

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 120

Control valves

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1. Scope

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

- Control valves
- Self-acting pressure regulators

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

2. Reference documents

The equipment shall satisfy the requirements of the country of installation and specific standards referred to in this specification.

Where national regulations exist, their provisions and those of standards and codes they refer shall apply, supplementing or amending the provisions of this general Specification.

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 addendums, is the latest revision published at the effective date of this document.

Reference	Title
ANSI/FCI 70-2	Control Valve Seat Leakage
API SPEC 6A	Specification for Wellhead and Christmas Tree Equipment
API SPEC 6D	Specification for Pipeline and Piping Valves
API STD 598	Valve Inspection and Testing
API STD 609	Butterfly Valves: Double-flanged, Lug- and Wafer-type
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.34	Valves - Flanged, Threaded and Welding End
ASME B16.47	Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
ASME B31.3	Process Piping
ASTM A352	Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low- Temperature Service
ASTM A703	Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts

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Reference	Title
Directive 2014/34/EU	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the Laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast) (ATEX) (Superseeds Directive 94/9/EC)
Directive 2014/68/EU	Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the Laws of the Member States relating to the making available on the market of pressure equipment (recast) (PED) (Superseeds Directive 97/23/EC)
EN 10204	Metallic products - Type of inspection documents
IEC 60034-1	Rotating electrical machines - Part 1: Rating and performance
IEC 60534 (Parts 2-1; 2-3; 3-1; 3-2; 4; 5; 8-3; 8-4)	Industrial-process control valves - Parts 2-1; 2-3; 3-1; 3-2; 4; 5; 8-3; 8-4
IECEX	International Electrotechnical Commission System for Certification to Standards relating to Equipment for use in Explosive Atmospheres (IECEX System)
ISA Guide (ISBN 978-1556175657)	Control Valves, Practical Guides for Measurement and Control
ISA-75.01.01	Industrial-Process Control Valves - Part 2-1: Flow capacity - Sizing equations for fluid flow under installed conditions
ISA-75.05.01	Control Valve Terminology
ISA-75.19.01	Hydrostatic Testing of Control Valves
ISA-RP75.23	Considerations for Evaluating Control Valve Cavitation
NACE MR 0175	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production
ISO 15156-3	Petroleum and natural gas industries - 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 15848-1	Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves
MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
MSS SP-61	Pressure Testing of Valves

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Reference	Title
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 addendums, is the latest revision published.

Reference	Title
GS EP COR 004	Limiting flow velocities calculations for erosion corrosion purpose
GS EP COR 170	Materials for upstream sour service application - Specification for selection and design
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 design criteria
GS EP DEV 001	Asset Objects Tagging
GS EP INS 101	Instrumentation Design
GS EP INS 102	Instrumentation Identification
GS EP INS 114	Instrument Tubing and Fittings
GS EP INS 137	On/Off Valve Control Panels and Actuators
GS EP INS 138	Electric Actuators for On/Off Valves
GS EP MEC 253	Anti Surge System for Centrifugal and Axial Compressors
GS EP PVV 112	Piping material classes
GS EP PVV 150	Valves in cryogenic service
GS EP PVV 154	Ball Valves according to API SPEC 6D or API SPEC 6A
GS EP PVV 155	Gate, Globe and Check Valves
GS EP PVV 156	Axial Valves & Axial Flow Check Valves according to API SPEC 6D or API SPEC 6A
GS EP PVV 157	Butterfly Valves
GS EP PVV 611	Welding of pressure containing piping and equipment
GS EP PVV 612	Piping and equipment subject to severe sour service. Metallurgical and welding requirements

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Reference	Title
GS EP PVV 622	Piping and equipment subject to mild and intermediate sour service. Metallurgical and welding requirements

3. Terminology and Definitions

There are five types of statements in this specification, the “shall”, “should”, “may”, “can” and “must” statements. They are to be understood as follows:

Shall	Is to be understood as mandatory. Deviating from a “shall” statement requires derogation approved by Company.
Should	Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide a similar level of protection and this shall be documented.
May	Is to be understood as permission.
Can	Is to be understood as a physical possibility.
Must	Expresses a regulatory obligation.
Company	TOTAL E&P or any TOTAL E&P subsidiary.
Contractor	Any Party that has signed a Contract with Company for the Engineering, Procurement, Construction, and Installation in part(s) or in full of a project.
Vendor	The package Vendor sub-contracted by the Contractor or by Company.
Supplier	The Party that manufactures or supplies equipment, either individually or as a Packaged unit for the project.

3.1 Definitions

For the purpose of this specification, the definitions also given in [ISA-75.05.01](#) are applicable.

