International Association of Oil & Gas Producers

SPECIFICATION
S-729J

October
2021

# Specification for Control Valves

**NOTE This version (S-729J) of the specification document provides the justification statements for each technical requirement, but is otherwise identical in content to S-729.**



JIP33
JOINT INDUSTRY PROGRAMME

**Revision history**

| VERSION | DATE | PURPOSE |
|---|---|---|
| 0.1 | October 2021 | Issued for Public Review |

## Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

# Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

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## List of Tables

# Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of control valves for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.


**JIP33 Specification for Procurement Documents**
**Technical Specification**

This specification is to be applied in conjunction with the supporting procurement data sheet, information requirements specification (IRS) and quality requirements specification (QRS) as follows.

**IOGP S-729: Specification for Control Valves**

This specification defines the technical requirements for the supply of the equipment.

**IOGP S-729D: Procurement Data Sheet for Control Valves**

The procurement data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The procurement data sheet may also include fields for supplier provided information attributes subject to purchaser's technical evaluation. Additional purchaser supplied documents may also be incorporated or referenced in the procurement data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

**IOGP S-729L: Information Requirements for Control Valves**

The IRS defines the information requirements, including contents, format, timing and purpose to be provided by the supplier. It may also define specific conditions which invoke information requirements.

**IOGP S-729Q: Quality Requirements for Control Valves**

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the data sheet or in the purchase order.

The terminology used within this specification and the supporting procurement data sheet, IRS and QRS is in accordance with ISO/IEC Directives, Part 2.

The procurement data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser defined requirements (procurement data sheet, IRS, QRS);

d) this specification.

# 1 Scope

## 1.1

This specification defines the requirements for the design, sizing and selection, materials, inspection and testing, marking, preparation for shipment and preservation for general, severe and special service control valves using a pneumatic actuator, i.e. diaphragm, piston, single and double-acting, with accessories:

— sliding stem control valves;

— rotary control valves.

***Justification***

*Scope of supply is decided based on the "use case" from OpCos and manufacturers. Aim to cover approximately 80% of the total control valve population used in the industry.*

## 1.2

This specification shall be applied to control valves:

— in throttling (modulating) applications;

— in on-off or gap control applications;

— used as a final element of a safety instrumented function where the function of the valve is not considered to provide primary isolation (e.g. emergency shutdown or process shutdown, or a blowdown function).

***Justification***

*To ensure correct usage of this specification for an application other than those specified above thereby preventing control valve failures.*

## 1.3

This specification covers the physical boundary for the use of control valves in production facilities, transportation, refining, petrochemical, distribution and storage, with the following exclusions.

a) List of valves excluded:

  — subsea choke valves designed in accordance with API Specification 17D;

  — topside production choke valves (API Specification 6A and non-API) and valves designed in accordance with API Specification 6A;

  — subsea control valves designed in accordance with API Specification 6DSS.

b) List of special service valves excluded:

  — control valves within the process equipment licensor scope where the specific make and model is prescribed by the licensor;

  — process gas-actuated control valves;

  — control valves with special requirements that are part of a proprietary OEM package (e.g. fuel control valves);

— de-superheater control valves;

— process applications such as oxygen, chlorine, caustic and acids;

— pressure-independent chemical injection valves.

***Justification***

*a) subsea choke, topside choke and subsea control valves follows specific international standards and JIP33 control valve specification is structured as a standalone specification (without any overlay to international standards) and hence the concept of overlay and standalone cannot be managed in a single specification.*
*b) special service control valves are excluded where: — the key information is provided by licensors or OEM; — we need to write many additional stringent non-standardized requirements for sizing, performance, materials and cleaning for each special services which will defeat the purpose of JIP33. — "use case" is outside JIP33 80/20 rule.*

### 1.4

This specification may be used for the procurement of some of the excluded valves/applications in 1.3. Supplementary requirements are required for the extended use of this specification.

***Justification***

*The general requirements are common for all types of control valves and only the additional/supplementary requirements are different for these applications which needs to be specified. This requirement will give clarity for the users.*

## 2 Normative references

The following publications are referred to in this document, the procurement data sheet (S-729D) or the IRS (S-729L) in such a way that some or all of their content constitutes requirements of this specification. For dated references, only the edition cited applies. For undated references, the latest edition of the references document (including any amendments) applies.

ANSI/FCI 70-2, *Control Valve Seat Leakage*

ANSI/ISA 75.01.01, *Industrial-Process Control Valves - Part 2-1: Flow capacity - Sizing equations for fluid flow under installed conditions*

ANSI/ISA 75.02.01, *Control Valve Capacity Test Procedures*

ANSI/ISA 75.05.01, *Control Valve Terminology*

ANSI/ISA 75.08.01, *Face-to-Face Dimensions for Integral Flanged Globe-style Control Valve Bodies (Classes 125, 150, 250, 300, and 600)*

ANSI/ISA 75.08.02, *Face-to-Face Dimensions for Flanged and Flangeless Rotary Control Valves (Classes 150, 300, and 600, and PN 10, PN 16, PN 25, PN 40, PN 63 and PN 100)*

ANSI/ISA 75.08.04, *Face-to-Face Dimensions for Buttweld-End Globe-Style Control Valves (Class 4500)*

ANSI/ISA 75.08.05, *Face-to-Face Dimensions for Buttweld-End Globe-Style Control Valves (Class 150, 300, 600, 900, 1500, and 2500)*

ANSI/ISA 75.08.06, *Face-to-Face Dimensions for Flanged Globe-style Control Valve Bodies (Classes 900, 1500, and 2500)*

ANSI/ISA 75.08.08, *Face-to-Centerline Dimensions for Flanged Globe-Style Angle Control Valve Bodies (Classes 150, 300, and 600)*

ANSI/ISA 75.11.01, *Inherent Flow Characteristic and Rangeability of Control Valves*

ANSI/ISA 75.17, *Control Valve Aerodynamic Noise Prediction*

ANSI/ISA 75.19.01, *Hydrostatic Testing of Control Valves*

ANSI/ISA 75.25.01, *Test Procedure for Control Valve Response Measurement from Step Inputs*

ANSI/FCI 91-1, *Standard for Qualification of Control Valve Stem Seals*

ANSI/NACE MR0103/ISO 17945, *Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments*

ANSI/NACE MR0175/ISO 15156-1, *Petroleum, petrochemical, and natural gas industries — Materials for use in $H_2S$-containing environments in oil and gas production — Part 1: General principles for selection of cracking-resistant materials*

ANSI/NACE MR0175/ISO 15156-2, *Petroleum, petrochemical, and natural gas industries — Materials for use in $H_2S$-containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons*

ANSI/NACE MR0175/ISO 15156-3, *Petroleum, petrochemical, and natural gas industries — Materials for use in $H_2S$-containing environments in oil and gas production — Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

API Standard 609, *Butterfly Valves: Double-flanged, Lug- and Wafer-type, and Butt-welding Ends*

API Standard 6ACRA, *Age-hardened Nickel-based Alloys for Oil and Gas Drilling and Production Equipment*

ASME B16.5, *Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard*

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 BPVC, Section VIII, Division 1, *Rules for Construction of Pressure Vessels*

ASTM A105/A105M, *Standard Specification for Carbon Steel Forgings for Piping Applications*

ASTM A182/A182M, *Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service*

ASTM A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A194/A194M, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A216/A216M, *Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service*

ASTM A217/A217M, *Standard Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service*

ASTM A276/A276M, *Standard Specification for Stainless Steel Bars and Shapes*

ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ASTM A350/A350M, *Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components*

ASTM A351/A351M, *Standard Specification for Castings, Austenitic, for Pressure-Containing Parts*

ASTM A352/A352M, *Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service*

ASTM A453/A453M, *Standard Specification for High-Temperature Bolting, with Expansion Coefficients Comparable to Austenitic Stainless Steels*

ASTM A479/A479M, *Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels*

ASTM A564/A564M, *Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes*

ASTM A705/705M, *Standard Specification for Age-Hardening Stainless Steel Forgings*

ASTM A739, *Standard Specification for Steel Bars, Alloy, Hot-Wrought, for Elevated Temperature or Pressure-Containing Parts, or Both*

ASTM A995/A995M, *Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts*

ASTM A1014/A1014M, *Standard Specification for Precipitation-Hardening Bolting (UNS N07718) for High Temperature Service*

ASTM A1082/A1082M, *Standard Specification for High Strength Precipitation Hardening and Duplex Stainless Steel Bolting for Special Purpose Applications*

ASTM B564, *Standard Specification for Nickel Alloy Forgings*

ASTM B637, *Standard Specification for Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service*

EN 10204, *Metallic products – Types of inspection documents*

EN 13445, *Unfired pressure vessels*

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60534-1, *Industrial-process control valves – Part 1: Control valve terminology and general considerations*

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 60534-2-4, *Industrial-process control valves – Part 2-4: Flow capacity – Inherent flow characteristics and rangeability*

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 60534-3-3, *Industrial-process control valves – Part 3-3: Dimensions – End-to-end dimensions for buttweld, two-way, globe-type, straight pattern control valves*

IEC 60534-4, *Industrial-process control valves – Part 4: Inspection and routine testing*

IEC 60534-5:2004, *Industrial-process control valves – Part 5: Marking*

IEC 60534-8-3, *Industrial-process control valves – Part 8-3: Noise considerations – Control valve aerodynamic noise prediction method*

IEC 60534-8-4, *Industrial-process control valves – Part 8-4: Noise considerations – Prediction of noise generated by hydrodynamic flow*

IEC 60534-9, *Industrial-process control valves – Part 9: Test procedure for response measurements from step inputs*

IEC 60721-2-1, *Classification of environmental conditions – Part 2-1: Environmental conditions appearing in nature – Temperature and humidity*

IEC 60721-3-0, *Classification of environmental conditions – Part 3-0: Classification of groups of environmental parameters and their severities – Introduction*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEEE 1, *IEEE Recommended Practice — General Principles for Temperature Limits in the Rating of Electrical Equipment and for the Evaluation of Electrical Insulation*

IOGP S-563:2018, *Material Data Sheets for Piping and Valve Components*

IOGP S-705, *Supplementary Specification to API Recommended Practice 582 Welding Guidelines for Welding of Pressure Containing Equipment and Piping*

IOGP S-715, *Supplementary Specification to NORSOK M-501 Coating and Painting for Offshore, Marine, Coastal and Subsea Environments*

