International Association of Oil & Gas Producers

SPECIFICATION

IOGP S-611

May 2025

Version 2.0

Supplementary Specification to API Standard 600 for Steel Gate Valves

JIP33 JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
2.0	May 2025	Second Edition
1.0	May 2019	First Edition

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).

This second edition cancels and replaces the first edition published in May 2019. Due to technical writing requirements leading to extensive changes, this second edition should be treated as a new document.

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Introduction

The purpose of the IOGP S-611 specification documents is to define a minimum common set of requirements for the procurement of steel gate valves in accordance with API Standard 600, 14th edition, May 2021, Steel Gate Valves—Flanged and Butt-welding Ends, Bolted Bonnets, for application in the petroleum and natural gas industries.

The IOGP S-611 specification documents follow a common structure (as shown below) comprising a specification, also known as a technical requirements specification (TRS), a procurement data sheet (PDS), an information requirements specification (IRS) and a quality requirements specification (QRS). These four specification documents, together with the purchase order, define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Supplementary Technical Requirements Specification (TRS)

This specification is to be applied in conjunction with the supporting PDS, IRS and QRS as follows.

IOGP S-611: Supplementary Specification to API Standard 600 for Steel Gate Valves

This specification defines technical requirements for the supply of the equipment and is written as an overlay to API 600, following the API 600 clause structure. Clauses from API 600 not amended by this specification apply as written. Modifications to API 600 defined in this specification are introduced by a description that includes the type of modification (i.e. *Add*, *Replace* or *Delete*) and the position of the modification within the clause.

NOTE Lists, notes, tables, figures, equations, examples and warnings are not counted as paragraphs.

IOGP S-611D: Procurement Data Sheet for Steel Gate Valves (API)

The PDS defines application-specific requirements. The PDS is applied during the procurement cycle only and does not replace the equipment data sheet. The PDS may also include fields for supplier-provided information required as part of the purchaser's technical evaluation. Additional purchaser-supplied documents may also be incorporated or referenced in the PDS to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-611L: Information Requirements for Steel Gate Valves (API)

The IRS defines information requirements for the scope of supply. The IRS includes information content, format, timing and purpose to be provided by the supplier, and may also define specific conditions that invoke the information requirements.

IOGP S-611Q: Quality Requirements for Steel Gate Valves (API)

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 PDS or in the purchase order.

The specification documents follow the editorial format of API 600 and, where appropriate, the drafting principles and rules of ISO/IEC Directives Part 2.

The PDS and IRS are published as editable documents for the purchaser to specify application-specific requirements. The TRS and QRS are fixed documents.

The order of precedence of documents applicable to the supply of the equipment, with the highest authority listed first, shall be as follows:

a) regulatory requirements;

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

c) purchaser-defined requirements (e.g. PDS, IRS and QRS);

d) this specification;

e) API 600.

1 Scope

Add after third paragraph

For sizes larger than DN 1050 (NPS 42), the requirements of Annex H apply.

Add to section

Additional requirements or amendments (not included in this specification) may be needed to purchase valves of the following designs/applications:

— two-piece split wedge design;

— parallel seat double-disc gate design;

— pressure seal bonnet design;

— short pattern valves;

— cryogenic service valves with a design temperature below -46 °C (-50 °F);

— high-temperature valves with a design temperature above 455 °C (850 °F);

— buried valves with stem extensions;

— body cavity relief by external piping and valves;

— soft sealing parts (i.e., thermoplastics and elastomers).

2 Normative References

Add to first paragraph

The following documents are referred to in this specification, the PDS (IOGP S-611D) or the IRS (IOGP S-611L) in such a way that some or all of their content constitutes requirements of these specification documents.

Add to section

ANSI/NACE MR0175/ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production*

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

API Recommended Practice 591:2019, *Process Valve Qualification Procedure*

API Specification 5L, *Line Pipe*

API Specification 6A, *Specification for Wellhead and Tree Equipment*

API Specification 6D:2021, *Specification for Valves*

API Specification 6FA, *Standard for Fire Test of Valves*

API Specification 17D:2021, *Specification for Subsea Wellhead and Tree Equipment*

API Standard 598:2023, *Valve Inspection and Testing*

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

API Standard 602, *Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries*

ASME B16.34:2020, *Valves — Flanged, Threaded, and Welding End*

ASME B31.3:2022, *Process Piping*

ASME Boiler and Pressure Vessel Code (BPVC), *Section V:2023, Nondestructive Examination*

ASME Boiler and Pressure Vessel Code (BPVC), *Section VIII, Division 1:2023, Rules for Construction of Pressure Vessels*

ASME Boiler and Pressure Vessel Code (BPVC), *Section IX, Welding, Brazing, and Fusing Qualifications*

ASME PCC-1, *Guidelines for Pressure Boundary Bolted Flange Joint Assembly*

ASNT ACCP-CP-1, *ASNT Central Certification Program*

ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

ASTM A262:2021, *Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels*

ASTM A578/A578M, *Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*

ASTM A609/A609M:2012, *Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof*

ASTM A703/A703M, *Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts*

ASTM A961/A961M, *Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications*

ASTM D4894, *Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials*

ASTM D4895, *Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion*

ASTM F2168, *Standard Specification for Packing Material, Graphitic, Corrugated Ribbon or Textured Tape, and Die-Formed Ring*

ASTM F2191/F2191M, *Standard Specification for Packing Material, Graphitic or Carbon Braided Yarn*

AWS A4.2M, *Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Austenitic-Ferritic Stainless Steel Weld Metal*

EN 1179, *Zinc and zinc alloys - Primary zinc*

EN 1591 (all parts), *Flanges and their joints - Design rules for gasketed circular flange connections*

EN 14772:2021, *Flanges and their joints - Quality assurance inspection and testing of gaskets in accordance with the series of standards EN 1514 and EN 12560*

FSA-G-604-07, *Oxidation Test Standard for Flexible Graphite Gasket Materials*

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

IOGP S-563:2021, *Material Data Sheets for Piping and Valve Components*

ISO 8249, *Welding — Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10497, *Testing of valves — Fire type-testing requirements*

ISO 13628-4:2010, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 4: Subsea wellhead and tree equipment*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 15609 (all parts), *Specification and qualification of welding procedures for metallic materials — Welding procedure specification*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 15848-1:2015/Amd.1:2017, *Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 1: Classification system and qualification procedures for type testing of valves*

ISO 15848-2:2015, *Industrial valves — Measurement, test and qualification procedures for fugitive emissions — Part 2: Production acceptance test of valves*

ISO 17781:2017, *Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels*

PED 2014/68/EU, *Pressure Equipment Directive*

Replace Section 3 title with

3 Terms, Definitions, and Acronyms

Add new section 3.0 to start of section

3.0 Acronyms

CRA corrosion-resistant alloy

DN diamètre nominal (French for nominal diameter)

EDS element data sheet

EP extreme pressure

HBW Brinell hardness with tungsten ball

HSE health, safety and environment

IP ingress protection (rating code)

MDS material data sheet

MPD maximum pressure differential

MT magnetic particle testing

NDE nondestructive examination

NPS nominal pipe size

OD outer/outside diameter

ppm parts per million

PT liquid penetrant testing

PTFE polytetrafluoroethylene

QSL quality specification level

RT radiographic testing

SWL safe working load

UT ultrasonic testing

VPCI vapor phase corrosion inhibitor

VT visual testing

Add new term 3.5

3.5
batch
component batch
Components of the same design, material, size, rating and heat number that are from a single purchase order and that are manufactured in the same location.

Add new term 3.6

3.6
corrosion allowance
The thickness that is added to the minimum required thickness given by the selected standard to account for loss of material due to corrosion.

Add new term 3.7

3.7
lagging
Material that is used for insulation.

Add new term 3.8

3.8
maximum pressure differential
MPD
The maximum difference, between the upstream and downstream pressure across the gate, at which the gate may be operated.

Add new term 3.9

3.9
position indicator
A device that shows the position of the valve gate.

Add new term 3.10

3.10
pressure-containing part
A part whose failure to function as intended results in a release of contained fluid into the environment and that includes, as a minimum, the body, bonnet, stem, gland flange and pressure boundary bolting.

Add new term 3.11

3.11
pressure-controlling part
A part that is intended to prevent or permit the flow of fluids and that includes, as a minimum, the gate and the seats.

Add new term 3.12

3.12
tack weld
A temporary weld that is used to fix the workpieces or assemblies to be joined in proper position for welding.

Add new term 3.13

3.13
drive train
A part of the valve drive that is located between the operator and the gate and includes, as a minimum, the stem, gate, yoke, stem nut, bonnet and bolting, but excludes the operator.

Add new term 3.14

3.14
operator actuator
A mechanical device (or assembly) for opening or closing a valve.

Note 1 to entry: The operator actuator can be a handwheel with or without a gearbox.

Note 2 to entry: The operator actuator can be an electric, hydraulic or gas device bolted or otherwise attached to the valve.

Add new term 3.15

3.15
major weld repair
Weld repair where either the depth exceeds the lesser of 0.2 of the wall thickness and 25 mm (1 in.), or the repair surface area exceeds 65 cm^2 (10 in^2).

