INTERNATIONAL STANDARD

ISO 14723

First edition
2001-12-01

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

Industries du pétrole et du gaz naturel — Systèmes de transport par conduites — Vannes de conduites immergées

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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.

The main task of technical committees is to prepare International Standards. Draft 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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14723 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 C, D and E form a normative part of this International Standard. Annexes A and B are for information only.

Introduction

This International Standard is based on ISO 14313. It has been developed to address special requirements specific to subsea pipeline valves.

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 contractor from offering, or the company from accepting, alternative engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the manufacturer should identify any variations from this International Standard and provide details.

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

1 Scope

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

This International Standard is not applicable to valves for pressure ratings exceeding PN 420 (Class 2500).

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

Annex B of this International Standard provides a checklist summary of information to be provided by the manufacturer and/or purchaser 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.

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

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

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

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

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

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, *Buttwelding ends*

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

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

ASME B31.4, *Pipeline transportation systems for liquid hydrocarbons and other liquids*

ASME B31.8, *Gas transmission and distribution 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, Section IX, *Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators*

ASTM[2)] 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 578/A 578M, *Standard specification for straight-beam ultrasonic examination of plain and clad steel plates for special applications*

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

AWS[3)] QC1, *Standard for AWS certification of welding inspectors*

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*

MSS[4)] SP-44, *Steel pipeline flanges*

MSS SP-55, *Quality standard for steel castings, flanges, fittings and other piping components — Visual method for evaluation of surface irregularities*

NACE[5)] MR 0175, *Sulfide stress cracking resistant metallic materials for oilfield equipment*

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

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

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

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

5) National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 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.

[ISO 14313:1999]

3.2
bi-directional valve
valve designed for blocking the fluid in both downstream and upstream directions

[ISO 14313:1999]

3.3
bleed
drain or vent

[ISO 14313:1999]

3.4
block valve
ball or gate valve that blocks flow into the downstream conduit when in the closed position

NOTE 1 Valves are either single- or double-seated, bi-directional or uni-directional.

NOTE 2 Adapted from ISO 14313:1999.

3.5
breakaway thrust [torque]
thrust [torque] required for opening a valve with maximum pressure differential

NOTE Adapted from ISO 14313:1999.

3.6
by agreement
agreed between manufacturer and purchaser

[ISO 14313:1999]

3.7
double-block-and-bleed 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

[ISO 14313:1999]

3.8
drive train
all parts of a valve drive between the operator and the obturator, including the obturator but excluding the operator

[ISO 14313:1999]

3.9
flow coefficient
q_V
volumetric flowrate 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 100 kPa (14,7 psi)

NOTE 1 It is expressed in cubic metres per hour.

NOTE 2 q_V relates to the flowrate coefficient C_V in US gallons per minute at 15,6 °C (60 °F) resulting in 1 psi pressure drop as follows:

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

NOTE 3 Adapted from ISO 14313:1999.

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

[ISO 14313:1999]

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

[ISO 14313:1999]

3.12
locking device
part or an arrangement of parts for securing a valve in the open and/or closed position

[ISO 14313:1999]

3.13
manual operator
wrench (lever) or handwheel with or without a gearbox

[ISO 14313:1999]

3.14
maximum pressure differential
MPD
maximum difference between the upstream and downstream pressures across the obturator at which the obturator may be operated

NOTE Adapted from ISO 14313:1999.

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

[ISO 14313:1999]

3.16
nominal pressure class
PN class
numerical pressure design class as defined in ISO 7005-1 and used for reference purposes

NOTE The nominal pressure class is designated by the letters PN followed by a number.

[ISO 14313:1999]

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.

[ISO 14313:1999]

3.18
obturator
closure member
part of a valve which is positioned in the flow stream to permit or block flow

EXAMPLE Ball, clapper, disc, gate or plug.

NOTE Adapted from ISO 14313:1999.

