



Exploration & Production

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS SPS 002

Design of subsea structures

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Contents

1. Scope	3
2. Reference documents.....	3
3. Introduction	6
3.1 Responsibility.....	6
3.2 Abbreviations	6
4. General requirements	7
4.1 Functional requirements.....	7
4.2 Intervention requirements	7
4.3 Protection corrosion requirement	8
4.4 Abandonment requirement.....	9
5. Structure requirements.....	9
5.1 Introduction	9
5.2 Design requirements.....	10
5.3 Concept 1: Multiwell Template with Manifold requirements	11
5.4 Requirements for Concepts 2A and 2B	12
5.5 Concept 3: two slot structure.....	13
5.6 Concept 4: Individual wells.....	13
5.7 Jumper requirements	13
6. Piping system requirements	13
6.1 Functional requirements for manifold piping system.....	13
6.2 Manifold barrier requirements	14
6.3 Piping design requirements.....	14
6.4 Preservation requirements for piping system	15
6.5 Additional requirements for piggable lines.....	15
6.6 Valves.....	16
7. Installation requirements.....	16
7.1 Transportation requirements	16
7.2 Lifting requirements	16
8. Interfaces	18



1. Scope

The purpose of this specification is to provide specific requirements for Subsea Structures.

This specification covers the following development concepts:

- **Concept 1:** Multi-well Template with Production Manifold:
 - Concept 1A Integrated template/manifold
 - Concept 1B Modular template/manifold
- **Concept 2:** Individual Wells Connected to a Subsea Manifold Centre
 - Concept 2A Cluster configuration
 - Concept 2B Satellite configuration
- **Concept 3:** Two slots structure
- **Concept 4:** Individual wells in daisy chain configuration (Production or injection).

The specification covers both permanently installed structures, equipment and associated tools, temporary equipment required for offshore installation and commissioning of the systems as well as potential intervention work.

The document is valid for all phases of a field development such as engineering, procurement, construction, testing, installation, commissioning and operation.

Specific requirements to valves in the manifold systems or other valves on Subsea Structures are defined in separate specifications listed hereafter.

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 technical specification is complementary to document **GS SPS 001** and **GS SPS 014**. Therefore this technical specification shall be read in conjunction with said document and the other COMPANY specifications and standards identified herein.

The specification for design of Subsea Structures shall furthermore comply with COMPANY project specifications and other standards listed hereafter unless otherwise stated by COMPANY.

The reference list does not include all specifications, codes and standards that may be applicable for Subsea Structures. The reference list includes Regulations, COMPANY Specifications and Standards where specific references have been made in this document.

**Standards**

Reference	Title
ISO 13628-1	Subsea production systems
ISO 13628-4	Subsea wellhead and christmas trees
ISO 13628-6	Subsea production controls
ISO 13628-8	ROV Interfaces on subsea production systems
ISO 13628-9	ROT Intervention Systems

Professional Documents

Reference	Title
DNV 81	Rules for Submarine Pipeline Systems 1981
DNV 96	Rules for Submarine Pipeline Systems 1996
DNV	Certification Note 2.7-1. Offshore Containers
DNV	Rules for Planning and Execution of Marine Operations
DNV	Rules for Certification of Lifting Appliances

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
GS COR 100	Design of cathodic protection of offshore structures
GS COR 350	External protection of offshore and related structures and equipment by painting
GS COR 560	Physical and chemical treatment of hydrostatic test water
GS PLR 100	Submarine Pipeline Systems
GS PLR 231	Fabrication of hot bends for pipelines and flowlines
GS PVV 614	Welding of duplex and superduplex stainless steel pipework
GS SPS 001	Design Philosophy and Requirements for Subsea Stations
GS SPS 003	Foundation design considerations for Subsea Structures
GS SPS 004	Subsea Manifold System Gate Valves
GS SPS 005	Subsea Ball Valves
GS SPS 006	Service Valves in Subsea Stations
GS SPS 007	Tie-In Systems
GS SPS 008	Thermal Insulation of Subsea Stations
GS SPS 009	Corrosion Protection of Subsea equipment
GS SPS 011	Mechanical Completion Requirements for Subsea Equipment
GS SPS 012	Documentation Requirements for Subsea Stations
GS SPS 013	Wellhead and Guidance Systems
GS SPS 014	Drill through Horizontal X-Mas tree Systems
GS SPS 015	Gate Valves and Actuators in Subsea X-Mas tree Systems
GS SPS 016	Subsea Insert Chokes and Associated Running and Retrieval Tools
GS SPS 017	Workover/Completion Systems
GS SPS 018	Light intervention system for DTHT
GS SPS 019	Subsea Production Control Systems
GS SPS 020	Subsea Control Unit Functional Requirements
GS SPS 021	Subsea Matedable Electrical/Optical Connectors
GS SPS 022	Environmental testing of Subsea Electronics
GS SPS 023	Cleaning and Flushing of Hydraulic Systems
GS STR 201	Materials for offshore steel structures