4 Pressure/Temperature Ratings

Add new section

4.5 Cavity Relief

4.5.1

When body cavity relief is specified, a hole with a diameter greater than or equal to 3 mm (0.12 in.) shall be drilled in the closure member outside the seat facing area.

4.5.2

The pressure-relief hole shall connect the valve body cavity with the high-pressure side of the valve when in the closed position.

5 Design

Add new section 5.0 before section 5.1

5.0 Design Codes

Valves shall be in accordance with ASME B16.34 standard class gate valves.

5.3 Body Dimensions

5.3.1 Flanged Ends

5.3.1.1

Add to section

The minimum Brinell hardness of grooves of ring type joint flanges shall be in accordance with Table 10.

Add new Table 10

Table 10—Minimum Brinell Hardness of Grooves of Ring Type Joint Flanges

Flange Material	Gasket Material	Minimum Brinell Hardness
Carbon steel	—	110 HB
Alloy steel (3.5 % Ni)	316L stainless steel	180 HB
Alloy steel (2.25 % Cr, 1 % Mo)	Alloy steel (5 % Cr, 0.5 % Mo)	150 HB
Austenitic stainless steel	316L stainless steel	180 HB
Duplex stainless steel	316L stainless steel	190 HB
Alloy 625	UNS N06625	220 HB

Add to section

Bolting bearing surfaces shall be spot faced or back faced in accordance with MSS SP-9.

5.3.1.2

Delete "or ISO 5752" from first sentence

Add to section

Face-to-face dimensions shall be in accordance with Table 11.

NOTE For combinations of valve size and class not included in Table 11, see Annex H.

Add new Table 11

Table 11—Face-to-face Dimensions

Valve Size DN (NPS)	Class 150 mm (in.)	Class 300 mm (in.)	Class 600 mm (in.)
1000 (40)	As per ASME B16.10	1930 (76)	2286 (90)
1050 (42)	787 (31)	1981 (78)	2438 (96)
1200 (48)	864 (34)	2235 (88)	2540 (100)
1270 (50)	—	—	2540 (100)
1321 (52)	1000 (40)	—	—
1372 (54)	1050 (42)	—	—
1422 (56)	—	2438 (96)	2692 (106)

Add new section

5.3.1.3 Lateral Misalignment

5.3.1.3.1

For valve sizes DN 100 (NPS 4) and below, the lateral misalignment of flange centerlines shall not exceed 2 mm (0.079 in.).

5.3.1.3.2

For valve sizes above DN 100 (NPS 4), the lateral misalignment of flange centerlines shall not exceed 3 mm (0.118 in.).

Add new section

5.3.1.4 Parallel Misalignment

5.3.1.4.1

For valve sizes DN 600 (NPS 24) and below, the parallel misalignment between flanges shall not exceed 2.5 mm/m (0.03 in./ft).

5.3.1.4.2

For valve sizes above DN 600 (NPS 24), the parallel misalignment between flanges shall not exceed 1.75 mm/m (0.02 in./ft).

Add new section

5.3.1.5

Valves with flanged ends shall accommodate, without contacting other body parts, heavy hex series nuts with dimensions in accordance with ASME B18.2.2.

5.3.2 Butt-welding Ends

5.3.2.2

Add to section

For valve sizes not listed in ASME B16.10, end-to-end dimensions shall be as specified in the PDS.

5.3.2.3

Add new list section

— the sulfur content of carbon steel welding ends shall not exceed 0.020 % by mass;

Add new list section

— the phosphorus content of carbon steel welding ends shall not exceed 0.025 % by mass.

Add new section

5.3.2.5 Pup Pieces

5.3.2.5.1

Outside diameter, wall thickness, material grade and composition of the extension (pup) pieces shall be as specified.

5.3.2.5.2

When specified, butt-welded end valves shall be provided with extension pup pieces in accordance with Table 12.

Add new Table 12

Table 12—Pup Lengths

Valve Size DN (NPS)	Pup Length mm (in.)
50 to 200 (2 to 8)	200 mm (8 in.)
250 to 500 (10 to 20)	Minimum 1*D* and maximum 500 mm (20 in.)
≥ 550 (≥ 22)	800 mm (32 in.)
Key *D* is the outside diameter of the pipe.	

5.3.2.5.3

The material grade of the pup piece shall be greater than or equal to that of the valve body or the associated piping/pipeline.

5.3.2.5.4

An additional piece (e.g., test ring) made of the same material as that of the extension pup pieces shall be provided.

5.3.2.5.5

Final assembly and leak testing of the valve shall be performed after welding and heat treatment of extension pup pieces.

5.3.2.5.6

The ratio of the minimum yield strength of the extension pup piece material to the valve body material or extension pup piece to the pipe shall not exceed 1.5:1.

5.3.2.5.7

Where the specified minimum yield strength of the adjoining pipe material exceeds the specified minimum yield strength of the valve material by more than 1.5:1, the extension pup piece shall be of an intermediate strength so that the maximum yield strength ratio of 1.5:1 across the valve to extension pup piece weld and extension pup piece to the pipe weld is satisfied (e.g., the extension pup piece between an ASTM A350 LF2 valve and an API 5L X60 pipeline may be of ASTM A694 F52 / API 5L X52 material).

5.3.2.5.8

The extension pup piece material shall be in accordance with the applicable IOGP S-563 MDS.

5.3.2.5.9

The end preparation and alignment of extension pup pieces shall be in accordance with ASME B31.3 or, when specified, an alternative specification.

5.3.2.5.10

Heat-treatment delivery conditions shall be marked on the extension pup piece using a low-stress die stamp.

5.4 Bonnet

5.4.2

Add to first list item

or on attachment by tack welding

5.4.4

Add to section

The eyebolt pin shall not be anchored by split pins or cotter pins.

Add new section

5.4.6 Lagging

When applicable, lagging extension lengths shall be specified.

NOTE Suggested dimensions for lagging requirements are provided in Annex G.

5.5 Bonnet-to-body Joint

Add new section 5.5.0 before section 5.5.1

5.5.0

Flanges with a circular or a non-circular shape shall have a flange facing finish in accordance with ASME B16.5.

5.5.1

Add to sentence

as specified

5.5.4

Add to section

The hardness of ring-joint gaskets shall be at least 30 HBW less than the hardness of the body/bonnet sealing surfaces.

5.5.7

Add to section

Bolting bearing surfaces shall be spot faced or back faced in accordance with MSS SP-9.

Add new section

5.5.12 Bolting

5.5.12.1

The bolting preload shall not be less than the calculated bolt load required to seal under hydrostatic test conditions.

5.5.12.2

The bolt stress resulting from preload shall not exceed 70 % of yield at the design temperature.

5.5.12.3

Bolting preload torques calculations shall be in accordance with API 6A, ASME PCC-1 or EN 1591 (all parts).

5.5.12.4

Bolting lubricant for bolting preload torque calculations shall have the same coefficient of friction on the threads and nut face as the one used in production.

5.6 Gate

5.6.1

5.6.1.1

Add to section

Valves DN 50 (NPS 2) and above shall be furnished with a flexible wedge.

5.6.3

In second paragraph, replace "DN 650 (NPS 26)" with

DN 300 (NPS 12)

5.7 Yoke

5.7.3

Add to section

Separate yokes shall be attached to the bonnet with studs and nuts using through holes.

Add to section

Separate yokes shall not be attached to the bonnet using slotted holes.

Table 3—Minimum Wear Travel and Maximum Stem Projection

Add rows "1100 ≤ DN ≤ 1200 (44 ≤ NPS ≤ 48)" and "1250 ≤ DN ≤ 1500 (50 ≤ NPS ≤ 60)"

Valve Size Range, DN (NPS)	Minimum Wear Travel, *h* mm (in.)	Maximum Stem Projection mm (in.)
1100 ≤ DN ≤ 1200 (44 ≤ NPS ≤ 48)	25.4 (0.96)	76.2 (3)
1250 ≤ DN ≤ 1500 (50 ≤ NPS ≤ 60)	32.0 (1.25)	96.0 (3.78)

5.8 Stem and Stem Nut

5.8.1

Add to section

Stem sections shall be cylindrical, within a tolerance of 0.05 mm (0.002 in.).

Add to section

Out of straightness of the entire length of the valve stem shall not exceed 0.4 mm/m (0.005 in./ft).

5.8.7

Add to section

The stem-to-gate connection of the valve shall be in accordance with the strength requirements of API 591:2019, Annex B.

5.9 Packing and Packing Box

5.9.1

Add to section

The stem packing arrangement shall prevent extrusion.

Add to section

The packing shall consist of die-formed, exfoliated graphite rings with anti-extrusion braided end (top and bottom) rings or fully braided packing set in accordance with Figure 5 and Figure 6.

Add to section

The bottom of the packing box shall be flat and perpendicular to the axis of the stem.

