



Exploration & Production

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS SPS 016

Subsea insert chokes and associated running and retrieval tools

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1. Scope

The purpose of this specification is to define the functional and design requirements for the hydraulic operated insert choke valves to be installed on subsea X-Mas Tree Systems, and associated running tools. Minimum design and material requirements have been addressed. The specific field data will be provided for each field application.

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 shall therefore be read in conjunction with said document and the other COMPANY specifications and standards identified therein.

The Subsea Insert Choke and associated Running/Retrieval Tool shall comply with all relevant statutory requirements and specifications as well as all relevant, ISO, API, and other referenced standards, unless otherwise stated by Project Group.

Standards

Reference	Title
ANSI B16.5	Pipe flanges and flanged fittings
ASME/ANSI B16.34	Valves - Flanged, Threaded, and Welding End
ASME	Boiler and Pressure Vessel Code Section V - Non Destructive Examination
ISO 10433	Specification for Wellhead Surface Safety Valves and underwater Safety Valves for Offshore Service (replaces API 14D)
API 6A	Specification for Wellhead and Christmas Tree Equipment

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	



Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS SPS 001	Design Philosophy and Requirements for Subsea Station
GS SPS 014	Drill Through Horizontal Tree Systems
GS SPS 019	Subsea Production Control Systems

3. Introduction

3.1 Responsibility

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

4. System description

This document specifies the requirements for the complete choke system, consisting of the following main elements:

1. Body/bonnet sealing system
2. Choke insert with guide arrangement
3. Mechanical connector
4. Valve body
5. Actuator with ROV override
6. Choke running and retrieval tool.

Retrieval of the choke insert shall be possible with a running tool deployed by liftwire, or by a conventional ROV equipped with dedicated tool systems.

The insert choke valve shall be designed to allow retrieval/re-install and test of all wear parts without removing the choke valve body from the flowline system.

The remote control system will provide hydraulic power for the choke actuator and electrical service for the remote position indicator.

5. Insert choke assembly

The insert choke valve assembly shall be designed for the field specific conditions defined for each individual project. The design shall be identified by design life, external and internal design pressures and temperatures, material compatibility with produced medium, injected chemicals such as methanol, inhibitors, and other chemical substances relevant for each specific project.

5.1 Design requirements

The following design requirements are applicable to the choke assembly:

The design of the valves shall be in accordance with the requirements defined in this specification, the referred design code [ISO 10433](#) and [API 6A](#), minimum PSL 3.

The actuator and choke internals shall be vertically retrievable as a single unit.

Choke control characteristics shall be designed to allow adjustments to within 1% of full travel.

The choke trim will be specified for each specific project. Either External Sleeve type or Plug and Cage type shall be available.

The choke trim and body shall be designed to provide specified pressure reduction capabilities for flow in both directions. CV curves for both flow directions shall be provided.

The choke insert shall include a proven guidance system providing accurate alignment of the insert during installation and retrieval, and shall include a mechanical connector with capability to sustain the full range of operational loads and pressures it will be exposed to.

The choke valve stem and end stops shall be capable of accommodating the full actuator thrust and ROV input torque over the entire opening and closing cycle.

The weakest point of the valve actuation system shall be outside the stem seal area.

A secondary connector release mechanism shall be provided to unlatch the retrievable insert to choke body connector in case the running tool fails to release the connector.

A back flowing capability shall be provided for gas injector wells which can be oil producers during a certain period of time.

5.2 Sealing requirements

The following requirements are applicable to the sealing arrangements:

1. The primary seal system in bonnet, insert bean and actuator stem shall be metal to metal.
2. Body/bonnet primary seal shall be bi-directional metal-to-metal. The seal shall achieve initial energising on final mating of the connector. Full energising by internal pressure assistance is acceptable.
3. The insert assembly shall have both primary metal-to-metal seals and secondary PTFE, PEEK or similar non elastomeric back up seals.
4. The design shall ensure that all seals are adequately protected during the installation for operation within the entire tolerance envelope.