3.2 Abbreviations

The following terms and abbreviations will be used in this document.

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ATEX	Atmosphere and Explosives - European Union Directive 2014/34/EU
DN	Nominal Diameter
IP	Ingress Protection
ISA	Instrument System Automation society
ISO	International Standards Organization

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NDE	Non-Destructive Examination
NPS	Nominal Pipe Size
PID	Piping & Instrumentation Diagram

4. General Requirements

Control valves selection and design is based on the requirements of the particular process application, operating conditions, piping specification (material, class) and environmental conditions.

In general, control valves are to be used for throttling or modulating service.

Where on-off control service is required, ball valves should be used. For Design of Ball valves used for on-off control refer to [GS EP INS 137](#) and [GS EP PVV 154](#). However some requirements of [GS EP PVV 154](#) are not mandatory, such as bidirectional sealing, drain vent and ancillary connections when sealing is unidirectional, gas testing, or testing to [API SPEC 6D](#) or [API SPEC 6A](#).

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

Control valves and accessories selection shall also comply with [GS EP INS 101](#) (standardization, components application in hazardous area, instruments housings material, etc.).

4.1 Environmental Conditions

Control valves shall be suitably designed for permanent operation under the prevailing environmental conditions of the installation location or as specified by project particular Design Conditions.

It should be noted that the environmental conditions at the fabrication yard may be different to those of the final site location. Therefore, the fabrication yard storage and installation conditions shall also be taken into account.

4.2 Type Approval by IMO Class Society

Hull-related control valves on board 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.

5. Control Valves

5.1 Selection

5.1.1 Globe valves

The following selection order for the type of valve is applicable:

- 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.

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- c) Class 900 and above with RTJ connections: top-entry type control valves only.
- d) Valve designed according to [API SPEC 6A](#) Class 5000, 10000 and 15000: 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.

For erosive and severe service, top-entry type control valves are mandatory.

5.1.2 Segmented ball valves, Eccentric disc/plug valves

Segmented ball valves, Eccentric disc/plug valves shall be side-entry type.

5.1.3 Butterfly valves

Butterfly valves shall be side-entry type.

5.1.4 Axial flow valves

Axial flow valves shall be side-entry type.

5.2 Classification and Application

Control valve types are primarily classified as either linear motion or rotary motion.

5.2.1 Linear Motion Valves

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

5.2.1.1 Globe Valves

In general, globe valves shall be considered as first choice for clean hydrocarbon general service applications.

Globe valves shall be one-piece cast or forged body with bolted bonnet, straight-through, single ported, contoured/balanced plug, and of cage-guided design.

Cage design shall be multi-hole, removable type, to allow in-situ maintenance of cage, plug and seat ring.

Angle-type globe valve (not choke valves) can be considered if justified for applications with suspended solids (slurries), erosion, high pressure drop liquid service, flashing, self-draining piping design, etc.

Split body design is not accepted.

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

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- Cryogenic service
- Sanitary service.

5.2.1.1.1 Double-Ported Globe Valves

The use of double-ported globe valves is subject to Company written approval. The inherent higher leakage rate of double-ported valves inherently limits their application.

5.2.1.1.2 Three-way Globe Valves

The use of three-way globe valves should be limited to temperature control applications. Any other use shall be subject to Company written approval.

5.2.1.2 Axial Flow Valves

Axial flow valves shall be

- Cage-guided piston type
- One-piece cast body, integral seals or bolted bonnet with packing assembly, cage-guided balanced piston
- Linear or rotary actuated.

5.2.2 Rotary Motion valves

5.2.2.1 General

Rotary motion valves for throttling/modulating control application shall be either of:

- Segmented ball
- Eccentric disc/plug
- Butterfly type.

Other types of plug or ball valves shall be subject to Company written approval.

Rotary motion control valves design shall be, one-piece cast body with integral or bolted bonnet, trunnion-mounted closure member, allowing throttling control up to 90 degrees rotation.

Split-body or floating closure member (i.e. ball, disc or plug) design is not accepted.

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 of the flow direction.
- The seat retaining ring diameter is larger than the internal diameter of the adjacent piping.
- The use of bolting, locking devices, or lock welding in the process fluid stream is not permitted.

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5.2.2.2 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, erosive, high viscosity, and high rangeability applications.

5.2.2.3 Eccentric Disc and Plug Valves

Eccentric disc valves may only be used in case the available pressure drop is lower than 0.2 bars (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.

5.2.2.4 Butterfly Valves

Butterfly valves shall not be used above ASME Class 600 as per [GS EP PVV 157](#).