IOGP S-716, *Specification for Small Bore Tubing and Fittings*

ISO 8573-1, *Compressed air — Part 1: Contaminant and purity classes*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 12944-1, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction*

ISO 12944-2, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems*

ISO 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods*

ISO 15848-1:2015, *Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 1: Classification system and qualification procedures for type testing of valves*

ISO 15848-2, *Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 2: Production acceptance test of valves*

MSS SP 61, *Pressure Testing of Valves*

NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

NFPA 70, *National Electrical Code*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60534-1, ISA 75.05.01 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org.obp

— IEC Electropedia: available at http://www.electropedia.org/

**3.1**
**severe service**
application where one or more of the following criteria is met for the specified operating conditions:
— cavitation potential: $(P_1\text{-}P_2)/(P_1\text{-}P_V)$ is greater than 0,5 for water and aqueous solutions
— cavitation potential: $(P_1\text{-}P_2)/(P_1\text{-}Pv)$ is greater than 0,7 for single-phase fluids other than water and aqueous solutions
— flashing in liquids: $P_2$ is less than $P_V$
— choked flow: where the pressure drop ratio $(P_1\text{-}P_2)/P_1$ is greater than 0,7
where
$P_1$ is the upstream pressure
$P_2$ is the downstream pressure
$P_V$ is the vapour pressure of the fluid at flowing temperature

**3.2**
**special service**
application where one or more of the following apply:
— aerodynamic compressor anti-surge control valves
— low-temperature and cryogenic conditions where the service temperature ranges between -47 °C (-51 °F) and -196 °C (-320 °F)
— release of gases from pressurized liquids or outgassing
— erosive conditions (e.g. applications with entrained solids or particles)
— trim blockage may occur due to potential scaling or wax formation
— supercritical fluids are present

**3.3**
**general service**
criteria or applications not defined as severe or special

**3.4**
**pressure-containing part**
part whose failure to function as intended results in a release of contained fluid into the environment

Note 1 to entry: Includes as a minimum the body, bonnet, stem, gland flange, bolting and body/bonnet gasket that pass through the pressure boundary.

**3.5**
**pressure-controlling part**
part intended to control the flow of fluids

Note 1 to entry: Includes as a minimum the plug and seat.

# 4 General

### 4.1

Valves and actuator control equipment shall be designed to operate for the specified:

— environmental conditions; or

— environmental classification in accordance with IEC 60721-3-0 and climatic classification in accordance with IEC 60721-2-1.

***Justification***

*Environmental conditions could damage equipment or make the equipment malfunction. Hence valves need to be designed to suit the specified environmental conditions or environmental/climatic classification.*

### 4.2

Valve design and pressure-temperature ratings shall be in accordance with ASME B16.34 for the specified pressure class.

***Justification***

*Body cracks or failures can happen when pressure-temperature ratings or minimum body wall thickness is not followed. To ensure the integrity of the body for the specified service and to prevent valve body failures, these requirements should be met which will avoid injuries to personnel.*

# 5 Valve body style

## 5.1 General

Separable flanges shall not be used with globe or rotary valves.

***Justification***

*a. When removing the valve for service, the actuator will rotate and may harm the service personnel if suitable precautionary measures are not taken. b. Actuator needs extra support which could increase the installation time. The cost-benefit which is expected from using separable flanges will be lost due to* *additional effort involved in the design and installation of the support. c. Due to the above two reasons separable flanges are not acceptable.*

## 5.2 Sliding stem control valves

### 5.2.1

Globe valves shall be a single-piece casting or forged body with a bolted bonnet design.

***Justification***

*Single piece avoids body leakages, prevent accidents due to spillage and avoids escalation of fire.*

### 5.2.2

Globe valves shall be a single-port design.

***Justification***

*Single-port design is a well-proven design that achieves the specified leakage class requirement e.g. from class IV to class VI. Minimizes product contamination or loss of inventory.*

## 5.3 Rotary control valves

### 5.3.1

Butterfly valves shall be designed in accordance with API Standard 609.

***Justification***

*API 609 covers the required types, size and ratings for the butterfly valves normally used in the industry. The detailed technical requirements of this standard were already proven the use case" by OpCos and various manufacturers. By referencing this standard in JIP33 specification, we can eliminate re-writing the requirements again within the JIP33 specification.*

### 5.3.2

Wafer type butterfly valves shall not be selected for:

— flammable products;

— toxic applications.

***Justification***

*Wafer type normally encounters leakages and hence the following applications have to be avoided for the reasons stated below. a. Flammable product leakages could potentially escalate the fire. b. Toxic gas exposure or inhalation could be fatal to the operator.*

### 5.3.3

For lug and wafer type butterfly valves, the body material shall have the same nominal coefficient of thermal expansion as the connected pipe material.

***Justification***

*If there is a difference in coefficient of thermal expansion for materials, different rate of expansion and contraction will take place. This will lead to leakages between the mating flange and body gasket which may result in injury to the operator or loss of inventory.*

### 5.3.4

Lug type butterfly valves with a body size DN 200 (NPS 8) or above, installed between pipe sections, shall have drilled-out threads.

***Justification***

*Drilled-out threads will aid easy installation. As the number of holes increases, aligning all the threaded bolts could be difficult. By this arrangement, the installation is made easy.*

# 6 Valve body design

### 6.1

The pressure rating of the valve body shall be greater than or equal to the pressure rating of the connected piping.

***Justification***

*The control valve is part of the piping system and hence to achieve the design integrity for the overall system, the control valve pressure rating must be the same as per the adjacent piping. Mismatch in rating will damage the valve internals which will result in poor valve performances, process upset or pose risk to the operator due to body cracks.*

## 6.2 Connection size

### 6.2.1

The valve body size shall be at least DN 25 (NPS 1) except for depressurization applications.

***Justification***

*It is hard to achieve controllability in sizes smaller than DN 25 (NPS 1) which may upset the process.*

### 6.2.2

Valves in depressurization applications shall have a minimum body size of DN 50 (NPS 2) rated for at least ASME Class 300.

***Justification***

*When de-pressurization occurs, a large pressure differential will create forces or moments that may exceed the limit of size DN 25 (NPS 1) and ASME Class 150. This will lead to flange leakages and pave way for the escalation of fire. DN 50 (NPS 2), ASME Class 300 will avoid such a situation.*

### 6.2.3

The valve size shall not be smaller than two sizes from the pipe size.

NOTE Typical line sizes and their corresponding minimum valve sizes are indicated in Table 1.

*Justification*

*Restricting the control valve body size not less than two sizes from the pipe size will avoid procuring an undersized control valve. The effect of the undersized valve may result in a lower flow rate, spending more energy on a pump to push the liquid. In addition, cavitation or flashing may happen within the valve which could damage the valve components.*

**Table 1 — Minimum valve size**

| **Upstream line size — DN (NPS)** | 25 (1) | 40 (1½) | 50 (2) | 80 (3) | 100 (4) | 150 (6) | | 200 (8) | 250 (10) | 300 (12) | 350 (14) | 400 (16) | 450 (18) | 500 (20) | 600 (24) | 700 (28) | 750 (30) | 800 (32) | 900 (36) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Minimum valve size — DN (NPS)** | 25 (1) | 25 (1) | 25 (1) | 40 (1½) | 50 (2) | 80 (3) | | 100 (4) | 150 (6) | 200 (8) | 250 (10) | 300 (12) | 350 (14) | 400 (16) | 450 (18) | 500 (20) | 600 (24) | 700 (28) | 750 (30) |

### 6.2.4

Body flange dimensions of valve sizes between DN 25 (NPS 1) and DN 600 (NPS 24) shall be in accordance with ASME B16.5.

*Justification*

*Will aid manufacturer to quote correct end connection and eventually minimizes the flange mating issues during installation.*

### 6.2.5

The body flange dimensions of valve sizes between DN 650 (NPS 26) and DN 1500 (NPS 60) shall be in accordance with ASME B16.47.

*Justification*

*Will aid manufacturer to quote correct end connection and eventually minimizes the flange mating issues during installation.*

## 6.3 Connection type

Valves with welded end connections shall have a facility to perform in-situ seat and stem leakage tests.

*Justification*

*Will avoid cutting the valve from piping during testing. This requirement will save time and cost.*

## 6.4 Flow direction

### 6.4.1

The normal flow direction of sliding stem valves shall be marked with an arrow as follows:

— permanently cast on the valve body;

— engraved on the valve body; or

— on a stainless steel plate riveted to the valve body.

***Justification***

*Will avoid incorrect valve installation and avoid delay in start-up.*

### 6.4.2

The normal flow direction of rotary valves shall be marked with an arrow:

— engraved on the valve body;

— on a stainless steel plate riveted to the valve body or bonnet; or

— stamped on the flange rim.

***Justification***

*Will avoid incorrect valve installation and avoid delay in start-up.*

### 6.4.3

Valves in bidirectional applications shall be marked with an arrow indicating the specified flow direction.

***Justification***

*Will avoid incorrect valve installation and avoid delay in start-up.*

## 6.5 Valve dimensions

### 6.5.1

The valve body face-to-face, centre-to-face and end-to-end dimensions shall be in accordance with Table 2.

***Justification***

*Will aid to replace the valve between various manufacturers without any alteration to piping. Will aid 3D model progress even up to 60% model review without the receipt of GA drawing since the dimensions are standard based on the ordered body style. This will save time and enable engineering to progress without waiting for the approved GA diagram.*

**Table 2 — Body face-to-face, centre-to-face and end-to-end dimensions**

| Body style | IEC/API standards | ISA standards |
|---|---|---|
| Globe style with integral flanges | IEC 60534-3-1 (up to ASME class 1500) | ISA 75.08.01 (up to ASME class 600)<br>ISA 75.08.06 (for ASME class 900 to class 2500) |
| Globe style angle with integral flanges | IEC 60534-3-1 (up to ASME class 1500) | ISA 75.08.08 (up to ASME class 600) |
| Flanged and flangeless rotary control valves | API Standard 609 (butterfly valves up to ASME class 600)<br>IEC 60534-3-2 (except butterfly valves up to ASME class 600) | ISA 75.08.02 (up to ASME class 600) |
| Buttweld end globe style | IEC 60534-3-3 (for ASME class 150 to class 2500) | ISA 75.08.04 (for ASME class 4500)<br>ISA 75.08.05 (for ASME class 150 to class 2500) |

### 6.5.2

When the selected valve pressure classification and sizes are outside the limits of the standards indicated in Table 2, ASME B16.10 dimensions shall apply.

