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GP 78-10

Design, Fabrication, Transportation, and Installation of Subsea Manifolds

Group Practice

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This is the first issue of Engineering Technical Practice (ETP) GP 78-10. This Group Practice is not a stand alone document, but is part of a larger suite of ETPs that define BP's integrity, reliability, quality management, design, and testing philosophy for subsea projects. It shall be used in accordance with other ETP Category 78 documents for subsea equipment, which provide further detail necessary to undertake and execute a subsea project.

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1. Scope

- a. This GP provides guidance on the design, fabrication, transportation and installation of subsea manifolds for subsea oil or gas production, and for water or gas injection in water depths up to 10 000 feet. The scope also includes:
 1. Templates.
 2. Subsea Processing - separator and pump units.
 3. Gas lift manifolds.
 4. Riser base manifolds.
 5. Water alternating gas manifolds.
- b. This GP does not provide guidance for the following subsea equipment:
 1. Control systems.
 2. Umbilical termination assemblies (UTAs).
 3. Subsea distribution units (SDUs).
 4. Tie-In spools.

2. References

The following referenced documents may, to the extent specified in subsequent clauses and normative annexes, be required for full compliance with this GP:

- For dated references, only the edition cited applies.
- For undated references, the latest edition (including any amendments) applies.

2.1. Normative references

GP 06-10	Corrosion Management.
GP 06-14	Erosion Control.
GP 06-20	Materials for Sour Service.
GP 06-29	Corrosion Protection during Hydro testing.
GP 06-31	Cathodic Protection.
GP 06-60	Painting of Steel Surfaces.
	and GP 06-67, GP 06-70, GIS 06-311, GIS 06-601.
GP 18-01	Welded Fabrication and Construction.
GN 18-003	Deposition of CRA Weld Overlay in Tubulars and Other Components.
	and GP 18-04; GIS 18-011, GIS 18-012.
GP 78-10	Welded Fabrication and Construction.
GP 32-10	Inspection and Testing of new equipment in Manufacture Overall strategy and Criticality assessment.
GP 32-17	Quality Management Requirements for New Subsea Equipment (draft).
GP 36-20	Material Specification and Selection for Subsea Equipment.
	and GIS 36-103, GIS 36-107.
GP 43-46	Pipeline Pressure Testing and Pre-commissioning.
GP 43-50	Pigging, Pig launchers and Receivers.
GIS 43-352	Subsea Gate and Ball Valves.



and GIS 43-318, GIS 43-319, GIS 43-331, GIS 43-334;

The entire 78 series Subsea.

GP 78-00	Principles of Subsea Design and Execution.
GP 78-03	Achieving Reliability in Subsea Projects.
GP 78-04	Reliability Techniques for Subsea Projects.
GP 78-05	Testing of Subsea Equipment: FAT, EFAT, and SIT (Onshore).
GP 78-06	Qualification of Technology for Subsea Projects.
GP 78-09	Subsea Safety Instrumented Systems - HIPPS.
GP 78-11	Subsea Chemical Injection systems (draft).
GP 78-12	Well Jumper and Flowline Connection systems (draft).
GP 78-13	Design Guidelines for Flying Leads and Terminations.
GP 78-14	Subsea Isolation.
GP 78-17	P&ID Guidelines.
GP 78-18	Design and Operation of Subsea Production Control Systems Supplementary Guidance to EN ISO 13628 Pt. 6.
GP 78-19	Design and Operation of Subsea Umbilicals.
GP 78-21	Subsea Electrical (LV) and Optical Connections.
GP 78-25	Integrity Management of Subsea Systems (draft).
GP 78-29	Dropped Object Risk Management Guidance for Subsea Systems and Projects when Considering Dropped Object Protection.
GP 78-30	Integrated Subsea System Testing/Commissioning/Start-up (Offshore).

[v1] By accessing the Engineering Technical Practices Portal website the most up to date list of the Series 78 subsea documents, as well those referenced, is available.

2.2. Informative BP references

[The Reliability Implementation Manual](#)

“Implementing Subsea Reliability Improvement in Projects” May 2007

2.3. Relevant national/international codes and standards

- Various standards are directly relevant to application within subsea projects. These standards are referenced in the body of the text.
- Working with contractors and suppliers in the application of this GP may introduce variances between the requirements of the standards and this GP. In such an instance BP shall determine the practice to be followed with due regard to local regulatory requirements.