In general Butterfly control valves are accepted for seawater, steam and chemical services in all sizes, when the available pressure drop is low (e.g. gravity flow) and in cryogenic services (see section 5.2.4.3 below).

Butterfly control valves shall be designed to [API STD 609](#) as per [GS EP PVV 157](#) with the following exceptions:

- Triple eccentric design is not mandatory
- Examination, Inspection and Testing in compliance with section 11 Inspection and Testing of the present specification, not as per [API STD 598](#).

Non-lined butterfly valves shall have:

- An eccentric design with metal seats
- A flow efficient closure member to obtain a control range up to 85% of the operating stroke.

5.2.3 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

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- having a pressure drop > 30 bar

shall be designated as a self-acting control valve and comply with the design requirements for control valves.

Other self-acting valves shall comply with the requirements for self-acting regulators (refer to section 5.3.3).

5.2.4 Special Services Applications

5.2.4.1 Severe Service

Process applications identified as severe services shall require suitably designed specialized valves, therefore referred to as severe service control valve both in engineering documentation (datasheets, sizing calculations notes etc.) and procurement execution. Refer to section 5.4.5 for the definition of severe service conditions.

Severe service control valves should generally be cage-guided globe or angle type valve equipped with a multi-stage type trim. Design and selection of body and trim shall be supported by suitable total velocity control and kinetic energy calculation. Other types of valves may be selected, depending on the Process condition, with Company written approval.

5.2.4.2 Anti-Surge and Recycle Service

Anti-surge and recycle service control valves shall comply with this specification and **GS EP MEC 253**.

5.2.4.3 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.

Globe, axial flow valves, segmented ball and eccentric disc/plug type valves can be used for cryogenic service.

Globe valves can be either multi-hole cage-guided or contoured plug design.

Vibrations through the valve shall be avoided due to the weakening and embrittling of materials at cryogenic temperatures. When multi-stage trim is necessary, labyrinth type should be used, in order to reduce risk of vibrations.

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 or forged body, with bolted extended bonnet and integral flanged body.

Split body and wafer type end-connection design are not permitted.

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5.2.4.4 Sanitary Service

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.

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 are included in the Valve Scope of supply.

5.2.4.5 Lethal and Toxic Service

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 than 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
- Toxic service: "low fugitive emission" rotary motion type valves for 150, 300, 600# rated valves
- Toxic service: "low fugitive emission" linear motion type valves for valves rated 900# and above.

In all cases an [ISO 15848-1](#) low-emission certificate shall be provided.

If above toxic service valves do not meet the low fugitive emissions requirements, then bellow type valves shall be used.

5.3 Design Requirements

5.3.1 Process Criteria

As per [GS EP ECP 103](#) the pressure drop across a control valve should be at least 20% of the system dynamic pressure at normal flow rate, or 0.7 bar (10 psi), whichever is greater.

The velocity at the valve outlet must remain below the maximum velocity criteria provided in [GS EP COR 004](#).

In case of multi-phase mixtures, then the fluid data, including any solid particles, shall be provided as required by the sizing program of the Valve Supplier.

5.3.1.1 Piping Geometry Factor and Piping Arrangement

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.

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

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cooperation with the Valve Supplier 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 **GS EP ECP 103**.

5.3.1.2 Flow Conditions

For each control valve, the data sheet shall define, as a minimum, the process data for the following three flow conditions: normal flow rate, maximum flow rate and minimum flow rate.

Control valves should 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.

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.

For self-acting pressure regulators, the maximum droop (offset) at maximum flow shall be:

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

5.3.2 Valve Characteristics

Valve trim characteristics (inherent), should preferably be determined based on dynamic process simulations. Where this is not possible, then the criteria using a ratio "R", referred to as "control valve authority", based on the known values of the allowable pressure losses across the valve and the circuit (piping system) should be used. Refer to Table 1 below.

The value of "R" should be preferably kept between 0.2 and 0.5 by inherent design of process piping 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, vapour, steam	Equal %	Linear
	Compressor recycling, surge control	Equal %, Linear, Modified Linear	
Temperature Control	Mixing of 2 liquids having different properties	Equal %	Linear
	Gas, vapour, steam	Equal %	Linear
	Heat exchanger bypass	Linear	Linear
	Other	Equal %	Linear

Notes:

- 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.

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.

Quick opening type trims shall be avoided and their application subject to Company written approval.

5.3.3 Self-Acting Regulator Requirements

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. Pilot-operated regulators are not accepted for downstream (back) pressure regulation for liquid service.

Self-acting pressure regulators may use a non-metallic closure member for applications other than 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.

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-