Reference	Title
GS STR 301	Fabrication of offshore steel structures
GS STR 401	Load-out, sea-fastening, transportation and installation of offshore structures
GS STR 404	Marine aspects for load-out, transportation and installation of offshore structures

3. Introduction

3.1 Responsibility

Deviations from any of the requirements defined herein shall be treated as non-conformances in accordance with COMPANY procedures.

It is the responsibility of anyone who supplies structures and equipment according to this specification to ensure compliance with all relevant statutory requirements.

3.2 Abbreviations

The following abbreviations are used:

- ANSI American National Standards Institute
- BOP Blow Out Preventer
- CCDS Cuttings and Cement Disposal System
- FAT Factory Acceptance Test
- FBS Foundation and Bottom Structure
- HP High Pressure
- ID Internal Diameter
- JM Jumper Module
- LP Low Pressure
- MM Manifold Module
- ND Nominal Diameter
- PLM Pigging Loop Module
- ROT Remote Operated Tool
- ROV Remote Operated Vehicle
- SI Scale Inhibitor
- SP Spare
- SU Service Umbilical
- TMGB Template Mounted Guide Base

4. General requirements

4.1 Functional requirements

Templates and Satellite Structures shall be designed for BOP envelopes of semisubmersible and monohull drilling rigs suited for the field waterdepth as a minimum. The design shall preferably allow for any BOP orientation in steps of 90°. Minimum requirement is that rig shall be able to work at any well slot on the same template without having to change heading.

The Subsea Structures shall protect piping and valve arrangements and other equipment from dropped objects. An impact energy value of 10-kJ/diameter 100 mm shall be considered.

All modules shall preferably be independently retrievable. Production capability should be maintained after retrieval of one or more X-Mas trees from a Subsea Production Station.

Design of Subsea Structures shall ensure that cement return and accumulation of cuttings are clearly visible by ROV around each wellhead area.

4.2 Intervention requirements

The Subsea Structures shall be designed for required access with both working and inspection ROVs with envelopes according to industrial standards.

In general, the Subsea Structures shall be designed to minimise risk for snagging of ROV umbilical and local guide wires. Typical components can be guide funnels, stand-off anodes, electrical connectors in parking positions and in connected positions, installation rigging arrangements, etc.

In case of using local guideline technique, design of Subsea Structures shall take into account the following:

- During rig or large vessel operations above subsea installations, the rig or vessel will be moved off location during running of heavy equipment and components. This could expose the equipment installed subsea to damage from sweeping and snagging local guide wires.
- If local guide wires are considered, the receptacles shall be designed for side loads from "off location" running of equipment.
- ROV access to receptacles for retrievable guideposts shall be ensured.

Grabber bars or docking platforms to allow the work ROV to dock or land in a stable position should be provided. The location of the grab bars shall be on the left side of the components to be operated and shall ensure suitable envelope and work condition for the ROV.

ROV platforms should be flush and without any obstructions for the ROV.

ROV handles at intervention points and on ROV tooling shall be of X-bar type

ROV access shall be provided for operation of valves on production and injection headers and branch lines without operation of hinged protection covers or roof hatches if any.

Intervention on ROV operated valves shall be from the same elevation. If required the valves shall include stem extensions to ensure that ROV torque tool receptacles are at same elevation. Preferably, there shall be horizontal ROV access for operation of valves on service, hydraulic and chemical injection lines.

The SUPPLIER shall provide for each valve the associated torque requirement and the reference of the corresponding torque tool..

The ROV tools shall include a reaction plate or similar arrangement preventing rotation of the tool when being held and operated by the ROV.

Reliable torque limiting facilities shall be provided on all torque tools. Means of torque adjustment shall be fully documented in the tool technical documentation.

The valve torque tools shall be fitted with a valve interface of shape, dimensions and tolerances according to relevant standards.

