



Exploration & Production

GENERAL SPECIFICATION

Drilling & Wells

GS EP FP 411

Subsea Horizontal Christmas Tree System

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1. Scope

This document defines the technical requirements for the design, manufacture, assembly and test of the a horizontal subsea Xmas Tree systems for both production and injection (gas and water) wells.

Equipment covered by this specification includes:

- Tubing hangers and running tools systems
- Subsea Xmas Tree, and running tools systems
- Test and handling tools
- Shipping skids, baskets and slings.

Items **not** included in this specification are:

- Wellheads
- IWOCS
- Downhole completion equipment
- Production control system
- Insert Chokes
- DHPT system.

The IWOCS requirements are defined in [GS EP FP 412](#) while the Wellhead System is described in [GS EP FP 410](#).

Contractor shall identify and supply any other equipment, materials, facilities, etc deemed to be necessary or required to complete and/or ensure the satisfactory installation and operation of the subsea trees and associated installation and workover systems.

Contractor shall supply a comprehensive listing with quantities and proposed locations of use of all equipment, jigs fixtures etc. which are not part of the deliverables but which are deemed necessary to complete the fabrication and in-house testing activities.

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 supplementary to document [GS EP SPS 001](#), and shall be therefore read in conjunction with said document and other COMPANY specifications and standards identified therein. The relationship between the main COMPANY documents defining the requirements to the Subsea Stations is illustrated in [GS EP SPS 001](#).

The subsea HXT system shall comply with all applicable industry standards listed in this document such as ISO, API and other referenced standards unless otherwise stated by Company.

If a discrepancy between standard and / or specifications, the more stringent shall apply, unless otherwise stated by Company.



Standards

Reference	Title
ISO 13628	Petroleum and Natural Gas Industries - Design and operation of subsea production systems - Part 1 - General requirements and recommendations - Part 4 - Subsea Wellhead and Tree Equipment - Part 8 - Remotely Operated Vehicle (ROV) - interface on subsea production systems
ISO 10423	Petroleum and Natural Gas Industries – Drilling and Production Equipment – Wellhead and Xmas Tree Equipment Second Edition
ISO 898-1	Part I - Bolts, screws and nuts
SAE AS 4059 E	Cleanliness classification of hydraulic fluids
NACE MR 0175 / ISO 15156	Material Requirements. Sulphide Stress Cracking. Resistant Metallic Material for Oil Field Equipment
ASME	Boiler and Pressure Vessel Code
ISO 9000	Quality Management Systems – Fundamentals and vocabulary
ISO 9001	Quality Management Systems – Requirements

Professional Documents

Reference	Title
API SPEC 6A	Specification for Wellhead and Xmas Tree Equipment
API SPEC 8C	Drilling and Production Hoisting Equipment
API SPEC 16A	Specification for Drill Through Equipment
API SPEC 16D	Control Systems for Drilling Well Control
API SPEC 17D	Specification for Subsea Wellhead and Xmas Tree Equipment
API SPEC 5 CT	Specification for Casing and Tubing
API RP 17H	ROV Interfaces with Subsea Equipment
API RP 16 Q	Design and Operation of Marine Drilling Riser System

**Regulations**

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP SPS 001	Design Philosophy and Requirements for Subsea Stations
GS EP SPS 007	Tie-In Systems
GS EP SPS 010	Preservation Requirements for Subsea Package
GS EP SPS 011	Mechanical Completion for Subsea stations
GS EP SPS 012	Documentation Requirements for Subsea Stations
GS EP SPS 015	Subsea Gate Valves and Actuators in Subsea Xmas Tree Systems
GS EP SPS 016	Subsea Insert Chokes and Associated Running and Retrieval Tools
GS EP SPS 019	Subsea Production Control System
GS EP SPS 022	Environmental testing of Subsea Electronics
GS EP SPS 023	Cleaning and Flushing of Hydraulic Systems
GS EP FP 410	Subsea Wellhead and Guidance Systems
GS EP FP 412	Workover Subsea Completion Systems for Horizontal tree



