

INTERNATIONAL
STANDARD

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**Petroleum and natural gas industries —
Pipeline transportation systems —
Pipeline valves**

*Industries du pétrole et du gaz naturel — Systèmes de transport
par conduites — Robinets de conduites*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

This International Standard was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

Annexes B, C and D form a normative part of this International Standard. Annex A is for information only.

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Introduction

This International Standard is based on API Specification 6D, twenty-first edition, March 1994.

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

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Petroleum and natural gas industries — Pipeline transportation systems — Pipeline valves

1 Scope

This International Standard specifies requirements and gives recommendations for the design, manufacturing, testing and documentation of ball, check, gate and plug valves for application in pipeline systems meeting the requirements of ISO 13623 for the petroleum and natural gas industries.

Valves for pressure ratings exceeding PN 420 (Class 2500) are not covered by this International Standard.

Annex A of this International Standard provides guidelines to assist the purchaser with valve type selection and specification of specific requirements when ordering valves.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

NOTE Non-International Standards may be replaced, by agreement, with other recognized and equivalent national or industry standards.

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 148, *Steel — Charpy impact test (V-notch).*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 228-2, *Pipe threads where pressure-tight joints are not made on the threads — Part 2: Verification by means of limit gauges.*

ISO 5208, *Industrial valves — Pressure testing of valves.*

ISO 7005-1, *Metallic flanges — Part 1: Steel flanges.*

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

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

ISO 13623, *Petroleum and natural gas industries — Pipeline transportation systems.*

ASME B1.1, *Unified inch screw threads (UN and UNR thread form).*

ASME B1.20.1, *Pipe threads, General purpose (inch)*.

ASME B16.5, *Pipe flanges and flanged fittings — NPS 1/2 through NPS 24*.

ASME B16.10, *Face-to-face and end-to-end dimensions of valves*.

ASME B16.25:1997, *Buttwelding ends*.

ASME B16.34:1996, *Valves — Flanged, threaded, and welding end*.

ASME B16.47, *Larger diameter steel flanges — NPS 26 through NPS 60*.

ASME B31.4:1992, *Liquid transportation systems for hydrocarbons, liquid petroleum gas, anhydrous ammonia, and alcohols*.

ASME B31.8:1995, *Gas transmission and distribution piping systems*.

ASME Boiler and Pressure Vessel Code:1998, Section V, *Non destructive examination*.

ASME Boiler and Pressure Vessel Code:1998, Section VIII, Division 1, *Rules for construction of pressure vessels*.

ASME Boiler and Pressure Vessel Code:1998, Section VIII, Division 2, *Alternative rules for construction of pressure vessels*.

ASME Boiler and Pressure Vessel Code, Section IX, *Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators*.

(American Society of Mechanical Engineers, 345 East 47th Street, NY 10017-2392, USA)

ASNT SNT-TC-1A, *Recommended Practice No. SNT-TC-1A*.

(American Society of Non-Destructive Testing, P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518, USA)

ASTM A 193/A 193M, *Standard specification for alloy-steel and stainless steel bolting materials for high-temperature service*.

ASTM A 320/A 320M, *Standard specification for alloy steel bolting materials for low-temperature service*.

ASTM A 370, *Standard test methods and definitions for mechanical testing of steel products*.

ASTM A 388/A 388M, *Standard practice for ultrasonic examination of heavy steel forgings*.

ASTM A 435/A 435M, *Standard specification for straight-beam ultrasonic examination of steel plates*.

ASTM A 577/A 577M, *Standard specification for ultrasonic angle-beam examination of steel plates*.

ASTM A 609/A 609M:1997, *Standard practice for castings, carbon, low-alloy, and martensitic stainless steel, ultrasonic examination thereof*.

(American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA)

AWS QC1, *Standard for AWS certification of welding inspectors*.

(The American Welding Society, 550 NW LeJeune Road, Miami, FL 33126, USA)

EN 287-1, *Approval testing of welders — Fusion welding — Part 1: Steels*.

EN 288-3, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels*.

EN 473:1993, *Qualification and certification of NDT personnel — General principles.*

(CEN, European Committee for Standardization, Central Secretariat, Rue de Stassart 36, B-1050, Brussels, Belgium)

MSS SP-44, *Steel pipeline flanges.*

(Manufacturers Standardization Society of the Valve & Fittings Industry Inc., 127 Park Street N.E., Vienna, Virginia 22180, USA)

NACE MR 0175, *Sulfide stress cracking resistant metallic materials for oilfield equipment.*

NACE TM 0177, *Laboratory testing of metals for resistance to specific forms of environmental cracking in H₂S environments.*

NACE TM 0284, *Evaluation of pipeline and pressure vessel steels for resistance to hydrogen-induced cracking.*

(National Association of Corrosion Engineers, P.O. Box 218340, Houston, Texas 77218, USA)

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply:

3.1

ANSI rating class

numerical pressure design class defined in ASME B16.5 and used for reference purposes

NOTE The ANSI rating class is designated by the word "Class" followed by a number.

3.2

bi-directional valve

valve designed for blocking the fluid in both downstream and upstream directions

3.3

bleed

drain or vent

3.4

block valve

gate, plug or ball valve that blocks flow into the downstream conduit when in the closed position

NOTE Valves are either single- or double-seated, bi-directional or uni-directional.

3.5

breakaway thrust

breakaway torque

thrust or torque required for opening a valve with maximum pressure differential

3.6

by agreement

agreed between manufacturer and purchaser

3.7

double-block-and-bleed (DBB) valve

valve with two seating surfaces which, in the closed position, blocks flow from both valve ends when the cavity between the seating surfaces is vented through a bleed connection provided on the body cavity

3.8

drive train

all parts of a valve drive between the operator and the obturator, including the obturator but excluding the operator

3.9**flow coefficient** K_V

volumetric flow rate, in cubic metres per hour, of water at a temperature between 5 °C (40 °F) and 40 °C (104 °F) passing through a valve and resulting in a pressure loss of 1 bar (14,7 psi)

NOTE K_V relates to the flow coefficient C_V in US gallons per minute at 15,6 °C (60 °F) resulting in a 1 psi pressure drop as follows:

$$K_V = \frac{C_V}{1,156}$$

3.10**full-opening valve**

valve with an unobstructed opening capable of allowing a sphere or other internal device for the same nominal size as the valve to pass

3.11**handwheel**

wheel consisting of a rim connected to a hub, for example by spokes, and used to operate manually a valve requiring multiple turns

3.12**locking device**

part or an arrangement of parts for securing a valve in the open and/or closed position

3.13**manual actuator****manual operator**

wrench (lever) or handwheel with or without a gearbox

3.14**maximum pressure differential (MPD)**

maximum difference between the upstream and downstream pressure across the obturator at which the obturator may be operated

3.15**nominal pipe size (NPS)**

numerical inches designation of size which is common to components in piping systems of any one size

NOTE The nominal pipe size is designated by the letters NPS followed by a number.

3.16**nominal pressure (PN) class**

numerical pressure design class as defined in ISO 7005-1 and used for reference purposes

NOTE The nominal pressure (PN) class is designated by the abbreviation PN followed by a number.

3.17**nominal size (DN)**

numerical metric designation of size which is common to components in piping systems of any one size

NOTE Nominal size is designated by the letters DN followed by a number.

3.18**obturator****closure member**

part of a valve, such as a ball, clapper, disc, gate or plug, which is positioned in the flow stream to permit or block flow

3.19**operator**

device (or assembly) for opening or closing a valve

3.20**position indicator**

device to show the position of the valve obturator

3.21**powered actuator****powered operator**

electric, hydraulic or pneumatic device bolted or otherwise attached to the valve for powered opening and closing of the valve

3.22**pressure class**

numerical pressure design class expressed in accordance with either the nominal pressure (PN) class or the ANSI rating class

NOTE In this International Standard, the pressure class is stated by the PN class followed by the ANSI rating class between brackets.

3.23**pressure-containing parts**

parts, such as bodies, bonnets, glands, stems, gaskets and bolting, designed to contain the pipeline fluid

3.24**pressure-controlling parts**

parts, such as seat and obturator, intended to block or permit the flow of fluids

3.25**process-wetted parts**

parts exposed directly to the pipeline fluid

3.26**reduced-opening valve**

valve with the opening through the obturator smaller than at the end connection(s)

3.27**seating surfaces**

contact surfaces of the obturator and seat which ensure valve sealing

3.28**stem**

part that connects the obturator to the operator and which may consist of one or more components

3.29**stem extension assembly**

assembly consisting of the stem extension and the stem extension housing

3.30**support ribs or legs**

metal structure which provides a stable footing when the valve is set on a fixed base

3.31**through-conduit valve**

valve with an unobstructed and continuous cylindrical opening

3.32**twin-seat, both seats bi-directional, valve**

valve with two seats, each sealing in both directions

3.33**twin-seat, one seat uni-directional and one seat bi-directional, valve**

valve with two seats, one sealing in one direction and the other in either direction

3.34**uni-directional valve**

valve designed for blocking the flow in one direction only

3.35**venturi plug valve**

valve with a substantially reduced opening through the plug and a smooth transition from each full-opening end to the reduced opening

4 Symbols and abbreviations**4.1 Symbols**

C_v Flow coefficient in imperial units

K_v Flow coefficient in metric units

4.2 Abbreviations

BM	Base metal
CE	Carbon equivalent
DBB	Double-block-and-bleed
DN	Nominal size
HAZ	Heat-affected zone
HR	Rockwell hardness
HV	Vickers hardness
MPD	Maximum pressure differential
MT	Magnetic-particle testing
NDE	Non-destructive examination
NPS	Nominal pipe size
PN	Nominal pressure
PQR	Procedure qualification record
PT	Penetrant testing
PWHT	Post-weld heat treatment
SMYS	Specified minimum yield strength
WM	Weld metal
WPS	Weld procedure specification
WQR	Welder qualification record

5 Valve types and configurations

5.1 Valve types

5.1.1 Gate valves

Typical configurations for gate valves with flanged and welding ends are shown, for illustration purposes only, in Figures 1 and 2.

Gate valves shall have an obturator which moves in a plane perpendicular to the direction of flow. The gate can be constructed of one piece for slab-gate valves or of two or more pieces for expanding-gate valves.

Gate valves shall be provided with a back seat or secondary stem sealing feature in addition to the primary stem seal.

5.1.2 Lubricated and non-lubricated plug valves

Typical configurations for plug valves with flanged and welding ends are shown, for illustration purposes only, in Figure 3.

Plug valves shall have a cylindrical or conical obturator which rotates about an axis perpendicular to the direction of flow.

5.1.3 Ball valves

Typical configurations for ball valves with flanged or welding ends are shown, for illustration purposes only, in Figures 4, 5 and 6.

Ball valves shall have a spherical obturator which rotates on an axis perpendicular to the direction of flow.

5.1.4 Check valves

Typical configurations for check valves are shown, for illustration purposes only, in Figures 7 to 11. Check valves may also be of the wafer type.

Check valves shall have an obturator which responds automatically to block fluid in one direction.

5.2 Valve configurations

5.2.1 Full-opening valves

Full-opening valves shall be unobstructed in the fully opened position and have an internal bore as specified in Table 1. There is no restriction on the upper limit of valve bore sizes.

Full-opening through-conduit valves shall have a circular bore in the obturator that will allow a sphere with a nominal size not less than that specified in Table 1 to pass.

Welding-end valves may require a smaller bore at the welding end to mate with the pipe.

5.2.2 Reduced-opening valves

The internal bore of reduced-opening valves shall be less than the internal bore specified in Table 1.

Table 1 — Minimum bore for full-opening valves (mm)

DN (mm)	NPS (inches)	Pressure class			
		PN 20 to 100 (Class 150 to 600)	PN 150 (Class 900)	PN 250 (Class 1500)	PN 420 (Class 2500)
15	½	13	13	13	13
20	¾	19	19	19	19
25	1	25	25	25	25
32	1¼	32	32	32	32
40	1½	38	38	38	38
50	2	49	49	49	42
65	2½	62	62	62	52
80	3	74	74	74	62
100	4	100	100	100	87
150	6	150	150	144	131
200	8	201	201	192	179
250	10	252	252	239	223
300	12	303	303	287	265
350	14	334	322	315	—
400	16	385	373	360	—
450	18	436	423	—	—
500	20	487	471	—	—
550	22	538	522	—	—
600	24	589	570	—	—
650	26	633	617	—	—
700	28	684	665	—	—
750	30	735	712	—	—
800	32	779	760	—	—
850	34	830	808	—	—
900	36	874	855	—	—
950	38	925	—	—	—
1 000	40	976	—	—	—
1 050	42	1 020	—	—	—
1 200	48	1 166	—	—	—
1 350	54	1 312	—	—	—
1 400	56	1 360	—	—	—
1 500	60	1 458	—	—	—

