



Exploration & Production

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS SPS 025

Subsea hydraulic spring return quarter turn actuators
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1. Scope

This Technical Specification defines the minimum requirements for the design and manufacture of hydraulic spring return actuators for operating subsea ball valves, which will be used in Emergency ShutDown service (ESD) in high pressure subsea pipelines.

This specification relates specifically to the supply of the hydraulic actuator, its mounting/interface with the subsea ball valve, which it will operate, and its interface with the control system.

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.

Standards

Reference	Title
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure/High Temperature Service
BS 1133 Part 6	Temporary protection of metal surfaces against corrosion (during transport and storage)
BS 5500	Unfired Fusion Welded Pressure Vessels
BS 3382	Cadmium Plating and Threaded Fittings
BS 4882	Bolting for Flanges and Pressure Containing Purposes
BS 5750	Quality Systems
DIN 500-49	Certificates on material testing

Professional Documents

Reference	Title
NAS 1638	Cleanliness requirements of parts used in hydraulic systems

Regulations

Reference	Title
Not applicable	



Codes

Reference	Title
ASNT-TC-1A	Personnel Qualifications and Certification in Non Destructive Testing
ASME Section V	Boiler and Pressure Vessel Code - Non-Destructive Examination
ASME Section IX	Boiler and Pressure Vessel Code - Welding and Brazing Qualifications
ASME Section VIII Division 1	Boiler and Pressure Vessel Code - Pressure Vessels

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS PVV 142	Valves
GS SPS 005	Subsea Ball Valves

3. Definitions

The following is a list of definitions of the terms, which apply to this specification:

- **Purchaser**
Means Total or approved representative
- **VENDOR**
Means the person, firm or COMPANY who has been issued with the purchase order to supply the goods

4. Actuator operational requirements

4.1 Environmental

See attached Data Sheet (Appendix 1) for project specific environmental information.

4.2 Valve

See Valve Specification and data sheets (Reference Section 3) for details on ball valves to be operated.

4.3 Mounting and installation

Provision shall be made to the actuator and its mounting on the ball valve to enable easy installation and replacement subsea by divers.

The valve will be installed such that the spindle is within 5 degrees of vertical.

The control system interfaces shall be located such that they may be easily connected by a diver or ROV.

4.4 Hydraulic system pressure

VENDOR shall recommend a working pressure for the hydraulic fluid supply to the actuator up to a maximum of 220 barg.

Proof pressure shall be 150 % of working pressure.

4.5 Actuator torque requirements

The minimum actuator output torque shall be twice the maximum specified valve torque, at any point in the operation of the ball valve, when working at the recommended actuator hydraulic fluid working pressure when opening and for spring closing.

The maximum possible output torque from the actuator shall at no time exceed the maximum allowable ball valve torque.

4.6 Design life

The actuators shall be designed to operate for the design life of the Appendix 1) without maintenance.

4.7 Hydraulic fluid

The actuators shall be suitable for use with the hydraulic fluid requirements defined in the Data Sheets.

4.8 Valve closing time

It is intended that closing times of the valves will be within the range 15-30 seconds for valve sizes up to 24 inches, and about 40 seconds for valve sizes of 32 inches and above. Actuators shall be suitable to provide this speed of operation.

5. Actuator design and construction

5.1 Mechanism

VENDOR shall provide a detailed description of the actuators including a materials list.

A suitable mechanism shall be provided, as part of the actuator, to convert the linear movement of the hydraulic cylinder to a 90° rotation of the output adaptor.

The preferred mechanism will be a simple and robust design where friction and sliding surfaces should be minimised.

The mechanism shall be entirely contained within and protected by the actuator body. There shall be no moving parts outside the body (tactile indicators excepted See Section 5.2).

Adjustable end stops shall be fitted to the actuator to control each end of the stroke. They shall be capable of 3 degrees adjustment to either side of the nominal position of the output spindle.

The mechanism, which shall be operated by hydraulic cylinder(s) to open and spring(s) to close the ball valve, may be configured in any of the following ways:

- Single cylinder with spring return acting on the back of the piston
- Single cylinder with spring return acting on the mechanism
- Two cylinders opposed by two spring return assemblies acting on the pistons in a balanced configuration
- As above but acting on the mechanism.

5.2 Local position indicators

A local, mechanical, position indicator shall be fitted to the actuator to show the position of the ball within the valve.

The indicator may be one of two types:

- Visual
- Tactile.