5. The stem seal shall be designed to prevent ingress of sea water at the design water depth with atmospheric internal pressure.
6. The stem seal shall as a minimum include two separate sealing systems. One of the systems shall use a preloaded metal-to-metal seal, where the main sealing force is achieved from the preload.
7. The stem shall have adequate hardness and surface finish to sustain the seal load under dynamic conditions and avoid deterioration of functionality and/or sealing capability during use.
8. The non metallic stem seals shall be PTFE, PEEK or similar non elastomeric materials.
9. In the event of leakage from the stem, this shall be vented to ambient atmosphere without causing any pressurising of the actuator housing. A bleed port with a check valve shall be fitted to prevent sea water penetration into the stem housing.

5.3 External connections/Body penetrations

Penetrations in valve body and bonnet shall as far as possible be avoided. Any ports used for testing shall be plugged and seal welded.

Vent and drain valves/ports shall be provided at the highest possible, and at the lowest possible position of the valve to ensure effective venting.

6. Actuator

The following design and functional requirements are applicable to the choke valve actuator:

1. The actuator shall be remotely operated from the production control system.
2. For a stepping actuator the primary position indication shall be by using pulse count.
3. For a non-stepping actuator a Linear Variable Digital Transducer (LVDTs) or similar type of sensor shall be included. Such sensor shall provide position readout at surface with accuracy within 0.5% of the stem travel when included.
4. The actuator shall include an accurate visual position indicator, displaying full travel in both remotely controlled and in override mode, for monitoring from an ROV docked in position on the actuator.
5. Flushing of the actuator's hydraulic system shall be possible without disassembly of the actuator.
6. The actuator housing shall be pressure compensated. In addition, the housing shall be designed to withstand a maximum operational pressure based on the differential pressure between the ambient pressure and the actuator operating pressure. A pressure relief valve shall be implemented in the housing and set to 10% above the estimated differential pressure.
7. Full travel of the choke shall be achieved within maximum 10 minutes from fully closed to fully open.

7. Choke Valve Running and Retrieval Tool (CVRT)

The running and retrieval philosophy will be affected by the actual water depth and the insert weight.

7.1 Design requirements - Choke Valve Running Tool (CVRT)

The following paragraphs define the minimum requirements to design of a lift wire based running and retrieval tooling system for the choke valves:

1. The CVRT shall be designed for safe handling and lifting in offshore conditions.
2. The CVRT shall be operated by either remote hydraulic control from the surface, or mechanical / hydraulic intervention using ROV from a panel on the tool.
3. The CVRT shall be capable of being deployed on wire from both a semi submersible and mono hull intervention vessel.
4. For wire deployment, a weak link shall be used to prevent transfer of heavy loads onto the CVRT in case of vessel drift-off. The weak link shall be activated by ROV after landing and shall have three settings:
 - “Running” - the weak link is not activated
 - “Landed” - the link is activated and will release the wire from the tool at a given load.
 - “Disconnected” - the weak link is released from the tool. The system shall be designed to allow subsequent reconnection of the lift wire by using ROV.
5. The CVRT shall be guided by a suitable system, and shall land on dedicated landing pads.
6. A passive soft landing system designed to accommodate an impact velocity of 1.5 m/s if run by lift wire, shall be included.
7. The CVRT shall be positioned with sufficient accuracy, and if necessary, latched to the choke valve body to ensure that the choke insert can be lowered within the tolerance envelope for the insert and valve housing geometry.
8. The CVRT shall include an elevator system for controlled installation of the insert after landing of the tool with the insert in “upper” position. The elevator shall be capable of providing a retrieval force five times greater than the combined gravity and friction load for retrieval of the insert.
9. The CVRT shall be designed with clearances to adjacent structure or tree cap.
10. The CVRT shall not hamper any ROV operation or obscure ROV valve position indicators on tree, tree cap or manifold.
11. All operations shall be fully reversible at all stages of the operation.

7.2 Design requirements for ROV Based Choke Insert Running and Retrieval Tool

The following paragraphs define the minimum requirements to design of ROV based running and retrieval tool system for the choke valves:

1. The selected method shall be based on qualified or field proven operational techniques.
2. Pockets for hydraulic and electrical couplers in the body and bonnet hubs shall be avoided. ROV stab connectors on dedicated panel attached to the actuator housing shall be considered.
3. The connector setting torque shall be within torque tool capability with a minimum 50% allowance for increased unlocking torque.
4. The insert shall be guided and oriented directly into the valve housing by the ROV tooling system after docking of the ROV.