Add new Figure 5

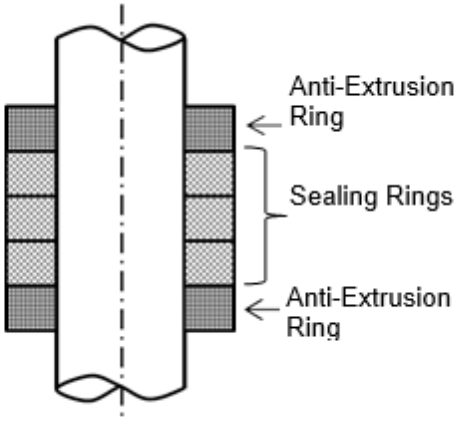

Figure 5—Die-Formed Flexible Graphite Packing

Add new Figure 6

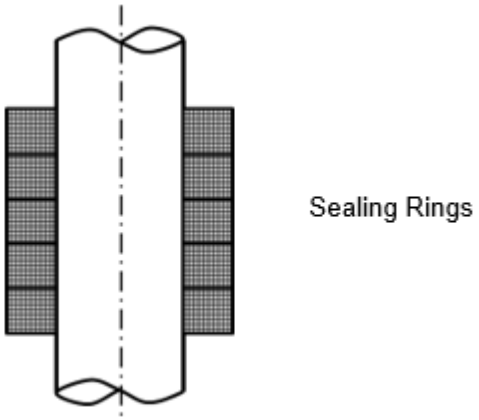

Figure 6—All Braided Graphite Rings Packing

5.9.4

Add to section

The packing gland shall protrude into the stuffing box by at least 1 mm (0.04 in.) prior to compressing the packing rings.

Add to section

Threaded glands shall not be used.

Add to section

The gland flange shall be constructed from a single piece of material.

5.9.6

Add to section

The stem shall be supported and have clearances to prevent rubbing contact with the adjacent static metallic components in any orientation.

5.11 Operation

5.11.1

Add to section

The handwheel or gearbox of the valve shall operate against an MPD equal to the full pressure rating at 38 °C (100 °F).

Add to section

When requested, the manufacturer shall provide the following data:

— number of turns for manually operated valves;

— valve top work details for interlock design.

Add to section

The rim pull force required to seat, unseat and stroke at the MPD at the minimum and maximum design temperatures shall not exceed 360 N (80 lbf).

Add to section

If the force or dimensional limitations are exceeded on directly installed handwheel, the valve shall be provided with a gearbox.

Add to section

Valves with bore sizes greater than or equal to those specified in Table 13 shall be fitted with a gearbox.

Add new Table 13

Table 13—Minimum Bore Sizes at which a Gearbox is Required

Class	Valve Bore Size at which a Gearbox is Required DN (NPS)
150	≥ 300 (12)
300	≥ 250 (10)
600	≥ 150 (6)
900	≥ 100 (4)
1500 and 2500	≥ 80 (3)

5.11.2

Add to section

Handwheel spokes shall not extend beyond the perimeter of the handwheel.

Add to section

Handwheel dimensions for class 300 and above valves shall not exceed the end to end dimensions or 750 mm (30 in.), whichever is smaller.

Add to section

Handwheel dimensions for class 150 valves shall not exceed twice the end-to-end dimensions or 750 mm (30 in.), whichever is smaller.

Add new section

5.11.7

5.11.7.1

The maximum output torque/force of the direct-mounted handwheel or gearbox shall be calculated applying a 360N (80 lbf) input rim pull force.

5.11.7.2

The drive train shall withstand the maximum output force of the actuator, gearbox or directly-mounted handwheel without permanent deformation.

Add new section

5.11.8 Gearboxes

5.11.8.1

The IEC 60529 IP code for gearboxes shall be IP65.

5.11.8.2

Gearboxes shall be filled with grease (extreme pressure type (EP type) or equivalent) or heavy-duty gear oil to a minimum of 80 % with all moving parts submerged.

5.11.8.3

External shafts shall be made of corrosion-resistant material.

5.11.8.4

Gearboxes shall allow for the handwheel to be orientated on site at any 90° increment relative to the initial position supplied.

5.11.8.5

The operating temperature for the gearbox, if not specified, shall be between -20 °C and 80 °C (-4 °F and 176 °F).

5.11.8.6

The dimensions of the gearbox shall not exceed the valve end-to-end dimensions for classes 300 and above.

5.11.8.7

Gearboxes dimensions for class 150 valves shall not exceed twice the valve end-to-end dimensions.

5.11.8.8

Gearbox handwheel diameters shall not exceed the dimensions specified in 5.11.2.

5.11.8.9

When the number of handwheel turns on a gear operator exceeds 100 from the fully open to the fully closed position, the number of handwheel turns shall be specified in the quotation.

5.11.8.10

Gearboxes shall be equipped with one or more easily accessible injection fittings and a weatherproof vent connection.

5.12 Bypasses and Other Auxiliary Connections

Add to section

The bypass shall be located on the side of the valve connecting the A-B or the E-F locations in accordance with ASME B16.34:2020, Figure 1.

Add to section

The bypass valve shall be of rising stem outside screw and yoke globe valve type in accordance with API 602.

Add to section

The bypass valve stem shall have the same general orientation as the primary valve stem.

5.13 Fugitive Emission Design Requirement

5.13.1

Add to sentence

and ISO 15848-1

Add to section

When specified, Annex I shall be normative.

Add to section

The fugitive emission type testing standard, method, tightness class and acceptance criteria shall be specified.

Add to section

Type testing to requirements of ISO 15848-1 or Annex I shall be in accordance with performance class ISO FE BH CO1 SSA1 for the designed temperature range.

Add new section

5.14 Lifting

5.14.1

Lifting sketches and handling instructions for safe lifting operation for valves and valve assemblies weighing at least 25 kg (55 lbs) shall be provided.

5.14.2

The weight of the valve shall be indicated on the lifting sketch.

5.14.3

Lifting lugs shall be provided for valves weighing more than 250 kg (550 lbs) including the operator and accessories.

5.14.4

When provided, lifting lug positions shall be based on the stem in the vertically up position and the specified installation orientation.

5.14.5

Lifting lugs shall not be made of cast iron or ductile iron material.

5.14.6

Carbon steel lifting points shall not be used on corrosion-resistant (e.g., 316 stainless steel) valve bodies.

5.14.7

Valves shall be marked to indicate the mandatory safe lifting points and lifting lug SWL.

6 Materials

6.1 Materials Other Than Trim Materials

Add new section

6.1.1

6.1.1.1

The material designation (e.g., ASTM) and material grade of all valve parts shall be provided.

6.1.1.2

Bolting and valve components shall not be cadmium plated.

6.1.1.3

Austenitic ductile iron stem nuts shall not be used in combination with austenitic stainless steel stem materials.

6.1.1.4

The gearbox or actuator including the mounting bracket shall be capable of operating at an atmospheric temperature of -20 °C to 80 °C (-4 °F to 176 °F).

Add new section

6.1.2

6.1.2.1

Trim components not listed in Table 7 shall have a corrosion resistance greater than or equal to that of the component to which they are coupled.

6.1.2.2

Trim components not listed in Table 7 shall have an allowable temperature range greater than or equal to that of the component to which they are coupled.

Add new section

6.1.3

When sour service is specified, valve components shall be in accordance with ANSI/NACE MR0103/ISO 17945 or ANSI/NACE MR0175/ISO 15156.

Add new section

6.1.4

Spiral wound gaskets with PTFE filler material shall be in accordance with ASTM D4894 or ASTM D4895.

Add new section

6.1.5

Austenitic stainless steel gaskets (spiral wound or ring joint) shall be in the solution-annealed condition.

6.2 Trim

Add new section

6.2.3

Stem, sliding elements and threaded components shall have hardness differences between contacting surfaces or surface treatment.

NOTE The required differential hardness to prevent galling varies depending on materials. A 50 HBW differential hardness is considered a general recommended practice.

Add new section

6.3 Welding

6.3.1

Welding, including repair welding, of pressure-containing and pressure-controlling parts shall be performed in accordance with procedures qualified to ASME BPVC, Section IX or ISO 15607, ISO 15609 (all parts), and ISO 15614-1.

6.3.2

Heat treatment shall be performed in accordance with IOGP S-563 MDSs.

6.3.3

Butt welds shall be of the full penetration type.

6.3.4

Weld procedure qualification for ferritic-austenitic (duplex and super duplex) stainless steel shall include microstructural examination including ferrite measurement, impact testing and corrosion testing in accordance with ISO 17781.

Add new section

6.4 Graphite Materials

6.4.1

Die-formed rings, flexible graphite and spiral wound gaskets with graphite filler shall be in accordance with ASTM F2168 Class 2 with supplementary requirements S3.1, S6.1, S6.2 and S10 included.

6.4.2

Braided yarn shall be in accordance with ASTM F2191/F2191M Class 2 with supplementary requirements S6.1 and S10 included.

6.4.3

Active sacrificial corrosion inhibition using zinc shall not be permitted.

6.4.4

The chlorine content shall be less than or equal to 50 ppm.

6.4.5

The fluorine content shall be less than or equal to 10 ppm.

6.4.6

The halogen content shall be less than or equal to 310 ppm.

6.4.7

Graphite oxidation testing shall be performed in accordance with EN 14772:2021, 6.7 or FSA-G-604-07.

6.4.8

The accumulated weight loss during graphite oxidation testing shall be less than 4 % per hour.

7 Testing, Inspection, and Examination

7.1 Inspection and Examination

7.1.1

Replace section with

Valves shall be inspected and examined for compliance in accordance with the specified QSL.