***Justification***

*Will aid 3D model progress even up to 60% model review without the receipt of GA drawing since the dimensions are standard based on the ordered body style. This will save time and enable engineering to progress without waiting for the approved GA diagram.*

## 6.6 Body/bonnet gasket and seals

### 6.6.1

Fluorocarbon-based FKM elastomers shall not be used for $CO_2$ service where the $CO_2$ content exceeds 15 % by volume.

***Justification***

*FKM elastomers will swell in $CO_2$ service. When rapid gas decompression occurs the elasticity changes at a faster rate which may cause the elastomers to fail. By avoiding FKM reduces the potential environmental and safety hazards.*

### 6.6.2

Elastomers shall not be used when the $H_2S$ concentration is greater than 5 % by volume.

***Justification***

*Elastomers in $H_2S$ service will become hard and brittle eventually loses the elasticity. By avoiding elastomers reduces potential failures, environmental and safety hazards.*

## 6.7 Packing

### 6.7.1

Valve stem flanges shall have a live-loaded packing arrangement or an adjustable bolted gland packing.

***Justification***

*Selecting an appropriate packing for an application should be given to the manufacturer and we should not limit our choice only to live-loaded packing as a default. This will optimize the overall cost and maintenance.*

### 6.7.2

The packing system shall be lubricant free.

***Justification***

*Even though most of the modern packings do not require lubrication, some packings may still require lubrication to avoid stem friction. Hence packings that require lubrication should be avoided to eliminate the need for operator intervention for routine lubrication. This will minimize the total cost of ownership.*

### 6.7.3

Packing for process design temperatures less than or equal to 200 °C (392 °F) shall be polytetrafluoroethylene based.

***Justification***

*Restricting the PTFE packing to its proven use case design temperature limits prevents packing failures. Also, minimizes environmental emissions and operator exposure to process fluids.*

### 6.7.4

Packing for process design temperatures greater than 200 °C (392 °F) shall be graphite based.

***Justification***

*Aid in preventing packing failures at higher temperatures and minimizes environmental emissions and operator exposure to process fluids.*

## 6.8 Fugitive emission or low emission packing

### 6.8.1

Fugitive emission packing shall be type tested and certified in accordance with ISO 15848-1 or ANSI/FCI 91-1.

NOTE Fugitive emission packing is also referred to as low-emission packing.

***Justification***

*Type tested design is a proven method of ensuring that the leakage rates are within the prescribed limits. Minimizes the release of substances harmful to the environment and humans.*

### 6.8.2

Type test qualification shall be performed in accordance with the specified endurance class.

***Justification***

*This requirement will minimize the packing failure thus preventing volatile organic compounds or emissions to the environment and operators. The requirement will prove that the expected leakage rate or emission performance is met for the specified endurance class.*

### 6.8.3

Bellows seal bonnets shall not be used.

***Justification***

*Bellows seal are more susceptible to failures and higher cost. Additionally, rarely used except may be to meet fugitive emission leakage requirements.*

## 6.9 Bonnet design

### 6.9.1 General

#### 6.9.1.1

Bonnets shall be integral or bolted type with fully retained gaskets.

***Justification***

*Bolted bonnet design will minimize the body/bonnet leakages thereby minimizing maintenance requirements.*

#### 6.9.1.2

Bonnet bolts shall not be used for mounting brackets or actuator control equipment.

***Justification***

*Additional stress may be created on bolts due to the bracket weight and weight of the equipment mounted on the bracket. Bolt failure will result in poor performance of the valve and eventually, the valve will not move.*

### 6.9.2 Extension bonnet

When standard bonnet packing cannot meet the process design temperature limits, extension bonnet design may be used.

***Justification***

*This requirement will direct the manufacturer to use the standard packing that can meet the design temperature limits on the first instance and not the operating temperature limits. If this is not possible, then the manufacturer will use an extension bonnet. This requirement will avoid extension bonnet and save huge costs. This requirement will provide clarity on which temperature has to be considered for selecting the packing.*

## 6.10 Lifting

### 6.10.1

Lifting points or a method for lifting shall be provided for valve assemblies weighing between 25 kg (55 lb) and 200 kg (440 lb).

***Justification***

*Manufacturer has to provide this information to avoid incorrect lifting of the equipment during transportation and installation. This requirement will avoid bent stem or damage to packing.*

### 6.10.2

Valve assemblies weighing more than 200 kg (440 lb) shall have lifting lugs.

***Justification***

*Heavier valve assemblies require special lifting hooks or fixtures to avoid incorrectly lifting the equipment during installation or maintenance. Incorrect lifting may lead to bent stem, damage to packing or injury to the operator during handling. Hence separate hooks or fixtures are needed.*

### 6.10.3

Lifting fixtures or hooks shall have a minimum design safety factor of 2.

***Justification***

*Failure of lifting hooks or fixtures are most common and ignored many times. Providing a minimum safety factor for the lifting hook or fixture will minimize the failure of the hooks or fixtures during installation thereby avoid injury to the operator or damage to equipment.*

# 7 Valve trim design

## 7.1 General

### 7.1.1

The seat ring shall not be pinned, spot-welded or threaded.

***Justification***

*Pinned design can shear away over time. Spot-welded design may not have adequate strength and dislodge over time. Threaded design will corrode and difficult to remove and the threading may be damaged during replacement. The above mentioned design in the justification will lead to poor performance of the trim or replacement made difficult. Hence these design should be avoided.*

### 7.1.2

Seat rings and cages shall be removable.

***Justification***

*Seat rings and cages will wear over time and hence these trim parts have to be replaced to meet the specified performance requirements.*

### 7.1.3

The cage and plug shall have the same nominal coefficient of thermal expansion.

***Justification***

*Variations in the clearance between the plug and the cage during operation will result in poor control of the process. This can be caused by the different coefficients of thermal expansion if dissimilar metals are used for the plug and the cage. The manufacturer should use the same material to ensure the clearance is maintained.*

## 7.2 Stem

### 7.2.1

The valve stem attached to the plug shall be threaded and pinned, threaded, pinned and welded or a single-piece design from bar stock.

***Justification***

*Avoid loosening of the plug from the stem thereby preventing poor control of the process.*

**7.2.2**

Rotary valves shall have a splined or keyed shaft.

***Justification***

*Splined or keyed shaft actuator interface minimizes the slippage between the actuator and the trim parts and also allows to transmit higher torque.*

## 7.3 Seat leakage

**7.3.1**

Valve seat leakage shall conform to IEC 60534-4 or ANSI/FCI 70-2.

***Justification***

*IEC and ANSI/FCI establishes the allowable leakages for each class. Mitigating the valve leakage as prescribed in the standard will minimize the loss of inventory or product contamination.*

**7.3.2**

Soft seating may be used in applications with a design temperature less than 200 °C (392 °F).

***Justification***

*Soft seat failure can occur at higher temperatures and hence soft seat has to be avoided. Seat failure may lead to leakages which will result in loss of inventory or product contamination.*

## 7.4 Severe service trims

### 7.4.1 Cage hole sizing

Cage holes shall be sized to prevent clogging by fluid particulates.

***Justification***

*Cage guided design may use a narrow path which could potentially clog. Hence manufacturer to provide the hole size considered for evaluation. This will avoid poor control of the process leading to shutdown and loss of production.*

### 7.4.2 Erosive service

Cage-guided, multi-stage trim used in erosive service shall have a protected seat design.

***Justification***

*Due to higher velocity, the seat material may erode quickly. By applying a design that protects the seat will extend the life of the seat.*

### 7.4.3 Cavitation service

**7.4.3.1**

For cavitation service, trims shall be hardened according to 10.5 or have an anti-cavitation design.

***Justification***

*Anti-cavitation or hardened trim reduces the cavitation impact on materials thereby extends the life. This requirement ensures to achieve the required valve performance.*

#### 7.4.3.2

Anti-cavitation trims shall be multi-stage, multi-turn or multi-slot design.

***Justification***

*Multi-stage trim avoids damage to trims which eventually helps to control the process effectively. Also, aid in reduced trim replacement which leads to less maintenance.*

### 7.4.4 Flashing

Angle valves used in flashing services shall have replaceable outlet liners.

***Justification***

*In the absence of outlet liners, permanent damage may happen due to extreme valve outlet velocity. Replaceable outlet liners will avoid permanent damage and can be replaced when needed without replacing the valve.*

# 8 Valve sizing and selection

## 8.1 General

#### 8.1.1

Valve sizing shall be calculated in accordance with IEC 60534-2-1 or ISA RP75.01.01.

***Justification***

*IEC and ISA have standardized the sizing equations over the years to produce a flow coefficient required for an application. Correct sizing helps to select a valve that can control the process efficiently without any upset.*

#### 8.1.2

When pipe reducers or pipe fittings are used at the valve inlet and outlet, capacity correction shall be included in the sizing calculation.

***Justification***

*Pipe reducers and other fittings will reduce the Cv. Estimating the correct Cv is important to arrive at a rated Cv which will aid smooth control of the process.*

#### 8.1.3

For three-way globe valves, each flow path shall be sized separately.

***Justification***

*The capacity requirement could be different for each path and hence the path needs to be sized separately.*

#### 8.1.4

For outgassing, supercritical fluids and multi-phase fluid applications, the sizing method, equations and correction factor used to calculate the $C_V$ shall be provided.

***Justification***

*Since there is no well-defined method described in the standards, the manufacturer has developed sizing methods. These methods and sizing equations and assumptions should be reviewed to ensure that the selected valve will perform for the intended process conditions.*

### 8.2 Operating range

#### 8.2.1

The travel of sliding stem valves shall be between 10 % and 90 % for the specified minimum and maximum flow conditions.

***Justification***

*The operating range ensures good control of the process which will avoid issues such as vibration, oscillation.*

#### 8.2.2

The travel of eccentric rotary valves and butterfly valves shall be between 15° and 60° for the specified minimum and maximum flow conditions.

***Justification***

*The operating range ensures good control of the process which will avoid issues such as vibration, oscillation.*

#### 8.2.3

The travel of high performance butterfly valves shall be between 15° and 70° for the specified minimum and maximum flow conditions.