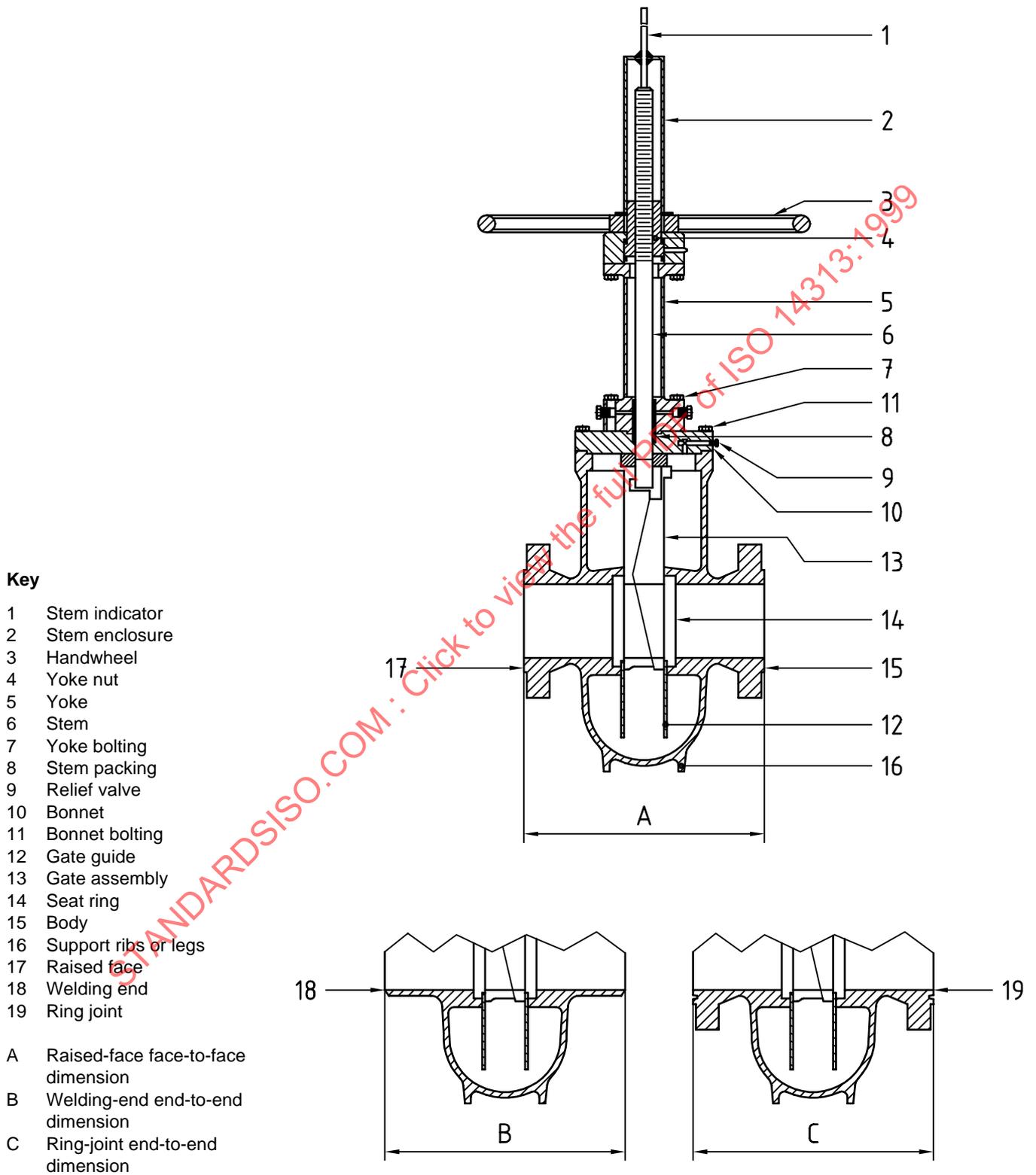


Figure 1 — Expanding-gate/rising-stem gate valve

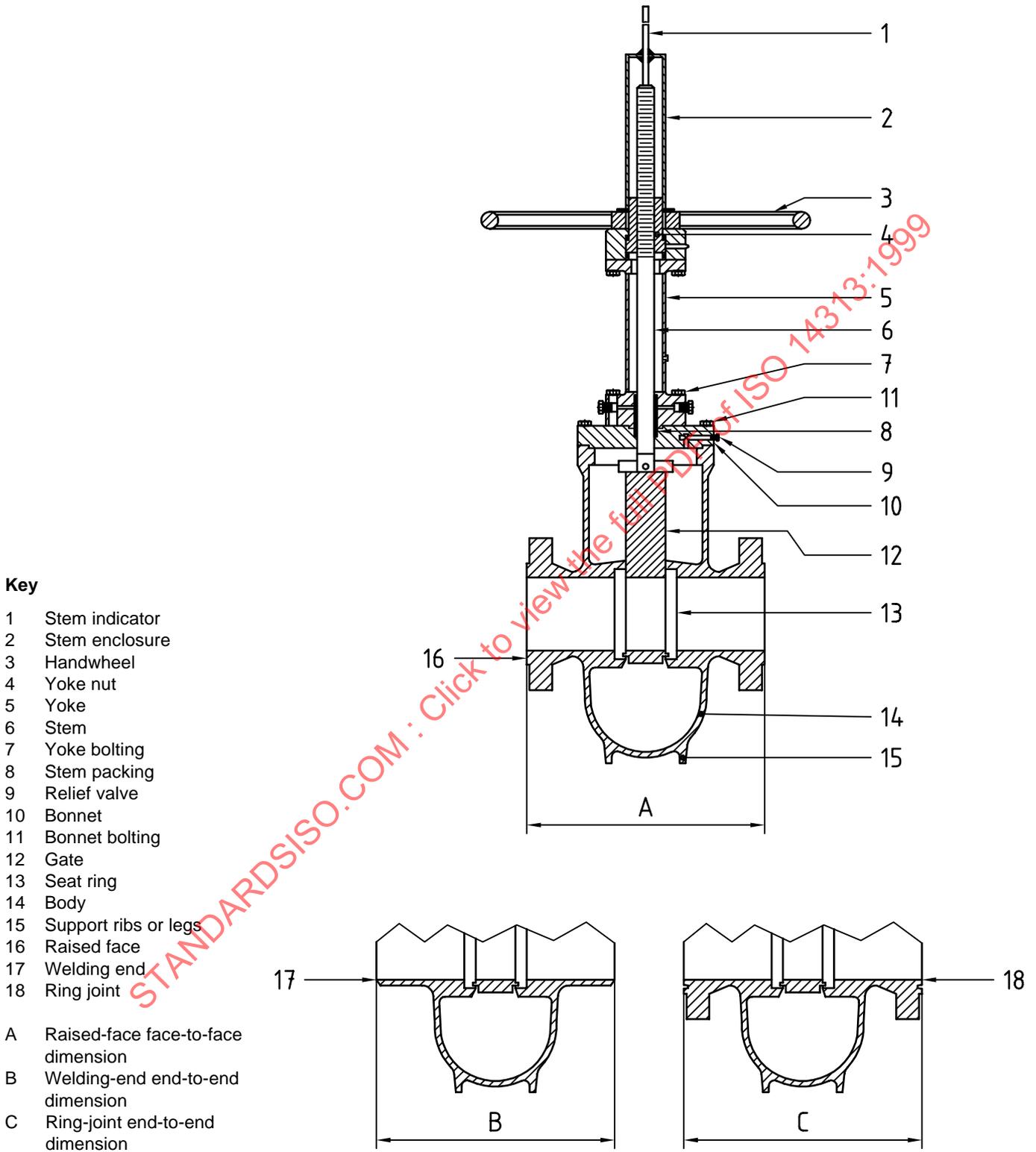
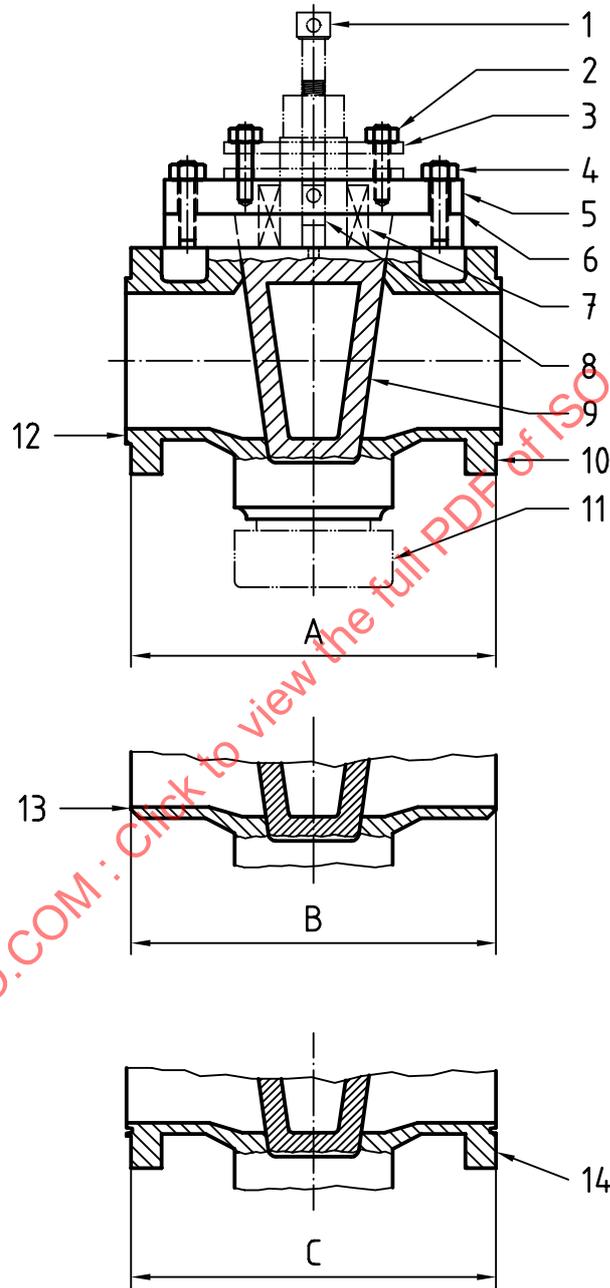


Figure 2 — Slab-gate/through-conduit rising-stem gate valve



Key

- 1 Lubricator screw
 - 2 Gland studs and nuts
 - 3 Gland
 - 4 Cover studs and nuts
 - 5 Cover
 - 6 Cover gasket
 - 7 Stem packing
 - 8 Lubricant check valve
 - 9 Plug
 - 10 Body
 - 11 Stop collar
 - 12 Raised face
 - 13 Welding end
 - 14 Ring joint
- A Raised-face face-to-face dimension
 B Welding-end end-to-end dimension
 C Ring-joint end-to-end dimension