3. Introduction

3.1 Definitions

Further to definitions as listed in Company specification **GS EP SPS 001**, the following shall apply:

Company	Total E&P or their nominated representative(s)
Contractor	The Company contracted for the performance of the work
Surf Contractor	The Contractor in charge of the engineering, supply, construction, transportation, and installation of the Umbilicals, Flowlines and Risers
Well Jumper	Connection between Well and Manifold or ILT
Flying Lead	Recoverable assembly of Electrical cables, chemical and hydraulic piping in between 2 units
Manifold Module (MM)	Retrievable manifold including structure and Piping
Bottom structure (BS)	Frame on top of the suction anchor receiving the MM
Production Jumper/Spool	Connection between Manifold production header and flowline
Manifold Control Module (MCM)	Subsea Control Module (SCM) controlling the Manifold
Tree Control Module (SCM)	Subsea Control Module (SCM) located on the Tree
Permanent Guide Base (PGB)	Base structure on top of the well, for tree orientation and jumper support
Subsea Distribution Unit (SDU)	Subsea Distribution Units are the umbilical network distribution structures incorporating the HDU (Hydraulic Distribution Unit) and the EDU (Electrical Distribution Unit). There are four types of SDU i.e. UCM, UDM, UTP and UTI
Umbilical Distribution Module (UDM)	SDU distributing to two branches
Umbilical Termination Production (UTP)	SDU terminating a production umbilical branch
Umbilical Termination Injection (UTI)	SDU terminating an injection umbilical branch

3.2 Responsibility

It is the responsibility of anyone who supplies equipment to this specification to ensure and document compliance with the requirements defined by this specification, other relevant standards and statutory requirements. Any deviation from any of the requirements defined herein shall be clearly indicated and treated as a non-conformance.

3.3 Abbreviations

The following abbreviations are used in this specification:

AAV	Annulus Access Valve
AMV	Annulus Master Valve
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-destructive Testing
AWS	American Welding Society
AWV	Annulus Wing Valve
BOP	Blow Out Preventor
CI	Chemical Injection
CP	Conductor Pipe
CRA	Corrosion Resistant Alloy
DHPT	Down Hole Pressure and Temperature Gauge
EFAT	Extended Factory Acceptance Test
EFTS	Electrical Feed Through System
FAT	Factory Acceptance Test
FPSO	Floating Production Storage and Offloading Unit
GS	General Specification
HAZ	Heat Affected Zone
HP	High Pressure
HXT	Horizontal Xmas Tree
ID	Internal Diameter
ILT	Inline Tee
IMR	Inspection Maintenance and Repair
IRCD	Injection Rate Control Device
ISO	International Standard Organization
ITC	Internal Tree Cap
IWC	Intelligent Well Completion
IWOCS	Installation and Workover Control System
LP	Low Pressure
MCM	Manifold Control Module
MODU	Mobile Offshore Drilling Unit
MPFM	Multiphase Flow Meter



MPI	Magnetic Particle Inspection
MQC	Multi Quick Connection
MSV	Multifunction Service Vessel
MTBF	Mean Time Between Failure
MTHRT	Mechanical Tubing Hanger Recovery Tool
NACE	National Association of Corrosion Engineers
NDT	Non Destructive Testing
PMV	Production Master Valve
PGB	Permanent Guide Base
PSL	Product Specification Level
PTFE	PolyTetraFluoroEthylene
PCV	Production Choke Valve
PFD	Production Flow Diagram
PWV	Production Wing Valve
QA	Quality Assurance
QC	Quality Control
ROT	Remotely Operated Tool
ROV	Remotely Operated Vehicle
SAM	Subsea Accumulator Module
SCM	Subsea Control Module
SCSSCV	Surface Controlled Subsurface Safety Valve
SDU	Subsea Distribution Unit
SIT	System Integration Test
SLV	Service Line Valve
SRT	Site Receive Test
SURF	Subsea Umbilicals, Risers and Flowlines
TH	Tubing Hanger
THRT	Tubing Hanger Running Tool
TRT	Tree Running Tool
VX t	VX seal test
WH	Well Head
WP	Working Pressure
XT	Xmas tree



XMT Xmas Tree
XOV Cross Over Valve

3.4 Documents

Documents : ISO 898-1 , API SPEC 8C, API SPEC 16A, API SPEC 16D, API SPEC 5 CT, API RP 17H, API RP 16 Q are an integral part of this document.