***Justification***

*The operating range ensures good control of the process which will avoid issues such as vibration, oscillation.*

### 8.3 Characteristics

#### 8.3.1

Inherent valve characteristics shall not be achieved by characterizing the positioner cams.

***Justification***

*Positioner trim characteristics are not reliable and may not produce characteristics that are required by the process. Hence the characteristics should be achieved within valve body.*

### 8.3.2

When the inherent flow characteristics or Cv are different to the manufacturer's published values, plots of travel versus flow shall be provided for 5 %, 10 % and every subsequent 10 % increment up to 100 % of rated travel.

***Justification***

*Normally the manufacturers publish the CV and characteristics based on testing. When there is no published data available from the manufacturer, a plot for travel vs flow should be provided to ensure correct characteristics is selected. This requirement will aid to recheck the dynamic analysis and eventually helps to control the process effectively.*

## 8.4 Velocity limitation

The valve body outlet velocity shall be limited to:

— 0,2 Mach for gas, vapor, and steam services, with any particulates including black powder;

— 0,3 Mach for wet gas, wet vapor and saturated steam services;

— 0,4 Mach for dry gas, dry vapor and superheated steam services;

— 0,5 Mach for gas in infrequent services or services such as venting and depressurization;

— 10 m/s (33 ft/s) for liquid services including water;

— 6 m/s (20 ft/s) for fluids containing erosive particles.

***Justification***

*Controlling the body outlet velocity will mitigate the majority of severe process conditions and will help in minimizing material erosion, trim damage and seat leakage issues. Eventually this requirement will lead to efficient control of the process without any process upset.*

## 8.5 Noise requirements

### 8.5.1

Aerodynamic noise calculations for gas, steam or vapour shall be performed in accordance with IEC 60534-8-3 or ISA 75.17.

***Justification***

*IEC and ISA have very prescribed sizing equations for calculating the noise. Precisely predicting the noise will lead to selecting a correct trim that will avoid noise issues to the operator.*

### 8.5.2

Hydrodynamic noise calculations for liquids shall be performed in accordance with IEC 60534-8-4.

***Justification***

*IEC and ISA have very prescribed sizing equations for calculating the noise. Precisely predicting the noise will lead to selecting a correct trim that will avoid noise issues to the operator.*

# 9 Valves used in safety instrumented systems

### 9.1

A dedicated solenoid valve shall be configured to achieve the specified fail-safe function.

***Justification***

*Take the valve to a fail-safe position quickly and reliably. This will prevent possible escalation of fire or other emergency situations.*

### 9.2

On a solenoid valve trip, valves shall switch to the fail-safe state, irrespective of the positioner control signal.

***Justification***

*This requirement will move the valve to a specified fail-safe position irrespective of the control signal to the positioner. This will prevent possible escalation of fire or other emergency situations.*

### 9.3

The valve and components used to achieve the fail-safe state shall be compliant with IEC 61508.

***Justification***

*Failure rate data is required to perform SIL calculation by others to establish the conformance to IEC 61508.*

# 10 Material selection

## 10.1 General

### 10.1.1

Material selection shall be based on the specified service and pressure-temperature envelope.

***Justification***

*Material selection shall be appropriate for the given service and within the P-T envelope established by relevant codes.*

### 10.1.2

Materials for pressure-containing parts including valve body and bonnet, gasket and bolting shall meet or exceed the piping specification of the connected piping.

***Justification***

*As a minimum, pressure-containing parts of the valve shall match the material of the piping the valve is attached to.*

### 10.1.3

Pressure-containing and pressure-controlling part materials shall be selected from Table 3 through Table 11, according to the material selection of the control valve.

*Justification*

*Reduce variants of pressure-containing and pressure controlling materials.*

**10.1.4**

Materials shall comply with the standards and IOGP S-563 material data sheets referenced in Table 3 through Table 11 for the listed components and any applicable additional requirements in this specification.

*Justification*

*Standardisation of material requirement, reduction of variance, safety risk reduction (prevent premature failure/corrosion)*

**10.1.5**

Free machining steel shall not be used.

*Justification*

*Mechanical and corrosion properties of free machining grades are reduced compared with their parent grades.*

**10.1.6**

Lifting lugs, supports, plugs and fittings welded directly to the valve body shall be of the same material grade as the body.

*Justification*

*Prevent dissimilar welds which may affect the integrity of the pressure containing body.*

**10.1.7**

Metallic gaskets shall be minimum 316 stainless steel.

*Justification*

*316 SS is the considered the minimum grade of SS material for these components to minimize the risk of corrosion.*

**10.1.8**

Asbestos and asbestos-containing materials shall not be used.

*Justification*

*Asbestos is a well know carcinogenic material in addition to causing other serious lung diseases (asbestosis) and its use is prohibited in most jurisdictions.*

**10.1.9**

Cadmium plating shall not be used.

***Justification***

*Cadmium is an extremely toxic industrial and environmental pollutant and a human carcinogen.*

#### 10.1.10

Mating surfaces of sliding elements and threaded components shall have different hardness values or an anti-galling coating.

***Justification***

*To prevent galling, mating parts shall have different hardness or a hard coating shall be applied.*

### 10.2 Materials

#### 10.2.1

Valves with the following basic materials shall have the materials of their components selected in accordance with Table 3 through Table 11:

— normal temperature carbon steel (NTCS);

— low temperature carbon steel (LTCS);

— austenitic stainless steel type 316 stainless steel;

— ferritic-austenitic stainless steel, type 22Cr duplex and 25Cr super duplex;

— ferritic low alloy Cr-Mo steels type 1¼Cr ½Mo and 2¼Cr 1Mo.

***Justification***

*Scope of material covered in the valve material selection table 3 to table 11.*

#### 10.2.2

If Table 3 through Table 11 do not list an MDS for a particular material grade, the materials shall be supplied in accordance with the material standard without additional requirements.

***Justification***

*Not all materials have an equivalent MDS and where this occurs no additional requirements are imposed.*

#### 10.2.3

Materials for pneumatic actuator components shall conform to the requirements specified in Table 12.

***Justification***

*1. Standardization will result in cost reduction. 2. Reduce variants and align with requirements specified for other valve actuators.*

**Table 3 — Normal temperature carbon steel – Sweet service, -29 °C (-20 °F) to 425 °C (800 °F)**

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A105 | IC004 | A [d] | | | | |
| ASTM  A216 WCB | IC006 | A [d] | | | | |
| ASTM A216 WCC | IC006 | A [d] | | | | |
| ASTM A182 F6A | IM104 | | A | | A | A |
| ASTM A182 FXM-19 | IS404 | | A | | | |
| ASTM A479 UNS S20910 XM-19 | IS107 | | A | | | |
| ASTM A479 UNS S41000 | IM107 | | A | | A | A |
| ASTM A276 T410 / ASTM A276 T420 | IM107/IM127 | | A | | A | A |
| ASTM A217 CA 15 | IM106 | | | | A | A |
| ASTM A564 Gr. 630 UNS S17400 | IU607 | | A | | | |
| ASTM A705 Gr. 630 UNS S17400 | IU604 | | A | | | |
| ASTM A182 F316/316L | IS104 | | A | | | |
| ASTM A276 316/316L | IS107 | | A | | | |
| ASTM A479 316/316L | IS107 | | A | | | |
| ASTM A193 B7 / ASTM A194 2H | IX110/IX120 | | | A | | |
| ASTM A193 B7M / ASTM A194 2HM | IX110/IX120 | | | A | | |
| ASTM A320 L7 / ASTM A194 7 | IX100/IX109 | | | A | | |
| ASTM A320 L7M / ASTM A194 7M | IX100/IX109 | | | A | | |

**Key**
A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.
[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.
[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.
[d] Corrosion allowance 3 mm.

## Table 4 — Normal temperature carbon steel – Sour service, -29 °C (-20 °F) to 425 °C (800 °F)

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A105 | IC004S | A [d] | | | A | |
| ASTM A216 WCB | IC006S | A [d] | | | A | |
| ASTM A216 WCC | IC006S | A [d] | | | A | |
| ASTM A182 FXM-19 | IS404SS | | A | | | |
| ASTM A479 UNS S20910 XM-19 | IS107S | | A | | A | A |
| ASTM A564 Gr. 630 UNS S17400 | IU607S | | A | | A | A |
| ASTM A705 Gr. 630 UNS S17400 | IU604S | | A | | A | A |
| ASTM A182 F316/316L | IS104S | | A | | A | A |
| ASTM A276 316/316L | IS107S | | A | | A | A |
| ASTM A479 316/316L | IS107S | | A | | A | A |
| ASTM A351 CF3M/CF8M | IS106S | | | | | A |
| ASTM A193 B7M / A194 2HM | IX110S / IX120S | | | A | | |
| ASTM A320 L7M / A194 7M | IX100S / IX109S | | | A | | |

**Key**
A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.
[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.
[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.
[d] Corrosion allowance 3 mm.

## Table 5 — Low temperature carbon steel – Sour service, -46 °C (-50 °F) to 345 °C (650 °F)

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A350 LF2 Class 1 | IC104S | A [d] | | | A | |
| ASTM A352 LCC | IC106S | A [d] | | | A | |
| ASTM A182 FXM-19 | IS404SS | | A | | | |
| ASTM A479 UNS S20910 XM-19 | IS107S | | A | | A | A |
| ASTM A182 F316/316L | IS104S | | A | | A | A |
| ASTM A276 316/316L | IS107S | | A | | A | A |
| ASTM A479 316/316L | IS107S | | A | | A | A |
| ASTM A351 CF3M/CF8M | IS106S | | | | | A |
| ASTM A182 F51 | ID144S | | A | | | A |
| ASTM A276 UNS S31803 | ID147S | | A | | | A |
| ASTM A995 Gr. 4A | ID146S | | | | | A |
| ASTM B564 UNS N06625 | IN104S | | A | | | |
| ASTM B637 UNS N07718 | - [e] | | A | | | |
| ASTM A320 L7M / A194 7M | IX100S / IX109S | | | A | | |

**Key**

A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.

[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.

[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.

[d] Corrosion allowance 3 mm.

[e] UNS N07718 compliant with API Standard 6ACRA.