The list of codes and standards given below is offered for high level guidance. It is advised that the application of this GP ensures that more detailed equipment and testing specific codes and standards be identified and complied with, as may be necessary and are listed at the end of Clause 11 of this document.

ISO 10423	Wellhead and Christmas Tree Equipment.
ISO 13628-1	Design and Operation of Subsea Production Systems, Part 1 General Requirements and Recommendations.
ISO 13628-4	Design and Operation of Subsea Production Systems, Part 4 Subsea Wellhead and Subsea Tree Equipment.
ISO 13628-5	Design and Operation of Subsea Production Systems, Part 5 Subsea Controls Umbilicals.



ISO 13628-6	Design and Operation of Subsea Production Systems, Part 6 Subsea Production Control Systems.
ISO 13628-8	Design and Operation of Subsea Production Systems, Part 8 Design and Operation of ROV Interfaces on Subsea Production Systems.
ISO 14723	Petroleum and natural gas Industries - Pipeline transportation systems - Subsea Pipeline Valves.

3. Terms and definitions

For the purposes of this GP, the following terms and definitions shall apply:

Qualification

The process of demonstrating that a system or item has reached a particular level of technology readiness, whether that involves using existing technology in a new environment or new technology.

Qualification Programme

The specific work done in a field development project or in a technology development project to satisfy qualification requirements for an item.

Technical Readiness Appraisal Process (TRAP)

A part of the IM process, this is a method used to define the degree of qualification for subsea equipment. The process is described in GP 78-03, GP 78-04, and GP 78-06.

4. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations shall apply:

AUV	Autonomous underwater vehicle.
BoD	Basis of design.
CCF	Closed caisson foundation.
CP	Corrosion protection.
CRA	Corrosion resistant alloy.
CT	Coiled tubing.
EDU	Electrical distribution unit.
EFAT	Extended factory acceptance test.
ER	Electrical resistance probe.
FAT	Factory acceptance test.
FEA	Finite element analysis.
FSM	Field signature monitor.
FSV	Floating support vessel.
HIPPS	High integrity pipeline protection systems.



HISC	Hydrogen induced stress cracking.
HP	High pressure.
HR	Hydrate remediation.
HRD	Hydrate remediation by depressurisation.
ID	Internal diameter.
IST	In-situ testing.
IT	Integration test.
IWOCS	Intervention work over completion system.
LP	Low pressure.
MPcp	Major Projects common process.
MPFM	Multi phase flow meter.
MSS	Manifold support structure.
MSV	Multi-role service vessel.
NB	Nominal bore.
OD	Outside diameter.
P&ID	Process and instrument diagram.
PIT	Post installation testing.
QM	Quality management.
R&M	Reliability and maintainability.
RAM	Reliability, availability, and maintainability analysis.
ROT	Remotely operated tooling.
ROV	Remotely operated vehicle.
SAM	Subsea accumulator module.
SCM	Subsea control module.
SCSSV	Surface controlled subsurface safety valve.
SDU	Subsea distribution unit.
SIS	Safety instrumented systems.
SIT	System integration test.
SoR	Statement of requirements.



SPS	Subsea production system.
SRT	Site receipt test.
SUT	Single unit test.
TDU	Tool deployment unit (ROV tooling).
U	Overall heat transfer coefficient.
URF	Umbilical, riser, and flowlines.
UTA	Umbilical termination assembly.
WAG	Water alternating gas – injection system.
XT	Xmas tree.

5. Design philosophy

5.1. General

- a. The final design of the manifold should reflect an iterative process between reservoir development, well tracks and overall field architecture. The core design of well bay valving and other functionality will be derived from the SoR, subsea isolation and barrier requirements as defined in GP 78-14 and the final field development architecture.

Fundamental decisions have to be made on subsea architecture in particular the number location and size of manifolds. Multiple factors have to be taken into account including reservoir development, drilling, installation and retrievability.

- b. The design shall be developed using equipment and methods with a proven reliability record for conditions compatible with those of the project.
- c. All components and assemblies shall undergo a Technology Readiness Review to the requirements of GP 78-06.
- d. Where proven equipment is not readily available, the status of current development shall be identified in accordance with GP 78-06.
- e. Evidence supporting the reliability status of equipment shall be available to validate status by use of the TRAP process described in GP 78-06.
- f. If such evidence cannot be established, project plans shall incorporate the necessary qualification programme activities as defined in GP 78-06.
- g. The field life shall be established and included in the SoR.
- h. Equipment shall be designed for the stated field life.
- i. Any local Regulatory requirements should also be considered when setting the design life.
- j. The management of change process shall be followed for those cases when design life of a component is not the same as the field life.
- k. Equipment should be designed for the planned water depth plus an agreed water depth margin of +/- 5%, which should take into account future intra-field water depth requirements. A greater range may also be adopted should standardisation be required.
- l. Equipment components such as valves, connector structures and connector hubs should be standardised wherever possible.



