

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 120

Control and Choke Valves

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1. Scope

This specification describes the minimum requirements for the design, sizing, selection and installation of:

- Control valves
- Choke valves
- Self-acting pressure regulators

for use on TOTAL Exploration & Production offshore and onshore facilities.

Both manual and actuated choke valves for surface production facilities are covered by this specification. However, this specification is not applicable to subsea choke valves and choke valves which are part of a wellhead assembly.

This specification shall be applied in conjunction with:

- [GS EP PVV 112](#)
- [GS EP PVV 142](#)

The PVV general specifications as referenced throughout this specification provide the mandatory requirements related to metallurgy, casting, welding, machining and material examinations. This specification provides additional requirements to the referenced PVV specifications.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
API 609	Lug and Wafer Type Butterfly Valves
API 6A / ISO 10423	Specification for Wellhead and Christmas Tree Equipment
API 6D / ISO 14313	Specification for Pipeline Valves (Gate, Plug, Ball, Check Valves)
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.34	Valves - Flanged, Threaded and Welded End
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B31.3	Process Piping
ASTM A 352	Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A 703	Steel Castings, General Requirements for Pressure Containing Parts

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Reference	Title
Class Society Rules	Particular design rules as per selected Class Society may be applicable for equipment installed on the hull of floating facilities and may require Class Society type approval
EN 10204	Metallic Products - Type of Inspection Documents
European Directive 94/9/EC dated 23 March 1994	Directive of the European Parliament and of the Council on the approximation of the Laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)
European Directive 97/23/EC dated 29 May 1997	Directive of the European Parliament and of the Council on the approximation of the Laws of the Member States concerning pressure equipment (PED)
FCI 70-2	Control Valve Seat Leakage
IEC 60034-1	Rotating electrical machines - Part 1: Rating and performance
IEC 60534-2-1	Industrial-Process Control Valves - Part 2.1: Flow Capacity - Sizing equations for fluid flow under installed conditions
IEC 60534-2-3	Industrial-Process Control Valves - Part 2.3: Flow Capacity - Test Procedures
IEC 60534-3-1	Industrial-Process Control Valves - Part 3-1: Dimensions - Face-To-Face Dimensions for Flanged, Two-Way, Globe-Type, Straight Pattern and Centre-To-Face Dimensions for Flanged, Two-Way, Globe-Type, Angle Pattern Control Valves
IEC 60534-3-2	Industrial-Process Control Valves - Part 3-2: Dimensions - Face-to-Face Dimensions for Rotary Control Valves Except Butterfly Valves
IEC 60534 (Parts 4; 5)	Industrial-Process Control Valves - Parts 4; 5
IEC 60534-8-3	Industrial-Process Control Valves - Part 8: Noise Considerations - Section 3: Aerodynamic Noise Prediction
IEC 60534-8-4	Industrial-Process Control Valves - Part 8: Noise Considerations - Section 4: Hydrodynamic Noise Prediction
IECEX	IEC System for Certification to Standards relating to Equipment for use in Explosive Atmospheres (IECEX System)
ISA Guide (ISBN 1-55617-565-5)	Control Valves, Practical Guide for Measurement and Control
ISA 75.01.01	Flow Equations for Sizing Control Valves
ISA 75.05 - All parts	Control Valve Terminology
ISA 75.19.01	Hydrostatic Testing of Control Valves
ISA RP75.23	Considerations for Evaluating Control Valve Cavitation

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Reference	Title
ISO 15156-3	Materials for use in H ₂ S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO 28079	Hard metals - Palmqvist toughness test
ISO 15848-1	Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves emissions
MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
MSS SP-61	Pressure Testing of Steel Valves
USP-NF	United States Pharmacopeia - National Formulary (approved materials for sanitary service equipment)

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 351	External protection of structures and equipment by painting. Floating structures
GS EP COR 354	External protection of onshore structures and equipment by painting
GS EP ECP 103	Process sizing criteria
GS EP EXP 203	Maintenance and inspection documentation preparation during project phase
GS EP EXP 217	Requirements to Vendors, Suppliers and EPC's for spare parts
GS EP INS 101	Instrumentation engineering, supply and construction general requirements
GS EP INS 107	Design and installation of instrumentation links
GS EP INS 137	On/off valve control panels and actuators functional and construction requirements
GS EP INS 900	Instrument hook-up diagrams
GS EP MEC 253	Anti Surge System for Centrifugal and Axial Compressors
GS EP PVV 112	Piping material classes

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Reference	Title
GS EP PVV 142	Valves
GS EP PVV 150	Valves in cryogenic service
GS EP PVV 611	Welding of pressure containing piping and equipment
GS EP PVV 612	Metallurgical and equipment subject to severe sour service. Metallurgical and welding equipment
GS EP PVV 613	Valves materials requirements for use in sour service
GS EP PVV 622	Piping and equipment subject to intermediate sour service. Metallurgical and welding equipment

3. Definitions

Company: TOTAL E&P or any TOTAL E&P subsidiary.

Contractor: Any party TOTAL E&P has signed a contract with for the Engineering, Procurement, Construction and Installation as part of a project or maintenance contract.

Manufacturer: The party having received a Purchase Order from Company, Contractor or Package Vendor for the manufacturing and supply of control or choke valves.

Package or package unit: Prefabricated process or utility self-contained unit, generally able to operate on its own, supplied fully tested and ready for immediate installation, being supplied by a designated Package Vendor.

4. General requirements

Control and choke valves design shall be based on the requirements of the process application, operating conditions, piping specification (material, class) and environmental conditions.

Control and choke valves are to be used for throttling or modulating service only. Discrete on-off (open/close) service, either control or safety, shall be performed by dedicated on-off ball valves in compliance with [GS EP INS 137](#) and [GS EP PVV 142](#).

Control and choke valves may be equipped with a solenoid valve to force the valve to fully open, closed or locked position during certain process conditions.

As mentioned in [GS EP INS 101](#), the final selection of the Valve Manufacturer upon tender and bid evaluation shall be subject to standardisation for each application type. Therefore, the Contractor shall ensure throughout the facility and subcontracted packages that the number of valve brands and models is reduced to the lowest minimum possible, i.e. preferably to one manufacturer for each application only. The Contractor shall equally coordinate his selection of valve brand and model with all Package Vendors accordingly, in order to avoid a large diversity of valves, accessories, spare parts, etc.

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5. Valve data sheets

An approved dedicated engineering data sheet shall be the basis for procuring the valves. Standard sizing and product data sheets provided by the Valve Manufacturer shall not be used as a substitute for the engineering data sheets.

Engineering data sheets are a collection of specific data provided by multiple disciplines (process, instrumentation, piping, valves, mechanical, etc.).

Engineering data sheets shall be segregated documents for the following applications:

- Regular Service Control Valves (includes steam service)
- Severe Service Control Valves
- Acid / Toxic / Lethal Service Control Valves
- Cryogenic Service Control Valves
- Anti-Surge Valves / Recycle Valves
- Special Design Control Valves
- Choke Valves (manual and actuated may be combined)
- Direct-Operated Self-Acting Pressure Regulators
- Pilot-Operated Self-Acting Pressure Regulators
- Other applications as may be the case.

The engineering data sheets for anti-surge valves are considered a joint responsibility of Contractor and Package Vendor, in case these valves are free-issued by the Package Vendor to Contractor for integration in the process piping outside the package battery limits. The Package Vendor shall anticipate possible additional control accessories required for control or monitoring by the Process Control System (PCS) in addition of the Package Unit Control Panel (UCP).

Contractor and Package Vendors shall issue an as-built revision of all engineering data sheets upon installation & commissioning of control valves, with all Vendor specific details completed, in the proper electronic format as per Contract.

6. Calculation and sizing criteria

6.1 General

The Valve Manufacturer shall provide adequate valve sizing calculations for the precise calculation of the flow coefficient Cv, the predicted noise level and the occurrence of flashing and harmful cavitation. In some cases, it may be required that the Valve Manufacturer shall issue sizing data sheets which reflect multiple flow or process conditions, which is typically the case for production choke valves and anti-surge / recycle valves.

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The Valve Manufacturer's designated sizing program shall execute these calculations in compliance with either one of the following referenced methods:

- [IEC 60534-2-1](#) Sizing equations for fluid flow under installed conditions
- [ISA 75.01.01](#) Flow equations for sizing control valves

The selected Cv shall be **at least** 1.1 times the calculated Cv at the worst case conditions (maximum flow and lowest available pressure drop).

Important notes:

- The above-mentioned IEC and ISA sizing methods are only covering single-phase fluids. Sizing methods/formulas for multi-phase fluids are developed by Valve Manufacturers themselves and might result in different sizing results between Valve Manufacturers.
- Valve Manufacturers are only permitted to use sizing software which has been validated in reality on test benches for the valve sizes, trim type and trim sizes (Cv) within the min/max validated range; interpolation of software validation tests outside the validation test limits is only permitted by using advanced computer fluid dynamic (CFD) models, subject to Company review and approval. The Valve Manufacturer shall be able to provide proof of sizing software validation tests.

Different Cv selection criteria may be applied for special cases such as venting and surge control (noise, erosion, etc.), being subject to Company approval.

As per [GS EP ECP 103](#) the pressure drop across a control valve shall be minimum 20% of the system dynamic pressure loss at normal flow rate, or 0.7 bar (10 psi), whichever is greater (this rule does not apply to choke valves).

The valve outlet velocity must remain below the maximum velocity criteria provided in [GS EP ECP 103](#).

In case of multi-phase mixtures, Contractor or Package Vendor shall determine and supply all fluid data as required by the sizing program of the Valve Manufacturer, including solid particles.

The effect of reduced inlet and outlet sizes of adjacent piping (i.e. the Piping Geometry Factor) and the valve pressure recovery shall be taken into account for sizing. For this reason, the piping diameter is mentioned on the engineering data sheets, and the Valve Manufacturer may assume that short-length concentric reducers/expanders will be installed to match the selected control valve, unless stated differently on the engineering data sheet. However, reducers and expanders for choke valves are not permitted; choke valves shall be designed with the same end connection dimensions of the adjacent piping, as per section 8.5.

In case of applications which may imply excessive vibration, cavitation and/or high kinetic energy, the Contractor or Package Vendor shall take into account the entire piping arrangement in joint cooperation with the Valve Manufacturer to ensure the entire piping arrangement is adequately sized, supported and protected against erosion, pipe stress and valve-induced vibrations and noise, meeting the maximum vibration criteria in section 11 of [GS EP ECP 103](#).

The Valve Manufacturer shall specify the reference standards and the calculation basis for all specified operating conditions and guarantee that the selected valves will be free from harmful cavitation and erosion throughout the range of operating conditions.

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Control and injection choke valves shall be sized to have an operating stroke between:

- Minimum 10% opening at minimum flow conditions
- 50% to 75% opening at normal flow conditions
- 85% to 90% opening at maximum flow conditions.

Production choke valves shall be sized with flow range from 10 to 100% opening, and take start-up conditions into account unless a dedicated smaller start-up choke is provided.

The sizing of butterfly-type control valves with a maximum flow around 85% is based on using a flow efficient disc. Conventional discs have a more narrow control range of a maximum flow at around 50 degrees (55%) opening and should therefore be avoided.

The process design should allow the normal flow condition between 50% and 75% of the maximum flow condition, in order to avoid a too limited control valve opening during normal flow conditions.

The definition of the minimum flow conditions is highly important for the Valve Manufacturer for sizing and adequate trim design; notably the pressure drop can be much higher at minimum flow conditions, therefore implying the worst case scenario for cavitating applications.

For these reasons, the minimum / normal / maximum flow conditions must all be well-defined on the engineering sheets. When upstream and/or downstream static pressures are a function of the flow rate, then this shall be clearly indicated on the data sheets.

In case of additional irregular flow (slugs, pumping, etc.), a second parallel control valve may be considered to ensure that the normal continuous flow is adequately controlled by the first valve only, while the additional flow is adequately controlled by both valves, using split-range control.

The dynamic process model shall take into account the nominal control valve stroking times as defined in section 10.6, i.e. 5 times the valve diameter. When faster stroking times are required, then this should be clearly mentioned on the P&ID and engineering data sheets.

The maximum droop (offset) at maximum flow of self-acting pressure regulators shall be:

- For pilot-operated regulators: less than 5% of the set pressure
- For direct-operated regulators: less than 10% of the set pressure.

6.2 Cavitation and flashing

This section does not apply to production choke valves; it does apply to injection choke valves.

The Contractor or Package Vendor shall provide an adequate solution in case harmful cavitation or flashing problems are indicated during valve sizing and selection by the Valve Manufacturer. Potential cavitation and flashing problems shall firstly be treated by adapting the piping arrangement, secondly by adapting the valve trim design and trim materials.

Therefore, Contractor or Package Vendor shall take into consideration the early sizing information provided by Valve Manufacturer(s) during piping and facility design.

For cavitation terminology and cavitation recommended practices, refer to [ISA RP75.23](#).

In any case, control valves shall not be exposed to Constant Cavitation, σ_c , at maximum operating conditions. Whenever possible, the Valve Manufacturer shall size the valve such that

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it shall not be exposed to Incipient Cavitation, σ_i , at normal operating conditions. When valves are exposed to Incipient Cavitation at normal operating conditions, then flow-exposed trim components shall be made of cavitation resistant materials as per section 7.6.

When the cavitation index $K > 0.7$, or when any pressure drop > 50 bar, or > 30 bar for flashing liquids, then the valve shall be designed as a severe service control valve as per section 6.5.

6.3 Erosion criteria for multi-phase applications

Any valve handling multi-phase flow (e.g. production choke valves) shall be designed on the basis of erosional velocity as defined in section 11 of [GS EP ECP 103](#). The valve outlet fluid velocity shall not surpass the maximum allowable erosional velocity. In case the fluid velocity inside the valve surpasses the maximum allowable erosional velocity, then internal wall protection measures (e.g. weld overlay, protective sleeves) shall be taken.

6.4 Noise control

The maximum allowable noise exposure and sound pressure levels on facilities operated by Company are defined by legislation (European Directives and local regulations) as well as by Company's HSE Directives and GS specifications.

In the absence of a more stringent requirement, the valve-originated noise shall not exceed at any given flow rate:

- 85 dB(A) for continuous service
- 90 dB(A) for intermittent service.