Figure 3 — Plug valve

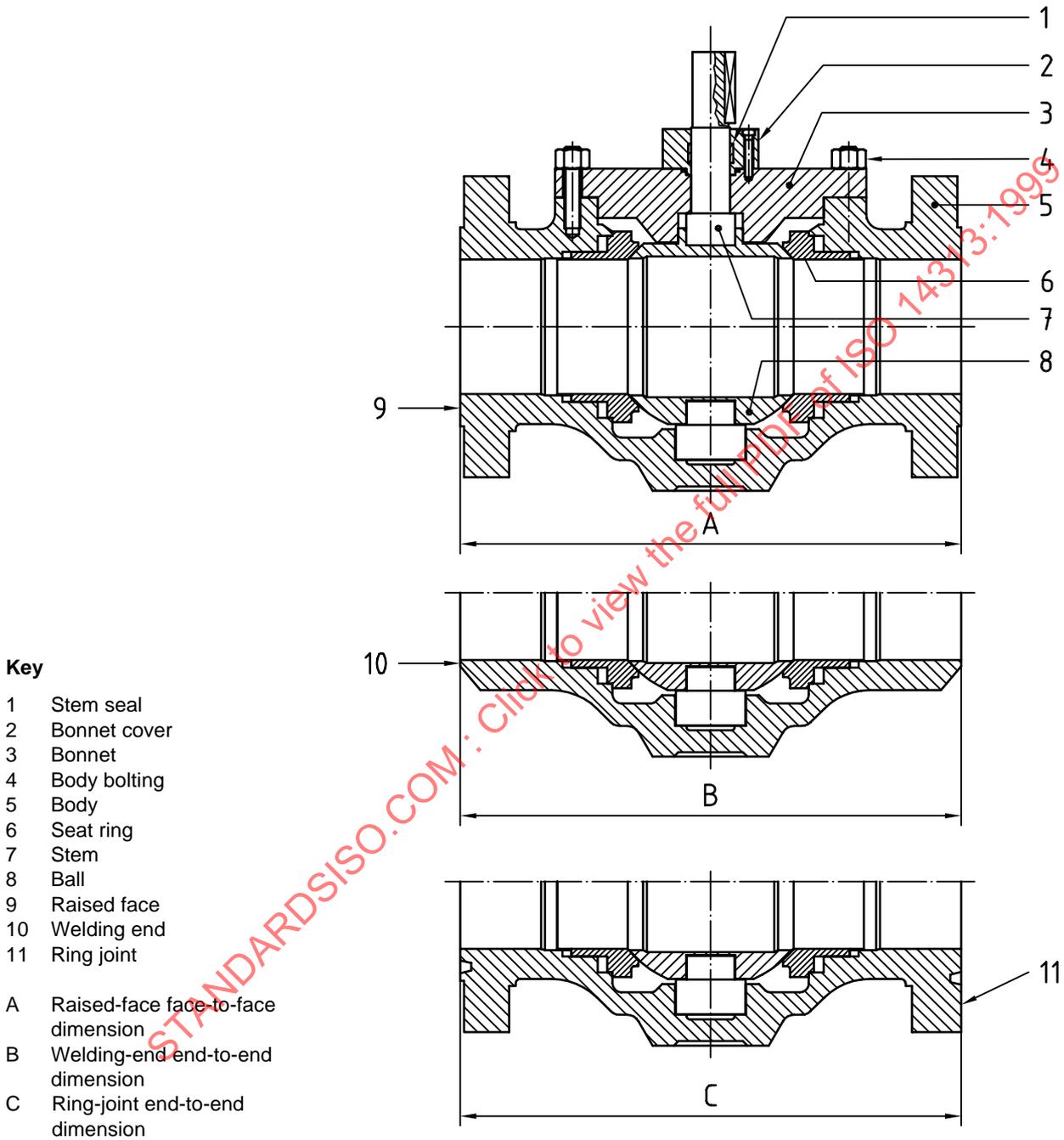


Figure 4 — Top-entry ball valve

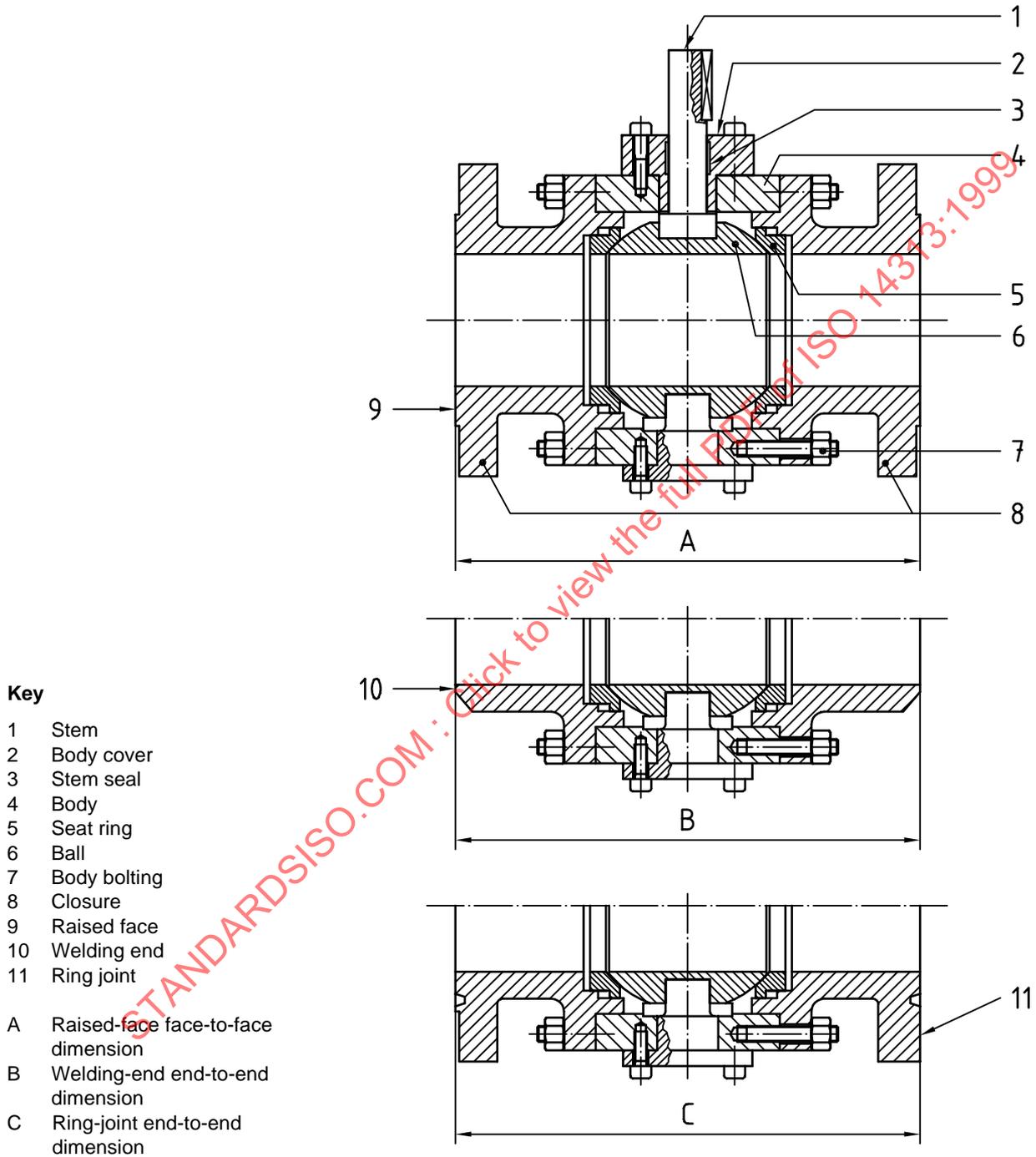


Figure 5 — Three-piece ball valve

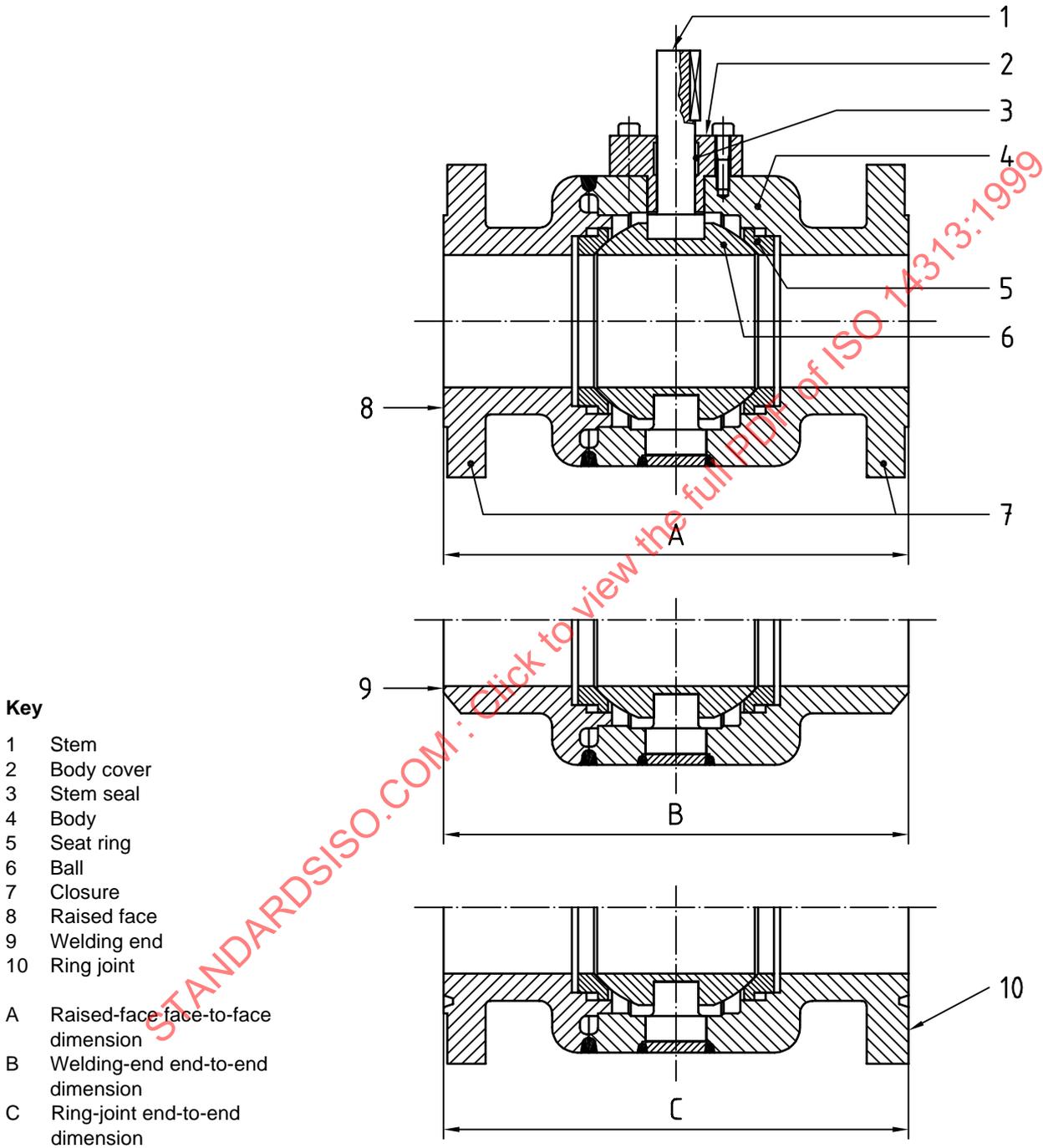


Figure 6 — Welded-body ball valve

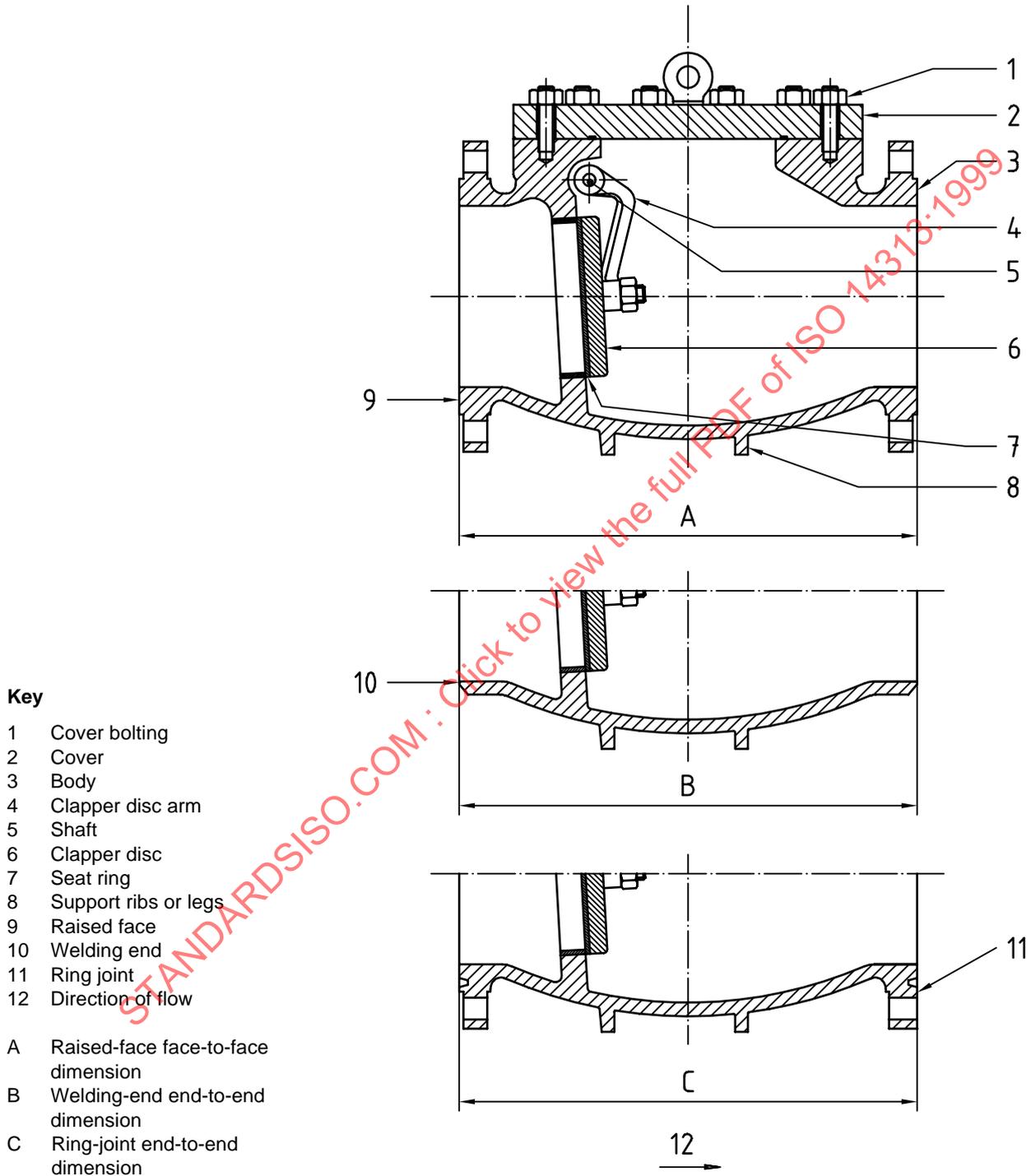
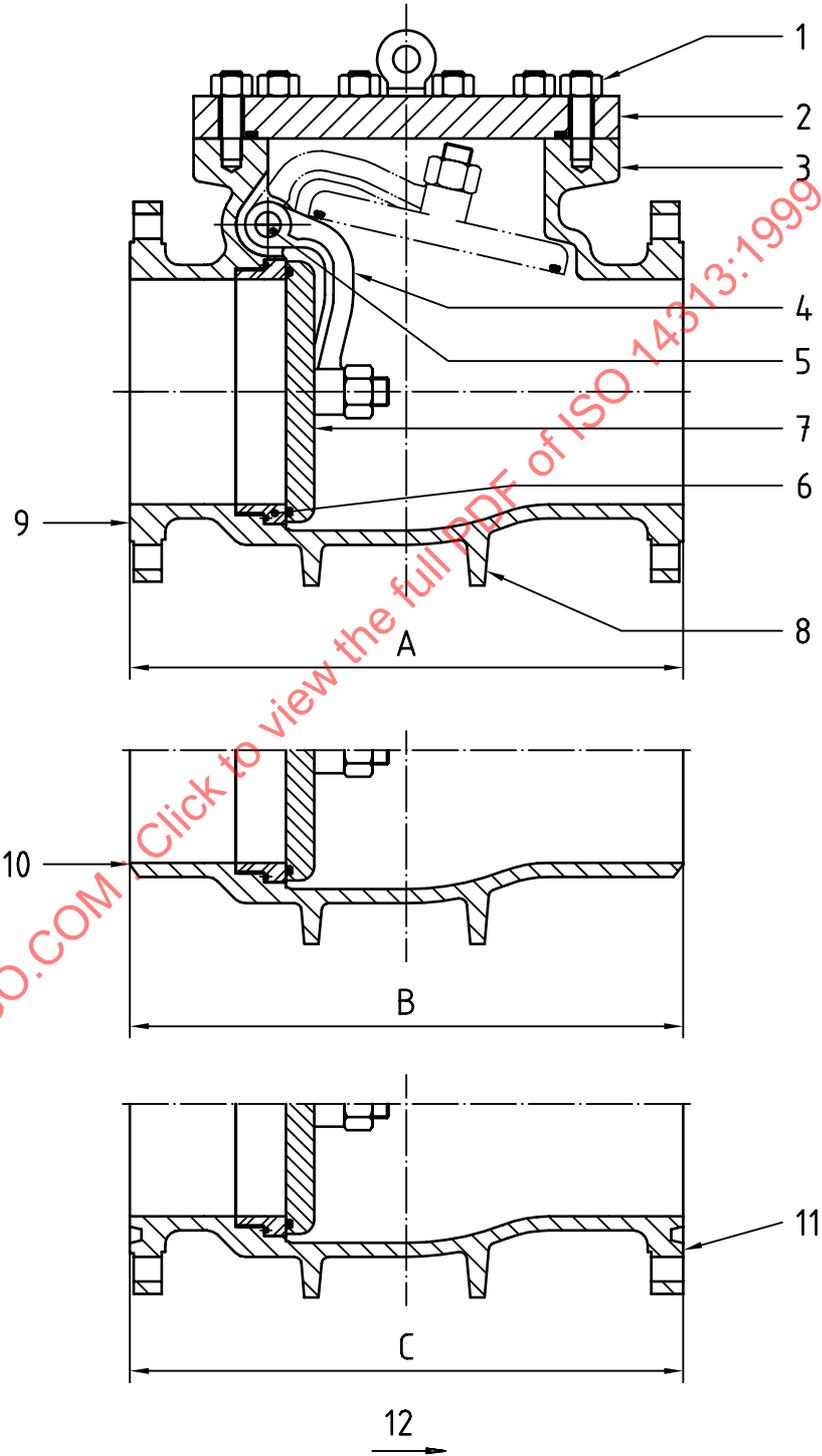