A visual indicator shall consist of a pointer and a scale showing, at least, the fully open and closed positions. The pointer and scale markings shall have a high contrast with the background. Reflective or fluorescent finishes are preferred. The design shall resist impacts from small dropped objects and from divers and ROV's working nearby.

A tactile indicator shall consist of a pointer and a scale showing, at least, the fully open and closed positions. The pointer and scale markings shall be as large as possible and shall stand off from the actuator body so as to be distinguishable by a diver wearing gloves. They shall be painted in a contrasting colour to the actuator body. The indicator shall resist impact from small dropped objects and from divers and ROV's working nearby. The indicator shall be strong enough to clear marine fouling, which may build up around it.

5.3 Remote position indicators

Electrical, remote position indicator sensors shall be fitted to the actuator.

Each sensor shall give an unambiguous electrical signal for a unique position of the ball within the valve. Provision shall be made to differentiate open and short circuit faults from true on/off signals.

Six sensors in total shall be supplied for each actuator, three primary and three redundant. Each set of three sensors shall be wired to separate electrical connectors, and failure of either set of sensors shall not affect the operation of the remaining sensors. The sensors shall indicate the following positions to the accuracy shown:

- Fully open ± 0.25 degrees
- Fully closed ± 0.5 degrees
- 10 % closed (for testing) ± 1 degree.

The fully open and fully closed sensors shall be provided with position adjustment over the range of ± 3 degrees from their normal positions.

The 10 % closed sensor will not require position adjustment.

Sensors shall be solid state with no moving parts. They shall be suitable for use at ambient seabed pressure when immersed in seawater, fill fluid or hydraulic fluid.

A two wire, self powered circuit shall be supplied capable of transmitting up to a distance of 1 km from the installation.

5.4 Hydraulic cylinders

The piston seals shall be designed such that there is no leakage during normal operation at recommended working pressure.

The hydraulic cylinders shall include ports for the hydraulic fluid and for cross connections where necessary.

Hydraulic cross connections and manifolding shall be inside the actuator body where possible. External pipes or valves where unavoidable shall be designed to minimise the risk of damage by snagging or from small dropped objects.

Hydraulic connections and passages shall be of sufficient internal cross-section area to allow free flow of fluid without the possibility of constriction, to ensure continued fast and efficient actuator operation.

5.5 Body

The actuator body shall:

- Contain the mechanism
- Have provision for attaching the hydraulic cylinder(s) and springs
- Have provision for attachment to the valve.

The body shall be filled with a suitable liquid medium to protect and lubricate the mechanism. A mineral based gear oil is preferred.

The body shall have suitable seals on all joints and on the output shaft to prevent ingress of seawater.

The body shall be pressure compensated to allow the internal and external pressures to equalise. A method shall be provided which will allow this pressure compensation while segregating the fill fluid from the seawater. An elastomeric bladder is preferred which where possible should be contained within the actuator body.

A body relief valve shall be fitted to avoid damage caused by pipeline fluids leaking from the valve stem seal or by internal leakage of hydraulic fluid.

Provision shall be made on the body such that the actuator can be lifted and manipulated as necessary during transit and installation.

The actuator body shall be as small as possible with a smooth outline and have a minimal stand off from the valve.

5.6 Springs

Springs shall be sized to provide at least twice the maximum valve torque requirement at any point in the operation of the ball valve. In particular there shall be sufficient torque available at

the end of the piston/spring stroke (i.e. spring fully extended and valve closed) to fully close the valve, against its end stops.

VENDOR shall show, by calculation, that the selected spring will conform with the following:

- Will provide sufficient force to obtain the required torque at the actuator output after being compressed for the design life
- Will not fail from stress corrosion cracking while compressed and immersed in the fill fluid or the hydraulic fluid for the design life
- Will not fail from fatigue within the estimated cycle life. Cycle life may be estimated by allowing for 10 open-close-open cycles for each year of the design life.

VENDOR shall estimate the expected mean time to failure for the spring when compressed and immersed in:

- Seawater
- Pipeline fluid.

Springs may be either:

- Single or multiple coil springs
- Disc (Bellville) springs.

The springs shall be assembled within the body such that it is impossible to gain access to or release them, either deliberately or accidentally, while compressed or preloaded.

Replacement of springs by divers shall not be required.

5.7 Materials

Materials shall be selected for:

- Corrosion resistance in seawater
- Compatibility with fill and hydraulic fluids
- Wear resistance/hardness.

The body material shall resist external corrosion by seawater for the design life (see Section 9.1 Corrosion Protection).

Body and shaft seals shall be compatible with seawater and with the fill and hydraulic fluids.