Measured at 1 m downstream of the valve and 1 m away from the outer surface of the pipe, obtained without the use of secondary noise reduction measures.

The engineering data sheets shall clearly mention if the maximum allowable noise levels are at continuous or intermittent service.

The Valve Manufacturer shall perform a noise prediction calculation for each individual control valve, based on [IEC 60534-8-3](#) for gas/vapor service and [IEC 60534-8-4](#) for liquid service. The accuracy of the predicted noise level shall be specified by the Valve Manufacturer and shall not be more than $-5/+5$ dB(A) as per [IEC 60534-8-3/4](#).

For multi-phase and multi-liquid applications, the Valve Manufacturer may apply his own noise prediction calculation method, which shall have been validated in reality on test benches or from measurements taken from identical valves in operation with known fluid composition and process conditions. The Valve Manufacturer shall be able to provide proof of validation for noise prediction from multi-phase/multi-liquid flow.

6.5 Severe service

Control valves identified as severe service control valves shall be separated from regular service control valves (data sheets and procurement) as both type of control valves have dedicated approved Valve Manufacturers as per Company's approved vendor list.

The following criteria apply to single-phase flow applications only. For two-phase flow applications refer to section 6.3.

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Severe service is defined if one or more of the following conditions apply:

- Liquid fluids: cavitation factor K: $(P_1 - P_2) / (P_1 - P_v) > 0.7$ for any given flow rate
- Compressible fluids: critical pressure drop ratio: $(P_1 - P_2) / P_1 > 0.5$ for any given flow rate
- Liquid & compressible fluids: pressure drop > 50 bar for any given flow rate
- Flashing liquid service: pressure drop > 30 bar for any given flow rate.

Where:

P_1 Upstream absolute pressure, measured at 2xD upstream of the valve

P_2 Downstream absolute pressure, measured at 6xD downstream of the valve

P_v Absolute liquid vapor pressure at inlet temperature

As per [ISA Guide](#) "Control Valves, Practical Guides for Measurement and Control", the Valve Manufacturer for severe service control valves shall provide the following calculations.

6.5.1 Liquid service applications

Option 1:

The design shall provide a sufficient number of discrete pressure drop stages, to maintain the liquid velocity exiting the trim below 30 m/sec (100 ft/sec) for single-phase liquids, and 23 m/sec (75 ft/sec) for cavitating, flashing, and/or erosive services. Valve Manufacturer shall specify number of discrete pressure drop stages required and provide body and trim exit velocity calculations.

Option 2:

This option, called 'the Sigma method' based on [ISA RP75.23](#), may only be applied when the Valve Manufacturer can prove that he has performed adequate laboratory testing, i.e. not on empirical data and not by means of interpolation. In this case, the following calculations shall be provided by the Valve Manufacturer in order to obtain:

$$\sigma_{service} \geq \sigma_{valve}$$

The Valve Manufacturer shall provide all relevant parameters used in the calculations, such as σ_{mr} , coefficients a & b , $d_{reference}$, $(P_1 - P_v)_{reference}$ etc.

6.5.2 Gas service applications

The design shall provide a sufficient number of discrete pressure drop stages to maintain the fluid velocity head (V_h), or kinetic energy (KE) exiting the trim, below 480 kPa (70 psi) for continuous and 1030 kPa (150 psi) for intermittent service. Valve trim exit fluid velocity head shall be calculated based on the [ISA Guide](#) as follows:

$$V_h = \text{Kinetic Energy (KE)} = \frac{\rho_0 V_0^2}{2g_c}$$

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Where:

- ρ_0 Valve trim exit fluid density
- V_0 Valve trim exit fluid velocity
- g_c Gravitational constant in unit of measurement

The Valve Manufacturer shall specify the required number of discreet pressure drop stages and also provide body and trim exit fluid velocity head calculations.

6.6 Valve characteristics

This section does not apply to choke valves.

When possible, the definition of the valve's trim characteristic (inherent-characteristic) should be based on a dynamic process simulation, in order to ensure a stable dynamic behavior and accuracy over the full control range. In the absence of a dynamic process simulation, which is required before control valve procurement, the following selection criteria shall be applied.

When the allowable or available pressure losses for the valve and the circuit are known, then the control valve ratio 'R', also referred to as "control valve authority", shall be used as the selection criteria for the control valve characteristic as per Table 1 here-after.

The value of R should remain between 0.2 and 0.5 (preferably close to 0.4 and definitely never below 0.2) in order to ensure that each increment of valve movement will have a proportional effect on the flow rate, without causing unnecessary pressure losses resulting into unnecessary pumping power or separator pressure/level fluctuations (high R value), or poor controllability due to low differential pressure across the valve (low R value).

Considering the equal % characteristic of a piped system, the installation of an equal % inherent-characteristic control valve will result into a near linear installed-characteristic when R remains between 0.2 and 0.5. Above 0.5, the pressure drop over the control valve becomes dominant and a linear inherent-characteristic control valve is normally required to obtain a near linear installed-characteristic for the overall piped system.

$$R = \text{control valve authority} = \frac{\Delta P_v}{\Delta P_v + \Delta P_c}$$

Where:

- ΔP_v Pressure drop across a fully open control valve
- ΔP_c Pressure drop across the remainder of the circuit
- $\Delta P_v + \Delta P_c$ Pressure across the whole circuit between 2 constant pressure systems, including any pump between the 2 systems

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Table 1 - Valve characteristic selection

		$0.20 < R < 0.5$	$R > 0.5$
Flow Control	Flow measurement proportional to flow linear	Equal %	Linear
	Flow measurement proportional to flow squared	Equal %	Linear
Level Control	Without bypass/return line	Equal %	Linear
	With bypass/return line	Linear	Linear
Pressure Control	Liquid	Equal %	Equal %
	Gas, vapor, steam	Equal %	Linear
	Compressor recycling, surge control	Equal %, Linear, Modified Linear	
Temperature Control	Mixing of 2 liquids having different properties	Equal %	Linear
	Gas, vapor, steam	Equal %	Linear
	Heat exchanger bypass	Linear	Linear
	Other	Equal %	Linear

Notes:

- Linear/squared flow measurement by process control system, not by flow sensor
- Bypass/return lines are considered to be two 2-way valves
- When 3-way valves are approved by Company, they shall always be linear type
- Anti-surge/recycle valve characteristic shall be defined by Package Vendor.

Quick opening type trims shall be avoided and are subject to Company approval.

When the allowable or available pressure losses for the valve and the circuit are not known, then the valve characteristic shall by default be equal % for single valves, and be linear for bypass and 3-way valve applications.

7. Control valve types & selection

Control valves shall meet the following design and selection criteria. For terminology, refer to [ISA 75.05](#).

7.1 Control valve selection order

The following selection order for the type of valve type shall be applied:

- Class 125 thru 600: top-entry or side-entry type control valves
- Class 900 and above with HUB connections: top-entry or side-entry type control valves
- Class 900 and above with RTJ connections: top-entry type control valves only.

Top-entry valves are preferred over side-entry valves for services where potential replacement or modification of internals is required, because they allow in-situ replacement of internals without disassembling the adjacent piping.

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For erosive and severe service, control valves shall always be top-entry type.

7.2 Linear motion control valves

7.2.1 General

Linear motion control valves shall either be globe valve type or axial flow piston type.

Linear motion control valves shall be globe type valves; other types such as plug, gate, piston, diaphragm, pinch or clamp type are not allowed. Globe valves design shall be:

- One-piece cast body with bolted bonnet (split body design is not allowed)
- Single-ported (see 7.2.2 on double-ported design)
- Balanced-plug cage-guided
- Removable cage design to enable in-situ maintenance of cage, plug and seat ring
- Multi-stage trim for severe service and excessive noise applications.

Globe valves shall be multi-hole cage-guided design by default; ported-cage or contoured plug designs may only be applied when it is a heavy top-guided design and only for:

- Valves ≤ 2 inch in case of excessive cavitation or noise, alloy steel or non-ferrous bodies
- Slurry service
- Continue presence of suspended solids
- Cryogenic service
- Sanitary service.

Globe valves shall have straightway type body; however angle type body may be used in special cases when deemed practical for operations or plant design. Angle type valves may provide some advantages for difficult service conditions (suspended solids, erosion, reduced size, etc) comparable with choke valves.

Axial flow valves shall be cage-guided piston type; other types without cage or non-metallic sleeve type are not allowed.

Axial flow valves design shall be:

- One-piece cast body (split body design is not allowed)
- Integral seals or bolted bonnet with packing assembly
- Cage-guided balanced piston
- Linear or rotary actuation.

7.2.2 Double-ported globe valves

The use of double-ported globe valves is subject to Company approval. The inherent higher leakage rate of double-ported valves shall be evaluated and may limit the application.

Double-ported globe valves shall be top & bottom guided.

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7.2.3 Three-way globe valves

The use of three-way globe valves is subject to Company approval. Three-way valves shall be avoided; a double two-way valve configuration is strongly preferred. In any case, the use of three-way valves for temperature control applications is not permitted for safety reasons.

In case three-way valves are approved by Company, then the flow paths shall be clearly marked on flange edges (by permanently fixed SS labels) and on P&ID's:

- 'C' to indicate the common flow path
- 'IN-1' and 'IN-2' to indicate the inlets of converging (mixing) three-way valves
- 'OUT-1' and 'OUT-2' to indicate the outlets of diverging three-way valves.

7.3 Rotary motion control valves

7.3.1 General

Rotary motion control valves shall be segmented ball, eccentric disc/plug or butterfly type. Other types, such as plug type valves, are not allowed.

Rotary motion control valves design shall be:

- One-piece cast body with integral or bolted bonnet (split body design is not allowed)
- Trunnion-mounted closure member (floating closure member is not allowed)
- Allow throttling control up to 90 degrees rotation.

The type of rotary motion control valves shall be selected in accordance with the following sections, adequately selected to the designated application as per the recommendations of the Valve Manufacturer.

Rotary motion valves shall be designed such that no part of the valve (e.g. seat retaining ring, bolting, etc) can enter the adjacent piping, regardless the flow direction. In other words, the seat retaining ring must have a diameter larger than the internal diameter of the adjacent piping, while bolting in the process fluid stream is not permitted at all. The use of bolting, locking devices, or lock welding, is not permitted, and not considered a solution to overcome this design rule.

7.3.2 Segmented ball valves

The closure member of segmented ball valves shall be 'V' edge shaped and may be either eccentric or concentric. Special shaped closure members may be used on a case-by-case basis, such as for excessive noise or erosion.

Segmented ball valves are preferred over eccentric disc/plug valves in case of:

- Slurry service
- Erosion
- High viscosity
- High rangeability.

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7.3.3 Eccentric disc and plug valves

Eccentric disc valves shall only be used in case the available pressure drop is lower than 0.2 bar (for example, flow control valves in oil metering skids). Eccentric plug valves may be used when the available pressure drop is above 0.2 bar.

7.3.4 Butterfly valves

Butterfly control valves are not permitted for hydrocarbon and hydraulic service applications, and their application is limited to ASME Class 125 and 150 as per [GS EP PVV 112](#). This rule may be altered for onshore LNG facilities, refer to section 7.5.1.

Butterfly control valves are preferred for seawater, steam and chemical services due to the easy application of a protective lining, small sizes and reduced weight for large-bore piping.

Butterfly control valves shall be designed according [API 609](#). The use of other design standards (e.g. DIN) shall not be allowed without proper compatibility verification, because any control valve shall be suitable for installation in a [ASME B31.3](#) piping system with [ASME B16.5](#) flanges.

Butterfly control valves may be used for:

- Seawater (firewater, cooling water, etc.) and chemical service: all diameters
- Other services: only allowed for large sizes (10 inch and above) when globe and segmented ball valves have proved unsuitable due to low available pressure drop or when excessive noise occurs.

Non-lined butterfly valves shall be eccentric design with metal seats, and have a flow efficient closure member to obtain a control range up to 85% of the operating stroke.

7.4 Special design control valves

Special design valves are sometimes required for particular process control applications. The design of these valves may be (very) different from the above-mentioned standardised linear and rotary motion control valves; for example, Joule-Thompson valves.

Special design valves may also cover non-standard valves such as lined globe valves for chemical service, or non-production related valves such as sanitary service valves, and which are often procured from a separate Valve Manufacturer.

Although the same general design requirements apply (Company's PVV specifications and this specification), special design valves may have different design features, and shall always be subject to an individual assessment and approval by Company's corporate specialists.

7.5 Specific applications

7.5.1 Cryogenic service

Cryogenic service concern all control valves operating in the temperature range from minus 46°C to minus 196°C.

Although the scope of [GS EP PVV 150](#) states that it does not cover control valves, the bonnets / glands / stem / packing design of control valves for cryogenic service shall fully comply with [GS EP PVV 150](#), including the requirements for inspection and testing.

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Globe, segmented ball and eccentric disc/plug valves can be used for cryogenic service:

- Globe valves can be either multi-hole cage-guided or contoured plug design
- Butterfly valves are permitted from NPS 16 inch and above, limited to NPS 30 inch for ASME Class 150, and limited to NPS 24 inch for ASME Class 300 and 600
- From ASME Class 900 and above, butterfly valves and eccentric disc/plug valves are not permitted: globe type valves shall be used.

Control valves used for cryogenic service shall be:

- One-piece cast body with bolted extended bonnet (split body design is not allowed)
- Integral flanged body (wafer type valves are not permitted).

7.5.2 Severe service

Severe service control valves are those valves submitted to operating conditions as defined in section 6.5. The design of severe service control valves shall comply with the design requirements for globe valves, but shall be equipped with a multi-stage labyrinth type trim designed to obtain the design criteria as defined in section 6.5.

Only Valve Manufacturers who can calculate and design a valve as per section 6.5 may supply valves for severe service applications, and being Company approved for severe service.

7.5.3 Anti-surge valves and recycle valves

Refer also to **GS EP MEC 253** for surge control systems and requirements for surge control valves. In case anti-surge valves and recycle valves are classified as a severe service valve, then their trim outlet kinetic energy (*KE*) shall be limited to 480 kPa in any given case, regardless if they are in continuous or intermittent operation.