**Table 6 — Low temperature carbon steel – Sweet service, -46 °C (-50 °F) to 345 °C (650 °F)**

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A350 LF2 Class 1 | IC104 | A [d] | | | | |
| ASTM A352 LCC | IC106 | A [d] | | | | |
| ASTM A182 FXM-19 | IS404 | | A | | | |
| ASTM A479 UNS S20910 XM-19 | IS107 | | A | | A | A |
| ASTM A182 F316/316L | IS104 | | A | | A | A |
| ASTM A276 316/316L | IS107 | | A | | A | A |
| ASTM A479 316/316L | IS107 | | A | | A | A |
| ASTM A351 CF3M/CF8M | IS106 | | | | | A |
| ASTM A182 F51 | ID144 | | A | | | A |
| ASTM A276 UNS S31803 | ID147 | | A | | | A |
| ASTM A995 Gr. 4A | ID146 | | | | | A |
| ASTM B564 UNS N06625 | IN104 | | A | | | |
| ASTM B637 UNS N07718 | - [e] | | A | | | |
| ASTM A320 L43 / A194 7 | IX100 / IX109 | | | A | | |
| ASTM A320 L7 / A194 7 | IX100 / IX109 | | | A | | |
| ASTM A320 L7M / A194 7M | IX100 / IX109 | | | A | | |

**Key**
A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.
[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.
[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.
[d] Corrosion allowance 3 mm.
[e] UNS N07718 compliant with API Standard 6ACRA.

### Table 7 — Austenitic stainless steel type 316, -198 °C (-325 °F) to 540 °C (1 000 °F)

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A182 FXM-19 | IS404 | | A | | | |
| ASTM A479 UNS S20910 XM-19 | IS107 | | A | | | |
| ASTM A182 F316/316L | IS104 | A | A | | A | A |
| ASTM A276 316/316L | IS107 | | A | | A | A |
| ASTM A479 316/316L | IS107 | | A | | A | A |
| ASTM A351 CF3M/CF8M | IS106 | A | | | | A |
| ASTM A193 B8M/B8MA / ASTM A194 8M/8MA | IS109 | | | A | | |

**Key**

A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.

[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.

[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.

### Table 8 — 22Cr DSS, -46 °C (-50 °F) to +260 °C (+500 °F)

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A182 F51 | ID144 | A | A | | A | A |
| ASTM A995 Gr. 4A | ID146 | A | | | A | A |
| ASTM A276 UNS S32750 / UNS32760 | ID257 | | A | | A | A |
| ASTM A193 B8MLCuNA / ASTM A194 GRADE 8MLCuNA | - | | | A | | |
| ASTM A193 B8MLCuN-CLASS 1B / ASTM A194 GR 9CA | - | | | A | | |
| ASTM A453 GR 660 Class D | IU100 | | | A | | |
| ASTM A1014 UNS N07718 / API Std 6ACRA (120K) | IN120S | | | A | | |
| ASTM A1082 UNS S32750, S32760 | ID260 | | | A | | |

**Key**

A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.

[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.

[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.

**Table 9 — 25Cr DSS, -46 °C (-50 °F) to +300 °C (+570 °F)**

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A182 F53/F55 | ID254 | A | A | | A | A |
| ASTM A276 UNS S32750 / UNS32760 | ID257 | | A | | | |
| ASTM A995 Gr. 6A | ID256 | A | | | A | A |
| ASTM A193 B8MLCuNA / ASTM A194 GRADE 8MLCuNA | - | | | A | | |
| ASTM A193 B8MLCuN-CLASS 1B / ASTM A194 GR 9CA | - | | | A | | |
| ASTM A453 GR 660 Class D | IU100 | | | A | | |
| ASTM A1014 UNS N07718 / API Std 6ACRA (120K) | IN120S | | | A | | |
| ASTM A1082 UNS S32750, S32760 | ID260 | | | A | | |

**Key**

A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.

[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.

[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.

**Table 10 — 1¼Cr ½Mo Low Alloy Steel, -18°C (0 °F) to 440 °C (825 °F)**

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/ bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A182 F316/316L | IS104 | | | | A | A |
| ASTM A182 F6A | IM104 | | A | | A | A |
| ASTM A479 UNS S41000 | IM107 | | A | | A | A |
| ASTM A276 T410/ ASTM A276 T420 | IM107/IM127 | | A | | A | A |
| ASTM A217 CA 15 | IM106 | | | | A | A |
| ASTM A276 316/316L | IS107 | | | | A | A |
| ASTM A479 316/316L | IS107 | | | | A | A |
| ASTM A351 CF3M/CF8M | IS106 | | | | A | A |
| ASTM A182 F11 Cl. 2 | IV104 | A [d] | A | | | |
| ASTM A217 WC6 | IV106 | A [d] | | | A | |
| ASTM A739 B11 | IV107 | | A | | A | |
| ASTM A193 B16 / ASTM A194 7 | - /IX109 | | | A | | |

**Key**
A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.
[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.
[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.
[d] Corrosion allowance 3 mm.

**Table 11 — 2¼Cr ½Mo low alloy steel, -29°C (-20 °F) to 540 °C (1 000 °F)**

| Material selection | MDS/EDS [a] | Pressure-containing parts | | | Pressure-controlling parts | |
|---|---|---|---|---|---|---|
| | | Body/bonnet | Stem | Bolting | Seat ring [b] | Plug, ball, disk, cage [c] |
| ASTM A182 F316/316L | IS104 | | | | A | A |
| ASTM A276 316/316L | IS107 | | | | A | A |
| ASTM A479 316/316L | IS107 | | | | A | A |
| ASTM A351 CF3M/CF8M | IS106 | | | | A | A |
| ASTM A182 F22 Cl. 3 | IV204 | A [d] | A | | | A |
| ASTM A217 WC9 | IV206 | A [d] | | | A | A |
| ASTM A739 B22 | IV207 | | A | | A | |
| ASTM A193 B16 / ASTM A194 7 | - /IX109 | | | A | | |

**Key**

A Acceptable alternative

[a] MDS or EDS requirements in IOGP S-563 apply.

[b] Seat hardfacing in accordance with IOGP S-563, EDS IH001.

[c] Trim material for severe service shall be hardfaced or solid hard material in accordance with 10.5.

[d] Corrosion allowance 3 mm.

**Table 12 — Material requirements for pneumatic actuator components**

| Item | Material |
|---|---|
| Actuator cylinder/covers/spring housing | Onshore: carbon steel with coating [a]<br>(Note: ductile iron can be specified for cylinder flanges)<br>Offshore and marine coastal: carbon steel [a] or 316 stainless steel |
| Actuator diaphragm material | Nylon reinforced neoprene or nitrile rubber (also called Buna N rubber) |
| Stroke adjustment components, piston rods and shafts exposed to external environment | Onshore: manufacturer to specify<br>Offshore and marine coastal: 316 stainless steel or better |
| Yoke | High tensile cast or ductile iron [a] |
| Mounting kit (connection between valve and actuator) | carbon steel with coating [a]<br>or 316 stainless steel |
| Tie-rods/bolts/nuts/washers | 316 stainless steel or low alloy steel with coating [a] |
| Actuator/valve connection bolts, nuts, washers, keys | 316 stainless steel |
| Brackets for mounting accessories like limit switch box, junction box, positioner | Onshore: carbon steel with coating [a]<br>Offshore and marine coastal: 316 stainless steel |
| Hand-wheel | Onshore: carbon steel with coating [a]<br>Offshore and marine coastal: 316 stainless steel |
| Buffer vessel or volume tank | Onshore: carbon steel with coating [a]<br>Offshore and marine coastal: 316 stainless steel |
| [a] The coating systems in accordance with Clause 15 shall be followed. | |

## 10.3 Welding and NDE

### 10.3.1

Welding and post weld heat treatment of pressure-containing parts and attachment welding to pressure-containing parts shall be performed in accordance with IOGP S-705.

***Justification***

*Code compliance and compliance with supplementary requirements for pressure containing parts*

### 10.3.2

Weld overlay and hardfacing shall comply with IOGP S-563:2018, IO001 and IH001.

***Justification***

*Compliance with minimum requirements for corrosion resistant overlay and hardfacing*

## 10.4 Sour service

When sour service is specified, materials and fabrication shall comply with ISO 15156 /NACE MR0175 or ISO 17945 /NACE MR0103 and the additional metallurgical, manufacturing, testing and certification requirements stated in the applicable material data sheet and element data sheet in IOGP S-563.

***Justification***

*To prevent SSC/SCC in sour service.*

## 10.5 Severe and erosive services

### 10.5.1

Closure member and seat materials for severe service shall be hardfaced.

***Justification***

*Reduce the risk of cavitation erosion, solid particle erosion, galling in severe service.*

### 10.5.2

Closure member and seat materials for erosive service shall be hardfaced, solid tungsten carbide or ceramic.

***Justification***

*Reduce the risk of erosion.*

### 10.5.3

Hardfacing or solid hard material shall be compatible with the process fluid.

***Justification***

*Reduce the risk of corrosion in severe and erosive service.*

### 10.5.4

Solid tungsten carbide shall be in accordance with IOGP S-563, EDS IH005.

***Justification***

*Reduce the risk of cavitation erosion, solid particle erosion, galling in severe service.*

# 11 Actuators

## 11.1 General

### 11.1.1

Sliding stem actuators shall have a valve travel indicator.

***Justification***

*Aid local operator to know the position during startup, commissioning and during normal operation. Aid to identify the sticky conditions of the stem which will aid to initiate maintenance action. Also, aid the operator to know the position when operating the valve using a handwheel.*

### 11.1.2

Rotary valve position shall be indicated using a travel indicator marked in degrees.

***Justification***

*Aid local operator to know the position during startup, commissioning and during normal operation. Aid to identify the sticky conditions of the stem which will aid to initiate maintenance action. Also, aid the operator to know the position when operating the valve using a handwheel.*

#### 11.1.3

Open, close and intermediate position indications shall be marked on a 316 stainless steel scale.

***Justification***

*SS 316 scale will not corrode and will aid to identify the position during the entire life cycle of the valve.*

#### 11.1.4

Pneumatic actuators and actuator control equipment shall be operable for the compressed air quality specified below, in accordance with ISO 8573-1:

— class 6 for particle size;

— class 3 for pressure dew point; and

— class 3 for oil concentration.

***Justification***

*Compressed air quality requirement will decide the correct selection of filter mesh and internal coating needs for the cylinder. Incorrect selection of filter mesh could lead to water accumulation and corrosion inside the actuator. This will lead to the malfunction of the actuator.*

### 11.2 Actuator sizing

#### 11.2.1

Actuators shall be sized for:

— maximum shut-off differential pressure; and

— minimum network air supply pressure.

