

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 121

Choke valves

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1. Scope

This specification describes the minimum requirements for the design, sizing, selection and installation of Choke valves 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 chokes valves which are part of a wellhead assembly for which dedicated Company General Specifications apply.

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
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.34	Valves - Flanged, Threaded and Welding End
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
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)

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Reference	Title
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; 4; 5; 8-3; 8-4)	Industrial-Process Control Valves - Parts 2-1; 2-3; 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 Guide 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
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
ISO 28079	Hardmetals - Palmquist toughness test
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
MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
UK HSE Safety Notice 11/2005	Potential catastrophic failure of pressure-balanced cage-guided control valves and chokes

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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 Operated ON/OFF Valve Actuators
GS EP PVV 112	Piping material classes
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 611	Welding of pressure containing piping and equipment
GS EP PVV 612	Piping and equipment subject to severe sour service. Metallurgical and welding requirements
GS EP PVV 622	Piping and equipment subject to mild and intermediate sour service. Metallurgical and welding requirements

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

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4. General Requirements

Choke valves shall be selected and designed based on the requirements of the particular process application, operating conditions, piping specification (material, class) and environmental conditions.

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

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

Choke 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

Choke 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

Some choke 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 choke valve has a Class requirement.

5. Choke Valves

5.1 Classification

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.

5.2 Selection

5.2.1 Angle Type Choke valves

Choke valves are generally angle body type. In that case the choke valve is mandatorily top-entry type.

Top-entry angle body choke valves shall be used for fluids containing solids/sand or for chokes in erosive service.

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5.2.2 Axial Flow Valves

Axial flow type body is not permitted for fluids containing solids/sand or for chokes in erosive service.

Axial flow valves are generally:

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

5.3 Lethal and Toxic Service

Choke valves for lethal and toxic service are not permitted to be installed in poorly ventilated, confined areas 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".

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.

5.4 Design Requirements

The Contractor or the Package Vendor shall prepare an engineering datasheet for each choke valve.

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 ([GS EP COR 004](#))
- Naturally present contaminants (e.g. H₂S, CO₂) and their worst case concentration
- Added contaminants (e.g. methanol, corrosion inhibitor, etc.)
- Start-up conditions (e.g. maximum differential pressure and start-up flow rates)
- Normal operational conditions (e.g. the minimum and maximum flow rates, temperatures and pressures).

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5.4.1 Process Criteria

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.

5.4.1.1 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 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](#).

5.4.1.2 Flow Conditions

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

Choke 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.

Production choke valves shall have no flow on the first 10% of the stem travel (with a minimum of 5 mm/0.2 inch) in order to protect the lower cage part and seat area against erosion.

Production choke valves should take start-up conditions and the normal operational conditions into account in a single trim design. A dedicated smaller start-up choke may be provided if a single design is not possible.

5.5 Calculations and Sizing Criteria

5.5.1 General

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

The Valve Supplier'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.

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The selected C_v shall be **at least** 1.1 times the calculated C_v 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 Suppliers themselves and might result in different sizing results between Valve Suppliers.
- Valve Suppliers are only permitted to use sizing software which has been validated on test benches for the valve sizes, trim type and trim sizes (C_v) 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 written approval. The Valve Supplier shall be able to provide proof of sizing software validation tests.

5.5.2 Injection choke valves sizing

Injection choke valves, handling treated single-phase fluids, are most frequently considered as severe service control valves.

Contractor or Package Vendor shall refer to [ISA Guide](#) for recommended practices used in the consideration of control valve selection for severe service applications.

As per [ISA Guide](#), the Valve Supplier for severe service control valves shall provide the following calculations.

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 Supplier 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 Supplier 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 Supplier in order to obtain:

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

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

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

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and 1030 kPa (150 psi) for intermittent service. Valve trim exit fluid velocity head shall be calculated based on the [ISA Guide](#) as follows:

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

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 Supplier shall specify the required number of discrete pressure drop stages and also provide body and trim exit fluid velocity head calculations.