3.19
operator
device (or assembly) for opening or closing a valve

[ISO 14313:1999]

3.20
pipe pup
short piece of pipe with length typically equivalent to one or two times its diameter, welded directly to the valve to prevent valve seal damage from girth welding, for transition of valve material to pipeline strength properties, or to provide a valve end mating the pipeline dimensions

3.21
position indicator
device to show the position of the valve obturator

[ISO 14313:1999]

3.22
powered operator
powered actuator
electric, hydraulic or pneumatic device bolted or otherwise attached to the valve for powered opening and closing of the valve

[ISO 14313:1999]

3.23
pressure cap
cap designed to contain internal pressure in the event of seal leakage or to prevent ingress due to hyperbaric pressure

3.24
pressure class
numerical pressure design class expressed in accordance with either the nominal pressure class or the ANSI rating class

NOTE 1 In this International Standard the pressure class is stated by the PN class, followed by the ANSI rating class between parentheses.

NOTE 2 Adapted from ISO 14313:1999.

3.25
pressure-containing part
part designed to contain the pipeline fluid

EXAMPLES Bodies, bonnets, glands, stems, gaskets and bolting.

NOTE Adapted from ISO 14313:1999.

3.26
pressure-controlling part
part intended to block or permit the flow of fluids

EXAMPLE Seat and obturator.

NOTE Adapted from ISO 14313:1999.

3.27
process-wetted part
part exposed directly to the pipeline fluid

NOTE Adapted from ISO 14313:1999.

3.28
protection cap
cover to protect valve parts from mechanical damage

NOTE A pressure cap may also be used for protection.

3.29
reduced-opening valve
valve with the opening through the obturator smaller than at the end connection(s)

[ISO 14313:1999]

3.30
remote-operated vehicle
ROV
underwater vehicle operated remotely from a surface vessel or installation

3.31
seating surface
contact surface of the obturator and seat which ensure valve sealing

NOTE Adapted from ISO 14313:1999.

3.32
shaft
part of a check valve that connects the obturator to the operator and which may consist of one or more components

3.33
stem
part that connects the obturator to the operator and which may consist of one or more components

[ISO 14313:1999]

3.34
support ribs
legs
metal structure which provides a stable footing when the valve is set on a fixed base

NOTE Adapted from ISO 14313:1999.

3.35
through-conduit valve
valve with an unobstructed and continuous cylindrical opening

[ISO 14313:1999]

3.36
twin-seat valve
⟨both seats bi-directional⟩ valve with two seats, each sealing in either direction

NOTE Adapted from ISO 14313:1999.

3.37
twin-seat valve
⟨one seat uni-directional and one seat bi-directional⟩ valve with two seats, one sealing in one direction and the other in either direction

NOTE Adapted from ISO 14313:1999.

3.38
uni-directional valve
valve designed for blocking the flow in one direction only

[ISO 14313:1999]

4 Symbols and abbreviated terms

4.1 Symbols

C_v Flow coefficient in United States Customary (USC) units

q_v Flow coefficient in SI units

4.2 Abbreviated terms

BM Base metal

CE Carbon equivalent

DN Nominal size

HAZ Heat-affected zone

HBW Brinell hardness

HIC Hydrogen-induced cracking

HRC 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

ROV Remote-operated vehicle

RT Radiographic testing

SMYS Specified minimum yield strength

SSIV Subsea isolation valve

UT Ultrasonic testing

VT Visual testing

WM Weld metal

WPS Welding 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 in Figures 1 and 2.

Gate valves shall have an obturator which moves in a plane perpendicular to the direction of flow. The direction of travel of the gate should be down for closed, but may be reverse-acting in which case the gate is up for closed.

5.1.2 Ball valves

Typical configurations for ball valves with flanged or welding ends are shown in Figures 3, 4 and 5.

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

5.1.3 Check valves

Typical configurations for check valves are shown in Figures 6, 7, 8 and 9.

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

5.2 Valve configuration

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 allows a sphere with a nominal size not less than that specified in Table 1 to pass.