Spring material selection shall take into consideration the possibilities of spring fatigue, creep and corrosion.

The mechanism shall be designed to operate in lubricating oil or hydraulic fluid but continue to function if the oil is displaced by seawater or pipeline fluid. In this case time to failure may be severely reduced.

Surface treatments may be specified to improve hardness and/or corrosion resistance. Chrome plating is not acceptable.

A low resistance, electrical connection shall be provided between the actuator and the valve to ensure electrochemical compatibility.

Studbolts and nuts shall conform to a suitable grade from [ASTM A 193/A 194](#) or [BS 4882](#). Bolts and nuts shall be cadmium plated to [BS 3382](#) and shall have a PTFE coating applied to the cadmium. The cadmium plating method shall prevent hydrogen embrittlement.

The material of the operated subsea pipeline ball valve and the type of cathodic protection used shall be taken into consideration when selecting actuator materials.

All pressure containing and torque transmitting parts of the actuator system shall have certification to [DIN 50049 3.1.B](#).

5.8 Manufacturing procedures

The manufacturing, quality control and inspection procedures shall be agreed between Purchaser and VENDOR before manufacture commences and shall include all proposed operations, depending on the method of manufacture, in the correct sequence.

The procedures shall include details of:

- Steelmaking process
- Forging/Casting procedures
- Heat treatment procedures
- Surface treatment procedures
- Methods of temperature control
- Methods of chemical analysis and mechanical testing
- Welding procedures and qualification.

Note: All welding procedure and qualification tests for pressure containing and torque transmitting parts shall be conducted in accordance with [ASME Section IX](#) and this Specification. All welding procedures and qualification test results shall be approved by the Purchaser prior to production welding. All welders and welding operators shall be qualified in accordance with the Purchaser approved welding procedure and [ASME Section IX](#) prior to production welding.

- Non-destructive examination procedures
- Defect removal
- Weld repair.

Note: Weld repairs to castings shall only be carried out to a detailed procedure approved by the Purchaser. Repairs shall be carried out before any heat treatment of castings. Weld repairs to forgings are not permitted.

- Machining process.

6. Inspection and NDT requirements

The responsibility for quality control and inspection rests with VENDOR.

Purchaser however, reserves the right to:

- Inspect work in progress to ensure that materials and workmanship are in accordance with this specification
- Determine which items shall constitute hold points for witness by Purchaser.

To attain the required high level of cleanliness of actuators, the inspection and good engineering workshop practice requirements shown below, shall be followed, but not necessarily be limited to:

- A visual inspection, by Purchaser, of the actuator and all internal components before assembly
- Hydraulic Actuator components shall be assembled in a clean environment
- Hydraulic Actuator components shall be meticulously cleaned and shall be free of all contaminants prior to assembly
- Assembly personnel shall have clean hands and shall be wearing clean outer clothing during assembly work
- Hydraulic Actuator system tubing where used shall be cut with purpose-designed pipe cutters (not hacksaws)
- Tubing shall be flushed prior to installation
- All components in the Hydraulic system shall be deburred
- Components removed from the clean room shall be installed immediately, or suitably protected, once brought to the shop floor
- All exposed components shall be suitably covered between disassembly, cleaning and assembly operations
- All exposed tubing and fittings shall be capped (plastic bags or plugs) between flushing and assembly operations.

7. Interfaces

7.1 Interface to valve

The ball valve MANUFACTURER will be responsible for the correct function of the actuator interface with the ball valve and will control all interface documentation.

The actuator shall be attached to the valve spindle and the valve bonnet in accordance with the interface drawings and information supplied.

Actuators shall be interchangeable.

The valve stem shall be designed such that the mating actuator can be located in only one orientation (e.g. the spline may have a unique locating key).

The method, bolts and mounting devices used to attach the actuator body to the ball valve shall be suitable for supporting the actuator and resisting maximum operating torque.

The integration testing of valve with actuator mounted shall be carried out in accordance with Section 8.3 in this Specification.



Provision shall be made to ensure that the actuator may be installed onto and removed from the ball valve after the valve has been installed subsea. The requirements shall include:

- Means to ensure that the valve and actuator stems are in line
- Means for diver, to handle and install actuator safely
- Means to support the spring cartridge where necessary
- Means to flush out the space between the valve and the actuator to displace seawater with a protective liquid.

7.2 Hydraulic interfaces to control system

The control system VENDOR will be responsible for the correct function of the hydraulic interface between the actuator and the control system and will control all interface documentation.

One hydraulic connection shall be provided on the actuator to open the ball valve; hydraulic fluid will be returned through the same connection on valve closure.