5.5.3 Production choke valves sizing

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 [GS EP COR 004](#).

In no case shall the valve outlet velocity exceed the maximum fluid velocities given by [GS EP COR 004](#).

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

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

Erosion damage potential shall be considered inside the valve as well as at the valve outlet. Internal wall protection measure (e.g. weld overlay, protective sleeves) shall be used to prevent erosion damage.

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.

5.5.4 Cavitation and Flashing

This section does not apply to production choke valves.

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 Supplier(s) during piping and facility design.

Contractor or Package Vendor shall refer to [ISA-RP75.23](#) for terminology and recommended practices used in the consideration of control valve selection for cavitating and flashing applications.

Injection Choke valves shall not be exposed to Constant Cavitation, σ_c , at maximum operating conditions. Whenever possible, the Valve Supplier shall size the valve such that it shall not be

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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.

5.5.5 Erosion Criteria for Multi-phase Application

The design of any choke valve handling multi-phase flow shall include:

- Consideration to adequate pressure staging or velocity control in order to avoid erosion damage inside the valve as well as at the valve outlet
- Use of Internal wall protection measure (e.g. weld overlay, protective sleeves) to prevent erosion damage.

The valve outlet fluid velocity shall not surpass the maximum allowable erosional velocity as defined by [GS EP COR 004](#).

5.5.6 Noise

Noise originating from the valve shall not exceed the following values, at any given flow rate:

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

This is the value, 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 Supplier shall:

- Perform a noise prediction calculation for each individual choke valve, based on [IEC 60534-8-3](#) for gas/vapour service and [IEC 60534-8-4](#) for liquid service
- Specify the accuracy of the predicted noise level, with a maximum uncertainty of -5/+5 dB(A) as per [IEC 60534-8-3](#) / [IEC 60534-8-4](#).

For multi-phase and multi-liquid applications, the Valve Supplier may apply his own noise prediction calculation method. A bench-test report evidence of its validation shall be provided.

When the nominal diameter of the choke valve is smaller than the diameter of adjacent piping, the Valve Supplier shall calculate the overall noise level combining the valve and upstream/downstream reducer/expander.

6. Choke Valve Construction

6.1 General Requirements

All valves shall have a service class (A thru D) assigned as per [GS EP PVV 155](#) or [GS EP PVV 156](#) as relevant.

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 155](#) or [GS EP PVV 156](#) as relevant for mandatory requirements on materials, fabrication and examination. Any welding or weld repair

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shall comply with [GS EP PVV 611](#), and major welding as defined in [ASTM A703](#) shall only be undertaken with the written approval of Company.

Valve bodies shall not be fitted with threaded plugs in pressure containing parts.

Valves used in sour service shall comply with [GS EP PVV 612](#), [NACE MR 0175](#), specific requirements of [GS EP PVV 155](#) or [GS EP PVV 156](#) as relevant and [GS EP PVV 622](#). Welding and weld repairs are not allowed for valves in sour service. However, for minor repairs only, a derogation request may be submitted before Purchase Order, supported by an unambiguous definition of "minor repair" (including size and localization of the repairs, description of welding repairs procedures and extent of NDE performed after repairs).

6.2 API SPEC 6A Application Rules

Choke valves are categorized as [API SPEC 6A](#) 'monogrammed' or 'compliant' as follows:

- [API SPEC 6A](#) monogrammed choke valves: any choke valve which is an integral part of an API piping system, or when deemed required by project 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 SPEC 6A](#) compliant choke valves: any choke valve part of an ASME piping system.

[API SPEC 6A](#) monogrammed valves shall have API end connections, and be manufactured in API accredited factories.

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

The applicable PSL shall be determined as per [API SPEC 6A](#) Annex A, except that PSL 1 classified valves are not permitted and that the minimum classification is 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 SPEC 6A](#).

Injection choke valves are not considered [API SPEC 6A](#) choke valves, unless the adjacent piping system consists of API piping.

6.3 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 (including external sleeves), 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.