Anti-surge valves and compressor recycle valves shall be cage-guided globe valves, and shall comply with the design requirements in this specification. When classified as a severe service valve, as per section 6.5, then they shall be equipped with a multi-stage labyrinth type trim. Anti-surge valves/compressor recycle valves with RTJ flanges (ASME Class 900 and above) are preferably angle-type valves.

The design of control valves used in surge control services shall meet the following minimum requirements:

- Tight shut-off (refer to section 9.9)
- Fast stroke speed, as per Package Vendor's requirements/specifications
- Low noise trim
- Vibration elimination.

Anti-surge valves may be equipped with special programmable-curve digital positioners to obtain a control performance or control characteristic superior to standard digital positioners.

7.5.4 Sanitary service control valves

Any control valve or self-acting regulator used for sanitary service (e.g. potable water) shall be specially designed for this and be **USP-NF** Class IV certified.

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Although single-ported globe valves are the preferred type of control valves for this service, other types such as membrane closure member or butterfly valve may be considered.

Sanitary control valves are most often angle type valves with special clamp type end connections, having special flange seals (o-rings). In that case, the clamps, seals and mating hub connectors to be welded on adjacent piping shall be supplied by the Valve Manufacturer.

7.5.5 Lethal and toxic service

As a general rule, control valves for lethal and toxic service are not permitted to be installed in poorly ventilated, confined and indoor areas. In case no other option is available then to install them in these areas, then a dedicated risk assessment shall be conducted to define whether bellow seals are required in that case, and exactly which [ISO 15848-1](#) emission criteria apply.

By default, irrespectively where these valves are installed, the following rules apply:

- Lethal service: bellow type valves exclusively, with pressure gauge and isolation manifold on the bonnet to monitor bellows failure, with [ISO 15848-1](#) low-emission certificate
- Toxic service: "low fugitive emission" rotary motion type valves for 150, 300, 600# rated valves, with [ISO 15848-1](#) low-emission certificate
- Toxic service: "low fugitive emission" linear motion type valves for valves rated 900# and above, with [ISO 15848-1](#) low-emission certificate, but when certificate is not available then bellow valves are to be used.

In case there are no valves available meeting the low fugitive emissions requirements for toxic service valves, then bellow type valves shall be used.

Ultra-sonic leak detection instruments are recommended for improved monitoring, but are not permitted as a replacement for below seals (safety by inherent design, not by monitoring).

Refer to section 9.6 for bellows design requirements and to section 9.8 for fugitive emissions.

7.6 Trim design requirements

Internal valve components shall not be locked using screws, welding or adhesives. Stem design shall be anti blow-out by design. Valve trims shall be of the quick-change type.

The flow direction in the valve, flow-to-close or flow-to-open, is a function of various parameters like valve type, model, size, noise, cavitation, erosion, leakage class, stem forces, controllability, etc. As such, the flow direction should be advised by the Valve Manufacturer.

The flow direction shall be clearly marked on the valve body by means of an arrow cast into the valve body or stainless steel plate securely fixed to the valve body after final painting.

Trim material shall be selected to withstand corrosion, erosion, cavitation, flashing and wear under worst operating conditions, and shall also take into account start-up conditions or other irregular operating conditions.

Trim material selection shall be based on application and operational experience (of Valve Manufacturer and Company) and total life cycle cost, and not be based on initial installation costs or manufacturing delays. AISI 316 stainless steel shall be used as a minimum, or equivalent/better as per Valve Manufacturer recommendations. Monel-400 ®, Hastelloy-C ® or Duplex ® stainless steel shall be used for seawater services.

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Above 20 bar pressure drop at normal flow conditions, all components with a flow throttling surface shall have a hard surface coating (e.g. Colmonoy ®, Stellite ®), or hard 2 to 3 mm weld overlay, or solid hardened components (e.g. 17-4 PH, Inconel ®, Nitronic ®).

Above 50 bar pressure drop at normal flow conditions, all components with a flow throttling surface shall be made of solid hardened material or hard 2 to 3 mm weld overlay (e.g. Stellite ®, tungsten carbide).

Note: Weld overlays are not allowed for precipitation hardening materials (e.g. 17-4 PH) or nickel-base alloys (e.g. X718, X750). Stellite 6 ® coating on particular martensitic steels such as AISI 410 can be allowed upon Company approval, based on proven experience and metallurgic examination by the Valve Manufacturer.

Note: Hard surface coating shall not be used when water treatment chemicals are present, as they may penetrate the coating causing the coating the peel off in the long term.

Attention shall be paid to wear and galling resistance between trim components, which may require (slightly) different materials. Valve Manufacturer should advice this.

7.7 Self-acting pressure regulators

Self-acting pressure regulating valves are not permitted as a substitution of, or complement to, overpressure protection by pressure safety relief valves or actuated on-off valves. The piping systems on both sides of the pressure regulating valve shall be adequately designed and protected to handle a failing pressure regulating valve in accordance with the applicable pressure design code.

Self-acting pressure regulators are considered any valve using the process medium as control medium, controlling autonomously the required upstream or downstream pressure. However, a clear distinction shall be made between "self-acting pressure regulators" and "self-acting control valves", as they are of different design and application while performing the same function. Therefore, any self-acting valve used in liquid or gaseous service and either:

- Having a pressure rating of ASME Class 900 or above
- Having a flange diameter of ASME NPS 14 inch or larger
- Having a pressure drop > 30 bar

shall be designated as a self-acting control valve, which shall comply with the design requirements for cage-guided regular or severe service linear motion control valves as per section 7.2. Other self-acting valves shall comply with the requirements for self-acting regulators here-after.

Self-acting pressure regulators shall be either direct-operated or pilot-operated type. However, direct-operated pressure regulators are permitted only for non-hazardous media such as instrument air and inert gases. Pilot-operated regulators shall be external pilot type, but pilot-operated regulators shall not be used for downstream (back) pressure regulation for liquid service.

Self-acting pressure regulators may use a non-metallic closure member for applications other then corrosive or chemical service. PTFE coating/lining may be used for metallic closure members to improve corrosion resistance, but not as a substitution for the mandatory minimum requirement of AISI 316.

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Self-acting pressure regulators used for the regulation of hydrocarbon, flammable and chemical fluids, or critical services such as instrument air or fire water, shall:

- Have a designated failure position (fail-open or fail-close) in case of fluid pressure loss (non fail-safe models are not allowed), which may also be obtained with a separate build-in protection device. In general, pilot-operated regulators are by design fail-close, while direct-operated regulators are by design fail-close for upstream pressure regulation and fail-open for downstream pressure regulation. If the required fail-safe position is not available, then a true control valve shall be used instead.
- Have a one-piece cast body with bolted bonnet (union or screwed bonnet / caps are not permitted).

Self-acting pressure regulators used for applications other than hydrocarbon, flammable and chemical liquids, and being non-critical service:

- May or may not have a designated failure position (unless specified on the P&ID)
- May either be a one-piece cast body or a cast body with welded flanges, with bolted or union bonnet.

Parallel-regulation with self-acting pressure regulators to obtain the required capacity is not permitted in any case; a single pressure control valve shall be used instead, being either self-acting or an ICSS control loop or local controller.

Series-regulation with self-acting pressure regulators shall be avoided when possible; it shall be limited to cases where the pressure drop over a single regulator would be too large. In that case, the downstream pressure regulator shall have the same design pressure as the upstream pressure regulator. The setpoint pressures between the upstream and downstream pressure regulator shall be adequately divided to avoid interaction, as per Valve Manufacturer's recommendations.

Self-acting regulators requiring a constant venting to atmosphere shall be not be used when technical possible. In case of flammable or toxic process media, when a vent to atmosphere is required in order to ensure the proper functioning in case of leakage, then the vent outlet shall be routed to an appropriate location for safe venting using adequately sized instrument tubing. When venting is applied, a full AISI 316 bug screen shall be fitted. Piped venting systems shall be designed to avoid liquid ingress, and be fitted with heat-tracing to avoid liquid build-up in case of risk of condensation or freezing (e.g. wet gas).

Self-acting regulators for sanitary service (potable water) shall be direct-acting angle type valves with special clamp type end connections, having special flanges with o-ring seals (not covered by Company specifications). The clamps, seals and mating hub connectors to be welded on adjacent piping shall be supplied by the Valve Manufacturer. These regulators shall be supplied with a dedicated key which forces the valve open during cleaning and disinfection activities. This key shall be permanently attached to the valve with a stainless steel wire.

7.8 Type approval by IMO Class Society

Control valves for hull-related control valves onboard a floating facility may be subject to certain design requirements. They shall therefore be type approved as per selected IMO [Class Society](#).

The engineering data sheets shall clearly indicate if a control valve has a class requirement.

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8. Choke valves

This section applies to both manual and actuated choke valves for surface production facilities, excluding subsea choke valves and choke valves part of a wellhead assembly for which dedicated Company General Specification apply.

Choke valves are split in two types, with dedicated requirements as defined here after:

- Production choke valves: any pressure/flow controlling device upstream of the first production separator, is classified as a production choke valve.
- Injection choke valves: any pressure/flow controlling device installed in a flowline used for water/gas/steam injection into a reservoir.

8.1 API 6A application rules

All production choke valves are classified as an **API 6A** choke valve, and are categorised as **API 6A** 'monogrammed' or 'compliant' as follows:

- **API 6A** monogrammed choke valves: any choke valve which is an integral part of a wellhead or part of an API piping system, or when deemed required by project/affiliate for non-API piping systems for reasons of particular conditions (corrosive, erosive, HP/HT, metallurgy, size, etc.), in which case adapter flanges on piping are required.
- **API 6A** compliant choke valves: any choke valve part of an ASME piping system.

API 6A monogrammed valves shall have API end connections, and be manufactured in API accredited factories.

API 6A compliant valves shall have end connections in accordance with the applicable piping class as per P&ID. The remaining **API 6A** design, manufacturing and quality control requirements as per applicable PSL level below still apply.

The applicable PSL shall be determined as per **API 6A** Annex A, except that PSL 1 classified valves are not permitted; the minimum classification shall be PSL 2.

The required PSL shall be clearly indicated on the choke valve engineering data sheet.

Any production choke valve designated for high pressure ($\geq$ API 15K rating) and high temperature (≥ 180 °C), is classified as PR-2, and shall be cycle tested during prototyping as per Annex F of **API 6A**.

Injection choke valves are not considered **API 6A** choke valves, unless the adjacent piping system consists of API piping.

8.2 Sizing rules

Injection choke valves, handling treated single-phase fluids, shall be sized on the basis of severe service as defined by section 6.5.

Production chokes valves shall be sized on the basis of the erosion-corrosion line sizing criteria at the valve outlet (not at the trim outlet) as defined by section 11 of **GS EP ECP 103**.

In no case shall the valve outlet velocity exceed the maximum fluid velocities given by section 11 of **GS EP ECP 103**.

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The engineering data sheets shall clearly indicate the fluid composition + the following:

- The worst case sand/solids content in weight percentage
- The worst case water content in volume percentage
- The approximate classification of corrosion intensity (section 11 of **GS EP ECP 103**)
- Naturally present contaminants (e.g. H₂S, CO₂) and their worst case concentration
- Added contaminants (e.g. methanol, corrosion inhibitor, etc.).

In any case, the valve outlet velocity shall not pose any risk of erosion or cavitation to the adjacent piping.

Therefore, the Valve Manufacturer shall provide clear calculations of the worst case valve outlet velocity and trim outlet velocity on his valve sizing sheets.

The engineering data sheets shall clearly indicate the start-up conditions (e.g. maximum differential pressure and start-up flow rates) and the normal operational conditions (e.g. the minimum and maximum flow rates, temperatures and pressures). The trim design shall take into account the start-up conditions and the normal operational conditions.

Production choke valves shall have a flow range from 10 to 100% opening, the first 10% valve opening (with a minimum of 5mm/0.2inch) shall have no flow in order to protect the lower cage part and seat area against erosion.

Production choke valves subject to handling multiple wells with different fluid properties shall be sized for the various production scenarios.

Multiple trim sets shall be provided as per Company instructions in case a single trim set will not be able to handle all the production scenarios selected by Company.

8.3 Trim design requirements

Choke valves shall be multi-hole cage-guided type trim design. Contoured/multi-step plug designs are not permitted.

Trim cages for production choke valves shall be either drilled-hole cage type or labyrinth cage type

Note: 'drilled' refers to the shape of the hole, not to the manufacturing method.

The selection between drilled-hole cages versus labyrinth cages for production choke valve applications shall be performed with care; both types have their limits, advantages and constraints.

The principle of periodic replacement of sacrificial trim components is not an acceptable design/selection criteria. The choke valve trim shall be fit for purpose.

Based on worst case scenarios, the maximum pressure drop per discrete pressure reduction step shall not exceed 50 bar under normal operating conditions (10-100% opening), up to 75 bar upon Company approval if noise erosion and erosional criteria are met, with a maximum of 100 bar under start-up conditions.

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Drilled-hole cage trims shall be used if debris, rocks or scaling larger than 5 mm in diameter is expected during normal operation (after well and flowline clean out), and in case of risk of hydrate formation upstream of the choke.

Labyrinth trims shall be used in case of exceeding the criteria for noise levels, cavitation and erosional velocity, and if no hydrates and objects larger than 5 mm in diameter are expected.

The presence of sand/particles and potential elevated erosion shall not be linked to the cage type; both cage types have capabilities to deal with sand erosion when properly taking into account. The Valve Manufacturer shall demonstrate proof of sand handling capacities for the offered valves in case of sand/particles, and if labyrinth cage trims (if selected) have sufficient sand passing and anti-clogging (self-relieving) capacities by design.

In case of risk of hydrate formation due to the pressure drop inside the trim, and when a labyrinth trim is intended, then the Valve Manufacturer shall demonstrate that the gas temperature will not drop below the hydrate forming point at any given location inside the labyrinth, taking into account the temperature drop(s) across the trim.

If a risk of hydrate formation during start-up exists prior to the choke's pressure drop, then labyrinth type trims shall not be considered, unless a dedicated start-up choke is provided.

In case of continuous hydrate formation during start-up and/or normal production, choke valves for gas production wells shall be preferably axial flow valve design.

For gas production wells with a risk of hydrate formation, the hydrate enthalpy curve for the particular gas well and/or combined gas wells shall be provided.