7.1.2

Add to sentence

with the amendments specified in Annex F

7.2 Pressure Test

Add to sentence

with the amendments specified in Annex F

Add to section

Chloride content of test water in contact with the austenitic and duplex stainless steel components of the valve shall not exceed 30 ppm.

7.3 Repairs of Defects

Add to section

Weld repair of materials shall be in accordance with the applicable IOGP S-563 MDSs.

Add to section

Weld repair of materials that are not covered in IOGP S-563 MDSs shall not be permitted without purchaser approval.

Add to section

Weld repairs shall not be permitted for pressure-containing castings that leak during pressure testing.

Add to section

Weld repairs shall be inspected in accordance with Annex F and the standard used for the component inspection.

Add to section

Weld repair of forgings, plates, seamless products and bars shall not be permitted.

Add to section

Additional weld repairs shall not be allowed on areas that have undergone major weld repair.

Add new section

7.4 Repairs of Weld Overlay and Hard Facing

7.4.1

Weld repair of corrosion-resistant weld overlay and hard facing shall be in accordance with the applicable IOGP S-563 EDS referenced in Annex D.

7.4.2

Weld repair of corrosion-resistant weld overlay and hard facing that are not covered in IOGP S-563 MDSs shall not be permitted without purchaser approval.
Add new section

7.5 Major Weld Repairs

Major weld repairs shall not be permitted without purchaser approval prior to the execution.

Add new section

7.6 Production Testing

7.6.1

When production valve testing is specified, a sample of the manufactured valves shall be subjected to fugitive emission production testing in accordance with ISO 15848-2 or, if agreed with the purchaser, another standard.

7.6.2

No adjustment shall be made to stem packing and gland flange bolts after final production testing.

7.6.3

When the valve is tested in accordance with ISO 15848-2 or Annex J, if the tightness class is not specified, class B shall be the minimum.

NOTE When specified, see Annex J for additional requirements to ISO 15848-2.

Table 8—Nominal Seating Surface, Stem and Backseat Bushing or Weld-deposit Materials and Hardness

Add row "22A" and row "22B"

Trim	Nominal Trim	Seating Surface Hardness (HB) Minimum [a]	Seating Surface Material Type [b]	Seating Surface Typical Specifications Grade			Stem/Backseat Bushing [p]		Stem Hardness (HB)	Backseat Bushing Hardness (HB)
				Cast (Integral)	Forged (Integral)	Welded [m]	Material Type [b]	Typical Specifications Type		
22A	Duplex	Note [d]	22Cr	ASTM A995 Gr. 4A	ASTM F51	AWS 5.9 ER2209 or ER2553	22Cr	ASTM A276 UNS S31803	Note [d]	Note [d]
22B	Super duplex	Note [d]	25Cr	ASTM A995 Gr. 6A	ASTM F53 or F55	AWS 5.9 ER2594	25Cr	ASTM A276 UNS S32750 or S32760	Note [d]	Note [d]

8 Marking

8.1 General

Add to section

The nameplate shall include the designation "IOGP S-611".

Add to section

The nameplate letter size shall be at least 3 mm (0.12 in.).

Add to section

Nameplate rivet holes, when applicable, shall be drilled prior to valve testing.

Add to section

The letter size height for markings on the body closure/end connector and bonnet/cover shall be at least 4 mm (0.16 in.).

Add to section

Markings on the body and the bonnet shall not be masked by painting or coating.

Add to section

If specified, an austenitic stainless-steel nameplate shall be provided for the gear operator.

8.2 Specific Markings

8.2.1

Add to section

For valves that have a body cavity relief, "HP" for "high pressure" shall be permanently marked on the high-pressure side (in the closed position) of the unidirectional valve body.

9 Preparation for Shipment

9.1 Coatings

9.1.1

Add to section

Pure cadmium or zinc coatings shall not be used.

Add new section

9.1.3

External coatings for end connections shall be in accordance with API 6D:2021, Annex G.

9.5 Packaging

Add new section 9.5.0 before section 9.5.1

9.5.0 Packing Preparation

9.5.0.1

Prior to shipment, valve internals shall be cleaned and dried.

9.5.0.2

Internal surfaces of the valve shall be free from cleaning agents, loose particles and organic substances.

Add new section

9.5.3

Valves shall be packed in an enclosed vapor-proof barrier material.

Add new section

9.5.4

Valve packaging shall have VPCIs applied in accordance with the VPCI manufacturer's instructions.

Annex B
(normative)

Information to be Specified by the Purchaser

In list section 2), add new list items cc) to kk)

cc) fugitive emission type testing standard, testing method and tightness class;

dd) fugitive emission production testing size of the sample, selection method, test method and acceptance criteria;

ee) QSL;

ff) lagging extension;

gg) optional requirements selected from Annex G;

hh) body cavity relief;

ii) minimum and maximum design temperature;

jj) wall thickness and inner diameter of the mating pipe;

kk) material requirement alternatives to IOGP S-563 MDSs.

Annex D
(normative)

Valve Material Combinations

Add to annex

When a material has a corresponding MDS in IOGP S-563, the requirements of that MDS shall apply.

Add to annex

When a weld overlay material, including hardfacing, has a corresponding EDS in IOGP S-563, the requirement of that EDS shall apply.

Add to annex

Alternative material requirements shall be permitted when specified in the purchasing documents.

Add new Annex F

Annex F
(normative)

Supplementary Requirements for Inspection and Testing

F.1 General

F.1.1

This annex specifies quality levels for gate valves.

F.1.2

QSL1 is the default quality level.

F.1.3

QSL2 to QSL4 are optional and may be specified.

NOTE The QSL defines the extent of inspection and testing to be undertaken by the manufacturer. The QSL is selected on the basis of service risk, with the QSL number increasing with the extent of inspection and testing required.

F.2 Inspection and Examination

F.2.1

NDE activities shall be conducted after final heat treatment or post-weld heat treatment.

F.2.2

F.2.2.1

A ferrite content check shall be performed on duplex and super duplex stainless steel welds supplied in the as-welded condition (e.g., welds between duplex / super duplex extension pup pieces and valve bodies).

F.2.2.2

The ferrite percentage range shall be measured using a calibrated ferrite content meter.

F.2.2.3

The ferrite content meter shall be calibrated in accordance with AWS A4.2M or ISO 8249.

F.2.2.4

Calibration blocks shall cover ferrite within the range of 25 % to 70 %.

F.2.2.5

Ferrite checks shall be undertaken on the OD at a minimum of three locations equally spaced around the circumference.

F.2.2.6

Coatings and surface oxide shall be removed prior to testing.

F.2.2.7

The test locations shall be ground to a minimum 120-grit finish prior to testing.

F.2.2.8

For welds in the as-welded condition, the acceptance criteria for the ferrite content shall be within the range of 30 % to 70 % in accordance with ISO 17781.

F.2.3

F.2.3.1

NDE personnel shall be qualified in accordance with ISO 9712 or ASNT SNT-TC-1A.

F.2.3.2

Personnel performing NDE evaluation shall be certified ISO 9712 or ASNT SNT-TC-1A Level 2.

F.2.4

NDE requirements shall be in accordance with Table F.1.

F.2.5

The extent, method and acceptance criteria of NDE and the item examination code shall be in accordance with Table F.2.

F.2.6

Visual examination after assembly shall include dimensional inspection of the following:

— end-to-end dimensions;

— flange dimensions including bolt hole orientation, bolt hole diameters and flange facings;

— gate seat position and stem projection in accordance with 5.6.6.

Add new Table F.1

Table F.1—NDE Requirements

Part	QSL1		QSL2 and QSL2G		QSL3 and QSL3G		QSL4	
	Cast	Forged	Cast	Forged	Cast	Forged	Cast	Forged
Body, bonnet, yoke, gland flange [e]	VT1	VT2	VT1	VT2	VT1	VT2	VT1	VT2
			MT2 [g] or PT1 [g]	MT1 [g] or PT1 [g]	MT2 [g] or PT1 [g]	MT1 [g] or PT1 [g]	MT2 or PT1	MT1 or PT1
			RT1 [a, g]	N/A	RT1 [a]	UT2	RT1 [a, d] and UT1	UT2
Welding ends (including pipe pup welding ends) [b]	VT1	VT2	VT1	VT2	VT1	VT2	VT1	VT2
			MT2 [g] or PT1 [g]	MT1 [g] or PT1 [g]	MT1 or PT1	MT1 or PT1	MT2 or PT1	MT1 or PT1
			RT3 [g] or UT4 [g]	UT2 [g]	RT3 or UT4	UT2	RT3 or UT4	UT2
Stem [c, e]	N/A	VT2	N/A	VT2	N/A	VT2	N/A	VT2
						MT1 or PT1		MT1 or PT1
						N/A		UT2
Pressure-containing bolting	N/A	VT4	N/A	VT4	N/A	VT4	N/A	VT4 and
								MT1 or PT1
Gate [c]	VT1	VT2	VT1	VT2	VT1	VT2	VT1	VT2
					MT2 [g] or PT1 [g]	MT1 [g] or PT1 [g]	MT2 or PT1	MT1 or PT1
Seat rings [c, e]	VT1	VT2	VT1	VT2	VT1	VT2	VT1	VT2
					MT2 [g] or PT1 [g]	MT1 [g] or PT1 [g]	MT2 or PT1	MT1 or PT1
Corrosion-resistant overlay	VT3 and PT1				VT3 and UT3 [f] and PT1		VT3 and UT3 and PT1	
Seals gaskets	VT4							
Pressure-containing welds	[h]		VT3		VT3			
			N/A		MT1 or PT1			
			RT2 or UT3		RT2 or UT3			
Fillet and attachment welds to pressure-containing parts	VT3				VT3			
					MT1 or PT1			
Hard facing	VT4				VT4 and PT1			
Sealing surfaces	VT4				VT4			
					MT3 or PT2			
Welded on lifting lugs	VT3							
	PT1 or MT1							
Integrally cast lifting lugs	RT3 or UT4							

Table F.1 *(continued)*

Part	QSL1		QSL2 and QSL2G		QSL3 and QSL3G		QSL4	
	Cast	Forged	Cast	Forged	Cast	Forged	Cast	Forged

Key

MT1, MT2, MT3, PT1, PT2, PT3, RT1, RT2, RT3, UT2, VT1, VT2, VT3, VT4: NDE codes. Refer to Table F.2.