5. Once preloaded, the connector shall be self locking.
6. The tool shall be positioned with sufficient accuracy, and if necessary, latched to the choke valve body to ensure that the choke insert can be placed within the tolerance envelope for the insert and valve housing geometry.
7. The tool shall include a system for controlled installation of the insert after landing of the tool with the insert in "upper/retracted" position. The system shall be capable of providing a retrieval force five times greater than the combined gravity and friction load for retrieval of the insert.

8. Material requirements

For valve components, the following requirements shall be observed.

For general material requirements reference is made to **GS SPS 001**. In addition, the following requirement shall apply:

1. The stem seal area and choke internals shall be made of materials with appropriate hardness and surface finish, or shall be hard faced by corrosion resistant Tungsten carbide, or a proven alternative.
2. The valve body and bonnet shall be made in accordance with the tree requirements for production and injection fluids.

For the choke trim components, the following conditions shall be taken into account:

- Periodic (intermittent) flow of liquid (oil/water) and gas/liquid into the choke
- Sand production as per Project data
- Liquid droplet erosion
- Cavitation in liquid phase
- Corrosion induced by erosion (also for shear in liquid)
- Background corrosion of binder material
- Galvanic corrosion of binder material
- Maximum flowrate
- Differential pressures (Project specific).

9. Testing

9.1 FAT Program

Testing of the choke valves shall be performed in accordance with **GS SPS 001** and the requirements defined below. The following acceptance criteria for the hydrostatic and gas test shall be used:

1. External test: no leakage
2. Hydraulic cylinders: no leakage

No body/bonnet separation is acceptable during pressure testing.

In addition to the requirements defined by the relevant standards, the valves shall undergo the following tests and verifications as part of the Unit FAT and System FAT programs:

1. Actuator functional test including any electrical position indicator.
2. The choke trim shall be cycled from fully open to fully closed positions and reverse. For a stepping actuator, overstepping by 50 hydraulic pulses against stalled positions in both directions shall be performed, and break out torque shall be recorded thereafter. The test shall be performed for both maximum and minimum pressure in choke cavity. The number of pulses to move the choke from fully open to fully closed and vice versa shall be recorded.
3. A functional test of the choke override mechanism shall be performed, and required torque to open and close recorded. Override to be operated to fully open and closed positions, applying full torque as specified for choke override mechanism. Required break out torque to be recorded. Number of turns to operate by ROV from fully closed to fully open shall be verified, and required operating pressure recorded.
4. LVDT position indicator to be verified against functional operation of trim (when applicable).
5. Travel of visual position indicator to be verified against trim position.
6. Number of steps from fully open to fully closed on a stepping actuator to be established.
7. Choke insert interface and functional test against running tool such as:
 - Insert installation and retrieval
 - Insert seal test facilities
 - Hydraulic line pressure test
 - Insert and tool misalignment and tilting test.

10. Qualification testing

10.1 General

The chokes shall be qualified for actual Project water depth and operating conditions.

All non qualified designs and components shall be qualified in accordance with the requirements **GS SPS 001**, and the relevant industry standards through the following test:

1. **API 6A**, PR2 performance testing, using realistic temperature gradients through the valve.
2. Cycle and pressure testing, including cycling to simulate the specified design life of choke (typical one million cycles for a stepping type actuator)
3. All electronic systems shall be qualified.
4. The choke valve running tool shall be qualified for use with the choke valve and associated structural interfaces.
5. Misalignment test to establish the tolerance band of the insert and choke valve running tool.

The following requirements shall be applied:

1. All relevant operational torque's shall be documented.
2. The choke valve assembly with housing, bonnet, actuator, bonnet and stem seal shall be tested with external pressure corresponding to the specified water depth.

3. Retrieval and installation of the choke insert shall be performed in shallow water test. The insert guidance and realistic operational sequences shall be simulated by test equipment or the dedicated tool.
4. All seals shall be verified. Where more than one seal is installed, each seal shall be tested individually.
5. For material selection, special consideration shall be made to avoid galling. The qualification test shall demonstrate that acceptable materials have been selected.
6. Number of turns to operate mechanical ROV override from fully closed to fully open and vice versa shall be verified.
7. Number of pulses to move the choke from fully closed to fully open and vice versa shall be verified for a stepping actuator.