The flow passage area of any trim type shall be adapted to avoid cage plugging and/or accumulation of solid particles around the cage, with a minimum flow passage area of $\geq 50 \text{ mm}^2$ (or $\geq \varnothing 8 \text{ mm}$). Smaller passages to meet lower Cv values of small choke valves will be subject to Company approval.

Any choke valve shall have solid hardened internals adapted to handle, as applicable, solids (sand), corrosive contaminants (e.g. CO_2 , H_2S) and chemicals (e.g. methanol, corrosion inhibitor), which shall all be clearly indicated on the engineering data sheet.

The throttling pressure reducing components of production chokes shall always be made of solid tungsten carbide, including the seat. Hard surface or weld-overlay materials are not permitted.

Tungsten carbide trim components shall always remain under compressing conditions.

Non-brittle sacrificial trims shall be supplied as per Company instructions for well start-up phases if erosive service with significant object impacts is expected for a short period (i.e. well clean-up, first oil/gas through flowlines, etc). The materials of these sacrificial trims shall be as per Valve Manufacturer's recommendation after a joint assessment with Company's specialists.

Protection cages (brick stoppers) and sacrificial trims for production chokes, and any trim for injection chokes, shall be made of corrosion resistive materials with improved mechanical properties, such as solid Inconel, 254 SMO or 17-4 PH. Weld-overlay designs are not permitted.

Choke trims shall be balanced plug design. As per UK HSE Safety Notice 11/2005, the equalizing ports shall be as large as possible as the structural integrity of the plug allows for. Fluid properties which could potentially block the plug's equalizing ports (wax, solids, hydrates, etc.) shall be clearly identified and quantified on the engineering data sheet.

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The trim's drive mechanism shall be designed to withstand the thrust created in case of plugged equalizing ports.

8.4 Trim impact resistance requirements

The trim components of production chokes shall have a proven minimum impact resistance against occasional large objects.

These trim components shall have a proven minimum impact resistance of 80 Joule from a 25 mm / 1 inch steel ball for valves NPS $\geq$ 4 inch, and a proven minimum impact resistance of 40 Joule from a 12.5 mm / 0.5 inch steel ball for valves NPS $\leq$ 3 inch.

The impact resistance shall preferably be achieved by the composition/grade/geometry of the tungsten carbide, or with the help of an additional softer protection cage. The softer protection cage shall have no pressure dropping functionality and not be affected by erosion.

Any tungsten carbide component shall be sintered from a composition containing cobalt, nickel and chromium as the binding materials. The manufacturing shall be a HIPPED (Hot Isostatically Pressed) process, providing a minimum hardness HRA $\geq$ 93 (Hv $\geq$ 1725) and a minimum fracture toughness K1c $\geq$ 9.25 MPa·m^{1/2} as per [ISO 28079](#) Palmqvist method.

The implementation of a protection cage does not relieve the requirement to have tungsten carbide components with the above-stated properties.

The Valve Manufacturer shall provide an impact resistance procedure and test report for each supplied trim size, and for the protection cage when applicable; interpolation of test results from different trim/cage sizes is not permitted.

The impact tests are typically performed with a hardened steel ball inserted into a large mass solid body, dropped from a calculated height. The test report shall clearly state ball size and include the test procedure demonstrating the test method and impact energy. Smaller or larger ball sizes are subject to Company approval.

Prior to assembly, the tungsten carbide components under test shall undergo a thorough visual and liquid penetrant examination and any defects, no matter how minor, shall be recorded in detail and mapped. After impact test, the tungsten carbide components shall undergo the same examinations.

The impact test shall be performed on a fully assembled valve, in half open position, ready to stroke after the impact test, or mock assembly with identical installation and trim loading, with plug installed.

The acceptance criteria are to have no (partial) destruction of the tungsten carbide components and that the valve shall be able to travel to closed position, i.e. the free movement of dynamic and static trim parts shall be verified after impact test, as part of the test report. Minor chips and cracks are acceptable as long as the component's integrity is maintained.

The softer protection cages do not require liquid penetrant examination, but will require dimensional inspection after each test, demonstrating that the tungsten carbide cage is not touching the protection cage (no force from protection cage on tungsten carbide cage).

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8.5 Body design requirements

Choke valves shall be angle type body. Straightway (axial flow) type body is limited to non-RTJ flanged valves (< ASME Class 900), and can be used for any ASME or API Pressure Class when hub type end connections are used

However, angle type body is mandatory for RTJ type end connections to enable valve removal without dismantling adjacent piping.

Axial flow type body shall not be used for fluids containing solids/sand or for chokes in erosive service.

The choke valve body shall be designed as follows:

- Non-API classified choke valves: one-piece integral flanged cast body or forged block with forged welded neck flanges
- PSL 2 classified choke valves: either one-piece integral flanged cast body or forged block with forged welded neck flanges
- PSL 3 & 3G classified choke valves: either one-piece integral flanged cast body or forged block with forged welded neck flanges, or bolted-to-body flanges
- PSL 4 classified choke valves: forged block with bolted-to-body flanges (welding is not permitted for any part of the choke valve).

End connection shall always be solid flanges or hub connectors. Any other kind of end connection is not permitted.

The fluid entering the valve shall be equally distributed (in flow and pressure) around the outside of the cage, avoiding high fluid velocities and erosion of the body surrounding the cage. Adequate port orientation versus the fluid flow direction shall ensure an equal flow and pressure loading across all ports. The valve's inlet compartment surrounding the cage shall therefore be kept as large as possible, and possibly equipped with hardened sleeves for erosion protection as per Valve Manufacturer's recommendation.

Choke valve end connections shall have identical diameter as adjacent piping system. Upstream reducers and downstream expanders are not permitted; the choke valve inlet and outlet connection shall be adapted to the given inlet and outlet piping diameters.

The internal transition from the valve trim to the valve outlet shall be a smooth taper venturi shape with an angle not exceeding 30 degrees. A protective hardened sleeve or Stellite® outlet liner shall be provided to protect the valve body in cases where the trim exit velocity might cause erosion of the valve body, keeping in mind that the valve outlet velocity shall not pose any risk of erosion or cavitation to the adjacent piping (section 8.2).

Equally, in case the body center module is smaller than the upstream piping, the internal transition from the valve inlet to the section surrounding the trim cage shall be smooth taper shaped, avoiding erosional and jetting conditions.

Therefore, the internal diameter of the adjacent inlet and outlet piping shall be clearly mentioned on the engineering data sheets, and the choke valve end connections shall accurately match these dimensions (< 1 mm).

All chokes valves shall be equipped with a safety vent in order to release trapped pressures prior to releasing the bonnet bolting as per [API 6A](#).

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The flow direction shall be clearly marked on the valve body by means of an arrow cast into the valve body or stainless steel plate securely fixed to the valve body after final painting.

Refer to section 9.7 for stem seal requirements.

8.6 Actuator arrangements

The principle type and design requirements for choke valve actuators and associated control accessories shall comply with section 10 and 11. This section provides additional requirements particular to choke valves installation arrangements.

Choke valves can be equipped with stepped actuators when a fail-safe position is not required (i.e. fail-lock).

Three different actuator mounting arrangements can be used:

1. Classic yoke assembly: this arrangement requires the actuator to be removed separately before bonnet and internals are removed - preferred for surface applications, unless defined differently on the data sheets.
2. Integral assembly: this arrangement implies that actuator, bonnet and internals are removed all in one - limited to subsea applications.
3. Permanent actuator mounting: this arrangement allows bonnet and internals to be removed without dismantling the actuator (the actuator is mounted under 90 degrees on a permanent support) - shall only be selected when frequent trim change out or high valve availability (short down time) is required.

Choke valves shall be installed with their actuator orientated vertically upwards. Horizontal orientated actuators shall be avoided.

Horizontal actuator orientation will be subject to Company approval, and shall be accompanied with a confirmation of the Valve Manufacturer that the valve and actuator can handle the weight and vibrations of the actuator in horizontal position.

Sufficient clearance above/around the actuator shall be provided to allow for actuator removal and trim disassembly.

All control accessories, tubing, etc. shall be installed to account for the final actuator orientation, and allow for both vertical and horizontal lifting slings to be around the valve.

Horizontal orientated actuators shall be provided with lifting lugs for both vertical and horizontal lifting.

The valve orientation and actuator orientation shall be clearly mentioned on the engineering data sheets and in the Purchase Order.

8.7 Material requirements

The stem shall be made of corrosion resistant steel and be compatible with the specified NACE level. It shall be reminded that 17-4PH is not permitted when the H₂S partial pressure is exceeding 3.4 kPa (0.5 psi) in any given condition as per NACE MR0175 / [ISO 15156-3](#), and that better materials shall be selected in that case, while AISI 316 can only be used ≤ 82 °C.

In case the H₂S partial pressure is above 3.4 kPa (0.5 psi), then superior stem materials such as UNS 20910 (e.g. Nitronic 50) or Inconel 708 shall be envisaged.

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Cast bodies for PSL-2 classified choke valves shall include volumetric NDE testing.

Body-bonnet connections shall be a bolted connection. The material of bonnet bolting and any other bolting related to pressure-containing parts shall be in accordance with section 8.7 of [GS EP PVV 142](#). The mechanical properties of pressure-containing bolting for [API 6A](#) monogrammed valves shall be in compliance with [API 6A](#).

The dynamic sealing surface of the stem shall be wear resistant against wearing by the seals, and galling with other metallic components.

Choke valve materials are subject to:

- Company's agreement on origin of materials and manufacturing as per section 9.1
- Material certificates as per section 12.2
- Impact test criteria for API compliant choke valves as per section 12.2
- Impact test criteria for API monogrammed choke valves as per [API 6A](#)
- For API monogrammed valves: quality control requirements according applicable PSL category, requiring independent 3rd party involvement for some PSL categories.

The application and implementation of [API 6A](#) quality control requirements does not relieve the Valve Manufacturer from Company's requirements in section 9.1 and 12.2.

8.8 Adjacent piping design requirements

In any case, permanent pipe supports nearby the inlet and outlet end connections shall be provided to:

- Prevent the choke valve to be used as a pipe support (an eventual valve support shall be for the valve only)
- Allow upstream and downstream piping to be in free position when the choke valve is not installed.

For upstream piping sections:

- Straight lengths with a minimum of 5D shall be provided
- In case of sand production: long radius pipe elbows (3D or 5D bending radius) or target tees shall be used
- Reduced bore manual or actuated valves shall remain at least 10D to 15D upstream of the choke valve
- Reducers or reducing spool pieces are not permitted; the valve's inlet end connection shall be the same diameter as the upstream piping.

For downstream piping sections:

- Straight lengths of at least 10D to 20D without change of direction or reduced diameter shall be provided. If this is proven impossible (such as for subsea applications), then the first bend shall be made using a target tee with sacrificial impact surface or adequate wall thickness for erosion/cavitation allowance, unless the application is free from erosion or cavitation risks.

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- There shall be no valve between the choke valve and the first bend or target tee, or be at least full bore and 20D downstream of choke valve in case of no bend or target tee.
- Expanders or expanding spool pieces are not permitted; the valve's outlet end connection shall be the same diameter as the downstream piping.

The choke valve elevation and valve accessibility shall allow for easy actuator mounting and trim replacement operations, avoiding the need for temporarily scaffolding.

In general, the Contractor shall provide adequate pipe supports, pipe stress and pipe vibration calculations, meeting the criteria defined in section 11 of [GS EP ECP 103](#).

9. Valve body

9.1 Origin of materials and manufacturing

The Valve Manufacturer shall submit during tender a "Declaration of Materials and Manufacturing Origin", clearly listing:

- All casting companies for the supply of cast and forged components
- All companies for welding and examination of cast and forged components
- All companies for machining, assembling and testing

which may be used for the fabrication of any pressure-containing or process-wetted valve component, including Valve Manufacturer himself. This list shall be set up for each valve component, per valve model, size and pressure range.

The Valve Manufacturer shall clearly list which of his own factory/factories (names and addresses) is/are proposed. In case the Valve Manufacturer will use more than one of his own factories at different geographic locations, then the Valve Manufacturer shall clearly list which factory will be used for each valve and/or valve component.

It shall be noted that Company approval of a Valve Manufacturer is related to a specific factory at a specific geographic location.

Casting companies are also subject to Company approval. The fact that a Valve Manufacturer is listed on Company's approved vendor list does not imply a general approval for any casting company or steel mill possibly used by the Valve Manufacturer. The Valve Manufacturer may only order valve components casting companies approved prior by Company.

Non-approved casting companies shall have obtained Company approval before Purchase Order.

The casting company identification and heat number shall both be clearly visible at the final product by means of embossed or stamped numbers.

9.2 Valve body design

Material selection for all body components shall be in strict accordance with [GS EP PVV 142](#) and [GS EP PVV 112](#). The material pressure-temperature ratings for the valve body shall be in accordance with the associated piping class and not as a function of the operating pressure-temperature limits. However, internals (trim) and non-metallic components may be subject to the operating pressure-temperature limits on a case-by-case basis.

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Self-acting regulators shall be considered as a globe type valve.

All valves shall have a service class (A thru D) assigned as per [GS EP PVV 142](#), clearly identified on the engineering data sheets, to identify particular requirements on material selection, design, examination and testing. Class A may not be used for flammable and chemical fluids.

Valve Manufacturer shall provide the detailed ASTM, AISI or UNS material code, also clarifying generic trademark names, for all body, bonnet, bolting or trim components, including material details for non-metallic components such as seals, gaskets, etc.

Even when better quality or grade materials are proposed, then the Valve Manufacturer shall include this in the mandatory List of Deviations during tender for review and approval by Company as per section 18.

Cast components shall be free from injurious blowholes, porosity, shrinkage faults, cracks or other defects in accordance with [MSS SP-55](#). Refer to [GS EP PVV 142](#) for mandatory requirements on materials, fabrication and examination. Any welding or weld repair shall comply with [GS EP PVV 611](#), and major welding as defined in [ASTM A 703](#) shall only be undertaken with the written approval of Company.

Valve bodies may not be fitted with threaded plugs in pressure containing parts, while bottom flanges are not allowed for cryogenic service control valves.