4. System description

4.1 System overview

The Subsea Xmas Tree System comprises of a set of equipment which can be divided into two groups:

- Permanently Installed Equipment
- Workover/Completion Equipment

This specification covers the following permanently installed main sub systems with running tools and auxiliary equipment:

- Tubing Hanger System
- Horizontal Tree Assembly

5. Principal equipment (or product) requirements

5.1 Introduction

The following paragraphs define the principal equipment or product requirements for all units included within the Horizontal Tree (HXT) System. The general philosophies, functional, operational and technical requirements to the subsea station are defined in GS EP SPS 001.

5.2 Scope of the specification

This specification applies to the tubing hanger and HXT Equipment and directly associated tooling. For the Horizontal Tree, the specification does not cover the connector at the end of the flowpool which interfaces with either the template connector or the jumper connector. For this connection, reference is made to document GS EP SPS 007.

The Specification does not cover the Control pod. For this equipment, reference is made to the document GS EP SPS 019.

5.3 General Design Philosophies

5.3.1 General

The HXT System shall be designed to operate on the mudline under the specific field conditions and operating life. Requirements for control of the different valves in the HXT system during the workover/completion and production phases are given in Appendix (see PDF attached).

The basic design pressure for the HXT System is 690 bars (10000 psi). However, some hydraulic functions may require a hydraulic pressure greater than 690 bars. The components of



the units which can be in contact with such high pressures even in the event of a failure on the first sealing element shall be designed to withstand this pressure.

The tree shall provide a pressure containing conduit for the produced or injected fluid. The Xmas tree shall provide the ability to control and isolate the well pressure.

Vertical flow isolation and access shall be achieved by dual slick line retrievable crown plugs in the tubing hanger or in the TH and Internal Tree Cap (ITC). To be able to permanently benefit from the two sealing barriers elements this equipment shall be capable for providing the monitoring of the pressure in the cavity created by the two tubing hanger set isolation plugs.

The cavity in between the installed crown plugs shall be monitored for any pressure deviations during production mode.

All equipment shall be designed for safe and efficient handling and make up with the maximum operating conditions of the drilling rigs.

5.3.2 Horizontal Tree Barrier and Valve Configuration

The location of the HXT below the BOP induces the necessity for the tree to abide by a double barrier against any pressurized effluent between the well and the environment during all drilling, completion or work-over operations. This requirement adds itself to the double barrier philosophy always demanded for production phases and intervention operation. It has strong implications on many equipment specifications, such as the sealing ability of the tree bore protectors in front of the penetration, the use of an additional barrier (compared to the sole VX type gasket) on the tree lower connection, the doubling of the production and annulus tree valves. One shall refer to the detailed specification on the related items of equipment.

The subsea HXT System shall be configured in accordance with the dual barrier element philosophy, which implies there shall be two independent testable barriers between the produced fluids and the environment. A barrier element, in this context, is defined as a gate valve, needle valve or bore plug with metal to metal seals.

Well flow and annulus pressure are controlled by gate valves in the lateral bores. As a minimum, the production and annulus master valves and annulus access valve shall be integral with the HXT block.

Vertical flow isolation shall be achieved by use of dual wireline installed plugs. Two (2) options may be considered:

- Dual set plugs in the TH
- One plug in the TH one plug in the ITC.

For both plugs, the primary seals shall be metal to metal.

Both barrier elements shall have the facility to be tested bi-directionally. Additionally, a facility to test and monitor the pressure between the plugs from the work over and production control system shall be provided.

The design shall allow for communication from annulus to production. Communication shall be established downstream the production master valve and upstream the production wing valve.

All valves shall be capable of sealing with low pressure (100 psi) differentials and with marginal pressure gradients. For test requirements in general, reference is made to section 12 of this specification.