Figure 7 — Reduced-opening swing check valve



- Key**
- 1 Cover bolting
 - 2 Cover
 - 3 Body
 - 4 Clapper disc arm
 - 5 Shaft
 - 6 Seat ring
 - 7 Clapper disc
 - 8 Support ribs or legs
 - 9 Raised face
 - 10 Welding end
 - 11 Ring joint
 - 12 Direction of flow
- A Raised-face face-to-face dimension
 B Welding-end end-to-end dimension
 C Ring-joint end-to-end dimension

Figure 8 — Full-opening swing check valve

Key

- 1 Body
- 2 Hinge
- 3 Nut
- 4 Closure plate/stud assembly
- 5 Seat ring
- 6 Bearing spacers
- 7 Hinge pin
- 8 Hinge pin retainers
- 9 Direction of flow

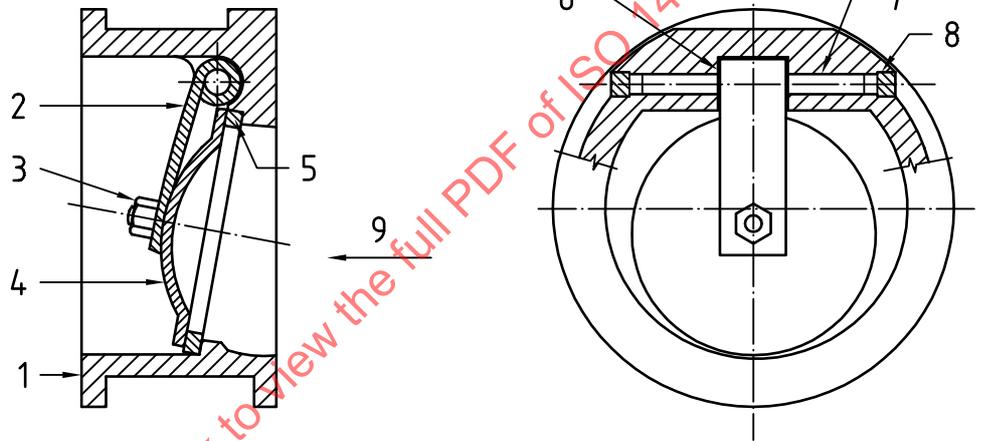
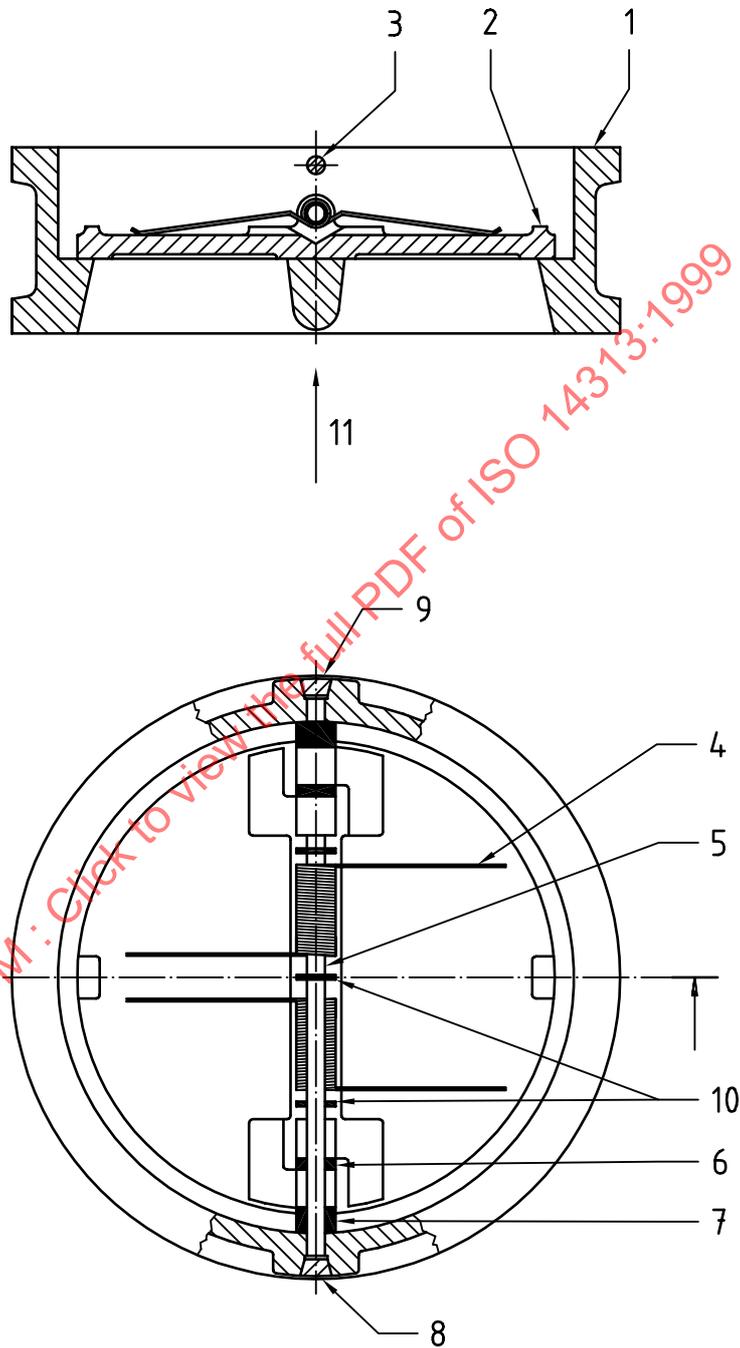


Figure 9 — Single-plate wafer-type check valve, long pattern



Key

- 1 Body
- 2 Closure plate
- 3 Stop pin
- 4 Spring
- 5 Hinge pin
- 6 Plate lug bearings
- 7 Body lug bearings
- 8 Stop pin retainers
- 9 Hinge pin retainers
- 10 Spring bearings
- 11 Direction of flow

Figure 10 — Typical dual-plate wafer-type check valve, long pattern

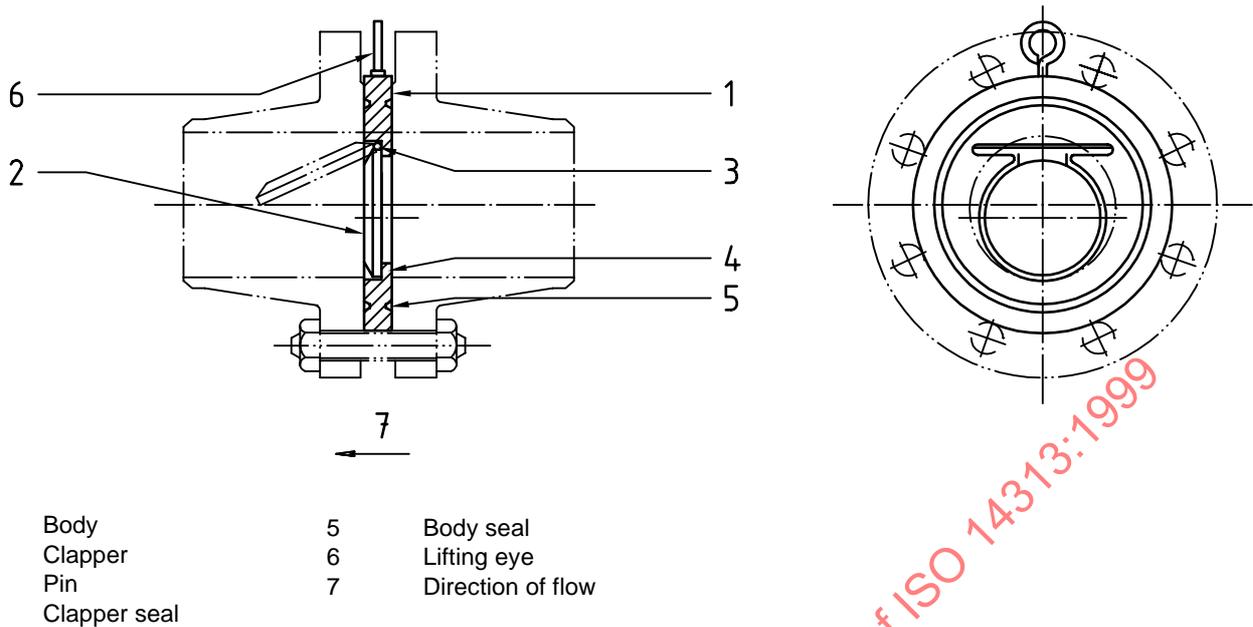


Figure 11 — Single-plate wafer-type check valve, short pattern

6 Design

6.1 Pressure and temperature rating

The nominal pressure (PN) class or the ANSI rating class shall be used for the specification of the required pressure class.

Valves covered by this International Standard should be furnished in one of the following classes:

PN 20 (Class 150)	PN 150 (Class 900)
PN 50 (Class 300)	PN 250 (Class 1500)
PN 64 (Class 400)	PN 420 (Class 2500)
PN 100 (Class 600)	

Pressure classes shall be specified by the purchaser in accordance with the applicable rating tables for material groups in ASME B16.34.

The purchaser may specify intermediate design pressures and temperatures for his specific application.

Allowable operating pressures and temperatures for valves made of materials not covered by ASME B16.34 shall be determined by calculations in accordance with an agreed pressure vessel design standard, such as ASME Section VIII, Division 1 and Division 2, or BS 5500.

Non-metallic parts may limit minimum and maximum operating pressures and temperatures.

The maximum operating pressure at the minimum and maximum operating temperatures shall be marked on the nameplate.

6.2 Sizes

All valves, except for reduced-opening valves, shall be furnished in the nominal sizes (DN) listed in Tables 2 to 6. Reduced-opening valves shall be furnished in the nominal sizes in accordance with Table 1.

NOTE In this International Standard, DN sizes are stated first followed by the equivalent NPS size between brackets.

Except for reduced-opening valves, valve sizes shall be specified by the nominal sizes (DN) or nominal pipe size (NPS).

Reduced-opening valves with a circular opening through the obturator shall be specified by the nominal size of the end connections and the nominal size of the minimum bore of the obturator in accordance with Table 1, except that for valve sizes DN 50 (NPS 2) or smaller the actual bore of the obturator shall be specified. For example, a DN 400 valve with a reduced 334-mm-diameter circular opening through the obturator shall be specified as 400 × 350.

Reduced-opening valves with a non-circular opening through the obturator and reduced-opening check valves shall be designated as reduced-bore valves and specified by the nominal size corresponding to the end connections followed by the letter "R". For example, a reduced-bore valve with DN 400 end connections and a 381 × 305 mm rectangular opening through the obturator shall be specified as 400R.

6.3 Face-to-face and end-to-end dimensions

Unless otherwise agreed, face-to-face and end-to-end dimensions of valves shall be in accordance with Tables 2 to 6.

Face-to-face and end-to-end dimensions for valve sizes not specified in Tables 2 to 6 shall be in accordance with ASME B16.10. Face-to-face and end-to-end dimensions not shown in Tables 2 to 6 or in ASME B16.10 shall be established by agreement.

The length of valves having one welding end and one flanged end shall be determined by adding half the length of a flanged-end valve to half the length of a welding-end valve.

Tolerances on the face-to-face and end-to-end dimensions shall be ± 2 mm for valve sizes DN 250 and smaller, and ± 3 mm for valve sizes DN 300 and larger.

The nominal size and face-to-face or end-to-end dimensions shall be stated on the nameplate if not specified in or not in accordance with Tables 2 to 6.