11. Inspection, test and transportation equipment

11.1 Inspection and cleaning tool

The Inspection and Cleaning tool shall be ROV deployed. The tool shall interface the choke body to inspect and clean the seal surfaces of bonnet and bean seal prior to reinstallation of the choke insert.

11.2 Test & Transportation equipment

A combined CVRT test and transportation frame shall be provided. The frame shall include the following test facilities and equipment:

1. Two sets of dummy choke housings to allow transportation and protection of a new insert, easy change out and transportation of the insert.
2. Facilities for:
 - Test of bonnet seal.
 - Test of bean seal.
 - Test of electrical connector interfaces
 - Test of hydraulic interfaces
 - Verification of mechanical interfaces
3. CVRT Lock down facilities
4. The test and transportation frame shall be designed for offshore lifting and transportation.



12. Choke Data

Field: _____

Water Depth: _____

Flow Data:

Max. Operating temp: _____ Liquid specific gravity: _____ Gas specific gravity: _____

	Minimum	Normal	Maximum
Liquid Flow Rate	_____	_____	_____
Gas Flow Rate or GOR	_____	_____	_____
Inlet Pressure	_____	_____	_____
Outlet Pressure	_____	_____	_____

Service: Standard Sour Sour/Low temp.

Abrasive type: _____

Inlet Connection Size: _____

Outlet Connection Size: _____

Special Dimensions for replacement chokes (if required): _____

API PSL level: _____

Material Class: _____

Temperature Class: _____



Water Injection Subsea Chokes Characteristics:

Design Criteria	Design values	Notes
Choke characteristic	Linear or equal percentage	
Operating principles	Remote and ROV operating modes Choke insert shall be retrievable with dedicated tool and ROV assistance.	
Position Indicator	Better than 1% error of stroke	SUPPLIER to indicate flow rate accuracy versus relevant water flow rates.
Reference rate of water to fully open choke @ pressure	To calculate Cv: _____ BPD @ upstream pressure: _____ bars maximum DP: _____ bars	DP should be minimum because FPSO does not provide extra pressure to control flow rates through fully open chokes
Relevant flow rates	_____ BPD	SUPPLIER shall indicate the flow rate by step
Upstream pressure range	_____ to _____ bars	
Total temperature range	_____ to _____ °C	SUPPLIER shall provide temperature limits
Back Flow	Allowed but not foreseen	



Oil Producers Subsea Chokes Characteristics:

Design Criteria	Design values	Notes
Choke characteristic	Linear or equal percentage	
Operating principles	Remote and ROV operating modes Choke insert shall be retrievable with dedicated tool and ROV assistance.	
Position Indicator	Better than 1% error of stroke	SUPPLIER to indicate flow rate accuracy versus relevant oil flow rates.
Reference rate of water to fully open choke @ pressure	To calculate Cv: _____ BPD @ upstream pressure: _____ bars maximum DP: _____ bars	
Relevant flow rates	_____ BPD	SUPPLIER shall indicate the flow rate by step
Upstream pressure range	_____ to _____ bars	
Total temperature range	_____ to _____ °C	SUPPLIER shall provide temperature limits
Back Flow	Allowed but not foreseen	



Gas Injection Subsea Chokes Characteristics:

Design Criteria	Design values	Notes
Choke characteristic	Linear or equal percentage	
Operating principles	Remote and ROV operating modes Choke insert shall be retrievable with dedicated tool and ROV assistance.	
Position Indicator	Better than 1% error of stroke	SUPPLIER to indicate flow rate accuracy versus relevant gas flow rates.
Reference rate of water to fully open choke @ pressure	To calculate Cv: _____ Sm ³ /d @ upstream pressure: _____ bars maximum DP: _____ bars	DP should be minimum because FPSO does not provide extra pressure to control flow rates through fully open chokes
Relevant flow rates	_____ Sm ³ /d	SUPPLIER shall indicate the flow rate by step
Upstream pressure range	_____ to _____ bars	
Total temperature range	_____ to _____ °C	SUPPLIER shall provide temperature limits
Back Flow	Required	