Valves in sour service shall comply with [GS EP PVV 612](#), [GS EP PVV 613](#) and [GS EP PVV 622](#). Welding and weld repairs are not allowed for valves in sour service.

All wetted materials of any valve for sanitary service shall be [USP-NF](#) Class IV certified.

9.3 Bonnets and bolting

Bonnets, including bottom flanges when existing, shall be the same material as the valve body. Valve Manufacturer's standard bonnets are normally used.

The use of extended bonnets is limited to:

- Service class D applications ($T > 200^{\circ}\text{C}$, or above as per Manufacturer's standard)
- Cryogenic service (refer to [GS EP PVV 150](#))
- When thermal or acoustic insulation is applied around the valve body
- When pressure seal bonnets or bellow seal bonnets are used
- When special stem packing arrangements are required for acid or noxious fluids.

Bonnets and bottom flanges shall be a bolted design with fully retained gaskets. Screwed bonnets and union bonnets are not allowed, except for self-acting pressure regulators used for non-hazardous applications.

Bolting for bonnets, and bottom flange bolting when existing, shall be in strict compliance with Table 7 of [GS EP PVV 142](#).

9.4 Body center module size

The nominal size of the valve's body center module shall not be more than 2 sizes smaller than the upstream line size.

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9.5 End connections

Control valves shall have integral end connections in accordance with the applicable piping class as per [GS EP PVV 112](#) or project equivalent.

Flanges shall be of the type (RF, FF, RTJ, hub, API) as defined by the applicable piping class, and which shall be clearly mentioned on the engineering data sheet. Therefore, the piping class shall also be clearly mentioned on the engineering data sheet.

The allowable end connection sizes for ASME piping systems are: ASME NPS 2, 3, 4, 6, 8, 10, 12, 14 inch and larger. Intermediate sizes may not be used or selected. The use of end connections smaller than 2 inch shall be avoided and is subject to Company approval, and only NPS 1 inch or 1.5 inch are to be used in that case.

End connections for API piping systems shall be in compliance with [API 6A](#).

The Valve Manufacturer may assume that short-length concentric reducers will be installed to match the selected valve size, unless stated differently on the data sheet.

Control valves shall be designed for installation in [ASME B31.3](#) piping with [ASME B16.5](#) flanges.

The flange rating for any given control valve shall be:

- Minimum ASME Class 150 for GRP and PVDF piping
- Minimum ASME Class 300 for metallic piping.

For flange face roughness and hardness, refer to [GS EP PVV 142](#).

Straightway body control valves shall always have the same pressure rating and sizes for their inlet and outlet flanges. However, angle type choke valves may have different inlet and outlet pressure ratings and sizes.

Butterfly valves shall be either integral flanged or lug type (wafer type is not allowed).

The face-to-face or end-to-end dimension for control valves shall be in accordance with the following standards:

- [IEC 60534-3-1](#) for straightway globe type control valves
- [IEC 60534-3-2](#) for rotary type control valves
- [ASME B16.10](#) for angle globe type control valves
- [ASME B16.10](#) for severe service control valves and ASME flanged choke valves
- [API 6A](#) for API flanged choke valves
- [API 609](#) for butterfly control valves.

For reasons of Vendor interchangeability, any valve having Vendor specific dimensions shall be rejected, except for choke valves and severe service control valves which may require custom body sizes for their trim arrangement and/or flow pattern.

Sanitary control valves are often angle type valves with special clamp type end connections, having special flange seals (o-rings), according vendor specific end-to-end dimensions. Mating adapters (hub connectors) shall be welded to the adjacent piping. The clamps, seals and mating hub connectors shall be supplied by the Valve Manufacturer.

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9.6 Gaskets, seals, bellows and membranes

Metallic gaskets, seals, bellows and membranes shall be at least AISI 316, unless stated differently on the engineering data sheets. Non-metallic seals (excluding control valve packing) shall be selected in accordance with Table 4 of [GS EP PVV 142](#) and the notes there-under.

The engineering data sheets shall clearly mention the presence of any naturally present (e.g. H₂S) or added chemical fluid component (e.g. methanol, corrosion inhibitor) to enable an assessment of non-metallic process wetted parts.

The use of FKM (e.g. Viton®) and Polyamide (e.g. Nylon®, Vespel®) is strictly prohibited for process wetted parts in hydrocarbon and chemical service.

Pressure-containing non-metallic seals shall have mechanical properties in compliance with Appendix 2 of [GS EP PVV 142](#).

The non-metallic wetted parts of sanitary valves shall be [USP-NF](#) Class IV certified.

Bellow seals are prone to fatigue failure. Their application is limited to specific applications where no stem leakage is allowed such as acid, toxic and lethal process fluids (refer to section 7.5.5). Bellow seal valves shall be supplied with an additional stuffing box packing.

A pressure gauge with isolation manifold shall be provided to detect bellow leakage.

9.7 Stem seal assembly

Control valves shall have a stem sealing arrangement comprising an externally adjustable bolted packing glands / packing followers. The packing box assembly shall be removable without disturbing valve assembly. Packing flange studs and nuts shall be minimum AISI 316.

Axial flow type control valves may have different type of stem sealing arrangement inherent to their design (being non-accessible and being non-adjustable), but shall be such that the operating gear is isolated from the process fluid.

Choke valves shall have a stem sealing arrangement comprising of two independent spring-energised lip seals, allowing one seal to fail without loss of containment and without increased emissions.

As per [GS EP PVV 142](#), lip seals shall have a $\sigma_c \geq 30 \text{ N/mm}^2$ and $\sigma_f \geq 100 \text{ N/mm}^2$ at 23 °C.

Control valve packing materials shall be selected according to operating conditions, fluids and emission limitations. Materials should be non-abrasive with a low coefficient of friction. Reinforced PTFE packing is preferred for services between -46°C and +200°C. High purity reinforced graphite can theoretically be used for temperatures between -240°C and +550°C, but in reality it shall be applied as per Valve Manufacturer's specification.

Packing material shall be free of asbestos and man-made mineral fibers.

The use of FKM (e.g. Viton®) and Polyamide (e.g. Nylon®) is only permitted for stem seal assemblies for Service Class A valves (water, nitrogen, air, hydraulic oils).

Packing assemblies requiring external lubrication or grease may not be used.

Special packing requirements shall be subject to Company approval.

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9.8 Fugitive emissions

Control valves for hydrocarbon, flammable, hydrogen or chemical fluid service shall meet the following fugitive emission criteria as per [ISO 15848-1](#).

Choke valves shall comply with the stem seal assembly test as defined in section 12.11.3, or with [API 6A](#) PR-2 tests when the choke valve is PR-2 classified.

Temperature class (tRT) only is not acceptable, because packing temperature ratings shall be in accordance with the valve service class (s.c.) A thru D. The test medium shall be helium, not methane. The prototype test pressure will be the applicable ASME or API Class pressure rating.

- Tightness class : C as a minimum ($\leq 10^{-2} \text{ mg} \cdot \text{s}^{-1} \cdot \text{m}^{-1}$)
- Endurance class : CC1 (20.000 cycles)
- SSA class : SSA 1 (1 Stem Seal Adjustment during the test)
- Temperature class : (t-196°C) for cryogenic control valves, (s.c. C)
(tRT) + (t200°C) for PTFE packing control valves (s.c. A & B)
(tRT) + (t400°C) for graphite packing control valves (s.c. D)

The Valve Manufacturer shall provide with tender a prototype test certificate, or qualification program, for **each valve model, valve size and each ASME or API Class**, in conformity with the test report requirements defined in [ISO 15848-1](#). The test and type test report shall be established by a recognised third party approved by Company.

Testing and test certificates for temperature classes above 200°C might be obtained during manufacturing period, considering this might be non-standard for certain valve types or sizes.

A separate stainless steel plate, permanently fixed to the valve body after final painting, shall state the type test code as per section 6.6 of [ISO 15848-1](#), e.g.

ISO FE CH - CC1 - SSA 1 - t (RT, 200°C) - CL300 - [ISO 15848-1](#)

The fugitive emissions criteria shall be specified on the engineering data sheet. The absence of this data does not relieve the Valve Manufacturer to comply with these requirements.

When required by local legislation or when specified on the engineering data sheet, control valves may be equipped with a build-in leak detection device, which should preferably use the positioner's HART signal for data transfer when possible.

9.9 Seat leakage

Seat leakage classification shall be as per [FCI 70-2](#).

Seat leakage test shall comply with [IEC 60534-4](#).

If no seat leakage value is specifically stated on the engineering data sheet, then the minimum shut-off class shall be:

- Minimum Class II for double-ported valves
- Minimum Class III for metal seal butterfly valves
- Minimum Class III for production choke valves and for any valve in erosive service
- Minimum Class IV for injection choke valves and contoured plug valves

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- Minimum Class IV for cage-guided valves, soft seal butterfly valves and regulators
- Minimum Class V for any control valve installed in the fuel line to a fired heater or furnace.

Pump recycle valves and compressor anti-surge valves shall always be minimum Class V, or Class VI when strict machine energy management rules are specified.

All control valves connected to a flaring network shall be minimum Class V to reduce fugitive emissions through the flare.

Class VI can impact the trim design and trim materials accordingly. Also, Class VI valves may require early (frequent) trim replacement to maintain the required leakage rate, and shall therefore be specified with care and maintenance conscience. In case soft seals are not desired or not allowed, and when Class VI is required, then [MSS SP-61](#) shall be followed instead of [FCI 70-2](#).

10. Actuators

10.1 General

Control and choke valve actuators shall be fail-safe and by default be spring-opposed, either diaphragm, helical spline, or piston type. Other types (e.g. rack-and-pinion) are not permitted.

The use of double-acting springless actuators, using an air or hydraulic accumulator to ensure fail-safe position, is strictly limited to control valves having a nominal body diameter larger than NPS 14 inch, for choke valves and for anti-surge valves, in compliance with section 10.5.

The required fail position, in case of control signal or control medium loss, shall be indicated on the engineering data sheet and P&IDs, being 'Fail-Closed', 'Fail-Open' or 'Fail-Lock'.

Pneumatic actuators shall be used by default; hydraulic actuators shall only used for cases as described below.

Rotary motion actuators and valve stems shall have splined shafts.

Normally, the actuator acting mode is direct-acting for fail-open valves and reverse-acting for fail-closed valves. When 'Fail-Lock' position is selected, the control valve action in case of lock-up device failure shall be specified as well.

Actuators shall be equipped with a direct-mounted position/travel indicator for local position indication, pointing to a fixed scale with the words 'open' and 'closed' and intermediate position marks, all made of AISI 316 minimum.

Actuators shall be designed to avoid the ingress of corrosive elements. Diaphragm and piston actuator springs shall be fully enclosed and have linear characteristic permitting full stem travel.

The yoke design shall allow access for inspection and adjustment of the stem sealing. Closed yoke designs shall be self draining in installed position to avoid liquid build-up and corrosion.

10.2 Pneumatic actuators

Spring-return pneumatic actuators shall be the default type of actuator for control and choke valves.

Generally, diaphragm type actuators shall be used over piston type actuators.

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Any control or choke valve shall be able to operate at a minimum air supply pressure of 5 barg, unless stated differently on the engineering data sheet, allowing 1.0 barg pressure drop by the valve positioner. Any control or choke valve requiring a higher minimum air pressure shall be rejected unless this higher minimum air pressure is normally available on the facility.

Pneumatic actuators shall be designed to withstand the maximum facility instrument air pressure without overpressure protection.

10.3 Hydraulic actuators

The use of hydraulic actuators is limited to facilities where hydraulic oil is the sole available control medium (motive fluid) available.

10.4 Electrical actuators

The use of electric actuators for throttling control valves is limited to facilities where instrument air or hydraulic oil is not available. Furthermore, the use of electric actuators is limited to rotary motion actuators.

Electrical actuators shall preferably by 220~400 VAC powered instead of lower 24~48 VDC voltages, unless low DC voltage is the only available electrical power source on the facility concerned. The Contractor shall provide dedicated power loss and cable sizing calculations for low DC voltage applications.

Electrical actuators shall be given a designated service class (S1 thru S9) as per [IEC 60034-1](#), and which shall be clearly indicated on the engineering data sheet.

10.5 Double-acting actuators

Double-acting actuators can be either spring-opposed (preferred) or springless design, and are limited to control valves larger than NPS 14 inch, to choke valves and anti-surge valves.

Double-acting springless actuators shall be supplied with a dedicated air tank or nitrogen purged accumulator for hydraulic actuators) when a fail-safe function is required. There shall not be any element (e.g. check valve, manual valve, etc) between the air tank and actuator.

Air tanks shall have a pressure gauge with isolating manifold and liquid drain valve at the lowest point. Air tanks shall be designed to withstand the maximum facility air supply pressure (or minimum 12 barg) and be hydrostatic tested with a name plate in accordance with ASME.

The use of double acting springless actuators, their control schematic and the brand of individual components shall be subject to Company review and approval during tender. In any case, the use of double-acting pneumatic actuators for control valves installed at main production separators outlets is not allowed.

A single SMART positioner capable of double-acting controls shall be used in any case; the use of discrete control elements is not permitted.

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10.6 Actuator sizing

Actuators shall be sized to move the trim in a stable and smooth fashion over the full stroking range considering simultaneously:

- Maximum process shut-off pressure (closed position with maximum operating upstream pressure and atmospheric downstream pressure)
- Minimum instrument air supply pressure (5 barg unless stated differently) or minimum hydraulic supply pressure, to the positioner.

Actuators shall be sized to ensure the necessary thrust or torque required to fully stroke the valve at maximum process shut-off pressure and at minimum actuator supply pressure, and to ensure control stability and low dead band on the long term.

The maximum full stroking time, expressed in seconds, for both directions **shall not exceed 5 times the valve NPS body diameter** under normal operating conditions. When faster stroking times are required, then this shall be clearly indicated at the engineering data sheets. Company or Contractor will specify the maximum stroking time for valves above 10 inch.

Choke valves may have particular (much longer) stroking times, as indicated on the P&ID's or as per project specification(s).

Although not preferred, boosters may be installed to meet the stroking time requirements, but the valve movements shall remain stable at 25%, 50% and 75% control signal step changes, i.e. minimal overshoot (< 1%) with no oscillation.