Table 2 — Gate valves — Face-to-face (A) and end-to-end (B and C) dimensions (mm)

DN (mm)	NPS (inches)	Raised face A	Welding end B	Ring joint C	Raised face A	Welding end B	Ring joint C
		PN 20 (Class 150)			PN 50 (Class 300)		
50	2	178	216	191	216	216	232
65	2½	191	241	203	241	241	257
80	3	203	283	216	283	283	298
100	4	229	305	241	305	305	321
150	6	267	403	279	403	403	419
200	8	292	419	305	419	419	435
250	10	330	457	343	457	457	473
300	12	356	502	368	502	502	518
350	14	381	572	394	762	762	778
400	16	406	610	419	838	838	854
450	18	432	660	445	914	914	930
500	20	457	711	470	991	991	1 010
550	22	—	—	—	1 092	1 092	1 114
600	24	508	813	521	1 143	1 143	1 165
650	26	559	864	—	1 245	1 245	1 270
700	28	610	914	—	1 346	1 346	1 372
750	30	610 ^a	914	—	1 397	1 397	1 422
800	32	711	965	—	1 524	1 524	1 553
850	34	762	1 016	—	1 626	1 626	1 654
900	36	711 ^b	1 016	—	1 727	1 727	1 756
		PN 64 (Class 400)			PN 100 (Class 600)		
50	2	292	292	295	292	292	295
65	2½	330	330	333	330	330	333
80	3	356	356	359	356	356	359
100	4	406	406	410	432	432	435
150	6	495	495	498	559	559	562
200	8	597	597	600	660	660	664
250	10	673	673	676	787	787	791
300	12	762	762	765	838	838	841
350	14	826	826	829	889	889	892
400	16	902	902	905	991	991	994
450	18	978	978	981	1 092	1 092	1 095
500	20	1 054	1 054	1 060	1 194	1 194	1 200
550	22	1 143	1 143	1 153	1 295	1 295	1 305
600	24	1 232	1 232	1 241	1 397	1 397	1 407
650	26	1 308	1 308	1 321	1 448	1 448	1 461
700	28	1 397	1 397	1 410	1 549	1 549	1 562
750	30	1 524	1 524	1 537	1 651	1 651	1 664
800	32	1 651	1 651	1 667	1 778	1 778	1 794
850	34	1 778	1 778	1 794	1 930	1 930	1 946
900	36	1 880	1 880	1 895	2 083	2 083	2 099

Table 2 (concluded)

DN (mm)	NPS (inches)	Raised face A	Welding end B	Ring joint C	Raised face A	Welding end B	Ring joint C
		PN 150 (Class 900)			PN 250 (Class 1500)		
50	2	368	368	371	368	368	371
65	2½	419	419	422	419	419	422
80	3	381	381	384	470	470	473
100	4	457	457	460	546	546	549
150	6	610	610	613	705	705	711
200	8	737	737	740	832	832	841
250	10	838	838	841	991	991	1 000
300	12	965	965	968	1 130	1 130	1 146
350	14	1 029	1 029	1 038	1 257	1 257	1 276
400	16	1 130	1 130	1 140	1 384	1 384	1 407
450	18	1 219	1 219	1 232	1 537	1 537	1 559
500	20	1 321	1 321	1 334	1 664	1 664	1 686
550	22	—	—	—	—	—	—
600	24	1 549	1 549	1 568	1 943	1 943	1 972
		PN 420 (Class 2500)					
50	2	451	451	454			
65	2½	508	508	514			
80	3	578	578	584			
100	4	673	673	683			
150	6	914	914	927			
200	8	1 022	1 022	1 038			
250	10	1 270	1 270	1 292			
300	12	1 422	1 422	1 445			
<p>^a Through-conduit valves shall be 650 mm.</p> <p>^b Through-conduit valves shall be 800 mm.</p>							

Table 3 — Plug valves — Face-to-face (A) and end-to-end (B and C) dimensions (mm)

DN (mm)	NPS (inches)	Short-pattern			Reduced			Venturi			Round-port, full-bore		
		Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding End	Ring joint
		A	B	C	A	B	C	A	B	C	A	B	C
PN 20 (Class 150)													
50	2	178	267	191	—	—	—	—	—	—	267	—	279
65	2½	191	305	203	—	—	—	—	—	—	298	—	311
80	3	203	330	216	—	—	—	—	—	—	343	—	356
100	4	229	356	241	—	—	—	—	—	—	432	—	445
150	6	267	457	279	394	—	406	—	—	—	546	—	559
200	8	292	521	305	457	—	470	—	—	—	622	—	635
250	10	330	559	343	533	—	546	533	559	546	660	—	673
300	12	356	635	368	610	—	622	610	635	622	762	—	775
350	14	—	—	—	—	—	—	686	686	699	—	—	—
400	16	—	—	—	—	—	—	762	762	775	—	—	—
450	18	—	—	—	—	—	—	864	864	876	—	—	—
500	20	—	—	—	—	—	—	914	914	927	—	—	—
600	24	—	—	—	—	—	—	1 067	1 067	1 080	—	—	—
PN 50 (Class 300)													
50	2	216	267	232	—	—	—	—	—	—	283	283	298
65	2½	241	305	257	—	—	—	—	—	—	330	330	346
80	3	283	330	298	—	—	—	—	—	—	387	387	403
100	4	305	356	321	—	—	—	—	—	—	457	457	473
150	6	403	457	419	403	—	419	403	457	419	559	559	575
200	8	419	521	435	502	—	518	419	521	435	686	686	702
250	10	457	559	473	568	—	584	457	559	473	826	826	841
300	12	502	635	518	—	—	—	502	635	518	965	965	981
350	14	—	—	—	—	—	—	762	762	778	—	—	—
400	16	—	—	—	—	—	—	838	838	854	—	—	—
450	18	—	—	—	914	—	930	914	914	930	—	—	—
500	20	—	—	—	991	—	1 010	991	991	1 010	—	—	—
550	22	—	—	—	1 092	—	1 114	1 092	1 092	1 114	—	—	—
600	24	—	—	—	1 143	—	1 165	1 143	1 143	1 165	—	—	—
650	26	—	—	—	1 245	—	1 270	1 245	1 245	1 270	—	—	—
700	28	—	—	—	1 346	—	1 372	1 346	1 346	1 372	—	—	—
750	30	—	—	—	1 397	—	1 422	1 397	1 397	1 422	—	—	—
800	32	—	—	—	1 524	—	1 553	1 524	1 524	1 553	—	—	—
850	34	—	—	—	1 626	—	1 654	1 626	1 626	1 654	—	—	—
900	36	—	—	—	1 727	—	1 756	1 727	1 727	1 756	—	—	—

Table 3 (continued)

DN (mm)	NPS (inches)	Short-pattern			Reduced			Venturi			Round-port, full-bore		
		Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding End	Ring joint
		A	B	C	A	B	C	A	B	C	A	B	C
PN 64 (Class 400)													
50	2	—	—	—	292	292	295	—	—	—	330	—	333
65	2½	—	—	—	330	330	333	—	—	—	381	—	384
80	3	—	—	—	356	356	359	—	—	—	445	—	448
100	4	—	—	—	406	406	410	—	—	—	483	559	486
150	6	—	—	—	495	495	498	495	495	498	610	711	613
200	8	—	—	—	597	597	600	597	597	600	737	845	740
250	10	—	—	—	673	673	676	673	673	676	889	889	892
300	12	—	—	—	762	762	765	762	762	765	1 016	1 016	1 019
350	14	—	—	—	—	—	—	826	826	829	—	—	—
400	16	—	—	—	—	—	—	902	902	905	—	—	—
450	18	—	—	—	—	—	—	978	978	981	—	—	—
500	20	—	—	—	—	—	—	1 054	1 054	1 060	—	—	—
550	22	—	—	—	—	—	—	1 143	1 143	1 153	—	—	—
600	24	—	—	—	—	—	—	1 232	1 232	1 241	—	—	—
650	26	—	—	—	—	—	—	1 308	1 308	1 321	—	—	—
700	28	—	—	—	—	—	—	1 397	1 397	1 410	—	—	—
750	30	—	—	—	—	—	—	1 524	1 524	1 537	—	—	—
800	32	—	—	—	—	—	—	1 651	1 651	1 667	—	—	—
850	34	—	—	—	—	—	—	1 778	1 778	1 794	—	—	—
900	36	—	—	—	—	—	—	1 880	1 880	1 895	—	—	—

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Table 3 (continued)

DN (mm)	NPS (inches)	Reduced			Venturi			Round-port, full-bore		
		Raised face A	Welding end B	Ring joint C	Raised face A	Welding end B	Ring joint C	Raised face A	Welding End B	Ring joint C
PN 100 (Class 600)										
50	2	292	292	295	—	—	—	330	—	333
65	2½	330	330	333	—	—	—	381	—	384
80	3	356	356	359	—	—	—	445	—	448
100	4	432	432	435	—	—	—	508	559	511
150	6	559	559	562	559	559	562	660	711	664
200	8	660	660	664	660	660	664	794	845	797
250	10	787	787	791	787	787	791	940	1 016	943
300	12	—	—	—	838	838	841	1 067	1 067	1 070
350	14	—	—	—	889	889	892	—	—	—
400	16	—	—	—	991	991	994	—	—	—
450	18	—	—	—	1 092	1 092	1 095	—	—	—
500	20	—	—	—	1 194	1 194	1 200	—	—	—
550	22	—	—	—	1 295	1 295	1 305	—	—	—
600	24	—	—	—	1 397	1 397	1 407	—	—	—
650	26	—	—	—	1 448	1 448	1 461	—	—	—
750	30	—	—	—	1 651	1 651	1 664	—	—	—
800	32	—	—	—	1 778	1 778	1 794	—	—	—
850	34	—	—	—	1 930	1 930	1 946	—	—	—
900	36	—	—	—	2 083	2 083	2 099	—	—	—
PN 150 (Class 900)										
50	2	368	—	371	—	—	—	381	—	384
65	2½	419	—	422	—	—	—	432	—	435
80	3	381	381	384	—	—	—	470	—	473
100	4	457	457	460	—	—	—	559	—	562
150	6	610	610	613	610	610	613	737	—	740
200	8	737	737	740	737	737	740	813	—	816
250	10	838	838	841	838	838	841	965	—	968
300	12	—	—	—	965	965	968	1 118	—	1 121
400	16	—	—	—	1 130	1 130	1 140	—	—	—
PN 250 (Class 1500)										
50	2	368	—	371	—	—	—	391	—	394
65	2½	419	—	422	—	—	—	454	—	457
80	3	470	470	473	—	—	—	524	—	527
100	4	546	546	549	—	—	—	625	—	629
150	6	705	705	711	705	705	711	787	—	794
200	8	832	832	841	832	832	841	889	—	899
250	10	991	991	1 000	991	991	1 000	1 067	—	1 076
300	12	1 130	1 130	1 146	1 130	1 130	1 146	1 219	—	1 235

Table 3 (concluded)

DN (mm)	NPS (inches)	Reduced			Venturi			Round-port, full-bore		
		Raised face A	Welding end B	Ring joint C	Raised face A	Welding end B	Ring joint C	Raised face A	Welding End B	Ring joint C
		PN 420 (Class 2500)								
50	2	451	—	454	—	—	—	—	—	—
65	2½	508	—	514	—	—	—	—	—	—
80	3	578	—	584	—	—	—	—	—	—
100	4	673	—	683	—	—	—	—	—	—
150	6	914	—	927	—	—	—	—	—	—
200	8	1 022	—	1 038	—	—	—	—	—	—
250	10	1 270	—	1 292	—	—	—	—	—	—
300	12	1 422	—	1 445	—	—	—	—	—	—

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Table 4 — Ball valves — Face-to-face (A) and end-to-end (B and C) dimensions (mm)

DN (mm)	NPS (inches)	Full-bore and reduced-bore			Short-pattern, full-bore and reduced-bore		
		Raised face	Welding end	Ring joint	Raised face	Welding End	Ring joint
		A	B	C	A	B	C
PN 20 (Class 150)							
50	2	178	216	191	—	—	—
65	2½	191	241	203	—	—	—
80	3	203	283	216	—	—	—
100	4	229	305	241	—	—	—
150	6	394	457	406	267	403	279
200	8	457	521	470	292	419	305
250	10	533	559	546	330	457	343
300	12	610	635	622	356	502	368
350	14	686	762	699	—	—	—
400	16	762	838	775	—	—	—
450	18	864	914	876	—	—	—
500	20	914	991	927	—	—	—
550	22	—	—	—	—	—	—
600	24	1 067	1 143	1 080	—	—	—
650	26	1 143	1 245	—	—	—	—
700	28	1 245	1 346	—	—	—	—
750	30	1 295	1 397	—	—	—	—
800	32	1 372	1 524	—	—	—	—
850	34	1 473	1 626	—	—	—	—
900	36	1 524	1 727	—	—	—	—
950	38	—	—	—	—	—	—
1 000	40	—	—	—	—	—	—
1 100	42	—	—	—	—	—	—
1 200	48	—	—	—	—	—	—
1 400	54	—	—	—	—	—	—
1 500	60	—	—	—	—	—	—

Table 4 (continued)