5.3.3 Subsea chokes

For some applications, the tree assembly shall incorporate a retrievable choke on the flow loop between the wing valve and the flow line connector. Detailed requirements for the choke and associated running/retrieval tool are described in [GS EP SPS 016](#).

5.3.4 Field Proven Equipment

Proven equipment with verifiable reliability records shall be utilized. Where proven equipment and components are not readily available, Contractor shall advise the status of current design development.

Contractor shall prepare a comprehensive list, for Company review and approval, defining all areas where the recommended system incorporates equipment that has not seen extensive offshore service in the same configuration, water depth or service, or has been modified since qualification, and its proposal as to what qualification work is required.

5.3.5 Simple and Reliable Equipment

The quantity of subsea equipment shall be minimized and simple solutions shall be offered to enhance reliability and reduce the need for maintenance and repair throughout field life. Where necessary and agreed by Company the permanently installed scope may be minimized by incorporating active components in running tools.

The Contractor's proposed design, whilst satisfying all functional and operational requirements, shall offer design simplicity and a minimum number of components/connections in order to minimize the number of potential failure points and thereby maximize the reliability of the system.

5.3.6 Intervention and Inspection Maintenance Repair (IMR) Philosophy

Where applicable, equipment shall be specifically designed for maintenance by ROV/ROT.

Special consideration shall be given to safe equipment transportation and handling during offshore operations. Additional protection is required to minimize damage to equipment during offshore loading from supply boat to rig and vice versa.

The tree system shall be designed for maintenance using ROV, ROT intervention techniques. The intervention systems shall be designed for launch operation and retrieval from both a support vessel or drill rig.

Where ROV intervention is required, Contractor shall design, and verify for acceptance, equipment to enable all ROV or tooling access. Contractor shall be responsible for all technical aspects of any ROV tools and interfaces developed and all communications necessary with the ROV system supplier in order to produce fully ROV compatible equipment.

Contractor shall prepare a matrix defining all ROV override and intervention points, listing Tool Class or characteristics, actual torque values, number of turns, interface dimensions, etc.

The IMR philosophy is defined as follows:

- Intervention interfaces shall be to recognized standards in accordance with [ISO 13628](#)
- SCM and choke insert installation and replacement shall be performed by ROV/ROT means

- Installation and replacement of Multi-Phase Flow Meter (MPFM) shall be performed by by ROV or ROT means
- Sand detector shall be replaceable by ROV
- IRCD's shall be adjustable and replaceable by ROV
- Remotely operated subsea production chokes shall feature ROV override facilities and position indicator.
- All subsea valves shall have the facility for ROV over-ride unless specified otherwise
- Installation workover controls (IWOCS) electrical and hydraulic/chemical jumpers intervention shall be performed by ROV
- Replacement and hook-up of control system flying lead assemblies shall be by ROV
- Routine inspection of subsea equipment shall be carried out by ROV. Cathodic Protection measurement points shall be clearly and visibly marked
- It is the Contractor's responsibility to identify, design and provide ROT tooling systems, which address all functional, operational and safety issues associated with use in an offshore environment
- Contractor shall prepare a detailed list of ROV tools and ROT necessary for XMT IMR
- Contractor shall prepare a written summary of contingency ROV repair tasks for Company review.

5.4 Safe and Effective Transportation, handling and Subsea Installation

The tree frame shall provide adequate guidance for guideline-less intervention.

Systems shall be designed for single trip operation utilizing a standard, work class ROV.

The sensitivity of equipment installation and retrieval to adverse weather conditions and vessel motion shall be minimized.

All equipment shall be provided with lifting appliances/slides certified for offshore transportation and use. Lightweight units and tools shall be designed for deployment by drill pipe, wireline and/or ROV methods.

5.4.1 Size and Weight

All equipment run from a MSV shall, when it is fully equipped and together with its running tools and handling equipment, remain within the following dimensions and weight envelope (unless otherwise stated by Company):

- 6 m x 6 m foot print envelope
- 50 metric tons

5.4.2 Installation Efficiency

Contractor shall investigate all reasonable methods of reducing the offshore lifted weight.