Specific applications may require much faster stroking times (e.g. anti-surge valves), which shall be clearly specified in a dedicated specification by Contractor or by the Package Vendor, and which may require quick exhaust devices.

Hydraulic actuators shall be equipped speed control devices and mechanical adjustable end stops to avoid excessive stem/trim stress.

The engineering data sheet shall clearly state the maximum shut-off pressure, the minimum instrument air/hydraulic supply pressure and maximum stroking time.

10.7 Actuator material

The yoke material shall be high tensile strength cast or ductile iron as a minimum. Cylinders and membrane cases shall be made of cold-formed steel plate. The internal cylinder surface of piston type actuators shall have an adequate corrosion protection, such as Electroless Nickel Plated (ENP) coating, while the piston shall be corrosion resistant as well.

Actuator diaphragms shall be made of nylon-reinforced neoprene (NCI or CR) or nitril rubber (NBR) materials when used with instrument air or nitrogen.

In case of hydrocarbon instrument gas, all wetted actuator components shall be suitable for wet gas service; the use of FKM (e.g. Viton) parts is not permitted. Non-metallic components (e.g. diaphragm) are to be selected in accordance with Table 4 of **GS EP PVV 142**.

All actuator bolting shall be either AISI 316 or galvanised carbon steel, painted together with the actuator before assembling of positioner and accessories. All bolting for mounting the positioner, accessories and position indication shall be AISI 316. Cadmium plating of any component is not allowed. Stem connector assembly shall be AISI 316.

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10.8 Hysteresis and dead band

The total hysteresis + dead band for the entire valve assembly (control valve, actuator and accessories) shall be less than 1%. When requested, dead band test shall be based on [IEC 60534-4](#), refer to section 12.11.3 of this specification.

11. Accessories

All accessories specified on the engineering data sheets shall be supplied and mounted on the control valve by the Valve Manufacturer and the whole assembly shall be successfully functionally tested and be fully configured at the factory before expediting.

11.1 Standardisation of accessories

Although different Valve Manufacturers can be selected for different control valve applications, or in case of existing valve replacement, Contractor and Package Vendor shall standardise to one single brand & model for positioners, air sets and fittings for all control valves throughout the whole plant/installation, including package units.

Not all proprietary positioners and air sets are approved by Company, and the Valve Manufacturer shall therefore propose a positioner and air set as per approved vendor list attached to the tender request, or request this information when not provided during tender.

All Valve Manufacturers shall therefore install the final selected brand & model for the positioner, air set and fittings as instructed during tender, or by the purchase order, by Company, Contractor or Package Vendor. Any deviating supply shall be replaced, at Contractor's or Package/Valve Manufacturer's expense.

Particular control valves (e.g. anti-surge valves) may require a unique brand & model of positioner. However, standardised positioner shall be studied first.

The fact that some control valves are installed in a non-hazardous area (e.g. indoors) does not relieve the Contractor or Package Vendor to use identical equipment as installed in hazardous areas.

11.2 Ex, EMC and IP rating

As per [GS EP INS 101](#), all electrical equipment, regardless their location, shall be certified for use in zone 1 hazardous area.

ATEX [European Directive 94/9/EC](#) shall apply in European Countries and associated countries (eg Norway, Iceland)

ATEX European Directive or [IECEx](#) Standards shall apply in other countries.

All accessories (electrical and non-electrical) shall be at least IP 65 rated.

All electrical equipment shall be CE labeled for compliance with the [European ATEX](#) and [EMC Directives](#). ATEX/[IECEx](#), EMC and IP certificates shall be provided during tender, and shall be included in the final vendor documentation as per section 18.

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11.3 Pneumatic and hydraulic links

As per **GS EP INS 107** and **GS EP INS 900**, pneumatic and hydraulic links for:

- Tubing shall be minimum AISI 904L
- Compression fittings shall be minimum AISI 316L
- All tubing and fittings in seawater service shall be Monel-400 ® or Hastelloy-C ®
- All threaded connections shall be made using sealant paste; tape is not allowed
- Any other link component (e.g. tee, valve) shall be fully minimum AISI 316 or 316L (or Monel-400 ® or Hastelloy-C ® for seawater service).

As per **GS EP INS 101**, the **brand and sizing system** shall be standardised throughout the whole facility, including package units. The sizing system, i.e. metric or imperial sizes, and brand shall therefore be clearly stated on the engineering data sheets before tender.

11.4 Electrical links

As per **GS EP INS 101**, cable entries shall be 1/2 inch NPT female, unless stated differently by the engineering data sheet or project specification. All cable entries shall be bottom (preferred) or side entry; top entry is not allowed.

In case the Valve Manufacturer has to supply the cable gland(s), then the cable gland brand and model, including cable outer diameter, shall be specified by Contractor or Package Vendor.

Cable glands shall be either full AISI 316 (preferred) or alternatively nickel-plated brass, from a Company approved vendor.

11.5 Positioners

Positioners shall be of a Company approved brand and model.

Positioners shall be SMART type with HART protocol, connected to the process control system (PCS) via a dedicated hard-wired 24 VDC 4-20 mA loop.

Positioners, mounting brackets and bolting shall be minimum AISI 316. Aluminum and painted carbon steel parts are not permitted.

Anti-surge valves and compressor recycle valves may be equipped with special programmable-curve digital positioners to obtain a control performance or control characteristic superior to standard digital positioners, but this may not be used to enhance the performance of the valve itself.

Positioners shall be direct mounted on the actuator yoke.

Double-acting actuators shall be equipped with a single SMART positioner capable of double-acting control; the use of (additional) discrete control elements is not permitted.

Positioners shall be equipped with integral pressure gauges, indicating air/hydraulic supply pressure and output pressure, in barg or dual barg/psig scale. They shall be made of AISI 316 with shatterproof safety glass (no plastic components).

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Positioners used in case of instrument gas shall be special low-consumption models to reduce fugitive emissions to the minimum possible. A dedicated emission study and positioner selection procedure shall be applied in this case, before Purchase Order and as per section 18.

11.6 Air sets

By default, pneumatic control valves shall be furnished with an air-filter regulator, equipped with an integral pressure gauge. The outlet pressure shall be set to 90% of the actuator design pressure, but not more than 5 barg (refer to section 10.2) unless stated differently by the engineering data sheets or project specification(s).

Air-filter regulators shall be non-lubricating, unless specified by the Valve Manufacturer for large-size actuators. Such actuators shall be avoided when possible, because this will cause a continuous pollution at the positioner air outlet and oil build-up inside the actuator.

When required, air lubricators shall be externally adjustable oil-mist type with a minimum oil capacity for one month autonomous operation. Spherical glass (bowl) type air lubricators and air-filter regulators may not be used. Oil refill shall external and be possible while in operation.

Air-filters regulators shall be auto-draining type, and shall therefore be installed with their drain outlet vertically downwards. The Valve Manufacturer shall select the proper filter characteristics. Manual drains shall be operable by hand (no tools required).

Air-filter regulators, pressure gauges, safety relief valves and air lubricators shall be fully AISI 316, plastic outer components are not allowed. The pressure gauge shall have a barg or dual barg/psig scale and have shatterproof safety glass; liquid filling is not required. The regulator vent outlet shall be equipped with an AISI 316 bug screen. In case of winterisation, special vent outlets shall be carefully selected to prevent freezing.

Air-filter regulators are preferably mounted integrally to the positioner, unless this would cause the drain outlet not to be pointed downwards. In case of loose installation, it shall be located as close as possible to the positioner without protruding from the actuator cases (i.e. on the yoke); protruding components are often damaged during installation and operation.

Air-filter regulators, pressure gauges, safety relief valves and air lubricators shall be of a Company approved brand and model, and these shall therefore be clearly specified during tender by the Valve Manufacturer and on the engineering data sheets used for Purchase Order, and will be subject to standardisation as mentioned before.

11.7 Solenoid valves

When solenoid valves are used to obtain a fully open, fully closed or locked position of the control valve during particular process shutdown events, then it shall be located in the control line between the positioner and actuator. It can either be 2-way to lock the valve in actual position (fail-lock valve), or 3-way to force the valve in a fully closed or fully open positioning by venting the actuator to its fail-safe position.

Solenoid valves shall be integrally mounted to the actuator, or on an AISI 316 mounting plate, protruding as minimum as possible from the actuator case, avoiding clashing with lifting slings during lifting operations.

Solenoids valves design shall be 24 VDC, low-power type (10 Watt maximum), insulation Class H, equipped with an integral surge suppression diode.

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Solenoids valves shall be continuous powered during normal operation to ensure the fail-safe position of the control valve upon power failure.

Solenoid valves shall have an integral wiring terminal compartment (flying lead design is not permitted), and the whole assembly shall be fully AISI 316. The trim shall have soft seats to provide tight shut-off.

If there is a vent outlet then it shall be equipped with an AISI 316 bug screen, pointing downwards. In case of winterisation, special vent outlets shall be carefully selected to prevent freezing.

Solenoids valves shall of a Company approved brand and model, and these shall therefore be clearly specified during tender by the Valve Manufacturer and on the engineering data sheets used for Purchase Order.

A dedicated AISI 316 tag plate for the solenoid valve shall be mounted directly next to or at the solenoid valve, securely fixed by screws or rivets (no wire label).

11.8 Lock-up devices

Pneumatic lock-up devices shall only be provided when specified on the engineering data sheets, for all services that require the valve to remain in position in the event of air supply failure.

It shall be installed on the control line between positioner and actuator. When lock-up devices are applied in conjunction with a solenoid valve, the solenoid valve shall be installed between the lock-up device and the actuator.

The entire lock-up device assembly shall be fully AISI 316.

11.9 Position detection

Position detection (feedback) shall only be provided when specifically required for particular control actions (e.g. automated sequences, interlocks, anti-surge protection, etc.). This can be either full stroke analogue position feedback or discrete stroke end position detection, as indicated on the P&ID's.

When discrete stroke end position detection is required, then this shall be done by dedicated inductive type SPDT proximity switches, made of full AISI 316 (no plastic), with a minimum contact rating of 1 A at 24 VDC.

When analogue or discrete position detectors are flying-lead design, then they shall be properly terminated in a junction box. Flying leads shall be protected by an AISI 316 flexible conduit in those cases where cables are not armoured.

The whole position detection assembly shall be integrally mounted to the yoke, allowing position adjustment, without protruding from the actuator cases, using AISI 316 bolting, brackets, etc.

Dedicated AISI 316 tag plates shall be mounted directly next to position detectors or on the associated junction box, securely fixed by screws or rivets (no wire labels).

Position detectors shall of a Company approved brand and model, and these shall therefore be clearly specified during tender by the Valve Manufacturer for Company approval, and on the engineering data sheets used for Purchase Order.

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11.10 Hand wheels

Hand wheels shall only be provided when specified on the engineering data sheet.

The hand wheel shall be solid type, with declutching device, preferably side-mounted.

The hand wheel shall not interfere with the control valve full stroking.

Hand wheels or pump handles shall be made of solid bar steel.

The hand wheel function may also be obtained by an integral mounted hydraulic hand pump which can be manually vented to disengage the hydraulic cylinder

11.11 Limit stops

Limit stops shall only be provided when specified on the engineering data sheet.

Limit stops may not be part of the hand wheel mechanism, when provided. Adjustable limit stops shall be bolt type, adjustable over the full valve stroke, and be provided with a locking nut to prevent tampering. Non-adjustable limit stops shall be as per Valve Manufacturer's design.

To prevent unauthorized adjustments, the limit stops shall be provided with a security means, e.g. protective cap, special-shape key, etc.

The Valve Manufacturer shall set the limit stops at the required minimum or maximum valve opening.

11.12 Lifting devices

Removable lifting devices shall be provided for all valves heavier than 50 kg. The lifting devices shall be positioned in such a way that the completely assembled valve is in a straight position for mounting it in the adjacent piping, and in such a way that lifting slings cannot touch or damage any control component (e.g. positioners, air sets, etc).

For vertically installed valves, lifting lugs shall be provided for both horizontal and vertical lifting.

Butterfly valves are exempted from lifting lugs due to their shape; they are normally installed using lifting slings.

All lifting locations on valve and actuator shall be provided with an AISI 316 text plate stating for which purpose they can be used (e.g. valve, or actuator only, or both).

Lifting devices shall be removed after installation, stored and periodically strength tested as part of other lifting equipment in the facility. When required by the applicable local regulations, lifting devices shall be supplied with a strength test certificate.

11.13 Air tanks

Air tanks, associated accessories and supports shall be minimum AISI 316.

Air tanks shall have a design pressure superior to the maximum air supply pressure, avoiding the need for a pressure relief valve.

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12. Inspection and testing

12.1 General

The minimum rules and requirements related to inspection and testing of valve manufacturing are laid out in **GS EP PVV 142**. This complementary section provides more detailed requirements adapted to the manufacturing of control and choke valves.

The required inspection and testing plan (ITP) for valve manufacturing is divided into:

- Standard ITP: to be provided by default for 100% of the supplied valves
- Optional ITP: to be provided when specified by the purchase order, project specification or engineering data sheet, possibly per individual valve.

The standard tests are to be executed for 100% of the supplied valves by the Valve Manufacturer. Any test performed by his sub-suppliers may not be considered as a substitute for the tests and inspections listed here-after.

The Valve Manufacturer shall provide, free of charge, factory access and all necessary means to Company, or his representative, and to Contractor or Package Vendor, or their representative, for the witnessing of all tests and inspections described here-after. The 'representative' may be a designated Inspection Agency.

The minimum witness rate (excluding individual audits) for inspection and testing shall be as listed here after:

Table 2 - Extent of witnessing rate for inspection and testing

valve size (inlet flange)	All valves types and all service classes	All valves being: - Choke Valves - Severe Service	All other valves service class A, B, C, D all ASME classes and API 5000	
	pressure classes ≥ API 10000	all pressure classes	pressure classes ≤ 600	pressure classes > 600
≤ NPS 10"	100%	100%	25%	50%
≥ NPS 12"	100%	100%	100%	100%
			with a minimum of 1 valve per: - valve model - pressure class - valve size	

An individual test report shall be supplied for each supplied valve, and which shall accordingly be identified by an appropriate fabrication numbering system. A test report addresses one assembled valve only. All test reports and test certificates by third parties shall be collected and adequately organised in the Vendor Documentation books supplied with delivery and being available during inspections.