- m. Careful consideration should also be given to the design where fabrication and assembly are executed as “Local Content”. In particular, the potential levels of difficulty must be recognised in the welding of certain materials, in the application of insulation and in the relationship between insulation and the protection of materials susceptible to HIC.
- n. The available lift and depth capability of manifold installation vessels and equipment should be established and taken into account in determining the manifold configuration and field layout.
- o. The manifold and manifold foundation should be capable of being installed and retrieved by the locally available installation equipment at the time of installation.
- p. Conformance should be established with local and national regulations regarding the removal of equipment from the seabed at the end of field life.
- q. If the manifold piping design pressure is less than the XT rating, then well operations integrity checks should be undertaken e.g., following choke removal / replacement.
- r. Equipment interfaces should be proven prior to deployment as defined in GP 78-05 (FAT, eFAT and SIT).

5.2. Operation

- a. The spacing of clustered wells, manifolds and flowlines should be determined with consideration of simultaneous drilling/workover operations and production on adjacent wells.
Dropped object risk must be addressed.
- b. It may not be practical to have simultaneous drilling and production on adjacent wells in template manifolds.
- c. The well spacing shall permit definition of re-spud location and also allow for any necessary operational maintenance intervention.
- d. Well spacing considerations should be established during Select and subsequent MPcp design phases, and should be taken into consideration in the evaluation of field architecture and drill centre layout.
- e. The manifold piping and components shall be insulated to meet the operating requirements for cool down duration, as defined in the subsea system operating philosophy and SoR.
- f. Insulation shall be selected and qualified against both temperature and water depth requirements. The relevant ETP has as yet to be drafted.[v2]
- g. The manifold design should consider hydrate prevention and remediation measures as defined by the hydrate prevention and remediation philosophy found in the SoR and BoD.

Methods for hydrate prevention and remediation may involve depressurisation, chemical injection, access for intervention e.g., coiled tubing, heat input or a combination of these.

5.3. Maintenance and retrievability

- a. Where subsea manifolds contain equipment that inherently has a high likelihood of failure, such components or assemblies should be designed to be retrievable. Indeed consideration should also be given to the overall retrievability of the manifold assembly itself - this is a key design issue and is intimately associated with the selection of the connection system and jumper designs.
- b. For water depths of 200 m or less, diver intervention is practical for certain maintenance functions, subject to BP and local requirements and acceptance[v3]. However if a system is designed to be diverless, then a risk assessment is required before diver intervention would be permitted.



- c. For water depths greater than 200 m, intervention by remote means is limited to removal and change out of components by ROV/ROT interventions.
- d. In either case, equipment should be designed for zero planned maintenance for field life.
- e. Some components are likely to fail to meet the required performance criteria over the life of the development. Hence provision for planned intervention and potential remediation shall be made.
- f. The system design process shall identify the methods for monitoring performance and carrying out maintenance over the expected operating life of the field.
- g. Condition monitoring (failure detection) processes should be incorporated in the design to allow changes in performance to be measured.
- h. This should be achieved where possible by system instrumentation or by external survey.
- i. The basis of the maintenance philosophy should be defined through the identification of failure modes, method of rectification, intervention vessel availability and turn around time (TAR).
- j. Sparing should satisfy the selected maintenance strategy.
- k. The design of the subsea system shall provide for inspection by an ROV.

5.4. Intervention

5.4.1. Remotely operated vehicles (ROVs) and remote operated tooling (ROT)

- a. The requirements for remote intervention should be established and documented in a Project Intervention Tooling Specification.
- b. A full ROV task list should be developed and for every task, the methodology, interfaces and performance shall be verified through the design and manufacturing phases.
- c. Planned intervention on seabed components should normally be diverless and based on using ROVs and remote tooling.
- d. A common detailed design specification for remote intervention on the subsea facilities should be developed to cover subsea tasks across installation interfaces.

Boundaries need to be defined between the work scopes for the SPS, the URF and the work of the drilling contractors.