The valve torque tool shall be designed for valves with non-rising stems.

In all cases the ROV manipulator operational envelopes should be used for design purposes and checked against design.

The surrounding/interfacing structures and equipment such as valve stems and mini-guideposts shall be designed to avoid potential snagging points for the ROV and its tether or umbilical.

Low torque ROV operated valves shall be fitted with a handle suitable for operation directly by the ROV manipulator. The low torque valve handle shall be fitted with mechanical stops at either end-position preventing the valve to be overturned and overloaded. The stopping mechanism shall not protrude the front side of the valve panel.

The medium and high torque ROV operated valves shall be designed and tested to take a bending moment of minimum 3000 Nm and an axial force of 3000 N at the ROV interface and still be operable within the specified torque values.

Valve handles and attachments for ROV manipulator operation shall for low torque valves as a minimum be designed and tested to a torque of 400 Nm, a bending moment of 1000 Nm and an axial force of 5000 N.

The valve handle shall be used as the valve status indicator. Robust and clearly visible position marks for both handle positions shall be included.

The torque tools shall provide a torque 30% higher than the maximum required operating/break out torque value measured at the torque tool interface. For valves up to 75 mm bore diameter the maximum acceptable valve torque shall be at least 100% greater than the maximum required operating torque measured at the torque tool interface.

The valve stem and reaction system for ROV operated valves shall be designed to transfer only rotational torque to the valve. Other loads such as axial force, sideways force and bending moment shall not be transferred to the valve actuators.

4.3 Protection corrosion requirement

Protection corrosion is covered in [GS SPS 001](#) and [GS SPS 009](#) documents.

The Subsea Structures shall include a corrosion protection system for:

- Valves
- Wells
- PCS equipment

The following areas can be uncoated:

- Chemical injection and hydraulic lines
- Machined surfaces on hinges and equivalent
- Grillage and Sea fastening.

Reusable and temporary items shall be coated.

4.4 Abandonment requirement

Reference is made to [ISO 13628-1](#) section 8.7 “Decommissioning”.

An abandonment plan shall be provided by CONTRACTOR for COMPANY approval. This plan shall contain as a minimum:

- Description of installation with weight and dimensions
- General assembly drawings
- Decommissioning principles
- Lifting points location
- Identification of retrievable and non retrievable equipment
- Cost estimate of abandonment operations.

5. Structure requirements

5.1 Introduction

In this specification the Subsea Structures have been divided into the following types, as per [GS SPS 001](#) document:

- Template (integrated or modular)
- Manifold (for template or cluster/satellite configuration)
- 2-slot structures
- single wells.

For some field developments other types of structures may be required (e.g. subsea processing, protection structures at pipeline connections, etc.).

5.1.1 General requirements

All types of Subsea Structures shall be designed for the following general requirements:

1. The Subsea Structures shall be designed for field specific soil conditions. Soil characteristics are given in separate specification Project soil data.

The foundation method will be field specific. The selection of foundation method shall be recommended by CONTRACTOR and decided by COMPANY based on an evaluation of geotechnical conditions and loads as well as fabrication and installation constraints.

The following requirements shall apply for all types of foundation methods:

- The foundation system shall allow for:
 - $\pm 20\%$ variation in the soil characteristics
 - $\pm 0.5^\circ$ uncertainty on measured/estimated seabed slope
 - Vertical misalignment of conductors pipes
 - Penetration of skirt foundations shall be obtained from submerged weight only, no suction shall be required.

- All structures shall allow for the actual local seabed slope. CONTRACTOR shall demonstrate through appropriate design studies that the overall design is compatible with local slope conditions and installation/drilling/intervention/retrieval operations for each type of structure considered.

Design documentation shall include as a minimum:

- Modelling of the overall system with actual seabed characteristics: sea slope and soil characteristics with associated uncertainties and variations (modelling of the well conductor pipe and upper part of casings with corresponding vertical tolerances)
- Structures and foundation vertical and orientation tolerances
- Operational loads: drilling, completion, tie in, thermal expansion
- CONTRACTOR shall assess the robustness of the overall system to variations of major parameters with above assumed tolerances, like soil condition data, seabed slope, conductor pipe inclination, loads, etc.

CONTRACTOR shall assess the requirement for a levelling system on the basis on the above studies. Implementation of a levelling system shall be decided by COMPANY.