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12.2 Material certificates

The Valve Manufacturer shall submit material certificates giving the results of the chemical analysis and of the mechanical tests carried out in accordance with the requirements of the reference codes and standards for all metallic and non-metallic process wetted and pressure containing materials.

Cast and forged components shall only be accepted when they meet the requirements of the impact test at the given test temperature as per Table 3 here-after. Any component failing the impact test shall be rejected. Impact test results, including the specimen test temperature, shall be clearly stated on the material certificates.

Important note:

Table 3 applies to ASME/ASTM codes and standards. Different and more restrictive criteria may apply when the supply must comply with the [European Pressure Equipment Directive \(PED\) 97/23/EC](#). In case of conflict, the most restrictive criteria shall apply.

Table 3 - Impact test criteria for pressure-containing cast and forged components

Material	Design Temp.	W. T.	T Test	Impact Test Value
Carbon Steel	T ≥ -29°C	< ½ inch	n.a.	Impact testing not required
Low-Alloy Steel		≥ ½ inch	-29°C	min. 20 J average for 3 specimen min. 16 J for individual specimen unless otherwise specified
L.T. Carbon Steel Low-Alloy Steel	-29°C > T ≥ -46°C	All	-46°C	As per ASTM A 352 or: min. 20 J average for 3 specimen min. 16 J for individual specimen, whichever is greater, unless otherwise specified
SS 300 series (316, CF8M, etc.) SS 400 series (Monel 400 etc.)	All	All	Ambient	Impact testing not required, but in case of sour service subject to hardness test with HRC 22 max. or according ISO 15156-3
Duplex St. Steel	T ≥ -29°C T ≥ -46°C	All	-46°C	min. 27 J average for 3 specimen min. 20 J for individual specimen unless otherwise specified
Nickel-Alloy Steel Stainless Steel	-46°C > T ≥ -101°C	All	-101°C	As per applicable ASTM standard
9% Nickel-Alloy Stainless Steel	T < -101°C	All	-101°C	As per applicable ASTM standard
For all materials: the minimum impact test values are related to tests performed on full-section impact test specimen (10x10mm). Values for sub-sized specimen (when required) shall be agreed on by Company. Impact testing shall be performed per ladle (furnace) charge .				

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- **For bar stock and non-metallic components:** the steel mill or component manufacturer shall be clearly visible at the final product by means of embossed, stamped or laser engraved number (printing is only allowed for non-metallic parts), as per material certificate.
- **For cast or forged components:** the casting company identification and heat number shall both be clearly visible at the final product by means of embossed or stamped number, as per material certificate and/or heat number.

The material test report (certificate) shall clearly indicate/identify:

- Testing laboratory
- Foundry / Steel mill
- Heating numbers
- Chemical composition analyses
- Impact test temperature, impact and hardness test results

Material certificates shall be provided for any valve as follows, as per [EN 10204](#):

Table 4 - Type of material certificate required for each valve part

Valve Component	Minimum type of Material Certificate	
	service class A	service class B, C, D
Body (cast and forged)	3.1	3.1
End flanges (welded or bolted to body)	3.1	3.1
Bottom flanges	3.1	3.1
Bonnets	3.1	3.1
Bolting (for pressure containing parts)	2.2	3.1
Stem & pressure containing trim parts	2.2	3.1
Seats & Retainers	2.2	2.2
Seals & Gaskets	2.1	2.1
Packing Assembly ^(Note 1)	2.2	2.2
Bellows	2.2	3.1
Regulator Lower Spring Casing ^(Note 2)	2.2	3.1
Regulator stem & and trim parts	2.1	2.1 + PMI ^(Note 3)

Note (1): Not required when packing assembly is homologated by Company or certified by third party for compliance with fugitive emissions (being limited to valve model/size/class).

Note (2): Only in case hydrocarbon fluid is used as the control medium.

Note (3): Type 2.1 certificate applies for final machined product where traceability marking is impossible. The Valve Manufacturer shall apply Type 3.1 material certificate for the raw material.

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In case of self-acting control valves being equipped with a special actuator using the process medium for actuation: material certificates for the actuator shall be provided for all process-wetted parts in case of hydrocarbon process fluid, as per requirements for the valve body.

12.3 Pressure testing

Hydrostatic shell tests shall be executed for 100% of the supplied valves (control valves, choke valves and regulator valves) by the Valve Manufacturer in accordance with [ISA 75.19.01](#), which is in compliance with [ASME B16.34](#), but more practically dedicated to control valves, listing all ASME material groups and associated test pressures, including 'Special Class Valves' as defined in [ASME B16.34](#).

Other standards for pressure testing of metallic valves, such as IEC or ISO, may not be applied and are therefore not referenced in section 2.

Hydrostatic shell tests shall be applied to all **final machined** pressure-containing components at 1.5 times of their ASME or API Class rating, either individually or assembled. Hydrostatic pressure testing of non-final machined pressure containing parts is not permitted, it can only be considered as an early foundry quality test.

Hydrostatic tests shall be performed in-house by the Valve Manufacturer.

Regardless the type of valve and to which standard it has been designed, the minimum duration for hydrostatic shell tests for both internal and for witnessed tests shall be as per [API 6D](#) (and not as per ISA, ISO, ASME, IEC, or other standard):

Table 5 - Minimum duration of hydrostatic shell tests

Valve Size (inlet flange)	Duration (minutes)
≤ NPS 4"	2
6" ≤ NPS ≤ 10"	5
12" ≤ NPS ≤ 18"	15
≥ NPS 20"	30

However, [API 6A](#) monogrammed valves shall be hydrostatic tested in compliance with [API 6A](#).

Extended pressure tests up to 30 minutes can be requested by Company, or his representative, as long as stabilization is not achieved, or because of unsuspected behavior of the valve, or when a particular casting quality assessment is requested.

Dynamic stem seals which could be damaged by the hydrostatic shell test pressure, or trim parts that do not affect the pressure boundary, need not to be installed during testing. However, valves tested without stem sealing assembly installed shall be subject to a packing test as per [IEC 60534-4](#), refer to section 12.11.4 of this specification.

Bellows shall be tested separately at 1.1 times the maximum shut-off pressure.

The Valve Manufacturer shall test and provide a test report for each individual valve.

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12.3.1 Cryogenic service valves

Cryogenic service valves shall be hydrostatic tested for all pressure containing parts as here-above prior to cleaning, drying and final assembling, followed by a dedicated thermal cycle testing program as specified in section 12.8.

12.3.2 Hydraulic actuators, accumulators and hydraulic control assembly

Hydraulic actuators and accumulators shall be individually hydrostatic tested at 1.5 times design pressure for at least 5 minutes (using hydraulic oil) prior to assembling to valve.

After assembling of the entire hydraulic control assembly as supplied with the valve, the complete assembly shall be hydrostatic tested again at 1.1 times design pressure for at least 5 minutes.

Then a leakage test of the complete hydraulic assembly shall be performed at 1.1 times design pressure. Zero leakage shall be the acceptance criteria, by cutting off the pressure source and monitoring the pressure drop for at least 30 minutes. Pressure stabilization before may be required before pressure drop monitoring starts, and slight increase of pressure during monitoring may occur due to thermal effects.

12.4 Deformation inspection

Valves with bolted bonnets of ASME Class 900 and above, sized NPS 12" and above, shall be subject to deformation inspection directly after the hydraulic shell test, randomly with a minimum of one valve per valve model, per pressure class and per valve size.

For this, the bonnet (and bottom flange when existing) shall be dismantled, their gaskets removed and gasket surfaces cleaned. Then the bonnet and bottom flange shall be re-installed without gaskets or nuts, in order to verify any deformation of the body, bonnet or bottom flange. There shall be no excessive binding or friction between parts during assembling and the flange parallelism and flatness shall be within manufacturing tolerances, using feeler gauges or fine-film tape.

This inspection/test shall be done before final valve assembling, and only with the presence of a Company representative.

12.5 Seat leakage test

All valves with a seat leakage class V or Class VI shall be individually tested in accordance with [IEC 60534-4](#).

All valves other than Class V or Class VI shall be tested randomly, with a minimum of one valve per valve model, per pressure class and per valve size.

The test medium shall be liquid for all classes, except Class VI shall be gas tested.

The seat leakage test shall be performed conform [IEC 60534-4](#) Test Procedure 2, i.e. at $\pm 5\%$ of the maximum shut-off pressure as specified on the engineering data sheets, or as per ASME Class design pressure.

The seat leakage test pressure for self-acting pressure regulators shall be the set pressure.

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Regardless the type of valve and to which standard it has been designed, the minimum duration for seat leakage tests for both internal and for witnessed tests shall be as per [API 6D](#) (and not as per ISA, ISO, ASME, IEC, or other standard):

Table 6 - Minimum duration of seat leakage tests

Valve Size (outlet flange)	Duration (minutes)
≤ NPS 4"	2
≥ NPS 6"	5

However, [API 6A](#) monogrammed valves shall be seat leakage tested in compliance with [API 6A](#).

The Valve Manufacturer shall state on the test reports:

- Valve tag number
- Test medium
- Test differential pressure
- Flow direction
- Measured seat leakage flow rate
- Measured leakage to atmosphere (via vent outlet) for pressure regulators
- Leakage class and allowable seat leakage flow rate
- Test results (packing adjustment, other works, failed, passed, etc.).

12.6 Dimensional inspection

All valves shall be inspected for their face-to-face or end-to-end dimensions as per reference standard.

All valves shall be inspected for their flange face finish in accordance [GS EP PVV 142](#).

12.7 Functional test

All valves shall be functionally tested being completely assembled with actuator and all accessories fitted, after all other tests are completed and preferably after final painting (sand-blasting and painting after accessories are fitted is to be avoided).

The packing assembly shall be correctly tightened as per Valve Manufacturer's assembling procedure. The valve stem may be lightly lubricated.

The following tests shall be performed for 100% of the supplied valves:

- Fail-safe position (open, close or lock), including solenoid valves when installed
- Positioner calibration: 4 to 20 mA corresponds to 0 to 100% opening
- Stroking time: ensure full stroke duration at minimum air/hydraulic supply pressure

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And when installed:

- Limit switches: shall switch at their functional position within 3% of end of stroke
- Analogue position feedback: 4 to 20 mA corresponds to 0 to 100% opening
- Hand wheel: achieve full open and closed position, starting at mid position
- Limit stops: shall be set at required position after above tests.

And mandatory for anti-surge and compressor recycle valves:

- Overshoot test on a step change from 25% to 75% opening, and vice-versa, not exceeding 5% overshoot (overshoot cannot be detected when stepping to 0% or 100%).
- Valve footprint curve (full open-close-open hysteresis cycle) through valve software

Stroking times shall be tested on a 100% control signal step change, in both directions. When boosters are installed, additional stability (overshoot) test shall be done at 25%, 50% and 75% control signal step changes using electronic plotting equipment. Minimal overshoot shall be obtained (< 5%), otherwise speed control devices are to be installed.

When requested by Company, combined hysteresis and dead band tests shall be conducted as per [IEC 60534-4](#), and shall be $\leq 1\%$ of full range input signal.

Functional tests are normally performed under atmospheric conditions (zero differential pressure and at ambient temperature), unless stated differently in the Purchase Order.

12.8 Thermal cycle tests for cryogenic service valves

The Valve Manufacturer shall develop a detailed test procedure based on this section, including the cool down method, test equipment and test set-up for Company approval prior to testing. Detailed test reports per test, including calibration certificates of test equipment shall be included in the final test report.

The Valve Manufacturer's test procedure shall clearly illustrate the test rig, valve supports, temperature/pressure/flow sensors, purge schematic with gas supply, purge valves, etc. The valves shall be equipped with blind flanges provided with purge connections and passages for temperature sensors, submerged into the coolant bath (cold box).

Temperature sensors and recording shall be provided for at least:

- Room temperature
- Body outside temperature
- Closure member (if impossible: representing adjacent to closure member)
- Bonnet (at stuffing box / stem seal location)
- Coolant (inside cold box)

The seat leakage test shall be measured by an adequate flow meter. The leakage to the outside of the valve shall be measured using a helium mass spectrometer with a sniffer probe. The test procedure shall define the acceptance value as a function of each valve size/design.

The test/purge gas shall be either pure helium or a helium/nitrogen mixture (min. 2% helium). Its dew point shall be constantly measured, and always remain 5°C below test temperature.

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Attention and precautions shall be made to the fact that most of the testing in this section is based on gas testing. As such, dedicated test areas, protecting personnel by means of concrete walls/bunkers shall be provided, including protection against liquid nitrogen projection occurring from a failing valve submerged in liquid nitrogen. The cold box is not considered a safe barrier. Therefore, monitoring of pressures, temperatures and flow rates from a safe location is required, the use of electronic sensors is therefore recommended.

The valve shall be stroked remotely using the valve's positioner; valve stroking shall be recorded on a PC retrieved via HART signal.

Each cryogenic control valve shall be subject to the following tests and assembling sequence. The purpose is to demonstrate that the valve remains functional and leak tight throughout a full thermal cycle. Therefore, recording and comparing the stroking times at ambient and cryogenic temperatures is an important parameter. For this reason it is important to set and lock the air supply pressure to the positioner; the air supply pressure to positioner shall be noted in all test sheets during all test stages.

CWP means Cold Working Pressure; the maximum allowable pressure at minimum design temperature.

For bi-directional valves, seat leakage shall be tested in both directions.

1. Pre-assembling tests

- Hydrostatic testing of pressure-containing valve parts as per section 12.3.

2. Valve & actuator assembling and functional tests

- Thorough cleaning and drying of all valve parts, then final valve assembling
- Final assembling of actuator and control components (no temporary parts)
- Final adjustment of positioner and other control components
- Functional test for complete valve, actuator & control assembly
- Set & lock air pressure to positioner and record 5 times open/close stroking times.

3. Pre-cryogenic tests (at ambient temperature)

- Valve purged at low pressure (2 barg) test gas
- Perform functional test and record 5 times open/close stroking times
- Perform body tightness leak test, for 15 minutes at 100% CWP, valve open
- Perform seat leakage test, for 15 minutes at 110% CWP.