N/A: The manufacturer is not allowed to use this material form for that specific part.

NOTE 1 The NDE codes used in this table are defined in Table F.2 which specifies the extent, method and acceptance criteria of examination for each NDE code.

NOTE 2 Qualification and NDE requirements for pilot casting shall be in accordance with IOGP S-563:2021, 4.8, except when API 20A is an acceptable alternative to MSS SP-147.

[a] RT1 may be replaced, by agreement, with UT4 for castings with minimum wall thickness greater than 175 mm .

[b] See ASME B16.34:2020, 8.3.1.1 (a) (1).

[c] MT or PT shall be performed prior to coating or overlay.

[d] RT1 plus UT1 may be replaced by RT3.

[e] Requirements for examination of bar material and of forgings shall be the same.

[f] Applicable to machined surfaces only.

[g] 5 % or a minimum of one part per component batch shall be examined for QSL2. 10 % or a minimum of one part per component batch shall be examined for QSL3. If defects outside the acceptance criteria are detected, at least two additional parts shall be tested, and if any of these fails, all items from the batch represented shall be examined.

[h] NDE requirements shall be in accordance with ASME B31.3 for normal fluid service.

Add new Table F.2

Table F.2—Extent, Method, and Acceptance Criteria of Nondestructive Examination (NDE) and Item Examination Code

Examination	Extent	Method	Acceptance
RT1	Areas defined by ASME B16.34 for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting	ASME BPVC, Section V:2023, Article 2	ASME B16.34, Annex I up to QSL3 and QSL 3G, and ASME BPVC, Section VIII, Division 1:2023, Appendix 7 for QSL 4
RT2	100 %	ASME BPVC, Section V:2023, Article 2	ASME BPVC, Section VIII, Division 1:2023, UW-51 for linear indications and ASME BPVC, Section VIII, Division 1:2023, Appendix 4 for rounded indications
RT3	100 %	ASME BPVC, Section V:2023, Article 2	ASME BPVC, Section VIII, Division 1:2023, Appendix 7
UT1	Areas not covered by RT1	ASME BPVC, Section V:2023, Article 5	ASTM A609/A609M:2012, Table 2, Quality Level 2
UT2	All surfaces	ASME BPVC, Section V:2023, Article 5	Forgings: ASME BPVC, Section VIII, Division 1:2023, UF-55 for angle beam and ASME B16.34 for straight beam Plates: ASTM A578/A578M
UT3	Weldments: all surfaces	ASME BPVC, Section V:2023, Article 4	ASME BPVC, Section VIII, Division 1:2023, Appendix 12
	Overlay: all accessible machined surfaces	ASME BPVC, Section V:2023, Article 4 straight beam method	ASTM A578/A578M standard Level C
UT4	100 %	ASME BPVC, Section V:2023, Article 5	ASTM A609/A609M:2012, Table 2, Quality Level 1
MT1	All accessible surfaces	ASME BPVC, Section V:2023, Article 7	ASME BPVC, Section VIII, Division 1:2023, Appendix 6
MT2	All accessible surfaces	ASME BPVC, Section V:2023, Article 7	ASME BPVC, Section VIII, Division 1:2023, Appendix 7
MT3	All sealing surfaces	ASME BPVC, Section V:2023, Article 7	No rounded or linear indications in pressure-contact sealing surfaces are permitted Re-examination of questionable indications as per ASME BPVC, Section VIII, Division 1:2023, Appendix 6-3 (c) is acceptable
PT1	All accessible surfaces	ASME BPVC, Section V:2023, Article 6	ASME BPVC, Section VIII, Division 1:2023, Appendix 8
PT2	All accessible surfaces	ASME BPVC, Section V:2023, Article 6	ASME BPVC, Section VIII, Division 1:2023, Appendix 7

Table F.2 *(continued)*

Examination	Extent	Method	Acceptance
PT3	All sealing surfaces	ASME BPVC, Section V:2023, Article 6	No rounded or linear indications in pressure-contact sealing surfaces are permitted Re-examination of questionable indications as per ASME BPVC, Section VIII, Division 1:2023, Appendix 8-3 (c) is acceptable
VT1	100 % accessible as cast surfaces	7.1.2	7.1.2
VT2	100 % accessible as forged surfaces	Applicable MDS [b]	Applicable MDS [b]
VT3	Weldments: 100 % accessible as welded surfaces	ASME BPVC, Section V:2023, Article 9	No undercut reduction to the thickness of the area (considering both sides) to below the minimum thickness No surface porosity and exposed slag on or within 45 mm (1.77 in.) of sealing surfaces
	Overlay: applicable EDS [b]	Applicable EDS [b]	Applicable EDS [b]
VT4	100 % accessible surfaces	Manufacturer's requirements and applicable EDS [b]	Manufacturer's requirements and applicable EDS [b]

[a] For NDE requirements for pilot casting, refer to the applicable IOGP S-563 MDS or EDS as referenced in Annex D.

[b] Refer to the applicable IOGP S-563 MDS or EDS as referenced in Annex D. Where no MDS or EDS is referenced in Annex D, the applicable material standard applies without additional requirements.

F.3 Pressure Testing

F.3.1

The requirements of Table F.3 shall replace those of API 598:2023, Table 1.

F.3.2

When the test pressure is limited by extension pup pieces, testing procedures and manufacturing sequences shall be revised accordingly.

F.3.3

Testing shall be carried out in accordance with Table F.3.

F.3.4

For QSL2 and higher, the requirements of Table F.4 shall replace those of API 598:2023, Table 4.

F.3.5

Manually operated (i.e., with a handwheel or a gearbox) and actuated valves shall be seat tested after assembly of the operating mechanism.

Add new Table F.3

Table F.3—Pressure Testing Requirements for Quality Specification Levels (QSLs)

Sequence	Test Description	Size	ASME Class	QSLs					
				QSL1	QSL2	QSL2G [a]	QSL3	QSL3G [a]	QSL4
1	High-pressure backseat (water) [b]	All	All	Required	Required	Required	Required	Required	Required
2	Shell (water)	All	All	Required	Required	Required	Required	Required	Required
3	High-pressure closure (water)	All	All	Required	Required	None	Required	None	Required
4	High-pressure gas closure test	All	All	None	None	Required	None	Required	Required
5	Low-pressure closure (air or inert gas)	All	All	Required	Required	Required	Required	Required	Required
6	High-pressure gas backseat test [b]	All	All	None	None	None	None	None	Required
7	High-pressure gas shell test	All	All	None	None	Required	None	Required	Required
8	Production fugitive emission testing as per 5.13.3	All	All	When specified	When specified	When specified	When specified	When specified	When specified
9 [c]	Functional and torque test	All	All	None	Required	Required	Required	Required	Required

[a] QSL2G and QSL3G are designations used for gas service.

[b] Gland packing bolts shall be retightened to the manufacturer's recommended values after the back seat test (refer to 5.9 and 9.4).

[c] Functional testing of the valve may be performed during pressure tests.

Add new Table F.4

Table F.4—Duration of Required Test Pressure for Quality Specification Level 2 (QSL2) and Higher

Valve Size DN (NPS)	Minimum Test Duration [a] minutes				
	Hydrostatic Shell	Gas Shell	Backseat	Hydrostatic Closure	High/Low Gas Closure
≤ 100 (≤ 4)	2	5	2	2	5
150 to 250 (6 to 10)	5	15	5	5	15
300 to 450 (12 to 18)	15	15	5	5	15
≥ 500 (≥ 20)	30	30	5	10	30

[a] The test duration is the period of inspection after the valve is fully prepared and under full pressure. Test durations start only once the test pressure has stabilized.

F.3.6 Torque Measurements and Functional Testing

F.3.6.1 General

F.3.6.1.1

For functional testing, valve seats shall be free of sealant.

F.3.6.1.2

Lubricant required for assembly shall not exceed the viscosity range of SAE 10W motor oil.

F.3.6.2 Functional and Torque Testing

F.3.6.2.1

Valves ordered with a manual operator (i.e., handwheel or gearbox) or an actuator shall be tested with the final operator fitted on.