***Justification***

*To avoid under sizing or over sizing the actuator. Under sizing the actuator leads to higher leakage rates or not able to achieve the specified fail position. Over sized actuator may apply large forces on the seat/plug result in material damage. Hence sizing criteria to be defined to get the correct actuator size.*

#### 11.2.2

The sum of forces required by the actuator shall be calculated using:

— unbalanced forces arising based on the chosen body style;

— frictional forces due to valve drive train, trim and packing; and

— seating forces to attain the required seat leakage class.

***Justification***

*To avoid under sizing or over sizing the actuator. Under sizing the actuator leads to higher leakage rates or not able to achieve the specified fail position. Over sized actuator may apply large forces on the seat/plug result in material damage. Hence sizing criteria to be defined to get the correct actuator size.*

#### 11.2.3

For applications involving bi-directional flow, actuator sizing shall take account of the reverse flow maximum shut-off differential pressure.

***Justification***

*To avoid actuator performance issues during reverse flow.*

#### 11.2.4

The selected actuator torque/thrust shall be greater than or equal to 110 % of the calculated torque/thrust.

NOTE The valve should operate under the specified process conditions at 91 % of minimum network air supply pressure and the extra 10 % margin is only to account for any increase in friction due to usage.

***Justification***

*Packing friction will increase over time. Good mechanical spring could generate a force different from the catalog figures. Hence additional forces are required to mitigate the eventualities during the entire life cycle of the valve.*

### 11.3 Pneumatic actuators

#### 11.3.1

Pneumatic actuators shall be:

— single-acting diaphragm type with spring return;

— piston type with spring return; or

— double-acting piston type.

***Justification***

*Will give the manufacturer an option to select the suitable type of actuator based on calculated torque/thrust.*

#### 11.3.2

Double-acting actuators shall be used only if valve travel is greater than 100 mm (4 in).

***Justification***

*Normally double-acting actuator is economical for valve travel greater than 100 mm (4 in). In addition, substantial weight savings and reduction in actuator size can be achieved. Hence the use of a double-acting actuator should be used for valve travel greater than 100 mm (4 in.).*

#### 11.3.3

Double-acting actuators used in fail-safe applications shall be supplied with an air receiver.

NOTE Air receivers are also be referred to as buffer vessels or volume tanks.

***Justification***

*This requirement will aid in achieving the specified fail-safe position. In this way, we can avoid the escalation of fire.*

### 11.3.4

When the maximum allowable actuator casing pressure is less than the network maximum air supply pressure, tubing relief valves shall be installed in the pneumatic circuit.

***Justification***

*In the case of air filter regulator failure, the normal network air supply pressure will be seen by the diaphragm. Since the diaphragm design pressure is much lower than the normal network pressure, the diaphragm will burst and may result in an injury to the operator. Also, the excessive torque/thrust can damage the shaft and seat resulting in malfunction of the actuator. Hence the actuator should be protected to avoid such scenarios.*

### 11.3.5

The tubing relief valve set pressure with overpressure at full lift shall be less than the maximum actuator casing pressure.

NOTE Typically, the minimum relief valve set pressure is 110 % of the air filter regulator set pressure.

***Justification***

*To avoid bursting of actuator diaphragm and malfunction of the actuator.*

### 11.3.6

Exhaust, vent and breathing ports of actuators and control equipment shall not allow formation of ice or ingress of bugs.

***Justification***

*A bug screen or special designs will prevent blockage when the air exit the port thereby ensuring the valve to reach its fail-safe state.*

## 11.4 Travel stops

### 11.4.1

Travel stops shall be achieved by a mechanical device fitted to the valve or actuator.

***Justification***

*Mechanical stop achieves the stopping of the actuator physically thereby not passing the additional flow through the valve.*

### 11.4.2

Travel stop functionality shall be achieved independently from the handwheel.

***Justification***

*This requirement will avoid failures due to inter-dependencies on other devices such as handwheel. Ensures that the required maximum flow is passed through the valve thereby avoids unnecessary trips.*

#### 11.4.3

Adjustable travel stops shall be provided with a mechanism that prevents inadvertent operation.

***Justification***

*Avoid inadvertent operation by field personal and prevents flooding the downstream systems and trip.*

#### 11.4.4

The travel stop position shall be set at a position equal to the specified limiting $C_V$, flow or at the specified position in terms of percentage or degrees.

***Justification***

*This requirement will minimize process upset or trip. Also, flooding of downstream equipment.*

### 11.5 Handwheel

#### 11.5.1

The force required at the handwheel to apply the breakaway torque or thrust shall not exceed 360 N (80 lb).

***Justification***

*This requirement will help the operator to rotate the handwheel easily and to achieve the required position with minimal time to avoid any process upset.*

#### 11.5.2

The handwheel diameter shall not exceed 800 mm (32 in).

***Justification***

*This requirement will help the operator to rotate the handwheel easily and to achieve the required position with minimal time to avoid any process upset.*

#### 11.5.3

The handwheel shall close the valve in the clockwise direction.

***Justification***

*This requirement will coincide with current industry practices to avoid confusion to the operator.*

#### 11.5.4

The handwheel shall have a clutch mechanism for manual use.

***Justification***

*The clutch mechanism prevents any inadvertent operation of the handwheel by the operator.*

# 12 Actuator control equipment

## 12.1 General

### 12.1.1

Actuator control equipment, air receivers and pneumatic components shall be designed for the specified maximum network air supply pressure.

***Justification***

*Incorrect design lead to damage and may affect fail-safe function of the valve. Production loss is the major impact.*

### 12.1.2

Electronic devices and termination boxes shall be provided with an earth boss outside the housing or enclosure.

***Justification***

*Earth bosses of housing facilitate earthing made easy from outside which will protect the equipment as well as personnel. This requirement will also avoid malfunction due to interference.*

### 12.1.3

Accessories shall be accessible for repair or replacement without removing any part of the actuator.

***Justification***

*Ease the maintenance activity during design life.*

### 12.1.4

Electronic equipment and termination boxes shall have a minimum ingress protection of IP66 in accordance with IEC 60529 or NEMA 4X in accordance with NEMA 250.

***Justification***

*This requirement will standardize the accessories across the projects to minimize the spares.*
*Avoid equipment malfunction due to severe environmental conditions without any cost adder.*

## 12.2 Air filter regulators

### 12.2.1

Air filter regulators shall be installed in the supply line to the control valve.

*Justification*

*This requirement will protect the actuator from particles entering the positioner/actuator and also will regulate the instrument air pressure for the actuator to operate.*

#### 12.2.2

Air filter regulators shall be internal relief type with an integral filter and manual drain.

*Justification*

*Integral relief will bleed the excess pressure or air pressure fluctuations. An integral filter will prevent the entry of particles to the positioner and actuator. A manual drain will facilitate to drain of the water accumulated over a period of time. In essence, this requirement will ensure a trouble-free operation of the valve.*

#### 12.2.3

Adjustment of the air filter regulator setpoint shall prevent unintentional operation.

*Justification*

*Tamper proof design will prevent inadvertent operation thereby preventing undesired valve action or loss of production.*

## 12.3 Digital positioners and controllers

### 12.3.1 Mounting hardware

For offshore and marine coastal applications, the digital positioner or controller mounting bracket, mounting bolts and nuts material shall be 316 stainless steel.

*Justification*

*A positioner is the key element of the control valve. Any degradation in mounting arrangement due to corrosion will affect the control valve performances. Hence this requirement is needed.*

### 12.3.2 Diagnostics

#### 12.3.2.1

The digital positioner or controller shall have a diagnostic feature to detect if the valve does not move in accordance with the commanded position within the set time.

*Justification*

*This diagnostic feature will prove issues relating to the packing friction or the valve is stuck due to bent stem or there could be a leak on the pneumatic system.*

#### 12.3.2.2

The digital positioner or controller shall have a diagnostic feature to detect if the valve has moved away from the commanded position.

*Justification*

*This diagnostic feature will prove the issues relating more torque/thrust produced due to changes to air set or packing is completely worn out or too much of overshoot.*

**12.3.2.3**

The digital positioner or controller shall have a diagnostic feature to detect loss of power or air.

*Justification*

*This diagnostic feature will aid to identify whether the fail position is reached due to air supply failure or power supply failure. This will aid maintenance team to check and fix air/power supply issue.*

**12.3.2.4**

The digital positioner or controller shall have a feature to capture valve profiling.

NOTE Valve profiling is also referred to as valve signature or footprint.

*Justification*

*Valve profiling is a base line test which will aid the maintenance team to compare the signature stored with in the positioner against the profile captured during the base line testing and fix issues such as packing friction, actuator pressure fluctuations and calibration.*

**12.3.2.5**

The digital positioner or controller shall have a predictive diagnostics feature to alert performance degradation that may lead to malfunction.

*Justification*

*Digital positioner or controller diagnostics helps in predictive maintenance.*

### 12.3.3 Cyber security

**12.3.3.1**

Device type manager and device description files shall be obtained directly from the equipment manufacturer or downloaded from the equipment manufacturer's authorized secure website.

*Justification*

*To provide the latest DTM and/or DD file from the manufacturer of the equipment to ensure proper communication.*

**12.3.3.2**

Device type manager and device description files shall be signed by the equipment manufacturer using a trusted certificate authority.

***Justification***

*To ensure the file installed is the original manufacturer file that has not been interfered with.*

**12.3.3.3**

The digital positioner or controller shall be protected against inadvertent changes with the use of a physical switch, jumper or password.

***Justification***

*To provide a layer of security to avoid unwanted change by unauthorized persons.*

### 12.3.4 Electromagnetic immunity

Digital positioners or controllers shall be certified for electromagnetic immunity in accordance with IEC 61000-4-3 or IEC 61000-4-8.

***Justification***

*Electromagnetic interference will lead to measurement error that will result in improper functioning of the valve.*

## 12.4 Solenoid valves

**12.4.1**

Solenoid valves shall be direct-acting, spring return with power consumption less than 10 W.

***Justification***

*Standardization minimizes the types and aid to keep optimal spares.*

**12.4.2**

The solenoid coil insulation rating shall conform to IEC 60085 or IEEE 1.