Provision shall be made to enable make and break of the interface connection while the hydraulic system is pressurised. A block and bleed valve assembly shall be used and will be supplied as part of the actuator system.

The connectors shall be self sealing when separated and shall be designed to minimise contamination of the hydraulic fluid during make up.

VENDOR shall supply both halves of the connector.

7.3 Electrical interface to control system

The control system VENDOR will be responsible for the correct function of the electrical interface between the actuator and control system and will control all interface documentation.

Electrical connection shall be provided for the electrical sensors in the actuator; a single, multi way connector is preferred for each set of sensors (i.e. two connectors will be required, one for the primary sensors and one for the redundant sensors).

The connector shall be capable of acceptable operation for the specified design life.

VENDOR shall supply both halves of the connector.

8. Testing

8.1 General

All actuators shall be tested prior to shipment from VENDORS works (Integration testing however shall be as Section 8.3). VENDOR shall provide a jig or test stand for each size of actuator.

The test procedures shall be as stated in Section 8.2. Final test procedures to be agreed between VENDOR and Purchaser.

All tests shall be witnessed at the discretion of Purchaser.

Actuators shall not be accepted until all tests stated are completed successfully and to the satisfaction of Purchaser.

8.2 Factory acceptance tests

Before use in an acceptance test, the hydraulic fluid supply shall be circulated in a closed loop system until **NAS 1638** class 6 or better is achieved. Connection to the actuator shall only be made when the fluid is confirmed clean to this standard.

All materials shall be tested (or evidence provided) to show compatibility with the fluids with which they will be in contact.

Tests shall be performed in the following sequence:

- a) A performance test shall be carried out to confirm the relationship between hydraulic operating pressure and output torque, and spring force and output torque.

The relationship shall also be determined between operating pressure and maximum output torque and the results shall be recorded throughout the stroke at a minimum 5° or 10° intervals.

The output torque supplied by the spring at each extremity of the actuator stroke shall be recorded.

- b) The actuator shall be subjected to:

- An overload input of 150 % of recommended working pressure while locked against each end stop in turn
- 150 % of recommended working pressure at the centre of its stroke.

There shall be no signs of damage when examined both internally and externally.

A test pressure of 150 % of the recommended hydraulic operating pressure shall be applied to the actuator pressure port. Pressure shall be maintained for a minimum of six hours. Test media shall be an approved hydraulic fluid (see Data Sheet).

- c) An actuator hydraulic leak test shall be performed by fully stroking the actuator through 200 open-close-open cycles against the rated output torque using recommended hydraulic operating pressure. Static torque tests shall be repeated at 100 and 200 cycles and torque/rotation characteristics recorded as in a) above. Internal hydraulic leakage at the end of the test shall be less than 0.1 ml per six hours at working pressure.

Note: 200 cycles should not exceed the expected cycle life of the spring as defined in Section 5.6. If the spring breaks during this test it shall be replaced and the test continued. A record shall be kept of number of cycles to spring failure where appropriate.

- d) The electrical connector shall be connected and disconnected 50 times, in water, under a hydrostatic pressure equivalent to 150 % of the design depth. At the end of the test, insulation resistance of the mated coupler shall be greater than 500 M ohms and each contact resistance less than 1 ohm (This test may be carried out at connector MANUFACTURER's works. Alternatively results of a previous similar test may be submitted for Purchaser approval in lieu).

The actuator shall be hyperbarically tested in potable water at a pressure equivalent to 150 % of the hydrostatic pressure at the design depth. The relationship between hydraulic operating pressure and output torque shall be measured while under test and shall be as specified. The actuator shall be fully stroked through 100 open-close-open cycles while under pressure. There shall be no evidence of water ingress.



The function of the position indicator switches shall be demonstrated. The electrical connector which will be supplied with the actuator shall be used. Insulation resistance between the electrical conductors and ground shall be greater than 500 M ohms.

- e) Dimensions of interfaces shall be checked for accuracy.
- f) A Helium leak test shall be performed on the actuator body (there shall be no leakage).

The relief valve shall be calibrated to 15 psig and tested prior to mounting on the actuator body.

8.3 Valve to actuator integration testing

The integration testing of each actuator with the relevant ball valve may be conducted at either the valve or actuator VENDOR's works.

In either of the above cases it shall be the ball valve VENDOR's responsibility to inform Purchaser of the details for approval.

The actuator shall be assembled to the ball valve and the appropriate hydraulic filling procedures carried out (see Section 10).