DN (mm)	NPS (inches)	Full-bore and reduced-bore			Short-pattern, full-bore and reduced-bore		
		Raised face	Welding end	Ring joint	Raised face	Welding End	Ring joint
		A	B	C	A	B	C
PN 50 (Class 300)							
50	2	216	216	232	—	—	—
65	2½	241	241	257	—	—	—
80	3	283	283	298	—	—	—
100	4	305	305	321	—	—	—
150	6	403	403	419	—	—	—
200	8	502	521	518	419	419	435
250	10	568	559	584	457	457	473
300	12	648	635	664	502	502	518
350	14	762	762	778	—	—	—
400	16	838	838	854	—	—	—
450	18	914	914	930	—	—	—
500	20	991	991	1 010	—	—	—
550	22	1 092	1 092	1 114	—	—	—
600	24	1 143	1 143	1 165	—	—	—
650	26	1 245	1 245	1 270	—	—	—
700	28	1 346	1 346	1 372	—	—	—
750	30	1 397	1 397	1 422	—	—	—
800	32	1 524	1 524	1 553	—	—	—
850	34	1 626	1 626	1 654	—	—	—
900	36	1 727	1 727	1 756	—	—	—
950	38	—	—	—	—	—	—
1 000	40	—	—	—	—	—	—
1 100	42	—	—	—	—	—	—
1 200	48	—	—	—	—	—	—
1 400	54	—	—	—	—	—	—
1 500	60	—	—	—	—	—	—

Table 4 (continued)

DN (mm)	NPS (inches)	Full-bore		
		Raised face	Welding end	Ring joint
		A	B	C
PN 64 (Class 400)				
50	2	—	—	—
65	2½	—	—	—
80	3	—	—	—
100	4	406	406	410
150	6	495	495	498
200	8	597	597	600
250	10	673	673	676
300	12	762	762	765
350	14	826	826	829
400	16	902	902	905
450	18	978	978	981
500	20	1 054	1 054	1 060
550	22	1 143	1 143	1 153
600	24	1 232	1 232	1 241
650	26	1 308	1 308	1 321
700	28	1 397	1 397	1 410
750	30	1 524	1 524	1 537
800	32	1 651	1 651	1 667
850	34	1 778	1 778	1 794
900	36	1 880	1 880	1 895
950	38	—	—	—
1 000	40	—	—	—
1 100	42	—	—	—
1 200	48	—	—	—
PN 100 (Class 600)				
50	2	292	292	295
65	2½	330	330	333
80	3	356	356	359
100	4	432	432	435
150	6	559	559	562
200	8	660	660	664
250	10	787	787	791
300	12	838	838	841
350	14	889	889	892
400	16	991	991	994
450	18	1 092	1 092	1 095
500	20	1 194	1 194	1 200
550	22	1 295	1 295	1 305
600	24	1 397	1 397	1 407
650	26	1 448	1 448	1 461
700	28	1 549	1 549	1 562
750	30	1 651	1 651	1 664
800	32	1 778	1 778	1 794
850	34	1 930	1 930	1 946
900	36	2 083	2 083	2 099
950	38	—	—	—
1 000	40	—	—	—
1 100	42	—	—	—
1 200	48	—	—	—

Table 4 (concluded)

DN (mm)	NPS (inches)	Full-bore		
		Raised face A	Welding end B	Ring joint C
PN 150 (Class 900)				
50	2	368	368	371
65	2½	419	419	422
80	3	381	381	384
100	4	457	457	460
150	6	610	610	613
200	8	737	737	740
250	10	838	838	841
300	12	965	965	968
350	14	1 029	1 029	1 038
400	16	1 130	1 130	1 140
450	18	1 219	1 219	1 232
500	20	1 321	1 321	1 334
550	22	—	—	—
600	24	1 549	1 549	1 568
650	26	—	—	—
700	28	—	—	—
750	30	—	—	—
800	32	—	—	—
850	34	—	—	—
900	36	—	—	—
PN 420 (Class 2500)				
50	2	451	451	454
65	2½	508	508	540
80	3	578	578	584
100	4	673	673	683
150	6	914	914	927
200	8	1 022	1 022	1 038
250	10	1 270	1 270	1 292
300	12	1 422	1 422	1 445

DN (mm)	NPS (inches)	Full-bore		
		Raised face A	Welding End B	Ring joint C
PN 250 (Class 1500)				
50	2	368	368	371
65	2½	419	419	422
80	3	470	470	473
100	4	546	546	549
150	6	705	705	711
200	8	832	832	841
250	10	991	991	1 000
300	12	1 130	1 130	1 146
350	14	1 257	1 257	1 276
400	16	1 384	1 384	1 407

Table 5 — Swing check valves, reduced- and full-opening types — Face-to-face (A) and end-to-end (B and C) dimensions (mm)

DN (mm)	NPS (inches)	PN 20 (Class 150)			PN 50 (Class 300)			PN 64 (Class 400)			PN 100 (Class 600)		
		Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding End	Ring joint
		A	B	C	A	B	C	A	B	C	A	B	C
50	2	203	203	216	267	267	283	292	292	295	292	292	295
65	2½	216	216	229	292	292	308	330	330	333	330	330	333
80	3	241	241	254	318	318	333	356	356	359	356	356	359
100	4	292	292	305	356	356	371	406	406	410	432	432	435
150	6	356	356	368	445	445	460	495	495	498	559	559	562
200	8	495	495	508	533	533	549	597	597	600	660	660	664
250	10	622	622	635	622	622	638	673	673	676	787	787	791
300	12	699	699	711	711	711	727	762	762	765	838	838	841
350	14	787	787	800	838	838	854	889	889	892	889	889	892
400	16	864	864	876	864	864	879	902	902	905	991	991	994
450	18	978	978	991	978	978	994	1 016	1 016	1 019	1 092	1 092	1 095
500	20	978	978	991	1 016	1 016	1 035	1 054	1 054	1 060	1 194	1 194	1 200
550	22	1 067	1 067	1 080	1 118	1 118	1 140	1 143	1 143	1 153	1 295	1 295	1 305
600	24	1 295	1 295	1 308	1 346	1 346	1 368	1 397	1 397	1 407	1 397	1 397	1 407
650	26	1 295	1 295	—	1 346	1 346	1 372	1 397	1 397	1 410	1 448	1 448	1 461
700	28	1 448	1 448	—	1 499	1 499	1 524	1 600	1 600	1 613	1 600	1 600	1 613
750	30	1 524	1 524	—	1 594	1 594	1 619	1 651	1 651	1 664	1 651	1 651	1 664
900	36	1 956	1 956	—	2 083	2 083	—	2 083	2 083	—	2 083	2 083	—
950	38	—	—	—	—	—	—	—	—	—	—	—	—
1 000	40	—	—	—	—	—	—	—	—	—	—	—	—
1 100	42	—	—	—	—	—	—	—	—	—	—	—	—
1 200	48	—	—	—	—	—	—	—	—	—	—	—	—
1 400	54	—	—	—	—	—	—	—	—	—	—	—	—
1 500	60	—	—	—	—	—	—	—	—	—	—	—	—

Table 5 (concluded)

DN (mm)	NPS (inches)	PN 150 (Class 900)			PN 250 (Class 1500)			PN 420 (Class 2500)		
		Raised face	Welding end	Ring joint	Raised face	Welding end	Ring joint	Raised face	Welding End	Ring joint
		A	B	C	A	B	C	A	B	C
50	2	368	368	371	368	368	371	451	451	454
65	2½	419	419	422	419	419	422	508	508	514
80	3	381	381	384	470	470	473	578	578	584
100	4	457	457	460	546	546	549	673	673	683
150	6	610	610	613	705	705	711	914	914	927
200	8	737	737	740	832	832	841	1 022	1 022	1 038
250	10	838	838	841	991	991	1 000	1 270	1 270	1 292
300	12	965	965	968	1 130	1 130	1 146	1 422	1 422	1 445
350	14	1 029	1 029	1 038	1 257	1 257	1 276	—	—	—
400	16	1 130	1 130	1 140	1 384	1 384	1 407	—	—	—
450	18	1 219	1 219	1 232	1 537	1 537	1 559	—	—	—
500	20	1 321	1 321	1 334	1 664	1 664	1 686	—	—	—
600	24	1 549	1 549	1 568	1 943	1 943	1 972	—	—	—

Table 6 — Single- and dual-plate, long- and short-pattern, wafer-type check valves — Face-to-face dimensions (mm)

DN (mm)	NPS (inches)	PN 20 (Class 150)		PN 50 (Class 300)		PN 64 (Class 400)		PN 100 (Class 600)		PN 150 (Class 900)		PN 250 (Class 1500)		PN 420 (Class 2500)	
		Short- pattern	Long- pattern	Short- pattern	Long- pattern	Short- pattern	Long- pattern	Short- pattern	Long- pattern	Short- pattern	Long- pattern	Short- pattern	Long- pattern	Short- pattern	Long- pattern
50	2	19	60	19	60	19	60	19	60	19	70	19	70	NOTE	70
65	2½	19	67	19	67	19	67	19	67	19	83	19	83	NOTE	83
80	3	19	73	19	73	19	73	19	73	19	83	22	83	NOTE	86
100	4	19	73	19	73	22	79	22	79	22	102	32	102	NOTE	105
150	6	19	98	22	98	25	137	29	137	35	159	44	159	NOTE	159
200	8	29	127	29	127	32	165	38	165	44	206	57	206	NOTE	206
250	10	29	146	38	146	51	213	57	213	57	241	73	248	NOTE	250
300	12	38	181	51	181	57	229	60	229	NOTE	292	NOTE	305	NOTE	305
350	14	44	184	51	222	64	273	67	273	NOTE	356	NOTE	356	—	—
400	16	51	191	51	232	64	305	73	305	NOTE	384	NOTE	384	—	—
450	18	60	203	76	264	83	362	83	362	NOTE	451	NOTE	468	—	—
500	20	64	219	83	292	89	368	92	368	NOTE	451	NOTE	533	—	—
600	24	NOTE	222	NOTE	318	NOTE	394	NOTE	438	NOTE	495	NOTE	559	—	—
750	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—
900	36	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 100	42	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 200	48	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 400	54	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 500	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—

NOTE Dimensions to be established by agreement.

6.4 Minimum-bore full-opening valves

Minimum bores for full-opening valves shall not be less than those specified in Table 1.

6.5 Valve operation

The purchaser should specify the maximum pressure differential (MPD) at which the valve is required to be opened by the lever, gearbox or actuator. If not specified, the pressure rating as determined in accordance with 6.1 for material at 38 °C (100 °F) shall be the MPD.

The manufacturer shall provide the following data to the purchaser:

- the flow coefficient K_v ;
- the breakaway thrust or torque for new valve;
- the maximum allowable stem thrust or torque on the valve and, if applicable, the drive train.

6.6 Pigging

The purchaser shall specify the requirements for piggability of the valves. Clause A.4 may be used to assist.

6.7 Valve ends

6.7.1 Flanged ends

Standard end flanges shall be furnished with a raised face or ring joint faces (raised face or full face). Dimensions, tolerances and finishes, including drilling templates, flange facing, spot facing and back facing, shall be in accordance with:

- ASME B16.5 for sizes up to and including DN 600 (NPS 24), except DN 550 (NPS 22);
- MSS SP-44 for DN 550 (NPS 22);
- ASME B16.47 Series A for DN 650 (NPS 26) and larger sizes.

6.7.2 Welding ends

Welding ends shall conform to Figures 434.86 (a) (1) and (2) of ASME B31.4 or Figures 14 and 15 of ASME B31.8 unless otherwise agreed. In the case of a heavy-wall valve body, the outside profile may be tapered at 30° and then to 45° as illustrated in Figure 1 of ASME B16.25.

The purchaser shall specify the outside diameter, wall thickness, material grade, SMYS and special chemistry of the mating pipe, and whether cladding has been applied.

6.7.3 Special flanges and mechanical joints

Other end connections, such as special flanges or mechanical joints, may be specified by the purchaser.

6.8 Pressure relief

The manufacturer shall determine whether fluid can become trapped in the body cavity in the open- and/or closed-valve position.

If fluid trapping is possible, then valves for gas service, unless otherwise specified by the purchaser, and liquid service shall be provided with an automatic cavity pressure relief.

Cavity relief, when required, shall prevent the pressure in the cavity from exceeding 1,33 times the valve pressure rating determined in accordance with 6.1 for material at 38 °C (100 °F). External cavity relief valves shall be DN 15 (NPS ½) or larger.

6.9 Bypass, drain and vent connections

Bypass, drain and vent connections and plug entries shall be drilled and threaded unless otherwise specified. The purchaser may specify other types of connections, such as welded or flanged.

Threads shall be either tapered and capable of providing a pressure-tight seal or parallel-threaded. Connections or plugs with parallel threads shall have a head section for trapping and retaining a sealing member suitable for the specified valve service.

Thread sizes shall be in accordance with Table 7. Thread forms shall be in accordance with ASME B1.1, ASME B1.20.1, ISO 228-1, ISO 228-2 or ISO 7-1.

Table 7 — Thread sizes for bypass, drain and vent connections

Nominal size of connection		Thread size
DN (mm)	NPS (inches)	mm (inches)
15 to 40	½ to 1½	8 (¼)
50 to 100	2 to 4	15 (½)
150 to 200	6 to 8	20 (¾)
≥ 250	≥ 10	25 (1)

6.10 Handwheels and wrenches (levers)

Wrenches for valves shall either be of an integral design or consist of a head which fits on the stem and is designed to take an extended handle. The head design shall allow permanent attachment of the extended section if specified by the purchaser.

The maximum force required at the handwheel or wrench to apply the breakaway torque or thrust shall not exceed 360 N.

Wrenches shall not be longer than twice the face-to-face or end-to-end dimension of the valve.