F.3.6.2.2

The torque shall be measured directly on the input shaft of the gear or, for direct-mounted handwheels, on the stem.

F.3.6.2.3

Gearbox output torques shall be calculated using the gearbox mechanical advantage ratio.

F.3.6.2.4

Torque measurements shall be carried out at the break-to-open, break-to-close and end-to-close positions.

F.3.6.2.5

The rim pull force required to seat and unseat the valve shall be calculated.

F.3.6.2.6

Acceptance for functional and torque testing of the valve shall include the following requirements.

a) The valve shall demonstrate smooth operability.

b) The calculated rim pull shall not exceed the value listed in 5.11.1.

c) The measured torque results shall not exceed the manufacturer's documented valve torques.

F.3.6.3

The hydrostatic test fluid shall be fresh water containing a corrosion inhibitor.

F.3.6.4

Valves shall be completely drained of test fluid and dried immediately after hydrotesting.

F.3.6.5

Valves with a pressure seal body-to-bonnet joint shall be subjected to low-pressure gas shell test at 90 psi ± 15 psi (6 bar ± 1 bar) for 5 minutes.

F.3.6.6

The low-pressure gas shell test leakage criteria for valves with a pressure seal body-to-bonnet joint shall be in accordance with API 598:2023, 5.9.1.1.

Add new Annex G

Annex G
(informative)

Specified Customization—Supplementary Options to Specified Design and Manufacturing Requirements

G.1

The supplementary requirements of this annex apply only when specified in the purchase order or purchasing documentation.

G.2

When specified, handwheels shall be constructed of solid (non-hollow) materials.

G.3

When specified, valves shall be fire type-tested in accordance with ISO 10497 or API 6FA.

G.4

When specified, the nameplate shall contain metric and US customary units.

G.5

When specified, valves shall be marked in accordance with Table G.1.

G.6 Chainwheels

G.6.1

When specified, chainwheels shall be of direct-mounted adjustable sprocket rim type with chain guides.

G.6.2

When specified, chainwheels shall not be of the clamp-on type.

G.6.3

When specified, chainwheels shall be securely attached and provided with safety cables.

G.6.4

When specified, chainwheels for valves above DN 150 (NPS 6) without the gearbox shall incorporate a hammer-blow device.

G.7

When specified, lifting points shall be in accordance with API 17D:2021, Annex G and ISO 13628-4:2010, Annex K.

Add new Table G.1

Table G.1—Valve Marking

Item Number	Marking [a, b]	Location
1a	Manufacturer's name	On body and/or nameplate
1b	Trademark or mark (optional)	On body and/or nameplate
2a	Pressure class (except when row 2b applies)	On body and nameplate
2b	Intermediate pressure rating (agreed upon rated class)	On body and nameplate
3	Pressure-temperature rating — Maximum operating pressure at maximum operating temperature — Maximum operating pressure at minimum operating temperature	On nameplate
4	Face-to-face/end-to-end dimensions, if not as per ASME B16.10	On nameplate
5a	Body/end connector/bonnet/cover material designation and material grade	On body/ end connector/bonnet/cover and nameplate
5b	Body/end connector/bonnet/cover melt identification (e.g., case or heat number)	On body/end connector/bonnet/cover
6a	Body/bonnet material designation and material grade	On body/bonnet
6b	Body/bonnet melt identification (e.g., heat number)	On body/bonnet
7	Trim identification material grade symbols indicating material of stem and sealing faces of closure members if different from that of body	On nameplate
8	Nominal valve size	On body and nameplate
9	Ring joint groove number	On valve flange OD
10	SMYS (units) of valve ends, where applicable	On body weld ends
11	QSL1, QSL2, QSL2G, QSL3, QSL3G or QSL4	On nameplate
12	Unique serial number	On body and nameplate
13	Date of manufacture (month and year)	On nameplate
14	API 600	On nameplate
15	ASME B16.34	On nameplate
16	Product specification license number (if applicable)	On nameplate
17	Schedule on weld end valves	On weld ends or nameplate
18	Valve data sheet identification code	On nameplate

NOTE MSS SP-25 gives guidance on marking.

[a] Where the grade and class does not uniquely identify the material specification, the material specification, grade and class shall be marked (e.g., A516-70).

[b] When the body is manufactured from more than one type of material, body and end connector materials shall be identified.

G.8

When specified, a sample of austenitic stainless-steel gaskets (spiral wound or ring joint) shall pass an intergranular corrosion test in accordance with ASTM A262:2021, Practice E.

G.9

When specified, the following documents shall be retained by the manufacturer for a minimum of ten years from the start of the contract guarantee period:

a) design calculations;

b) cross-section drawings with parts and materials list, with the minimum and maximum design temperatures shown on the valve drawings;

c) manufacturing, testing and inspection procedures;

d) welding procedures and qualification records;

e) nondestructive testing procedures and qualifications;

f) material qualification records in accordance with IOGP S-563;

g) manufacturing, testing and inspection equipment calibration records;

h) nonconformance records;

i) list of applicable and authorized concessions, waivers and/or material substitutions;

j) list of applicable manuals (e.g., assembly or maintenance manuals);

k) material test reports and inspection certificates, traceable by heat number to the foundry or mill, including for sour service materials a statement confirming compliance with ANSI/NACE MR0175/ISO 15156 or ANSI/NACE MR0103/ISO 17945;

l) weld maps of major repairs;

m) heat treatment records, including heat treatment charts;

n) relevant fabrication drawings and sketches to facilitate the understanding of welding, heat treatment and NDE records;

o) visual inspection records;

p) chloride content;

q) pressure test results.

G.10

When specified, NDE reports, including sketches if applicable, that show the locations of examination traceable by heat or serial number shall be retained by the manufacturer for at least five years from the start of the contract guarantee period.

G.11

When specified, radiographs shall be retained by the manufacturer for a minimum of one year from the start of the contract guarantee period.

G.12

When specified, stainless steel bellows shall be hydrostatically tested with demineralized water that has a chloride content less than or equal to 2 ppm.

G.13

When specified, carbon steel yokes shall not be used for service temperatures below -20 °C (-4 °F) or above 400 °C (752 °F).

G.14

When specified, gearboxes shall be designed with rolling element thrust bearings.

G.15

When specified, packing boxes shall be manufactured from a corrosion-resistant material or overlaid with CRA material.

G.16

When specified, the IEC 60529 IP code for gearboxes shall be IP66.

G.17

When specified, the IEC 60529 IP code for gearboxes shall be IP67.

G.18

When specified, the number of packing rings in the packing box shall be a maximum of six.

G.19

When alloy 625 material is specified for sour service, hardness shall not exceed 35 HRC.

G.20

When specified, mechanical retention of the stem nut to the yoke shall be by permanent tack weld.

G.21

When specified, valves shall be in accordance with the PED 2014/68/EU.

G.22 Impact testing

G.22.1

When the PED 2014/68/EU is specified, the body and bonnet material component batch shall be impact tested.

G.22.2

Impact testing shall be performed in accordance with ASTM A961/A961M or ASTM A703/A703M S8 as applicable at a temperature of -29 °C (-20 °F) or lower if mandated by the material grade.

G.22.3

Acceptance criteria for impact testing shall be 27 J (20 ft·lbf) average, 20 J (15 ft·lbf) single.

G.22.4

For impact testing, the thickness of the test block shall be equal to the thickest part of the casting/forging component.

G.22.5

For impact testing of flanged components, the largest flange thickness shall be the ruling section.

G.22.6

For impact testing of flanged components, test specimens shall be taken in the center section with thickness/4 on each side.

G.22.7

When specified, impact testing shall be carried out on austenitic stainless steel.

G.23

When marine or offshore service is specified, valve bolting material shall be UNS N07718 in accordance with API 6ACRA.

G.24

When specified, galvanized bolting and components shall not be used.

G.25 Stem Protector

G.25.1

When specified, valves shall be equipped with a fully enclosed weatherproof stem protector.

G.25.2

With the valve in the fully open position, the stem protector design shall provide a minimum clearance of 25 mm (1 in.) between the top of the stem and the inside top of the stem protector.

G.25.3

If the stem protector obscures the position of the stem, the design shall be provided with a position indicator.

G.25.4

When specified, the stem protector shall have a stem nut grease injector.

G.26

When specified, valves shall be equipped with a non-pressure-containing stem extension in accordance with API 6D.

G.27 Lagging Extensions

G.27.1

When specified, valves shall include a lagging bonnet extension as specified in Table G.2.

G.27.2

Lagging extension lengths shall be measured from the top of the end flange rim or body diameter, whichever is larger, to the upper bonnet flange.

Add new Table G.2

Table G.2—Lagging Extension Lengths Clearance Required for Insulation

DN (NPS) Minimum	DN (NPS) Maximum	Lagging Extension Length mm (in.)
15 (½)	50 (2)	80 (3.0)
80 (3)	400 (16)	110 (4.5)
450 (18)	1200 (48)	120 (5.0)

G.27.3

The lagging extended bonnet shall be provided with an insulation collar plate.

G.28

When an adjustable collar plate is specified, the bolting shall be on the upper side.

G.29

When specified, manually operated isolation valves shall be supplied with brackets, locking plates or other devices to allow the valve to be locked in the open or closed position.