- e. Design for ROV intervention shall satisfy the requirements of ISO 13628-8.
- f. Design for ROT intervention shall [v4] meet the requirements of ISO 13628-9.
- g. ROV intervention should comply with regional standards.
- h. Tool deployment systems shall generally be based on ROV manipulator deployed tools. However, in high current environments, consideration should be given to the use of Tool Deployment Units (TDUs) as well as the requirement for subsea hardware to include the appropriate docking locations for the ROV. [v5]
- i. ROV overrides shall be provided for all remotely operated valves and chokes.
- j. All valves, connectors, and functional tasks which are ROV operated or over-ridden shall have visual indicators such that during intervention the ROV operator can confirm that the intervention is proceeding correctly.
- k. ROV docking aids and intervention heights should take account of seabed conditions that may affect visibility or operational performance.

In weak soil conditions operating efficiency can be improved by raising the height off the seabed to 2,5 m.



5.4.2. General

- a. Production flowlines and risers should be piggable with a cleaning pig and/or an intelligence pig, complying with the project pigging philosophy, local and national requirements.
- b. Where necessary, any such piping through the manifold should be similarly piggable and have an ID consistent with pigging requirements.
- c. Access points for hydrate remediation or wax blockage intervention within production flowline systems should be provided.
- d. Subsea system components shall have suitable identifying marks to ensure effective intervention and inspection.
- e. The selection of a common connection system should be provided for the flowline and well jumper connection systems. The selection of the connection system should comply with GP 78-12 and should take into consideration: retrievability, maintenance and the intervention philosophies.

5.4.3. High risk components

- a. The subsea system shall be designed such that high risk components, identified by failure likelihood and consequence, shall be retrievable or have the necessary redundancy satisfying the SoR, as appropriate.
- b. Components considered for being retrievable should include, but not be limited to:
 1. Multi-phase flow meters.
 2. Subsea Control Modules.
 3. Modularised sub - assemblies e.g., SDUs and EDUs.
 4. Choke Inserts.
 5. Sand detectors.
 6. Pumps, separators and valve modules on more complex assemblies.

5.4.4. Vessels for installation and intervention

Detailed assessment of the available installation vessels with their lifting and load capacities should be completed as part of the project, so as to determine the maximum size and weight of the largest components. Manifold installation/retrieval should be addressed from the following types of vessel:

- a. MSV.
- b. FSV.
- c. Operations DP support vessel.
- d. Drilling rig (moon pool size limitations).
- e. Lay barge (using the abandonment and recovery winch).
- f. J lay or reel lay vessel.

Experience has shown that it is cost effective to provide flexibility with regard to the type of vessel which is used to install or retrieve subsea components.

5.5. Inspection frequency, sparring, and storage

- a. The Operational Integrity management requirements shall be included in the SoR and BoD. The subsea facilities should be regularly inspected by ROV at intervals set out in the Integrity Management plan. Specific inspection requirements for erosion/corrosion



monitoring shall be identified and the means incorporated in the design eg wall thickness monitoring points. Such corrosion monitoring should be considered in the overall subsea integrity management strategy.

- b. Consideration should be given to inspection by AUV as appropriate.
- c. The sparing philosophy should consider providing installation and operational spares for SPS sub-systems.
- d. The possible advantages of adopting common spares with other regional developments should be investigated.
- e. Sufficient spares should be available for maintenance based on using a vessel of opportunity and/or for planned maintenance campaigns.
- f. There should be a storage and maintenance plan for all spares.
- g. This plan should address long term storage at regional onshore facilities and be based on expected environmental conditions at this site.

5.6. Protection

- a. The requirements for protection should be established by customary regional practice, regulatory requirements, and appropriate specific studies, and be included in the BoD.
- b. Design consideration should be given to:
 - 1. Installation, maintenance and inspection activities.
 - 2. Concurrent drilling and production activities.
 - 3. Fishing activities.
 - 4. Dropped objects (see 8.2.1.7).

6. General/system design

6.1. System overview

General design data shall be established and included in the subsea system design basis. This should include:

- 1. Bathymetry.
- 2. Soils data.
- 3. Shallow hazards data.
- 4. Locations and numbers of production manifolds.
- 5. Well locations and numbers of wells for each manifold.
- 6. Environmental data.
- 7. Metocean data.
- 8. Produced/injected fluids data.
- 9. Well completion fluids and chemicals should be considered when it is planned to flow completed wells back to the facility during well clean up operations.
- 10. Max/min well flow rates.
- 11. Design pressures, pressure break points and HIPPS where required.
- 12. Overall system philosophies and functional requirements, including redundancy.
- 13. Proposed well phasing.