Handwheel diameter(s) shall not exceed the face-to-face or end-to-end length of the valve or 1 000 mm, whichever is the smaller, unless otherwise agreed. Except for valve sizes DN 40 (NPS 1½) and smaller, spokes shall not extend beyond the perimeter of the handwheel unless otherwise agreed.

When specified by the purchaser, the handwheel of the gearbox input shaft shall be provided with a torque-limiting device, such as a shear pin, to prevent damage to the drive train.

6.11 Locking devices

Valves shall be supplied with locking devices if specified by the purchaser. Locking devices for check valves shall be designed to lock the valve in the open position only.

Locking devices for other types of valve shall be designed to lock the valve in the open and/or closed position.

6.12 Position indicators

Valves fitted with manual or powered actuators shall be furnished with a visible indicator to show the open and the closed position of the obturator.

For plug and ball valves, the wrench and/or the position indicator shall be in line with the pipeline when the valve is open and transverse when the valve is closed. The design shall be such that the component(s) of the indicator and/or wrench cannot be assembled to falsely indicate the valve position.

Valves without position stops shall have provision for the verification of open and close alignment with the operator/actuator removed.

6.13 Operators and stem extensions

6.13.1 Misalignment

Misalignment or improper assembly of components shall be prevented by suitable means, such as a dowel pin or fitting bolt, which ensure the unique location of manual or powered operators and stem extension assemblies.

6.13.2 Sealing

External connections shall be sealed, for example with gaskets or O-rings, to prevent external contaminants entering the mechanism.

6.13.3 Overpressure protection

Operators and stem extension assemblies shall be provided with a means of preventing pressure build-up in the mechanism resulting from stem or bonnet seal leakage.

6.14 Sealant injection

Seat and/or stem sealant injection shall be provided when specified.

6.15 Lifting lugs

Valves of size DN 200 (NPS 8) and larger shall be provided with lifting lugs.

6.16 Actuators

Actuators may be powered by electric, hydraulic or pneumatic means.

The interface between actuators and valve bonnet or stem extension assemblies shall be designed to prevent misalignment or improper assembly of the components.

The interface between actuators and valve bonnet or stem extension assemblies shall be sealed with gaskets or O-rings to prevent external contaminants from entering the assembly.

Means shall be provided of preventing pressure build-up in the actuator from stem or bonnet seal leakage.

The output of the actuator shall not exceed the maximum load capacity of the valve drive train.

NOTE Typical valve-to-actuator interfaces are given in ISO 5211.

6.17 Drive trains

6.17.1 Design thrust or torque

The design thrust or torque for all drive train calculations shall be at least two times the breakaway thrust or torque.

NOTE This factor of safety is to allow for thrust or torque increase in service due to infrequent cycling, low-temperature operation and the adverse effect of debris.

6.17.2 Allowable stresses

Tensile stresses in drive train components, including stem extensions, shall not exceed 67 % of SMYS when delivering the design thrust or torque. Shear, torsion and bearing stresses shall not exceed the limits specified in ASME Code Section VIII, Division 2, Part AD-132.

A strength efficiency factor of 0,75 shall be used for fillet welds.

6.17.3 Allowable deflections

For ball valves, the total torsional deflection of the extended drive train when delivering the design torque shall not exceed the overlap contact angle between the seat and obturator.

Deflections of the extended drive train shall not prevent the obturator from reaching the fully closed position.

6.18 Stem retention

Valves shall be designed with a stem anti-blow-out device to prevent stem ejection by internal pressure when the stem packing and/or retainer has been removed.

6.19 Fire safety

If specified by the purchaser, fire resistance certification of the design shall be provided, in accordance with clause A.5.

6.20 Anti-static device

If specified by the purchaser, valves shall be provided with an anti-static device and tested in accordance with clause C.5.

6.21 Design documents

The design shall be documented in a retrievable and reproducible form.

6.22 Design document review

Design documentation shall be reviewed and verified by competent personnel other than the person who performed the original design.

7 Materials

7.1 Material specification

Materials shall be procured to documented specifications.

Specifications for metallic parts shall, as a minimum, specify the requirements for:

- chemical properties;
- heat treatment;
- mechanical properties;
- testing;
- certification.

Metallic pressure-containing parts, except stems and gaskets, shall be made of materials listed in ASME B16.34 or, by agreement, an equivalent standard.

7.2 Service compatibility

All process-wetted parts, metallic and non-metallic, and lubricants shall be suitable for the commissioning fluids and service specified by the purchaser.

Non-metallic parts of valves intended for hydrocarbon gas service at pressures of PN 100 (Class 600) or above shall be resistant to explosive decompression.

7.3 Forged parts

Forged pressure-containing parts shall be forged close to the finished shape and size.

7.4 Welding ends

The chemistry of carbon steel welding ends shall meet the following requirements:

- a) The carbon content shall not exceed 0,23 % by mass in the ladle (heat) analysis or 0,25 % by mass in the product (check) analysis.
- b) The maximum content of both sulfur and phosphorus shall not exceed 0,035 % by mass.
- c) The carbon equivalent (CE) shall not exceed 0,43 in the ladle (heat) analysis or 0,45 in the product (check) analysis. The CE shall be calculated in accordance with the following formula:

$$CE = \% C + (\% Mn/6) + (\% Cr + \% Mo + \% V)/5 + (\% Ni + \% Cu)/15$$

The chemistry of austenitic stainless steels for welding ends shall meet the following requirements:

- a) The carbon content shall not exceed 0,03 % by mass, except under the conditions outlined in b) and c) below.
- b) A carbon content of up to 0,08 % by mass is permissible provided the material is stabilized with niobium and the niobium content is at least 10 times the carbon content by mass.
- c) For steels stabilized with niobium or tantalum, the combined mass of niobium and tantalum shall be at least eight times the mass of the carbon.

Requirements for the chemistry of welding ends made of other materials shall be established by agreement.

7.5 Toughness test requirements

All carbon and low-alloy steels for pressure-containing parts in valves with a specified design temperature below $-29\text{ }^{\circ}\text{C}$ ($-20\text{ }^{\circ}\text{F}$) shall be impact-tested using the Charpy V-notch technique in accordance with ISO 148 or ASTM A 370.

NOTE Design standards/codes or local requirements may require impact testing for minimum design temperatures higher than $-29\text{ }^{\circ}\text{C}$ ($-20\text{ }^{\circ}\text{F}$).

A minimum of one impact test, comprising a set of three specimens, shall be performed on a representative test bar of each heat of the material in the final heat-treated condition.

Test specimens shall be cut from a separate or attached block taken from the same heat, reduced by forging where applicable, and heat-treated in the same heat treatment batch, including stress-relieving, as the product materials except that:

- pressure-containing parts stress-relieved at or below a previous stress-relieving or tempering temperature need not be retested;
- retesting is not required after stress-relieving if the measured toughness of the material before stress-relieving is three times the required toughness.

Toughness testing may be performed during the qualification of the valve manufacturing procedure provided that the material for testing is heat-treated using the same equipment as during valve production.

The impact test temperature shall be as defined in the applicable material specifications and pipeline design standard/code.

Except for material for bolting, impact test results for full-size specimens shall meet the requirements of Table 8. Impact test results for bolting material shall meet the requirements of ASTM A 320.

Table 8 — Charpy V-notch impact requirements (full-size specimen)

Specified minimum tensile strength (MPa)	Average of three specimens (J)	Minimum for single specimen (J)
≤ 586	20	16
587 to 688	27	20
≥ 689	34	25

7.6 Bolting

Bolting shall be suitable for the specified valve service and pressure rating.

Bolting material with a mechanical strength above ASTM A 193 Grade B7 or hardness exceeding HRC22 shall not be used for valve applications where hydrogen embrittlement may occur, unless otherwise agreed. For example, hydrogen embrittlement can occur in buried pipelines with cathodic protection.

7.7 Sour service

Materials for pressure-containing and pressure-controlling parts and bolting shall meet the requirements of NACE MR 0175 if sour service is specified.

8 Welding

8.1 Qualifications

Welding, including repair welding, of pressure-containing and pressure-controlling parts shall be performed in accordance with procedures qualified to ASME Section IX or EN 288–3, and 8.2 and 8.3 of this International Standard. Welders and welding operators shall be qualified in accordance with ASME Section IX or EN 287–1.

NOTE The purchaser, pipeline design standards/codes, material specifications and local requirements may specify additional requirements.

The results of all qualification tests shall be documented in a procedure qualification record (PQR).

Post-weld heat treatment (PWHT) shall be performed in accordance with the relevant material specification.

NOTE Some pipeline-welding standards, such as BS 4515, may have more stringent requirements for the essential variables of welding. It may be necessary to provide full weld test rings, in the same heat treatment condition as the finished valve, for weld procedure qualification.

8.2 Impact testing

Impact testing shall be carried out for the qualification of procedures for welding on valves with a design temperature below -29 °C (-20 °F).

NOTE Design code and/or local requirements may require impact testing at minimum design temperatures above -29 °C (-20 °F).

A set of three weld metal impact specimens shall be taken from the weld metal (WM) at the location shown in Figure 12. The specimens shall be oriented with the notch perpendicular to the surface of the material.

A set of three impact specimens shall be taken from the heat-affected zone (HAZ) at the location shown in Figure 13. The notch shall be placed perpendicularly to the material surface at a location resulting in a maximum amount of HAZ material located in the resulting fracture.

HAZ tests shall be conducted for each of the materials being joined when the base materials being joined are of a different P-number and/or group number in accordance with ASME Section IX or when one or both of the base materials being joined are not listed in the P-number grouping.

Impact testing shall be performed in accordance with ISO 148 or ASTM A 370 using the Charpy V-notch technique. Specimens shall be etched to determine the location of the notch.

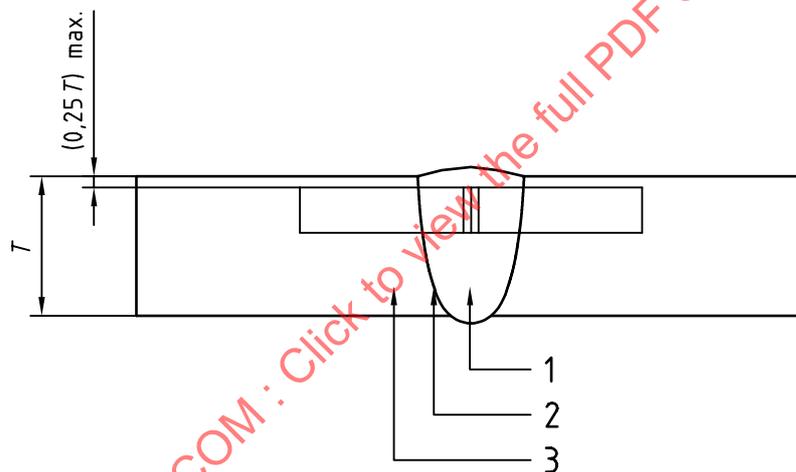
The impact test temperature for welds and heat-affected zones shall be at or below the minimum design temperature specified for the valve.

Impact test results for full-size specimens shall meet the requirements of Table 8.

8.3 Hardness testing

Hardness testing shall be carried out for the qualification of procedures for welding on pressure-containing and pressure-controlling parts in valves required to meet NACE MR 0175.

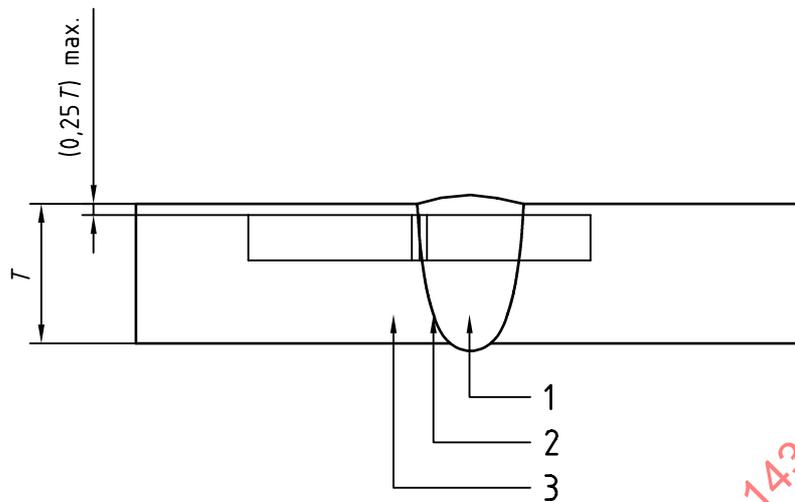
Hardness surveys shall be performed on base metal (BM), WM and HAZ as indicated in Figure 14 using the Rockwell HRC or Vickers HV₁₀ method.



Key

- 1 Weld metal
- 2 Heat-affected zone
- 3 Base metal

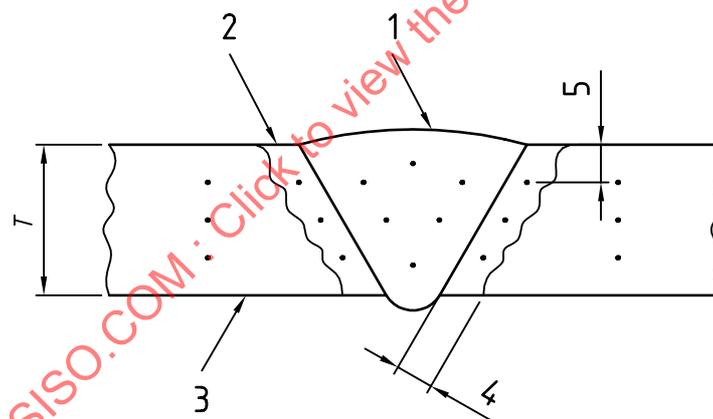
Figure 12 — Charpy V-notch weld metal (WM) specimen location



Key

- 1 Weld metal
- 2 Heat-affected zone
- 3 Base metal

Figure 13 — Charpy V-notch heat-affected zone (HAZ) specimen location



Key

- 1 Weld metal
- 2 Heat-affected zone
- 3 Base metal
- 4 1,5 mm (typical)
- 5 3,0 mm (typical)

Figure 14 — Hardness survey specimen location

9 Quality control

9.1 General

This clause specifies the quality control requirements for the manufacturing of valves. The purchaser shall specify which particular supplementary NDE requirements in Annex B shall be performed.