G.30

When specified, acceptance criteria for Charpy V-notch impact toughness testing of 20 Cr Group B, 22 Cr, 25 Cr and 27 Cr materials shall be in accordance with ISO 17781:2017, Table 2, QL I.

G.31

When specified, for valve sizes above NPS 2 (DN 50) with a cast pressure-containing part, the hydrostatic shell test procedure shall consist of the following steps:

a) primary pressure-holding period;

b) reduction of the pressure to zero;

c) secondary pressure-holding period.

G.32

When localized CRA weld is specified at the seats and seals areas, it shall extend beyond the contact area by a distance of at least 3 mm ($^1/_8$ in) on both sides.

Add new Annex H

Annex H
(normative)

Valves Outside of API 600 Size Limit

H.1

This annex applies to valve sizes above those listed in Table 1 and that meet the requirements of API 600, ASME B16.34 and this specification.

H.2

Design and calculations shall be in accordance with ASME B31.3:2022, 304.7.2, b, c or d requirements for unlisted components.

H.3

Wall thickness shall not be less than the thickness required for ASME B16.34 standard class including any corrosion allowance specified.

H.4

Valves shall be subjected to design validation testing in accordance with API 6D:2021, Annex F or the purchaser's specified validation test.

Add new Annex I

Annex I
(informative)

Fugitive Emission Type Testing in Accordance with ISO 15848-1

I.1 General

I.1.1

This annex specifies modifications to ISO 15848-1.

NOTE Validation tests that have been completed in accordance with IOGP S-611:2019, Annex J during their validity meet the requirements of this annex.

I.1.2

When specified, fugitive emission type testing shall be performed in accordance with ISO 15848-1 and this annex.

I.1.3

When there is a conflict between the requirements of ISO 15848-1 and this annex, the requirements of this annex shall govern.

I.2 Test Conditions

I.2.1 Test Fluid

I.2.1.1

The use of methane as a test fluid shall not be allowed.

I.2.1.2

The test fluid shall be helium gas of 97 % minimum purity, or a mixture of 10 % helium and 90 % nitrogen.

I.2.1.3

The use of a mixture of 10 % helium and 90 % nitrogen shall not be allowed for valve sizes below DN 300 (NPS 12).

I.2.1.4

When testing with a mixture of 10 % helium and 90 % nitrogen, the measured detector reading shall be multiplied with a factor 10.

I.2.2 Test Temperature

The test temperatures selected to qualify valve designs shall be the minimum and maximum design temperatures.

NOTE The manufacturer may use a wider temperature range during the qualification test provided that this range covers the minimum and maximum specified design temperature range.

I.3 Stem/Shaft Leakage Measurement

I.3.1

Stem leakage measurement shall be performed using one of the following methods:

a) vacuum method in accordance with ISO 15848-1:2015, A.1;

b) bagging accumulation method in accordance with ISO 15848-1:2015, A.2 and EN 13185:2001,10.4;

c) local leakage measurement (sniffing) in accordance with ISO 15848-1:2015, B.1.

I.3.2

Stem leakage measurement shall be expressed in mg/s, atm·cm^3/s, Pa·m^3/s or mbar·l/s.

I.4 Test Procedures

I.4.1 Test Equipment

I.4.1.1

Test equipment shall have a valid calibration certificate.

I.4.1.2

The equipment calibration certificate shall be valid for at least six months after the test completion.

I.4.1.3

The valve gland and body and bonnet joints shall be sealed with adhesive aluminium foil tape.

I.4.1.4

The tape shall have a hole at the highest point.

I.4.1.5

The tape shall have a tube at the bottom with the same diameter as that of the sniffer probe and a length of at least 20 times that of the tube diameter.

I.4.1.6

Body and bonnet static seal fugitive emission testing shall conform to the accumulation technique in accordance with the accumulation (bagging) method of ISO 15848-1:2015/Amd.1:2017, A.2 .

I.4.1.7

Personnel performing emission testing shall be qualified in accordance with the manufacturer's documented training program which is based on the Level 1 requirements specified in ISO 9712 or ASNT SNT-TC-1A for the tracer gas method.

I.4.1.8

Fugitive emissions shall be measured with a mass spectrometer.

I.4.1.9

The test shall be considered failed if the mass spectrometer reading exceeds the leakage rate for the applicable tightness class as specified in ISO 15848-1:2015, Table 1.

NOTE The minimum detectable leak rate for direct sniffing in accordance with EN 1179, technique B4 is 1 x 10-7 Pa·m^3/s (1 x 10-6 mbar·l/s).

I.4.2 Test Description

I.4.2.1

The valve mounting shall be with the stem or shaft in the horizontal position, unless otherwise agreed.

I.4.2.2

Leakage measurement shall cover potential leak paths including the drain, vent, body joint and bolting connections.

I.5 Performance Classes

I.5.1

Mechanical cycles for isolation valves CO1 shall be carried out at one upper (maximum design) and one lower (minimum design) selected test temperature thermal cycle.

I.5.2

The sequence of testing and the minimum number of mechanical cycles for isolating valves, endurance class CO1 shall be 205 mechanical cycles, full stroke with one upper (maximum design) thermal cycle and one lower (minimum design) thermal cycle as follows:

— 50 cycles at RT;

— 50 cycles at upper selected test temperature;

— 50 cycles at RT;

— 50 cycles at lower selected test temperature;

— 5 cycles at RT.

I.6 Marking

Production valves qualified by type testing in accordance with this annex shall be marked with the following information:

a) “IOGP FE”;

b) tightness class;

c) endurance cycle;

d) stem seal adjustment number;

e) temperature range;

f) pressure class;

g) S-611.

EXAMPLE IOGP FE BH — CO1 — SSA 1 — (−46 °C, 150 °C) — CL150 — S-611

Add new Annex J

Annex J
(informative)

Fugitive Emission Production Testing in Accordance with ISO 15848-2

J.1 Introduction

J.1.1

This annex specifies modifications to ISO 15848-2.

J.1.2

When specified, valves shall be subjected to fugitive emission production testing in accordance with ISO 15848-2 and this annex.

J.1.3

When there is a conflict between the requirements of ISO 15848-2 and this annex, the requirements of this annex shall govern.

J.2 Valve Selection

J.2.1 Lot Definition

The valves that constitute the lot from which the samples are drawn for testing shall have the following characteristics:

a) be part of the same purchase order;

b) have the same fugitive emission class;

c) be of the same type and design;

d) have the same stem diameter.

J.2.2 Sample Size

J.2.2.1

The number of samples (n) to be drawn from each lot shall be determined by the fugitive emission class and the purchase order quantity per fugitive emission class (X) as specified in Table J.1.

J.2.2.2

The sample strategy, including how many failed production tests per lot are acceptable, shall be determined in accordance with Table J.1.

J.2.3 Sample Selection

J.2.3.1

The samples shall be selected at random from each lot.

J.2.3.2

When the lot consists of various sizes and pressure classes, sampling shall be applied in such a way that it covers the entire production range from that lot.

Add new Table J.1

Table J.1—Sample Strategy for Production Testing

Purchase Order Size (X) per Fugitive Emission Class	Sample Size (n) [a] Class AH	Sample Size (n) [a] Class BH	Acceptance Number (Ac)
X ≤ 10	Minimum 1 or as specified by purchaser	Minimum 1 or as specified by purchaser	0
11 ≤ X ≤ 100	5 %	3 %	0
101 ≤ X ≤ 1000	4 %	3 %	0
X > 1000	3 %	2 %	0

[a] The actual sample size shall be rounded up to the next whole number, with a maximum total sample size of 10 % of the whole purchase order (rounded up to the next whole number).

J.2.4 Lot Acceptance

J.2.4.1

The lot shall be accepted when each tested valve meets the acceptance criteria in accordance with J.4.8.

J.2.4.2

Valves that fail the test shall be repaired and retested.

J.2.4.3

If a valve fails a test, additional valves shall be drawn from the failed lot in accordance with Table J.1.

J.2.4.4

Upon subsequent rejection, the failed valve shall be repaired and retested.

J.2.4.5

Upon subsequent rejection, the retest shall contain all valves from the lot.

J.3 Test Conditions

J.3.1 Test Fluid

J.3.1.1

The test fluid shall be helium gas of 97 % minimum purity, or a mixture of 10 % helium and 90 % nitrogen.

J.3.1.2

The use of a mixture of 10 % helium and 90 % nitrogen shall not be allowed for valve sizes below DN 300 (NPS 12).

J.3.1.3

When testing with a mixture of 10 % helium and 90 % nitrogen, the measured detector reading shall be multiplied by a factor 10.

J.3.1.4

97 % helium test gases shall be certified as containing a minimum of 97 % pure helium.

J.3.2 Leakage Management

J.3.2.1

Leakages shall be measured by the sniffing method in accordance with ISO 15848-1:2015, B.1.

J.3.2.2

Leakages shall be expressed in mg/s, atm·cm^3/s, Pa·m^3/s or mbar·l/s.

J.3.3 Test Pressure

The test pressure shall be the rated pressure at ambient temperature.

J.3.4 Mechanical Adjustments

J.3.4.1

A maximum of one mechanical adjustment of the valve gland bolting of the packing box or stem seals shall be undertaken.