In general closed profiles (rectangular hollow sections and tubulars) shall be flooded. Free circulation of seawater shall be avoided e.g. by using a split rubber grommet in each profile. During installation, the flooding of the closed profiles shall be sufficient to avoid hydrostatic collapse of the profiles without restricting the lowering speed of the structure through the water.

Subsea Structures shall include local protection of electrical cables and connectors, valves, small bore piping and other sensitive equipment in order to prevent impact from dropped objects, ROV, running tools, local guide wire snag and sling arrangements. Small-bore piping shall be routed in pipe racks and equipment shall be as little exposed as possible.

The Subsea Structures shall include permanent subsea marking as per **GS SPS 001**. The orientation of the subsea marking shall be according to the planned ROV intervention position. The numbering system for subsea marking of all valves, lines and well slots shall be agreed with COMPANY during detail engineering.

The Subsea Structures may include hold back points for installation and lay-down of sea lines.

The Subsea Structures shall be designed for the current velocity at seabed described as per Project specific information.

5.2 Design requirements

All applicable loads affecting the Subsea Structures shall be identified and evaluated. Loads acting on the Subsea System can be categorised as follows (non exhaustive list):

- Permanent loads
 - Self weight
 - Buoyancy
 - Pre-stressing
- Environmental loads
 - Wave, wind, current

- Water and air temperature
- Hydrostatic pressure
- Variable loads
 - Installation loads
 - Intervention loads
 - Drilling/completion/work over loads
 - Transportation loads
 - Vessel motion induced loads
 - Mechanical and pressure testing loads
 - Internal pressure and temperature induced loads (well casing and tubing, production lines, etc.)
 - Accidental loads.

Structural analysis shall be carried out for several load combinations. A matrix of load combinations shall be developed and selection of worst cases shall be justified and documented.

When production jumpers are used for connecting X-Mas tree to a manifold, they shall be designed whenever possible to slope downwards towards the manifold.

Valves shall not be placed at low locations to minimise the risks of hydrate blockage.

Sensors shall be of non-intrusive type, and preferably located on the upper part of the pipe.

Production pipe dead legs shall be avoided as much as possible.

5.3 Concept 1: Multiwell Template with Manifold requirements

5.3.1 General requirements

All sensitive equipment with a high potential for maintenance or replacement shall be easily accessible and retrievable from light intervention vessels.

Templates shall allow for further connection to a future in-line Template, i.e. daisy chaining of templates.

Templates shall allow for installation of a retrievable Pigging Loop Module for round trip pigging and circulation of stabilised crude oil. Subsea retrieval and installation of the Pigging Loop Module shall be possible without retrieval of the Manifold Module.

Retrievable Manifold Module shall be locked to the Template if proved necessary. In this case, the lockdown system shall include a positive action lockdown indicator for visual confirmation by ROV. If the Manifold Module or part of it is retrievable, the Manifold Module or its parts shall be designed for easy retrieval/replacement.

The Template shall provide landing and locking capability for the wellhead conductor housing. The locking mechanism shall be able to carry part of the loads from the Template/Manifold to counteract settlement of the Template. Assessment of these loads and of the resulting locking mechanism capability shall be established and documented by CONTRACTOR.

The Template shall allow for installation of a Jumper Module (JM) for connection of cluster/satellite wells to any of the template well slots.



The Template shall allow for a 1.5° inclination of the conductor housing in any direction.

The foundation system shall be designed for relevant worst case combination of operational and accidental loads both without and with any number of conductors installed (e.g. tie-in of sea lines, drilling loads, etc.).

The Template shall allow for vertical thermal expansion of the wellhead.

The Template system shall include washout prevention sleeves and cement return outlets.

The Template shall include cable trays for electrical cables from the main Service Umbilical (SU) to each X-Mas tree control module and to opposite main SU for further serial connection to the following in-line Template. The cable trays shall be routed for maximum protection of the cables and shall provide protection against mechanical damage on all sides of the cables.

The Template shall include cable trays for replacement of electrical cables by ROV. The cable trays shall have capacity for replacement of all electrical cables.

5.4 Requirements for Concepts 2A and 2B

Individual Wells connected to a Subsea Manifold Centre in cluster or satellite configuration.

5.4.1 Manifold centre requirements

The Manifold Centre shall include a retrievable Manifold Module.

Manifold incorporating two headers may be used for production. The manifold shall allow for further connection to a future in-line.