9.2 Measuring and test equipment

9.2.1 General

Equipment used to inspect, test or examine material or equipment shall be identified, controlled and calibrated at intervals specified in the manufacturer's instructions.

9.2.2 Dimension-measuring equipment

Equipment for measuring dimensions shall be controlled and calibrated in accordance with methods specified in documented procedures.

9.2.3 Pressure-measuring devices

9.2.3.1 Type and accuracy

Test pressure measuring devices shall be either pressure gauges or pressure transducers which are accurate to within $\pm 2,0$ % of the full-scale reading.

9.2.3.2 Gauge range

Pressure measurements shall be made between 25 % and 75 % of the full pressure range of the measuring device.

9.2.3.3 Calibration procedure

Pressure-measuring devices shall be periodically recalibrated with a master pressure-measuring device or a deadweight tester at 25 %, 50 %, 75 % and 100 % of the full pressure scale.

9.2.4 Temperature-measuring devices

Devices for measuring temperature, if required, shall be capable of indicating and recording temperature fluctuations of 3 °C (5 °F).

9.3 Qualification of inspection and test personnel

9.3.1 NDE personnel

NDE personnel shall be qualified in accordance with the requirements specified in ASNT SNT-TC-1A or EN 473 Level II as a minimum.

Personnel performing visual examinations shall have passed an annual eye examination in accordance with ASNT SNT-TC-1A or EN 473 within the previous twelve months.

9.3.2 Welding inspectors

Personnel performing visual inspection of welding operations and completed welds shall be qualified and certified to the requirements of AWS QC1, or equivalent, or a manufacturer's documented training programme.

9.4 NDE of repair welding

After defect removal, the excavated area shall be examined by magnetic particle (MT) or liquid penetrant (PT) methods prior to starting repair welding.

Repair welds on pressure-containing parts shall be examined using MT or PT methods. Acceptance criteria shall be specified in documented procedures.

The supplementary NDE requirements in Annex B, if specified by the purchaser, shall also apply to repair welding.

10 Pressure testing

10.1 General

Each valve shall be tested in accordance with this clause prior to shipment. The purchaser shall specify which particular supplementary tests in Annex C shall be performed, together with the frequency of testing.

Testing shall be performed in the sequence used in this clause for specifying the test requirements. Shell pressure testing shall be carried out before painting of the valves.

Test fluids shall be fresh water which may contain a corrosion inhibitor and, by agreement, antifreeze. The chloride content of test water for austenitic and ferritic-austenitic (duplex) stainless-steel body/bonnet valves shall not exceed 30 µg/g (30 ppm).

Valves shall be tested with the seating and sealing surfaces free from sealant except where the sealant is the primary means of sealing.

Tests specified with the valve half-open may also be performed with the valve fully open provided the body cavity is simultaneously filled and pressurized through a cavity connection.

Methods for monitoring pressures and/or leakage shall be adequate also when valve body connections are not available for direct monitoring.

A sufficient stabilization period shall be allowed for all pressure tests.

Pressure testing shall be performed in accordance with documented procedures.

10.2 Stem backseat test

Unless otherwise agreed, stem backseat testing shall be performed prior to shell testing.

Where a valve has a stem backseat feature, testing of the backseat shall commence with the seat free. Self-energized packing or seals shall be removed unless a test port is provided for this test.

The valves shall be filled with the ends closed off and the obturator in the partially open position until leakage of the test fluid around the stem is observed. The backseat shall then be closed and a minimum pressure of 1,1 times the pressure rating determined in accordance with 6.1 for material at 38 °C (100 °F) is applied for the duration specified in Table 9.

Monitoring for leakage shall be through a test access port or by monitoring leakage around the loosened packing.

No visible leakage is permitted at this test pressure.

Table 9 — Minimum duration of stem backseat tests

Valve size		Test duration (minutes)
DN (mm)	NPS (inches)	
≤ 100	≤ 4	2
≥ 150	≥ 6	5

10.3 Hydrostatic shell test

Hydrostatic shell testing shall be performed on the fully assembled valve prior to painting.

Valves shall be closed off and the obturator placed in the partially open position during the test. If specified by the purchaser, the method of closing the ends shall permit the transmission of the full-pressure force acting on the end blanks to the valve body. Where present, external relief valves shall be removed and their connections plugged.

The test pressure shall be 1,5 or more times the pressure rating determined in accordance with 6.1 for material at 38 °C (100 °F). The duration shall not be less than that specified in Table 10.

Table 10 — Minimum duration of hydrostatic shell tests

Valve size		Test duration (minutes)
DN (mm)	NPS (inches)	
15 to 100	½ to 4	2
150 to 250	6 to 10	5
300 to 450	12 to 18	15
≥ 500	≥ 20	30

No visible leakage is permitted during the hydrostatic shell test.

After hydrostatic shell testing, external relief valves shall be (re)fitted to the valve. The connection to the valve body shall be tested at 95 % of the set pressure of the relief valve for 2 minutes for valve sizes up to and including DN 100 (NPS 4), and 5 minutes for valve sizes DN 150 (NPS 6) and larger. The relief valve connection shall be free of visible leakage during this period.

Where provided, the external relief valve shall be set to relieve at the specified pressure and tested. The set pressure of relief valves shall be between 1,1 and 1,33 times the valve pressure rating determined in accordance with 6.1 for material at 38 °C (100 °F).

10.4 Hydrostatic seat test

10.4.1 Alternative test

High-pressure gas seat testing in accordance with clause C.4 may be performed in lieu of the hydrostatic seat test described below.

10.4.2 Preparation

Lubricants shall be removed from seats and obturator sealing surfaces except, by agreement, for assembly lubricants for metal-to-metal contact surfaces.

10.4.3 Test pressure and duration

The test pressure for all seat tests shall not be less than 1,1 times the pressure rating determined in accordance with 6.1 for material at 38 °C (100 °F). The test duration shall be in accordance with Table 11.

Table 11 — Minimum duration of seat tests

Valve size		Test duration (minutes)
DN (mm)	NPS (inches)	
15 to 100	½ to 4	2
≥ 150	≥ 6	5

10.4.4 Acceptance criteria

Leakage for soft-seated valves and lubricated plug valves shall not exceed ISO 5208 Rate A (no visible leakage). For metal-seated valves the leakage rate shall not exceed ISO 5208 Rate D, except that the leakage rate during the seat test in 10.4.5.5.2 shall not be more than two times ISO 5208 Rate D unless otherwise specified. The test procedures for various types of block valve are given in 10.4.5.

10.4.5 Test procedures for block valves

10.4.5.1 Uni-directional

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the test pressure applied to the appropriate end of the valve.

Leakage from each seat shall be monitored via the valve body cavity vent or drain connection. For valves without a body cavity connection, seat leakage shall be monitored from each seat at the respective downstream end of the valve (the valve end downstream of the pressurized test fluid).

10.4.5.2 Bi-directional

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the test pressure applied successively to both ends of the valve.

Seat leakage shall be monitored from each seat via the valve body cavity vent or drain connection. For valves without a body cavity vent or drain connection, seat leakage shall be monitored from the respective downstream end of the valve.

10.4.5.3 Twin-seat, both seats bi-directional

Each seat shall be tested in both directions.

Cavity relief valves shall be removed if fitted. The valve and cavity shall be filled with test fluid, with the valve half-open, until the test fluid overflows through the cavity relief connection.

To test for seat leakage in the direction of the cavity, the valve shall be closed. The test pressure shall be applied successively to each valve end to test each seat separately from the upstream side. Leakage shall be monitored via the valve cavity pressure relief connection.

Thereafter, each seat shall be tested as a downstream seat. Both ends of the valve shall be drained and the valve cavity filled with test fluid. Pressure shall then be applied whilst monitoring leakage through each seat at both ends of the valve.

10.4.5.4 Twin-seat, one seat uni-directional and one seat bi-directional

10.4.5.4.1 Uni-directional seat

With the valve half-open, the valve and the test cavity shall be completely filled with test fluid until fluid overflows through the valve cavity vent connection. The valve shall then be closed and the vent valve on the test closure opened to allow fluid to overflow, or the test closure on the downstream end of the valve removed. The test pressure shall then be applied to the upstream end (uni-directional seat end) and leakage monitored from the cavity connection. If leakage is also occurring through the downstream seat, the upstream seat leakage shall be taken as the sum of the leakage measured from the cavity and the downstream connections.

10.4.5.4.2 Bi-directional seat

The test in 10.4.5.4.1 shall be repeated to test the bi-directional seat in its upstream-sealing direction.

To test the bi-directional seat in its downstream-sealing direction, both ends of the valve shall be blanked off. With the valve half-open, the valve shall be completely filled with test fluid and pressurized to the test pressure. The valve shall then be closed and test fluid allowed to overflow from a connection on the test closure fitted to the end of the valve at the bi-directional seat end (i.e. downstream of the bi-directional seat). The test pressure shall be maintained on the cavity connection whilst monitoring seat leakage of the bi-directional seat at the overflow connection on the downstream test closure.

10.4.5.5 Double-block-and-bleed valves

10.4.5.5.1 Single-seat test

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the valve body vent valve opened to allow excess test fluid to overflow from the valve cavity test connection. The test pressure shall then be applied to one end of the valve and the pressure released at the other end. This test shall be repeated for the other valve end.

Seat tightness shall be monitored during each test via overflow from the valve cavity connection.

10.4.5.5.2 Double-block seat test

With the valve half-open, the valve and its cavity shall be completely filled with test fluid. The valve shall then be closed and the valve body vent valve opened to allow excess test fluid to overflow from the valve cavity test connection. The test pressure shall be applied simultaneously from both valve ends.

Seat tightness shall be monitored via overflow through the valve cavity connection.

The tests in 10.4.5.5 may be performed in any order by the manufacturer.

10.4.5.6 Check valves

The pressure shall be applied in the direction of the required flow blockage.

10.4.5.7 Installation of body connections after testing

Pressure-containing parts, such as vent/or drain plug(s) and cavity relief valves, shall be fitted, on completion of testing, in accordance with documented procedures.

10.5 Draining

Valves shall be drained of test fluids and, where applicable, lubricated before shipment.

11 Marking

11.1 Requirements

Valves shall be marked in accordance with Table 12.

On valves whose size or shape limits the body markings, they may be omitted in the following order:

- size;
- rating;
- material;
- manufacturer's name or trademark.

The nameplate and serial number may be omitted for valves smaller than DN 50 (NPS 2). The purchaser may specify requirements for the marking of valve components.

For valves with one seat uni-directional and one seat bi-directional only, the directions of both seats shall be specified on a separate identification plate as illustrated in Figure 15. In Figure 15, one symbol indicates the bi-directional seat and the other symbol indicates the uni-directional seat.

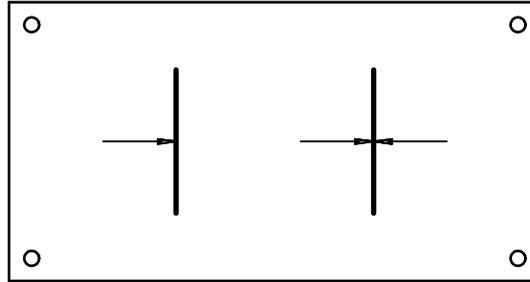


Figure 15 — Typical identification plate for valve with one seat uni-directional and one seat bi-directional

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Table 12 — Valve marking

	Marking	Application
1.	Manufacturer's name or trademark.....	On both body and nameplate
2.	Pressure class	On both body and nameplate
3.	Pressure/temperature rating:	On nameplate
	a) Maximum operating pressure at maximum operating temperature	
	b) Maximum operating pressure at minimum operating temperature	
4.	Face-to-face/end-to-end dimension (6.3).....	On nameplate
5.	Body material designation: Material symbol, e.g. AISI, ASME, ASTM or ISO.....	On both body and nameplate. Melt identification (e.g. cast or heat number) on nameplate only.
	NOTE When body is fabricated of more than one type of steel, the end connection material governs marking.	
6.	Bonnet/cover material designation: Material symbol e.g. AISI, ASME, ASTM, ISO	On bonnet/cover [including melt identification (e.g. heat number)]
7.	Trim identification: Symbols indicating material of stem and sealing faces of closure members if different from that of body.....	On nameplate
	NOTE MSS SP-25 gives guidance on marking.	
8.	Nominal valve size	On body or nameplate or both (where practicable)
	a) Full-opening valves: nominal valve size.....	On body or nameplate or both (where practicable)
	b) Reduced-opening valves: shall be marked as specified in 6.2	On body or nameplate or both (where practicable)
9.	Ring joint groove number.....	On valve flange edge
10.	SMYS and minimum wall thickness	On body weld bevel ends
11.	Flow direction (for check valves only)	On body of uni-directional valves only
12.	Seat sealing direction.....	Separate identification plate on valve body
13.	Unique serial number.....	On both body and nameplate
14.	Date of manufacture (month and year)	On nameplate
15.	ISO 14313.....	On nameplate