***Justification***

*Most of the solenoids are always energized and hence the coil will get heated up. By limiting the temperature limits specified in the international standards using good insulating materials will reduce the risk of coil failures.*

**12.4.3**

When solenoid valves and a positioner are specified for the same application, the solenoid valves shall be installed between the positioner signal output and the actuator.

***Justification***

*This requirement will ensure that the emergency action is always met even with a blockage on the signal line or the positioner.*

## 12.5 Position indication

### 12.5.1

Limit switches shall be magnetic or inductive proximity type.

***Justification***

*Proximity switches are well proven in the industry and also other switches such as mechanical switches may create contact problems in the long run.*

### 12.5.2

Adjustable limit switches shall be set at:

— 3° from the open and closed positions for quarter-turn actuators; or

— 3 % from the open and closed positions for linear actuators.

***Justification***

*Modern limit switches are operating very precisely at a specified set limit from the set limit. 3° or 3 % is an acceptable practice in the industry.*

### 12.5.3

Limit switches shall be provided with a junction box.

***Justification***

*Flexible cable is protected if mounted within the junction box and also aid to terminate the wiring.*

## 12.6 Air lock relay (lockup valve)

An airlock relay shall be provided if a "fail lock" position is specified.

***Justification***

*This requirement will aid to achieve the specified fail lock mode.*

## 12.7 Air receiver

### 12.7.1

The air receiver shall be sized to operate at least three valve strokes at normal network instrument air supply pressure in the event of air supply failure to double-acting actuators:

— fail open valve: open to close, close to open and open to close;

— fail close valve: close to open, open to close and close to open.

NOTE Air receiver is also referred to as volume tank or buffer vessel.

***Justification***

*Useful to depressurize a section of the pipe after a trip and to manually blowdown an area.*

**12.7.2**

On completion of three strokes, the air receiver pressure shall not be less than the minimum network instrument air supply pressure.

***Justification***

*Ensures three strokes can be achieved as specified.*

**12.7.3**

Air receivers shall be provided with a check and block valve for the supply line, a block valve for the pressure instrument connection, a drain valve and a vent valve.

***Justification***

*Pressure gauge/transmitter indicates the network pressure and drop in pressure could be monitored which could avoid an eventual trip. A Block valve will be used to isolate the gauge/transmitters. A check valve will ensure that the air will flow to the actuator in the event of air failure. Overall, this requirement will aid to operate the valve with double-acting actuators in the event of air failure.*

**12.7.4**

Air receivers shall be equipped with a pressure safety valve or rupture disc.

***Justification***

*Will protect the air receiver in the event of fire.*

### 12.8 Tubing, fittings and instruments valves

Instrument air supply tubing and fittings shall be in accordance with IOGP S-716.

***Justification***

*Standardizing tubing requirements will help to maintain fewer spares. IOGP S-716 dis-allows inter-mixing and interchanging which will avoid leakages and tube failures eventually preventing trip.*

## 13 Performance requirements

### 13.1 Hysteresis and dead band

The total hysteresis with dead band error for valves in severe and special services shall be less than or equal to:

— 2 % of the calibrated span for sliding stem valve sizes up to DN 400 (NPS 16) and rotary valve sizes up to DN 250 (NPS 10);

— 3 % of the calibrated span for sliding stem valve sizes greater than DN 400 (NPS 16) and rotary valve sizes greater than DN 250 (NPS 10).

***Justification***

*Valve performance criteria are crucial for tighter control of the process and to obtain optimized control of the process. Hence this requirement is essential.*

## 13.2 Anti-surge valves

### 13.2.1

On initiation of a trip command to the solenoid valve, the anti-surge valve shall be fully opened from the closed position within the specified time, or in no greater than 2 seconds.

NOTE Travel time includes dead time and excludes detection and logic solver time.

***Justification***

*This requirement will avoid the compressor going into surge and protect the equipment.*

### 13.2.2

Following a step change to the positioner or controller, the anti-surge valve shall be fully opened from the closed position within the specified time, or in no greater than 2 seconds.

NOTE Travel time includes dead time.

***Justification***

*This requirement will avoid the compressor going into surge and protect the equipment.*

### 13.2.3

The dead band for a valve with an actuator and positioner shall be less than 0,5 % of the calibrated span.

***Justification***

*Valve performance criteria are crucial for protecting the machine as well as quick control of the surge events. Hence these performance criteria are essential.*

### 13.2.4

If a limit is not specified, the overshoot shall not exceed 3 % of the calibrated span for a control signal step change within the 10 % to 80 % range.

***Justification***

*Valve performance criteria are crucial for protecting the machine as well as quick control of the surge events. Hence these performance criteria are essential.*

# 14 Factory acceptance testing

## 14.1 Mandatory testing

### 14.1.1 General

#### 14.1.1.1

Factory acceptance testing of sliding stem and rotary valves shall be performed in accordance with Table 13.

***Justification***

*Standardization of inspection and testing requirements will avoid delay in the procurement cycle. i.e. any additional tests which are added after order will affect the overall schedule. Also, standardization will help the manufacturer to bid correctly.*

**14.1.1.2**

Butterfly valves designed in accordance with API Standard 609 shall be tested in accordance with this specification.

***Justification***

*All the testing requirements are detailed under section 15 refers to IEC 60534 or ISA 75 series. To avoid conflict between the testing requirements specified in API 609 (which refers to API 598 for testing) and various IEC and ISA standards, this requirement is needed. This will aid the manufacturers to bid correctly.*

### 14.1.2 Visual inspection

A visual inspection shall be performed to verify the following:

— make/model number;

— cable/tube entry;

— tag plate and marking;

— flow direction;

— orientation of actuator;

— material grade for body/bonnet;

— coating and colour coding check;

— flange size, rating and surface finish;

— air filter regulator and air lock set pressure values;

— supply of accessories;

— plugs and adapters;

— positioner/controller configuration and jumper setting check.

***Justification***

*Avoid incorrect supply to the construction site and avoid delay to the schedule.*

### 14.1.3 Dimensional check

A dimensional check shall be performed to verify the following:

— face-to-face or center-to-face dimensions;

— dimensional information for valves with an actuator;

— bolt circle diameter, number of bolts and flange thickness.

***Justification***

*Avoid incorrect supply to the construction site and avoid delay to the schedule.*

**Table 13 — Factory acceptance test — Mandatory tests**

| Test | Extent of testing for severe and special service for all pressure classes | Extent of testing for general service | | Reference (in this specification) |
|---|---|---|---|---|
| | | ≤ 600 ASME class | ≥ 900 ASME class | |
| Visual inspection | 100 % | 1 valve per model per size per pressure class per lot | 20 % (minimum 1 valve per model per size per pressure class per lot) | 14.1.2 |
| Dimensional check | 100 % | 1 valve per model per size per pressure class per lot | 20 % (minimum 1 valve per model per size per pressure class per lot) | 14.1.3 |
| Hydrostatic test | 100 % | 1 valve per model per size per pressure class per lot | 50 % (minimum 1 valve per model per size per pressure class per lot) | 14.1.4 |
| Seat leakage test | Class V and Class VI — 100 %<br>Class IV — 1 valve per model per size per pressure class per lot | Class V and Class VI — 100 %<br>Class IV — 1 valve per model per size per pressure class per lot | Class V and Class VI — 100 %<br>Class IV — 1 valve per model per size per pressure class per lot | 14.1.5 |
| Packing test | 100 % | 1 valve per model per size per pressure class per lot | 20 % (minimum 1 valve per model per size per pressure class per lot) | 14.1.6 |
| Functional test | 100 % | 1 valve per model per size per pressure class per lot | 20 % (minimum 1 valve per model per size per pressure class per lot) | 14.1.7 |
| Positive material identification for body/bonnet/closure member | 100 % | 1 valve per model per size per pressure class per lot | 1 valve per model per size per pressure class per lot | 14.1.8 |
| Non destructive examination | See IOGP S-563 | | | 14.1.9 |

### 14.1.4 Hydrostatic test

#### 14.1.4.1

A hydrostatic shell test shall be carried out for pressure-containing components in accordance with IEC 60534-4 or ISA 75.19.01.

***Justification***

*Standardization of inspection and testing requirements will avoid delay in the procurement cycle. Also, standardization will help the manufacturer to bid correctly.*

#### 14.1.4.2

The hydrostatic test medium shall be filtered, potable water with a chloride content not exceeding 250 mg/l.

***Justification***

*This requirement will avoid corrosion inside the valve body components and extends the life of the valve.*

**14.1.4.3**

For hydrostatic testing of austenitic and duplex stainless steels, the chloride content in the testing medium shall not exceed 50 mg/l.

***Justification***

*The selected hydrostatic testing standard IEC or ISA do not specify testing medium halogen content. It is to be noted that there are many other hydrostatic test standards and each do not align themselves in terms of halogen contents for testing medium. Hence we have used the halogen content requirement for austenitic stainless steel valves from EN 13480-5:2017. This usually followed as a standard by most of the control valve manufacturer's in Europe. Eventually, this requirement will avoid corrosion inside the valve body components and extends the life of the valve.*

**14.1.4.4**

On completion of hydrostatic testing, valves shall be drained of test fluids and dried.

***Justification***

*This requirement will avoid corrosion inside the valve body components and extends the life of the valve.*

### 14.1.5 Seat leakage test

**14.1.5.1**

Seat leakage tests shall be performed in accordance with IEC 60534-4 or ANSI/FCI 70-2.

***Justification***

*Standardization of inspection and testing requirements to an international will aid in achieving the specified performance requirements. Also, standardization will help the manufacturer to bid correctly.*

**14.1.5.2**

Seat leakage tests shall be performed on assembled valves with actuators and actuator control components.

***Justification***

*This requirement will determine the correct bench mark for seat leakage rate and will help to compare against future seat leakage rates.*

**14.1.5.3**

If water is used as a testing medium for seat leakage testing on austenitic and duplex stainless steel valves, the chloride content in the testing medium shall not exceed 50 mg/l.

*Justification*

*This requirement will avoid corrosion inside the valve body components and extends the life of the valve.*

**14.1.5.4**

No adjustments shall be made to the actuator, body and bonnet assembly after completion of the seat leakage test.

*Justification*

*Any adjustments made to the valve assembly may create additional friction or force required to close the valve thereby affecting the seat leakage rate. Eventually will lead to product loss or contamination. Hence this requirement is needed.*

### 14.1.6 Packing test

Packing not subjected to fugitive emission testing shall be tested in accordance with IEC 60534-4.