The manifold centre shall allow for installation of a retrievable Pigging Loop Module for round trip pigging and circulation of stabilised crude oil. Installation and retrieval of the Pigging Loop Module shall be possible without retrieval of the Manifold Module. The PLM shall be designed for easy installation/replacement.

All sensitive equipment with a high potential for maintenance or replacement shall be easily accessible and retrievable from light intervention vessels.

The Manifold Centre shall include cable trays for electrical cables from the main SU to each of the X-Mas tree control modules. The cable trays shall be routed for maximum protection of the cables and shall provide protection against mechanical damage on all sides of the cables.

The Manifold Centre shall include cable trays for replacement of electrical cables by ROV. The cable trays shall have capacity for replacement of all electrical cables.

5.4.2 Satellite structure requirements

This part is also applicable for satellite tie back on a Template.

The Satellite Structures have been divided into two main types:

- Post-installed Satellite Structure
- Pre-installed Satellite Structure.

The Post-installed Satellite Structure shall be designed for installation after drilling. The structure may be supported and locked to the wellhead conductor, other parts of the X-Mas tree System or installed on the seabed. When supported on any part of the X-Mas tree System, the structure shall include an additional foundation system if capacity of conductor is insufficient.



The Pre-installed Satellite Structure shall be designed for installation prior to drilling. The Pre-installed Satellite Structure shall provide landing and locking capability for the wellhead conductor housing by inclusion of an appropriate Guide Base. The structure shall include a foundation system, which shall be designed for relevant load conditions without support from the wellhead.

All Satellite Structures shall allow for a 1.5° inclination of the conductor in any direction.

5.5 Concept 3: two slot structure

Based on the CONTRACTOR's proposed design for these two slot structures, previous sections will apply for a template type system and a cluster type system.

5.6 Concept 4: Individual wells

Requirements established for satellite wells are applicable for concept 4.

5.7 Jumper requirements

The following requirements are applicable for cluster arrangements only.

- The length of the jumper should not exceed 30 m.
- Design of the jumper shall allow for expected well head/X-Mas tree motions during completion/workover operations.
- Design shall allow for wellhead displacement during retrieval and reinstallation of all jumpers.

6. Piping system requirements

6.1 Functional requirements for manifold piping system

The manifold lines and valve arrangement shall reflect the hydrate prevention strategy.

For Manifolds with dual headers, these shall be separated by a remotely controlled hydraulically operated isolation valve to allow for bi-directional round trip pigging and circulation of stabilised crude oil when the Pigging Loop Module is in place.

Manifold for gas or water injection shall have one single header and may have one ROV operated isolation valve.

The manifold shall include branch lines from each well. Manifolds with two headers shall have full flexibility during normal production or well testing for routing the production stream to either of the headers. Distribution of production stream can be done either through ROV operated or remotely operated valves.

The manifold shall include one service line, several scale inhibitor and corrosion inhibitor lines in accordance with the scale and corrosion strategy, and hydraulic lines for distribution to each well. In addition lines shall be routed continuously through the manifold for further connection to a future in-line manifold if required by Project.

The manifold shall include hydraulic lines for control modules and accumulator modules. Number of lines to each module shall be according to requirements for the production control system.

Pipe routing shall minimise the number of low points.

6.2 Manifold barrier requirements

Definition of barrier elements in a manifold piping system shall be as per **GS SPS 001**. The manifold piping system shall include:

- One pressure resistant cap with metallic seals on all blind ends on lines, which may be exposed to wellhead pressure during normal production. Cap shall be easily ROV retrievable
- One ROV operated isolation valve on each line (large bore, small bore and service lines) to individual wells in order to:
 - Maintain production and barrier requirements during installation, commissioning, start-up and intervention on wells
 - Perform pressure testing of line connections to X-Mas tree.

One isolation valve on each line to a future in-line manifold centre or template in order to:

- Maintain production during installation, commissioning, start-up and intervention on second in-line template/manifold.
- Perform pressure testing of line connections to future in-line templates or manifold centre.

One isolation valve on each line to the manifold control and accumulator modules.

One isolation valve on each chemical injection line to the production headers.

All barrier elements shall be pressure tested at low and high pressure after installation in the piping system.

All isolation valves in lines exposed to wellhead pressure shall be in closed position during manifold installation. The barrier function shall be documented from both sides prior to sail away. The valves shall not be operated after this test.

6.3 Piping design requirements

The manifold piping material shall be as specified in table 7.1.