4. Cryogenic tests (at minimum design temperature)

- Cool down the valve to minimum design temperature
- Valve shall be kept purged at 2 barg with test gas
- Perform functional test at 2 barg and record 5 times open/close stroking times
- Perform seat leakage test, for 15 minutes at 110% CWP
- Perform functional test at 100% CWP and record 5 times open/close stroking times
- Perform leakage test of bonnet and stem seal assembly at 110% CWP, valve open.

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5. Post-cryogenic tests (at ambient temperature)

- Valve purged at low pressure (2 barg) test gas
- Perform functional test and record 5 times open/close stroking times
- Perform body tightness leak test, for 15 minutes at 100% CWP, valve open
- Perform seat leakage test, for 15 minutes at 110% CWP.

The valve shall be rejected in case the stroking times during or after cryogenic tests differs more than $\pm 5\%$ from the pre-cryogenic tests. Rejected valves may be resubmitted for retesting only after the cause or part has been identified and corrected or replaced. All rejections and corrections shall be noted in the test report.

12.9 Setpoint test for self-acting pressure regulators / control valves

Self-acting pressure regulators / control valves shall be setpoint tested using air or water as the test medium, at a low flow as per Valve Manufacturer's procedure or real flow when deemed necessary by Company (e.g. self-acting pressure control valves for water injection).

This test may be combined with the seat leakage test.

12.10 Standard tests for API 6A choke valves

All API 6A classified choke valves shall be subject to the manufacturing and quality control requirements as defined per PSL class. The Valve Manufacturer shall clearly list all requirements as per associated PSL class during tender.

The functional testing and their acceptance criteria for choke valves shall be as for other control valves described above.

12.11 Optional tests

Optional tests can be requested for in the project specification, Purchase Order, or as part of an audit or vendor approval program. These tests may also be requested, free of charge, at any stage by Company in case manufacturing faults have been discovered for previously supplied valves in order to re-evaluate manufacturers and their sub-suppliers.

Optional tests can be requested for 100% or other percentage of the supplied valves, but shall always be a minimum of one valve per valve model, per pressure class and per valve size.

12.11.1 Additional material examinations

Additional and special material examinations can consist of:

- Radiographic or ultra-sonic examinations to prove/analyse the quality of castings / forgings
- Hardness tests for particular spots or particular components
- Impact tests on specimens
- Other examinations as deemed necessary.

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12.11.2 Helium pressure test

In order to verify the quality of pressure-containing parts, helium shell pressure tests shall be conducted as follows:

- Assembled valve with internals removed
- Packing compartment and end connections adequately blinded
- 98% nitrogen / 2% helium mixture
- 60 minutes test duration, at 1.1 times the ASME Class design pressure.

Gas pressure tests shall only be conducted after hydrostatic tests. Testing ratios shall be defined by Company.

12.11.3 Stem seal assembly test and fugitive emissions test

Stem seal assembly tests are considered as general leakage verification or as a manufacturing quality control for any given control or choke valve type and service. However, they are not a replacement for the fugitive emissions tests as per [ISO 15848-1](#), because the stem seal assembly tests below are conducted with low pressure air, while fugitive emissions tests are to be conducted with helium at full ASME Class design pressure.

- Stem seal assembly tests shall be conducted as per [IEC 60534-4](#). The test medium may be compressed dry air or nitrogen at 4 barg. Leakage shall be detected using lead detection fluid sprayed on top of the seal. No visible leak (bubbles) shall occur.
- Fugitive emissions tests shall be conducted as per [ISO 15848-1](#) at ASME Class design pressure as per section 12.7. The test and type test report shall be established by a recognised third party approved by Company.

When either test fails and when repair, replacement or retightening of the seal is required, then the test percentage of the same valve model shall be doubled, and any other tests performed before these tests shall be redone.

12.11.4 Capacity test

Capacity tests (Cv value) shall be conducted as per [IEC 60534-2-3](#) on a fully IEC compliant and calibrated test system at Valve Manufacturer's factory or by a recognised third party, both subject to Company's prior approval.

12.11.5 Vacuum test

Control valves installed in vacuum service (e.g. seawater treatment) shall be tested for reverse packing leakage and overall tightness. A dedicated test and inspection procedure shall be established by the Valve Manufacturer, subject to Company review and approval.

13. Painting

All valves and their actuator, and any carbon steel accessory, shall be painted as per:

- [GS EP COR 350](#) for valves located at coastal and offshore process facilities
- [GS EP COR 351](#) for valves located at offshore floating structures (hulls)

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- **GS EP COR 354** for valves located at onshore process facilities
- Or according to the particular project specification(s).

The applicable painting system and final painting colour shall be clearly indicated at the engineering data sheets by Contractor or Package Vendor. The actuator shall have the same painting system as the valve body. In case the valve body does not require painting, then the actuator and any carbon steel accessory shall be painted as per painting system P01.

Painting shall only be applied after all mechanical tests and inspections have been performed, but the installation of any accessory (and functional testing therefore) is preferably done after final painting. Under no condition may any accessory, tubing or accessory brackets & bolting, nor the packing flange and bolting, be painted.

Tag plates and name plates (refer to section 13) shall be installed after final painting.

14. Valve marking

All valves shall be provided with the following marking:

- Dedicated flow direction indication being an embossed arrow in the casting or AISI 316 stainless steel plate, and flange designation for 3-way valves at each flange edge, refer to section 7.2.3.
- Dedicated AISI 316 stainless steel plate to identify the fugitive emission certification (when applicable) as per [ISO 15848-1](#), refer to section 9.8
- Dedicated AISI 316 stainless steel tag plate(s) for any separately tagged accessory
- Dedicated AISI 316 stainless steel plate(s) for valve identification (tag) and valve marking in accordance with [IEC 60534-5](#) and complementary information as provided here after. Depending on the available space, this can be more than one plate.

Company requires that all mandatory + supplementary information as per [IEC 60534-5](#) is provided on the plates, plus some additional information particular to Company:

Table 7 - Mandatory valve marking details

Origin	Item	Description	Location		
			On plate	On valve body	On flange edge
IEC	1	Nominal size (e.g. NPS 6")	•	•	•
IEC	2	Pressure rating (Class, e.g. ASME 600, API 5K)	•	•	•
IEC	3	Body material	•	•	
IEC	4	Manufacturer's name / logo	•	•	
IEC	5	Flow direction	•	•	
IEC	6	Ring joint number (if applicable)	•		•
IEC	7	Max. allowable working temperature (in °C)	•		
IEC	8	Flange identification (e.g. RF, RTJ)	•		•

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Origin	Item	Description	Location		
			On plate	On valve body	On flange edge
IEC	9	Max. allowable working pressure (in barg)	•		
IEC	10	Manufacturer's type, model	•		
IEC	12	Melt identification (i.e. heat number)		•	
IEC	13	Trim material	•		
IEC	15	Lining material (if applicable)	•		
IEC	17	Inspector stamp (Class Society)		•	
IEC	19	Rated Cv coefficient	•		
IEC	20	Max. allowable diff. pressure (if applicable)	•		
IEC	22	Serial number	•	•	
IEC	23	Rated travel (in mm or degrees)	•		
IEC	24	Inherent characteristic (e.g. Equal %, Linear)	•		
IEC	25	Tag number	•		
IEC	26	Failure position (i.e. Fail Open/Close/Lock)	•		
IEC	27	Permitted mounting position	•		
IEC	28	Actuator bench setting (i.e. min/max barg)	•		
CPY	-	Trim details (model, number, etc.)	•		
CPY	-	Valve service class as per GS EP PVV 142	•		
CPY	-	Special service nature (H ₂ S, etc)	•		

All plates shall be securely fixed to the valve body (or alternatively on the yoke) by means of AISI 316 screws or rivets at the factory after final painting; attaching by wire is strictly prohibited.

The Valve Manufacturer shall provide name plate drawings for comment and approval as part of the mandatory vendor documentation before/during manufacturing.

The actuator should be equipped with a dedicated nameplate indicating model and size.

All information on plates and labels shall be stamped or engraved by laser. The use of printing etc. is strictly prohibited. All information on body and flange edges shall be sized to be clearly readable after final painting and in the normal installed position.

15. Preservation and packaging

Valves are often exposed to longer periods of ambient storage conditions and to construction environments. Even when installed in the final piping, it may take some time before electrical and pneumatic links are being hooked-up to the accessories.

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For all these reasons, the Valve Manufacturer shall provide the following:

- All cable and tubing entries shall be plugged with **threaded** plastic or metal plugs (not by means of simple conical plugs) providing adequate IP50 level jet/dust protection
- Cable glands shall be fitted or not as per Purchase Order, but if installed it shall be equipped with adequate plastic IP50 level blind plug inside cable gland.
- All end connections shall be equipped with self-clamping plastic flange protectors, adequately protecting the **entire flange face** against any impact
- All valves shall be packaged (e.g. crating, hermetically sealed foil) as per project specification included in the Purchase Order. Crates shall be clearly marked outside with valve tag number(s), project or facility name and purchase order number.

In case entire spare valves are ordered, being subject to long term storage onboard the facility or onshore warehouse, then the Valve Manufacturer shall provide and install fully-bolted painted-metal blind flanges mounted on the valve using adequate gaskets to avoid humidity and dirt ingress.

16. Installation and commissioning

Control & choke valves shall be easy accessible for inspection and maintenance (trim replacement or complete valve removal).

Control & choke valves may **not** be installed during the construction, flushing or cleaning of the adjacent piping, instead, spool pieces shall be used.

Removing the internals is not an acceptable practice, as this would render invalid the overall integrity, calibration, functional test, and overall tightness of valves subject to fugitive emissions.

17. Spare parts and special tools

In case any special tool is required for the maintenance or in-situ replacement of actuators, internals, etc., then the Valve Vendor shall include these tools during tender and supply at least 3 sets of each special tool as part of the spare parts.

Spare parts for commissioning, start-up and 2 years operation are normally defined by the project specification included in the Purchase Order. In the absence of a project specification, the Valve Manufacturer shall by default prepare and complete the spare part lists as defined by **GS EP EXP 203** and **GS EP EXP 217**.

18. Documentation

18.1 Documentation to be provided during tender

The Valve Manufacturer shall supply 100% of the following statements, calculations, documentation and certificates with bid.

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1. Statement of Compliance

With **GS EP INS 120** + **GS EP PVV 142** + applicable project specifications and data sheets
 + **GS EP PVV 150** for cryogenic service valves
 + **USP-NF** Class IV for sanitary service valves.

2. List of Deviations

From applicable GS, project data sheets and specifications

3. Declaration of Materials and Manufacturing Origin

- All casting companies for the supply of cast and forged components
- All steel mills for the supply of bar stock materials
- All companies for welding and examination of cast and forged components
- All companies for machining, assembling and testing
- Valve Manufacturer's factory(s) location(s) used for the order concerned.

4. Calculations

Standard Calculations

Calculated + Rated Cv, min/max % opening, regulator flow rate, cavitation factor, noise prediction, recovery factor, pipe factor, etc.

Severe Service Calculations (as applicable)

Fluid velocity exiting the trim or Sigma values (liquid) or kinetic energy (gas).

Choke Valve Calculations (as applicable)

Erosional velocity (2-phase) or severe service calculations, multiple production cases.

Emissions study (as applicable)

Gas emission calculations for instrument-gas operated valves.

5. Trim design

Characteristic, flow direction, model, size, materials, leakage class

6. Valve body

Model, size, dimensions, end connections, materials for all individual components

7. Packing assembly

Type, model, materials for each valve model, pressure class and valve size

8. Actuator

Type, model, materials, regulator pilot components, HPU technical proposal (as applicable)

9. Accessories

Type, model, materials, datasheet for each accessory

10. Certification

ATEX/**IECEX**, EMC, IP, SIL, GOST, Fugitive Emissions, **API 6A** certificate (as applicable)

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11. General

Overall dimensions and weight of full assembly (valve + actuator)

12. Different standardised components

Commercial impact if different standardised accessories (items under 9) shall be supplied

18.2 List of Deviations

All deviations, as listed in the mandatory "List of Deviations", attached the technical proposal, shall be reviewed, clarified, approved or rejected one by one for Company final approval before Purchase Order.

18.3 Documentation to be provided after Purchase Order

Before manufacturing commences, The Valve Manufacturer shall re-issue all design and calculations provided during tender. Contractor and Package Vendor shall duly verify and correct any erroneous data before Company review and approval.

Manufacturing may only commence after Company approval of these documents, including:

- Inspection and test plan (ITP), including welder and inspector qualifications
- Manufacturing plan (selected casting companies, steel mills and other sub-vendors).

During manufacturing, the Valve Manufacturer shall issue for Company and Contractor review and approval.

- Inspection and testing procedures for all applicable items in section 12
- Name plates and tag plates drawings.

18.4 Final documentation

Final documentation shall include as a minimum:

- All documents updated as-built/as-supplied as listed in section 18.1, item 1 thru 11
- Test report and test certificates as per Inspection and Test Plan (ITP), in accordance with section 12 and the Purchase Order instructions
- Material certificates, NDE results/photos, (repair) welding examinations, etc.
- Digital valve footprint curve and overshoot graph for anti-surge and recycle valves
- Type approval(s) & reports by [Class Society](#) (when applicable)
- Spare parts list in accordance with section 17 and/or the Purchase Order instructions
- Product bulletin and data sheet for any supplied item
- Installation, Operation and Maintenance (IOM) manual.

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Bibliography

ASME V

European Directive
2003/10/EC dated 06
February 2003

European Directive
2004/108/EC dated
15 December 2004

FCI 91-1

GS EP INS 146

IEC 60079 – All parts

IEC 60529

ISA 75.02

ISA 75.13.01

ISA 75.25.01

Non-destructive Examination

Directive of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (Noise)

Directive of the European Parliament and of the Council on the approximation of the Laws of Member States relating to electro-magnetic compatibility (EMC)

Standard for Qualification of Control Valve Stem Seals

Design of generation and distribution of hydraulic energy

Electrical Apparatus for Explosive Gas Atmospheres

Degrees of Protection Provided by enclosure (IP code)

Control Valve Capacity Test Procedure

Method of Evaluating the Performance of Positioners with Analog Inputs Signals and Pneumatic Output

Test Procedure for Control Valve Response Measurement from Step Inputs