to the first paragraph: "The host facility UPS (where present and when of sufficient capacity) shall be used in preference to a dedicated Subsea System UPS.
- b. Add paragraph: "The design, function and intended mode of operation of an independent Subsea System UPS shall be defined in conjunction with the host facility ESS/PSS Systems".
- c. Add sentence to the second paragraph: "The SPCS designer shall confirm and/or refine the required theoretical harmonic distortion (THD) for each specific application".
- d. Add paragraph after the fifth paragraph: "No attempt shall ever be made to disconnect subsea wet-mate electrical couplings in a live condition. Contingency plans shall not be based upon the principle of live disconnection".

5.4.5. Redundancy

- a. Add paragraph and the following related sub-clauses: "As a minimum, the following levels of redundancy should be applied to all BP facilities:"
 - a) Add sub-clause: "Host Facility Power Supplies (Non-UPS) - Dual redundant power supplies from the host facility to dual redundant Subsea Control System UPS's, each rated for 100% of full load. (Caution: Supplies may be non-synchronous)".
 - b) Add sub-clause: "Host Facility UPS Feeds - Dual redundant power supply feeds from the host facility UPS to the EPU, each rated for 100% of full load".
 - c) Add sub-clause: "MCS Input Power Supplies – Dual redundant input power supplies from UPS, allowing all MCS components to offer an active standby dual redundant configuration".
 - d) Add sub-clause: "MCS Output Communication Channels - 100% Redundancy on all MCS components designed to facilitate an active standby dual redundant configuration".
 - e) Add sub-clause: "HPU Output Hydraulic Power Supplies - 100% Redundancy on all HPU subsea hydraulic supply critical components (e.g. pumps, filters, pump control pressure transducers etc.) providing active dual redundant outputs at each pressure level. Equipment to be powered from dual redundant power supplies on an A/B configuration. Where used, key non-redundant single components (e.g. Local PLC) should be provided with dual redundant UPS supplies in a fault tolerant configuration".
 - f) Add sub-clause: "Umbilical Cores – Dual redundant electrical power supplies, electrical communication channels, optical communication channels, hydraulic power supplies and key chemical injection supplies that are considered to be operationally required (e.g. specific hydrate inhibition requirements etc.).
 - g) Add sub-clause: "Additionally umbilicals should have spare multipurpose core(s) for further contingency".
 - h) Add sub-clause: "Subsea Control Modules (SCM) – Dual redundant Subsea Electronics Modules (SEM) should normally be used to improve system availability. Each SEM should be provided with dedicated electrical power, electrical communication and/or optical communication channels. Single non-redundant Directional Control Valves (DCV's) with redundant dual coil



electrical solenoids are acceptable. Single internal function line pressure sensors monitored by both SEM's are acceptable."

- i) Add sub-clause: "Key Subsea Sensors – Where specific sensors are considered to be essential for continued system or well operation, these should be dual redundant and each dedicated to one of the dual redundant SEM's".

Dual redundant in this case is taken to mean individual sensors in separate housings

- j) Add sub-clause: "Subsea Electrical Fault Isolation – Any subsea fault on one of the active dual redundant electrical power or communication channels shall not affect operation of the remaining redundant channel.
- k) Add sub-clause: "Subsea Hydraulic Fault Isolation – Any subsea fault on one of the active dual redundant hydraulic supplies shall not affect operation of the remaining redundant supply. It should be possible to isolate a fault in the hydraulic supplies to individual wells, without disruption to the remaining redundant supply, to allow the failed supply to be partially reinstated".

- b. Add paragraph and comment: "Dual redundant services (e.g. electrical power supplies, electrical communication channels and/or optical communication channels) shall not be terminated in any single subsea connector".

A key principle of subsea equipment redundancy is to ensure that the system is not exposed to potential single point system failures. In addition, the ability to fault-find a system without disrupting production cannot be achieved if a shared single connector is utilised.

- c. Add paragraph: "Dual redundant subsea electrical connectors shall not be mounted on a single unified connection interface (e.g. a single stabplate)".
- d. Add paragraph: "The use of an automatic shuttle valve on its own to select between two hydraulic supplies is not permitted.

The preferred solution is to use a shuttle valve in combination with 2 separate directional control valves.

5.4.6. Reliability

- a. Add paragraph: "When determining or considering reliability related issues the reference should be made GP 78 03 & 04 as the precedence document"

5.5. Functional Requirements

5.5.1. General Performance Requirements

5.5.2. Operating Pressure

- a. Add paragraph: "Water depth and, in the case of SCSSV's, the downhole setting depth, shall be considered when establishing the appropriate system operating pressure(s)".
- b. Add paragraph: "The specific SCSSV manufacturer should define, at the earliest opportunity, the maximum and minimum recommended SCSSV hydraulic supply overpressure which should be provided to the SPCS manufacturer and addressed in the System Hydraulic Analysis".
- c. Add paragraph and following sub-clauses: "Improvements in hydraulic system operation can normally be achieved by considering the following design features:"
 - a) Add sub-clause: "Allow extended valve actuator shift times to allow the use of lower quantities of subsea accumulation".