The production/injection piping system shall be designed according to **DNV 81**. **DNV 96** rule can apply in some cases subject to COMPANY agreement.

Service lines, hydraulic lines, scale inhibitor, chemical injection and gas lift lines shall be designed according to **DNV 81**.

All lines in the piping system shall be designed for external hydrostatic pressure with atmospheric pressure in the lines.

Design of the water/gas injection trunks of lines shall include a corrosion allowance of 1.5 mm thickness.

Production headers, branch lines and circulation lines shall be thermally insulated according to **GS SPS 008**.

Internal diameter in hydraulic lines shall be in accordance with hydraulic analysis for the total Subsea System.

Material selection shall ensure full compatibility with line service during all phases from fabrication to operation.

For 22Cr duplex, cold bending during fabrication shall not be performed.

The piping system shall be considered as permanently installed. All connections (e.g. to valves and hubs) shall be butt-welded.

Line type	Service	Pipe size	Material type
Production/test headers	Well fluid	all	22Cr duplex or cladding treatment
Production Branch lines	Well fluid	all	22Cr duplex or cladding treatment
Production Pig loop line	Well fluid	all	22Cr duplex or cladding treatment
Service lines	Methanol, well fluid	all	22Cr duplex, 6Mo
Injection header	Water/gas	all	H ₂ S service
Injection branch line	Water/gas	all	H ₂ S service
Chemical injection lines: - Scale Inhibitor - Corrosion Inhibitor or flow improver	Chemicals Injection	min. 3/8" ND note 1	316,6 Mo
Hydraulic lines: - High Pressure - Spare - Low Pressure	Hydraulic oil	min. 3/8" ND note	316,6 Mo

Note 1: Min. internal diameter in hydraulic lines shall be documented.

6.4 Preservation requirements for piping system

All lines shall prior to load out be filled with liquid Type of fluids and inhibitors will be specified by COMPANY at latest during detail engineering. As a minimum, production headers, branch lines, circulation lines, service lines and gas-lift lines shall be filled with inhibited water and 50% glycol.

Hydraulic and chemical injection lines shall be filled with hydraulic fluid. Use of additional biocides in the hydraulic fluid to reduce growth of micro-organisms after umbilical connection will be decided by COMPANY.

An arrangement for volume and pressure compensation in all pipe systems during storage, transportation and installation shall be included.

6.5 Additional requirements for piggable lines

For piggable lines the following additional requirements shall apply:

- Piggable lines shall be designed for bi-directional pigging. Bends in piggable lines shall have a radius of minimum five times the pipe ID for allowing instrumented pig, unless demonstrated by CONTRACTOR that shorter radius can be adopted.

- Piggable lines shall have constant internal diameter, tolerance on the inner diameter shall be $\pm 5\%$. Ovality tolerance shall be 1.5% except at extremities where ovality tolerance shall be 1%.

The internal surface of butt welds in the piping system shall have smooth transitions to avoid any damage of pigging gauge plate.

6.6 Valves

Valve requirements have been specified in separate valve specifications, refer to **GS SPS 004**, **GS SPS 005** and **GS SPS 006**.

Pressure rating of valves shall be sufficient to allow for pressure testing of flowlines and service umbilicals during installation with the valves in closed position. The test pressure for flowlines and service umbilical will be field specific.

7. Installation requirements

7.1 Transportation requirements

CONTRACTOR shall establish the motion characteristics of the vessels to be used for the transportation of the Subsea Structures from the fabrication site to the offshore field or to an inshore location.

CONTRACTOR shall establish the sea fastening arrangement in accordance with international standards and with the identified transportation vessels.

7.2 Lifting requirements

7.2.1 General requirements

General requirements for lifting of Subsea Structures and corresponding modules and components shall be:

- CONTRACTOR shall identify and document all possible installation methods, means and sequences for its proposed Subsea Production equipment design. Documentation shall include as a minimum:
 - General installation procedures and alternatives
 - Type and characteristics of handling support vessels, and estimated operational limits
 - Description of all possible installation sequences, highlighting the corresponding inherent flexibility
 - Recommended solutions.
- During rig or large vessel operations above subsea installations, the rig or vessel will be moved off location during running of heavy equipment and components. This could expose the equipment installed subsea to risk of damage from sweeping and snagging potential local guide wires.
- The delivery of Subsea Structures shall include lifting gear for installation and intervention. The lifting gear shall be suitable for lifting on land and offshore, both in air and submerged as required.