J.3.4.2

The test report shall show the location and timing of the mechanical adjustments.

J.3.5 Test Equipment

J.3.5.1

Fugitive emissions shall be measured with a mass spectrometer.

J.3.5.2

Mass spectrometers and helium leak detectors shall have a sensitivity of at least 1.0 x 10-10 Pa·m^3/s, 1.0 x 109 mbar·l/s or 1.0 x 10-9 atm·cm^3/s as specified in ASME BPVC, Section V:2023, Appendix IV, 1061.2.

J.3.5.3

Prior to commencing the test, the attached piping and tubing shall be checked for leaks.

J.3.5.4

Production valves shall be mounted with the stem and the bore in the specified installation orientation.

J.3.5.5

When the installation orientation is not specified, production valves shall be mounted with the stem and the bore in the horizontal orientation.

J.3.5.6

Test equipment shall have a valid calibration certificate.

J.3.5.7

The equipment calibration certificate shall be valid for at least six months after the test completion.

J.3.5.8

The valve gland, body and bonnet joints shall be sealed with adhesive aluminum foil tape.

J.3.5.9

The tape shall have a hole at the highest point.

J.3.6 Personnel

Personnel performing emission testing shall be qualified in accordance with the manufacturer's documented training program which is based on the Level 1 requirements specified in ISO 9712 or ASNT SNT-TC-1A for the tracer gas method.

J.4 Measurement of Stem/Shaft Seal Leakages

J.4.1

The test valve shall be half open and pressurized to the test pressure.

J.4.2

The stem seal leakage shall be measured using the sniffing method in accordance with ISO 15848-1:2015, B.1.

J.4.3

The measurements shall commence after the test pressure has been stabilized for the following durations:

— 15 minutes for valves with fugitive emission Class AH;

— 10 minutes for valves with fugitive emission Class BH.

J.4.4

Wherever practical, the measurement of stem leakage (including for valves with operator brackets, stem tapings, etc.) shall be in accordance with J.4.3.

J.4.5

Where J.4.4 is not practical on smaller manually operated valves, the stem seal shall be sniffed locally by means of a detector probe in accordance with ISO 15848-1:2015, B.1.

J.4.6

The tests shall be carried out in a still (draft free) environment.

J.4.7

The stem leakage shall be measured during the final mechanical cycle, when the closure member moves from the fully closed to the fully open position with the same sniffing technique.

J.4.8

The test shall be considered failed if the mass spectrometer reading exceeds the leakage rate for the applicable fugitive emission class as specified in Table J.2.

J.4.9

The minimum detectable leak rate for direct sniffing (refer to EN 1179, Technique B4) shall be 1 x 10-7 Pa·m^3/s (1 x 10^{-6} mbar·l/s).

J.4.10

If the test valve requires more than one mechanical adjustment, the test shall be considered as failed.

J.5 Certification of Compliance

Certification requirements shall be in accordance with this specification.

J.6 Sampling Plan Example (informative)

The sampling strategy for an example purchase order for gate valves is given in Table J.4.

— The purchase order quantity (X) per fugitive emission class is 1055 gate valves with fugitive emission class BH.

— As these valves are suitable for fugitive emission class BH, 2 % of each lot (rounded-up to the next whole number) are to be tested as per Table J.1.

— The maximum number of valves to be tested is 10 % per purchase order (rounded-up to the next whole number), i.e., 106 valves for the complete purchase.

— The valves are selected at random from each lot in accordance with Table J.3 and tested in accordance ISO 15848-2 and this annex.

If there is a failure in any of the tests (e.g., any test valve representing the second lot containing 437 valves), this lot is rejected, and the failed valve is repaired and retested.

— In addition, other valves are drawn at random from the lot and tested in accordance with Table J.1 (9 valves).

— Upon a subsequent rejection, the lot is rejected and the failed valves are repaired and retested.

— In addition, all valves from that lot are retested (and repaired) until all valves have passed the tests.

Add new Table J.2

Table J.2—Tightness Classes for Stem Seals

Fugitive Emission Tightness Class	Measured Leak Rate		Stem Seal Leak Rate	
	[mg/(s·m_{circ})]	[atm·cm^3/(s·mm_{dia})]	[Pa·m^3/(s·mm_{dia})]	[mbar·l/(s·mm_{dia})]
AH	≤ 10^{-5}	≤ 1.76 x 10^{-7}	≤ 1.78 x 10^{-8}	≤ 1.78 x 10^{-7}
BH	≤ 10^{-4}	≤ 1.76 x 10^{-6}	≤ 1.78 x 10^{-7}	≤ 1.78 x 10^{-6}

Key

M_{circ} is per m stem circumference at the point of measurement.

mm_{dia} is per mm stem diameter at the point of measurement.

NOTE 1 The measured leak rate is measured using the sniffing method in accordance with 6.1 a) with the helium test fluid specified in ISO 15848-2:2015, 5.1.

NOTE 2 The minimum dilution-corrected allowable leakage rate should not be lower than 3.5 x 10-7mg/s, 2.0 x 10-7 Pa·m³/s, 2.0 x 10-6 mbar·l/s or atm·cm³/s due to the constraints of the sniffing technique.

NOTE 3 The maximum leakage rate per stem diameter is indicated in Table J.4.

NOTE 4 For the steam seal leakage rate, the probe should be held at a distance less than 3 mm from the surface and moved at a speed not exceeding 20 mm/s.

Add new Table J.3

Table J.3—Leakage Rates per Stem Diameter

OD of Stem mm (in.)	Maximum Stem Leakage Rate per Fugitive Emission Class					
	AH			BH		
	atm·cm^3/s	Pa·m^3/s	mbar·l/s	atm·cm^3/s	Pa·m^3/s	mbar·l/s
10 (0.39)	1.76 x 10^{-6}	1.78 x 10^{-7}	1.78 x 10^{-6}	1.76 x 10^{-5}	1.78 x 10^{-6}	1.78 x 10^{-5}
15 (0.59)	2.64 x 10^{-6}	2.67 x 10^{-7}	2.67 x 10^{-6}	2.64 x 10^{-5}	2.67 x 10^{-6}	2.67 x 10^{-5}
20 (0.79)	3.52 x 10^{-6}	3.56 x 10^{-7}	3.56 x 10^{-6}	3.52 x 10^{-5}	3.56 x 10^{-6}	3.56 x 10^{-5}
25 (0.98)	4.40 x 10^{-6}	4.45 x 10^{-7}	4.45 x 10^{-6}	4.40 x 10^{-5}	4.45 x 10^{-6}	4.45 x 10^{-5}
30 (1.18)	5.28 x 10^{-6}	5.34 x 10^{-7}	5.34 x 10^{-6}	5.28 x 10^{-5}	5.34 x 10^{-6}	5.34 x 10^{-5}
35 (1.38)	6.16 x 10^{-6}	6.23 x 10^{-7}	6.23 x 10^{-6}	6.16 x 10^{-5}	6.23 x 10^{-6}	6.23 x 10^{-5}
40 (1.57)	7.04 x 10^{-6}	7.12 x 10^{-7}	7.12 x 10^{-6}	7.04 x 10^{-5}	7.12 x 10^{-6}	7.12 x 10^{-5}
50 (1.97)	8.80 x 10^{-6}	8.90 x 10^{-7}	8.90 x 10^{-6}	8.80 x 10^{-5}	8.90 x 10^{-6}	8.90 x 10^{-5}
60 (2.36)	1.06 x 10^{-5}	1.07 x 10^{-6}	1.07 x 10^{-5}	1.06 x 10^{-4}	1.07 x 10^{-5}	1.07 x 10^{-4}
70 (2.76)	1.23 x 10^{-5}	1.24 x 10^{-6}	1.24 x 10^{-5}	1.23 x 10^{-4}	1.24 x 10^{-5}	1.24 x 10^{-4}
80 (3.15)	1.41 x 10^{-5}	1.43 x 10^{-6}	1.43 x 10^{-5}	1.41 x 10^{-4}	1.43 x 10^{-5}	1.43 x 10^{-4}

Add new Table J.4

Table J.4—Sampling Strategy Applied to a Purchase Order of 1055 Gate Valves with Fugitive Emission Class BH

Lot	ASME Class	DN (NPS)	Quantity	Stem Diameter, mm (in.)	Samples per Lot
1	150	15 (0.5)	136	10 (0.39)	552 x 0.02 12 valves
	150	20 (0.75)	138	10 (0.39)	
	300	15 (0.5)	226	10 (0.39)	
	300	20 (0.75)	52	10 (0.39)	
2	150	25 (1)	363	16 (0.63)	437 x 0.02 9 valves
	150	40 (1.5)	14	16 (0.63)	
	150	50 (2)	48	16 (0.63)	
	300	25 (1)	4	16 (0.63)	
	300	50 (2)	8	16 (0.63)	
3	150	80 (3)	12	19 (0.75)	54 x 0.02 2 valves
	150	100 (4)	21	19 (0.75)	
	300	80 (3)	21	19 (0.75)	
4	150	150 (6)	4	28.6 (1.13)	12 x 0.02 1 valve
	150	200 (8)	6	28.6 (1.13)	
	300	150 (6)	2	28.6 (1.13)	

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* Cited in IOGP S-611J only.

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