*Justification*

*This test will prove that there are no visible leakages through packing thereby minimizes HSE issues.*

### 14.1.7 Functional test

**14.1.7.1**

Functional tests shall be performed on assembled valves with actuator and actuator control equipment.

*Justification*

*This test ensures that all the actuator control equipment, valve and actuator assembly together works well functionally. Also, aid to identify packing friction issues and jerky valve movement.*

**14.1.7.2**

Functional tests shall be performed by stroking the valve from 0 % to 100 % and vice-versa at least three times under atmospheric conditions, using the positioner signal to verify:

- set pressure for the air filter regulator and air lock relay, as applicable;
- specified power supply applied to the positioner/controller, position transmitters and solenoid valve, as applicable;
- limit switch setting, if applicable;
- valve rated travel;
- actuator bench set;
- position transmitter output, if applicable;
- positioner/controller settings and firmware revisions;
- movement is smooth without any jerking.

### *Justification*

*This requirement will prevent the incorrect supply of valve, actuator and actuator control equipment thereby avoid schedule delay. Also, avoid configurations at the site.*

**14.1.7.3**

The fail-safe position shall be checked for air supply and power supply failure.

### *Justification*

*This requirement ensures that the valve will move to a fail-safe position defined by the process in the event of air or power failure. This may prevent escalation of over-pressurization of downstream equipment or escalation of fire.*

**14.1.7.4**

Handwheel operation shall be checked from 0 % to 100 % open and vice versa.

### *Justification*

*This requirement ensures that the manual operation can be performed easily for the entire range.*

### 14.1.8 Positive material identification

Positive material identification of pressure-containing, pressure-retaining and pressure-controlling parts shall be performed 100 % on alloy steel, stainless steel, nickel alloy and non-ferrous alloy valves.

### *Justification*

*This requirement will prevent incorrect valve material to the construction site and schedule delay.*

### 14.1.9 Non destructive examination

**14.1.9.1**

Non destructive examination for pressure-containing and trim parts shall be performed in accordance with IOGP S-563.

### *Justification*

*Aim to meet the minimum required quality level for the body, bonnet and trim material to ensure that there is no defect. This requirement will prevent loss of containment, leakages and costly replacement within the life cycle.*

**14.1.9.2**

Non destructive examination for fabrication by welding, post-weld heat treatment, and weld overlay or hardfacing shall be in accordance with 10.3.

***Justification***

*Aim to meet the minimum required quality level for the body, bonnet and trim material to ensure that there is no defect. This requirement will prevent loss of containment, leakages and costly replacement within the life cycle.*

## 14.2 Supplementary testing

### 14.2.1 Rated valve travel test

Rated valve travel tests shall be performed with positioners in accordance with IEC 60534-4.

***Justification***

*This requirement will ensure that the required travel and leakage class is achieved for the chosen spring. This test will also prove incorrect selection of spring and other performance issues related to the actuator.*

### 14.2.2 Fugitive emission production test

Fugitive emission production tests shall be carried out in accordance with ISO 15848-2.

***Justification***

*This requirement will minimize the harmful emissions to the environment and personnel.*

### 14.2.3 Flow capacity test

Flow capacity tests shall be performed in accordance with IEC 60534-2-3 or ISA 75.02.01.

***Justification***

*In some instances, the valve size affects the equipment such as flare and compressor. Hence there is a need to perform the flow capacity test to ensure that the downstream equipment is adequately sized.*

### 14.2.4 Flow characteristic test

Flow characteristic tests shall be performed in accordance with IEC 60534-2-4 or ANSI/ISA 75.11.01.

***Justification***

*When the flow characteristics of the selected trim and body does not meet the published characteristic curve, this test should be performed. Ensures that the required operating range can be achieved in a stable manner.*

### 14.2.5 Step response test

Step response tests shall be performed using positioners or controllers in accordance with IEC 60534-9 or ISA 75.25.01.

***Justification***

*This testing will prove the required valve dynamic responses are achieved which will pave way for robust control in the evet of surge.*

### 14.2.6 Travel time test

Travel time tests shall be carried out on the valve from open to close position and vice versa using:

— normal network air supply pressure to the actuator;

— atmospheric pressure across the valve body; and

— booster/speed control devices set at required set values, if supplied.

***Justification***

*Travel time is essential performance criteria which will avoid process upset and shutdown.*

### 14.2.7 Low-temperature and cryogenic valves test

#### 14.2.7.1 Seat leakage test

The seat leakage test for low-temperature and cryogenic valves shall be performed in accordance with Table 14.

***Justification***

*Standardization of inspection and testing requirements will avoid delay in the procurement cycle. Also, standardization will help the manufacturer to cost correctly at the beginning which will avoid cost escalation at a later date.*

**Table 14 — Low-temperature/cryogenic seat leakage test**

| **Description** | Testing prerequisite and acceptance criteria |
|---|---|
| **Test pressure** | IEC 60534-4 or ANSI/FCI 70-2 |
| **Test temperature** | Specified minimum operating temperature |
| **Test gas** | — Helium gas (97 % pure) for applications with a design temperature less than -110 °C (-166 °F)<br>— Helium gas (3 % pure) for applications with a design temperature above -110 °C (-166 °F) or nitrogen |
| **Holding time** | 1 minute after temperature and pressure stabilization |
| **Acceptance criteria** | IEC 60534-4 or ANSI/FCI 70-2 |

#### 14.2.7.2 Hydrostatic shell and body/bonnet/stem seal leakage test

A single test for hydrostatic shell and body/bonnet/stem seal leakage shall be performed on low-temperature/cryogenic valves in accordance with Table 15.

***Justification***

*Standardization of inspection and testing requirements will avoid delay in the procurement cycle. Also, standardization will help the manufacturer to cost correctly at the beginning which will avoid cost escalation at a later date.*

**Table 15 — Low temperature / cryogenic shell (external leakage) test**

| **Description** | Testing prerequisite and acceptance criteria |
|---|---|
| **Test pressure** | Design pressure |
| **Test temperature** | Specified minimum design temperature |
| **Test gas** | Helium gas (97 % pure) or nitrogen in accordance with specified minimum design temperature |
| **Holding time** | 10 minutes after temperature and pressure stabilization |
| **Leakage testing for stem seal, body/bonnet and body/bonnet extension gasket area** | Sniffing probe with spectrometer |
| **Acceptance criteria** | MSS SP 61 |

#### 14.2.7.3 Functional test

**14.2.7.3.1**

When low-temperature and cryogenic valve seat leakage or shell hydrostatic testing is specified, functional testing shall be performed at the specified lowest operating temperature.

***Justification***

*This test will ensure that the valve will perform as intended for the process conditions specified. This requirement will avoid freezing of packing at low or cryogenic temperatures.*

**14.2.7.3.2**

The low-temperature and cryogenic valves functional tests shall be performed by stroking the valve from 0 % to 100 % and vice versa at least three times.

***Justification***

*Cryogenic functional testing will ensure that the valve will perform as intended for the process conditions specified. This requirement will avoid freezing of packing at low or cryogenic temperatures.*

# 15 Surface protection

## 15.1

Offshore and marine coastal coating systems shall be in accordance with IOGP S-715.

***Justification***

*Compliance with minimum common set of requirements for the procurement of coating and painting for offshore and marine environments.*

## 15.2

Onshore and non-marine coating systems shall be selected in accordance with ISO 12944-5.

***Justification***

*Minimum coating requirements to prevent external corrosion and ensure effective corrosion protection of materials.*

### 15.3

Onshore and non-marine coating systems shall be qualified to ISO 12944-6.

***Justification***

*Minimum coating requirements to prevent external corrosion and ensure effective corrosion protection of materials.*

### 15.4

Coating under insulation shall be in accordance with IOGP S-715.

***Justification***

*Compliance with minimum common set of requirements for the procurement of coating and painting under insulation.*

## 16 Marking, tagging and nameplate

### 16.1

Tag plates shall be marked with the tag numbers of the valve assemblies, air receivers, positioners, controllers, solenoid valves, limit switches and position transmitters.

***Justification***

*Identification of equipment helps the operation and maintenance team.*

### 16.2

Tag plates shall be 316L stainless steel.

***Justification***

*Material and fixing point to be specified for durability as per existing industry best practice.*

### 16.3

Tag plates shall be affixed with 316L stainless steel rivets or screws.

***Justification***

*Material and fixing point to be specified for durability as per existing industry best practice.*

### 16.4

Tag plate information shall be stamped or engraved.

***Justification***

*Experience demonstrates that illegibility causes problems.*

### 16.5

Markings shall be in accordance with IEC 60534-5:2004, Table 1, with items 19 and 28 mandatory.

***Justification***

*IEC has a dedicated standard for marking, which is defining mandatory and supplementary requirements.*

### 16.6

Three-way valves shall be marked to indicate the common inlet or common outlet port by a permanent stamp on the flange.

***Justification***

*Aid correct installation during entire life cycle.*

## 17 Preparation for shipment and preservation

### 17.1

Inside and outside surfaces of valves and threaded surfaces of accessories shall be protected from atmospheric corrosion during shipment and storage.

***Justification***

*This requirement will extend the life of the materials and also avoid product contamination.*

### 17.2

Open ports and connections shall be blanked off prior to packaging using covers or plugs made of hard plastic or a metal compatible with the port/flange material.

***Justification***

*This requirement will protect the surfaces and threads aiding trouble-free installation. Also, this requirement will prevent water/bugs from entering the accessories thereby preventing equipment malfunction. This requirement will avoid using wood and other materials that may retain moisture.*

### 17.3

The mounting surfaces of flanges and weld ends shall be protected from damage during shipment and storage.

***Justification***

*This requirement will avoid mechanical damage and prevent reordering/rectification of mating surfaces in case of damage.*

### 17.4

Packing shall prevent moisture, water or foreign matter entering the valve body and components.

### *Justification*

*This requirement will avoid water condensation and corrosion and eventually prevent equipment malfunction.*

## 17.5

Items that are not installed on the valve shall be packed separately, labelled and tied to the valve.

### *Justification*

*This requirement will avoid loss of items thereby prevent schedule delays. Also, this requirement will avoid the mixing of different components from different valves thereby avoid potential safety issues.*

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