The system shall be designed to minimize equipment installation times whilst maintaining maximum reliability of installation operations. Sensitivity to vessel motion and position shall be



minimized and Contractor shall provide equipment operating limitations in these terms within operation manuals.

All consumable parts (i.e. gaskets, seals, in a coupler: the resilient or changeable seal) shall be retained within recoverable assemblies.

All assemblies shall incorporate suitable pad eyes, lifting eyebolt preparations or alternatives, all complete with slings, to facilitate easy shop, test site, sea fastening and offshore handling by lifting or skidding.

All running tools shall complete their operation in a single trip.

All equipment combinations suitable for deployment or recovery shall be balanced to within 1 degree when suspended from the running profile. Counterweights and temporary balance weights shall be included where necessary.

All tool joints shall be designed to allow for minimum one thread cut-off. The tong neck shall accept an iron roughneck. All dynamic equipment that is capable of being placed/commanded to more than one position (e.g. connectors, chokes and valves) shall incorporate a visual means of identifying connection status suitable for ROV video recognition. All position indicators shall provide 'real time' visual positional information while the function is being operated.

A multi-stage guidance system shall be used for deployment of all heavy or sensitive modules.

Prior to all heavy lift operations, the rig shall be moved off station. Design of equipment shall consequently minimize the risks of snagging from slack lift wires, ROV umbilicals, etc.

5.5 Protection Philosophy

Local protection of tree components shall be provided by the tree frame. The framework shall provide protection against damage during lifting, transportation, storage, load-out, running/retrieval, installation and operational activities. Post installation, the framework shall provide protection against accidental damage and impact from remote operated vehicle (ROV) and remote operated tooling (ROT), and their umbilicals, and from dropped objects and snagging of cables associated with intervention or workover operations.

- Protection is to be provided for a dropped object of 100 mm diameter with an impact energy of 10 kJ
- Components, which are sensitive to impact, shall be located in non-exposed positions and/or be provided with removable protective covers provided that access for maintenance is not compromised.

5.6 Standardization and Equipment inter-changeability

5.6.1 Standardization

The reservoir management requirements may impose different types of down hole completions, for injection and production HXTs.

Contractor shall review the comprehensive range of HXT impacts of these particularities, including at least down hole functions penetrations (TH), piping, isolation valves and Electrical Feed Through System (EFTS), thermal insulation materials and methods, sensors specifications and SCM specification.

Contractor shall demonstrate that its standardization choices have reduced to a minimum the amount of HXT types on the project.

Contractor shall further demonstrate that the commonality of parts and materials between different types of equipment (e.g. injection/production HXT or TH) is optimized in order to ensure an optimal flexibility of the sourcing, machining, construction, testing and installation activities.

Where identical equipment could not be achieved, the design shall allow to easily reconfiguring the equipment from a type to another type offshore or at the service base (ref chapter on spares).

5.6.2 Inter-changeability

The need for total operational flexibility is the basis for the request of interchangeability, to be understood as the possibility to interface any serial number of part A with any serial number of part B.

The general rules are as follows:

- Tools shall be usable on any unit in a series of equipment it shall operate
- Any unit in a series of two parts meant to be interfaced can be swapped
- The interchangeability shall be demonstrated by Contractor for Company approval or tested by Contractor
 - Any subsea tree with any wellhead or guide base
 - Any subsea tree with any tubing hanger and tree cap
 - All running tools and test equipment to be fully interchangeable
 - All sets of ROV tools with all interfaces on the equipment
 - Any tree running tool with any subsea tree
 - For operational purposes, any production SCM with any production tree
 - For operational purposes, any injection SCM with any injection tree
 - Any choke insert with any choke insert body
 - For operational purposes, any production choke with any production tree
 - For operational purposes, any injection choke with any injection tree
 - Any SAM with any tree (if tree mounted)
 - Any MPFM with any production tree

Validation of component inter-changeability capability shall be demonstrated by equipment testing, ref. section 12 of this specification.