- The Subsea Structures shall be designed for lifting operations according to **DNV** Rules for Planning and Execution of Marine Operations.
- Design, fabrication, testing and documentation of lifting gears and corresponding pad eyes on the structures, modules and components shall be according to **GS SPS 001**, and **DNV** Rules for Certification of Lifting Appliances.
- The Subsea Structures shall be designed for hydrodynamic loads during installation and intervention based on following conditions:
 - Wave characteristics: Hs and Tp Project specific
 - Current velocity: Ref: Project specific
 - Hoisting speed: 0.5 m/s.

Installation loads shall be documented by numerical analysis and shall include dynamic response to motions of the installation vessel.

7.2.2 Special requirements for drilling rig installation

The modules or components shall be designed for installation on drill string, or on wire cable from an installation vessel.

In air weight of each module inclusive of transportation skid and rigging equipment shall be optimised to ease offshore handling operations.

Outer dimensions shall also be minimised for the same reasons as above.

Modules or components, which shall be installed through the moonpool of a drilling rig, shall be designed according to requirements for Remotely Operated Tools in **ISO standard 13628** Part 9 latest version.

All operations shall be fully reversible at any stage during installation. In particular effects from flooded profiles during lifting out of water shall be considered.

Guiding facilities (e.g. funnels, guiding frames, etc.) shall be included for safe transportation of components from skidding on deck to moon pool area and lowering from moon pool into sea.

All module/components shall include footings for transportation. Edges and obstacles, which may hook during lifting from supply vessel, shall be avoided.

The modules/components shall include facilities for correct orientation on seabed.

Modules and components shall be designed to accommodate a vertical impact velocity of 0.8 m/s if run on drill pipe and 1.5 m/s if run on wire.

7.2.3 Special requirements for vessel installation

The Subsea Structures, lifting devices and installation rigging arrangement shall be designed for a safe and reliable lifting operation.

The Subsea Structures shall include sufficient openings in mudmats and protection covers or roof hatches if any to avoid uplift during lifting through the splash zone and lowering through the water. Loads on the lifting equipment shall always be sufficient during submerged lifts.

The structure and retrievable modules and components shall be designed for 0.5 m/s landing velocity during installation on seabed and module installation on the structure.

The complete lifting arrangement including installation instrumentation shall be pre-installed on the structures prior to sailaway unless otherwise approved by COMPANY. Required rigging arrangements for removal and reinstallation of sea fastening for slings shall be included.

The lifting arrangement shall ensure that the structure is horizontal within 1° relative to the true horizontal for submerged lift. If required, ballasting weights on the structure shall be installed.

The rigging arrangements shall include a safe area for connection and disconnection of slings to crane hook on barge and installation vessel.

The rigging arrangements shall include safe access to lifting points for inspection of sling release system.

Attachment points for tugger lines shall be provided according with lifting procedure.

All installation instrumentation shall be installed on a retrievable frame or basket. The instrumentation may typically include gyro, battery package, bulls eye and micronav.

The lifting frame shall include a sling lay down area with railing for safe access and footings for transportation.

Design of the release system for lifting devices and instrumentation baskets shall ensure that release and retrieval can be performed in a controlled and safe way. The lifting devices (lifting shackles, slings, lifting frame, etc.) shall be prevented from falling or moving into the structure and damage equipment and components.

All lifting devices and rigging arrangements shall be designed and prepared for removal after installation.

Requirement for hydraulic dampers for reduction of hydrodynamic loads during installation shall be assessed and documented by CONTRACTOR, and approved by COMPANY.

8. Interfaces

CONTRACTOR shall give full consideration to Interfaces, both internal and external, during Design, Manufacture and Test of the Subsea Station.

Management of these interfaces is described in Project specific procedures.

CONTRACTOR shall actively contribute to the resolution of the interfaces by either feeding information to the Interface leader or by seeking the required information.

A non-exhaustive list of major interfaces to be taken into account during design and manufacture is provided here below.

- Drilling: loads, equipment guidance and orientation
- Tie-in: loads, flowline design, pipeline end termination, connection system
- Maintenance: light and heavy intervention, ROV/ROT intervention methods and means
- Production Operations: flowlines pigging, hydrate prevention and removal strategy, shut down situations
- Subsea Control system: umbilicals, host facility control system, and overall system availability target
- Installation: Operator's Strategy, available regional fleet, Project constraints
- Others.