A demonstration to confirm that the actuator and the space between the actuator and the ball valve has been properly filled shall be carried out.

The ball valve shall be opened by the actuator with full differential pipeline pressure across the valve. The maximum actuator hydraulic operating pressure required shall not be more than the recommended hydraulic working pressure. The hydraulic pressure shall then be released as quickly as possible, and the time taken to close the valve recorded. Torque measurements shall be recorded throughout the stroke by derivation from pressure/torque characteristics.

A demonstration to confirm the correct functioning of the electrical position indicators shall be carried out.

Electrical resistance between the actuator and the valve shall be measured and shown to be less than 1 ohm.

The procedures required for a diver to install the actuator on the valve subsea shall be demonstrated.

8.3.1 Safety note

A large valve will have considerable impact energy when closing. To counteract this closing force, the valve assembly must be securely anchored.

9. Corrosion protection and packing

9.1 Corrosion protection

After all tests are complete the actuator shall be coated in accordance with the protective finish used on the ball valve. The position indicators must in no way be obscured during the coating operation.

Protection covers shall be fitted on the electrical and hydraulic connectors.

9.2 Packing

The actuator may be packed filled or empty at the discretion of the VENDOR. If empty, the actuator shall be protected by an internal corrosion resisting coating according to [BS 1133 part 6](#).

The actuator shall be protected by a purpose built wooden crate suitable for road carriage. The level of packing for the actuator will depend on the integration test location (See Section 8.3). VENDOR shall submit a packing procedure for Purchaser approval.

Provision shall be made to handle the crate by a fork lift truck.

10. Final assembly onto ball valve

The actuator VENDOR shall supervise the final assembly of the actuator to the valve including filling of the actuator and the space between the actuator and the valve (see also Section 8.3).

The actuator end stops shall be adjusted to stop the valve at the fully open and fully closed positions.

The electrical position indicators shall be adjusted and set at the valve fully open and fully closed positions.

The hydraulic system shall be finally cleaned and flushed until the fluid meets and retains the requirements of [NAS 1638](#) Class 6.

11. Documentation

The following documentation written in the English language shall be submitted to the Purchaser:

- Material Certificates signed to signify compliance with all the requirements of the Specification
- Mechanical and Corrosion Test Reports
- NDT Test Reports
- Fabrication Drawings
- Design Calculations
- Certified Weight
- Spares Lists
- Special Tool Requirements
- Operating, Maintenance and Repair Manual.



Appendix 1 Data sheets



Environment Data Sheet

Client:

Project:

Field/Location:

Water Depth (meters):

Temperature range (°C): Pipeline (minimum/maximum):

Seabed (minimum/maximum):

Design Life (years):

Hydraulic Operating Fluid: low viscosity mineral oil or water/glycol fluid



Subsea Hydraulic Spring Return Quarter Turn Actuator VENDOR Response Data Sheet

Client:

Project:

Valve to be actuated

Nominal Bore:

Operating Pressure:

ANSI class:

MANUFACTURER:

Model:

Maximum Operating Torque (Nm):

(Not including the two times safety factor)

Actuator

MANUFACTURER:

Model:

Type of Mechanism:

Number of Cylinders:

Number of Springs:

Type of Springs:

Actuator Materials

Body:

Cylinder:

Piston:

Piston Seal:

Mechanism:

Shafts:

Shaft seals:

Fill fluid:

Pressure compensation Type:

Location:

Type of local position indicator:

Type of remote position indicator:

Location of remote position indicator:

Remote position indicator adjustment range:



Relief valve fitted (Yes/No):

Output travel range:

End stop adjustment method:

End stop adjustment range:

Recommended maximum working pressure (barg):

Proof pressure (barg):

Minimum output torque at recommended maximum working pressure (Nm):

Output torque at the following positions:

	Output torque (Nm)	
	Closing at zero pressure-spring assisted	Opening at working pressure
Fully open		
Quarter closed		
Half closed		
Three quarter closed		
Fully closed		

Displacement volume for 90 degrees output (litres):

Hydraulic Interface

Interface drawing number:

Connector type:

Connector size:

Electrical Interface

Interface drawing number:

Number of connectors:

Connector type:

Number of ways:

Valve Interface

Interface drawing number:

Output adaptor inside diameter (mm):

Output drive type:

Method of Attachment to Valve:

Provision to fill space between valve and actuator:

Support for spring cartridges:



Dimensions

Length (along axis of valve bore) (mm):

Width (across axis of valve bore) (mm):

Height (from valve bonnet) (mm):

Weight (kg):