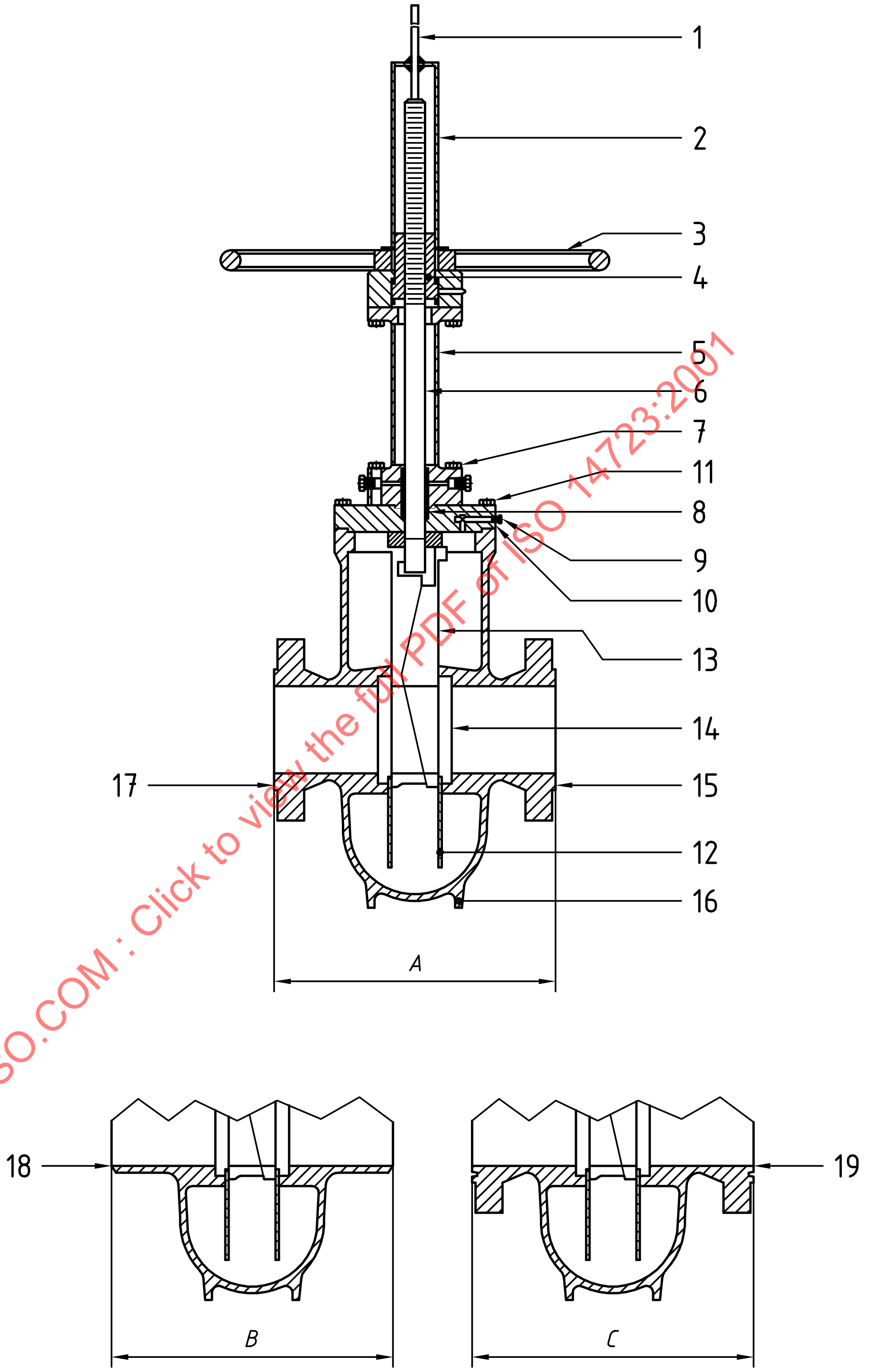
Welding-end valves may require a smaller bore at the welding end to mate with the pipe.

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 by pressure class

Nominal size		Minimum bore mm			
DN	NPS	PN 20 to 100 (Class 150 to 600)	PN 150 (Class 900)	PN 250 (Class 1500)	PN 420 (Class 2500)
50	2	49	49	49	42
65	2 1/2	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	—	—	—

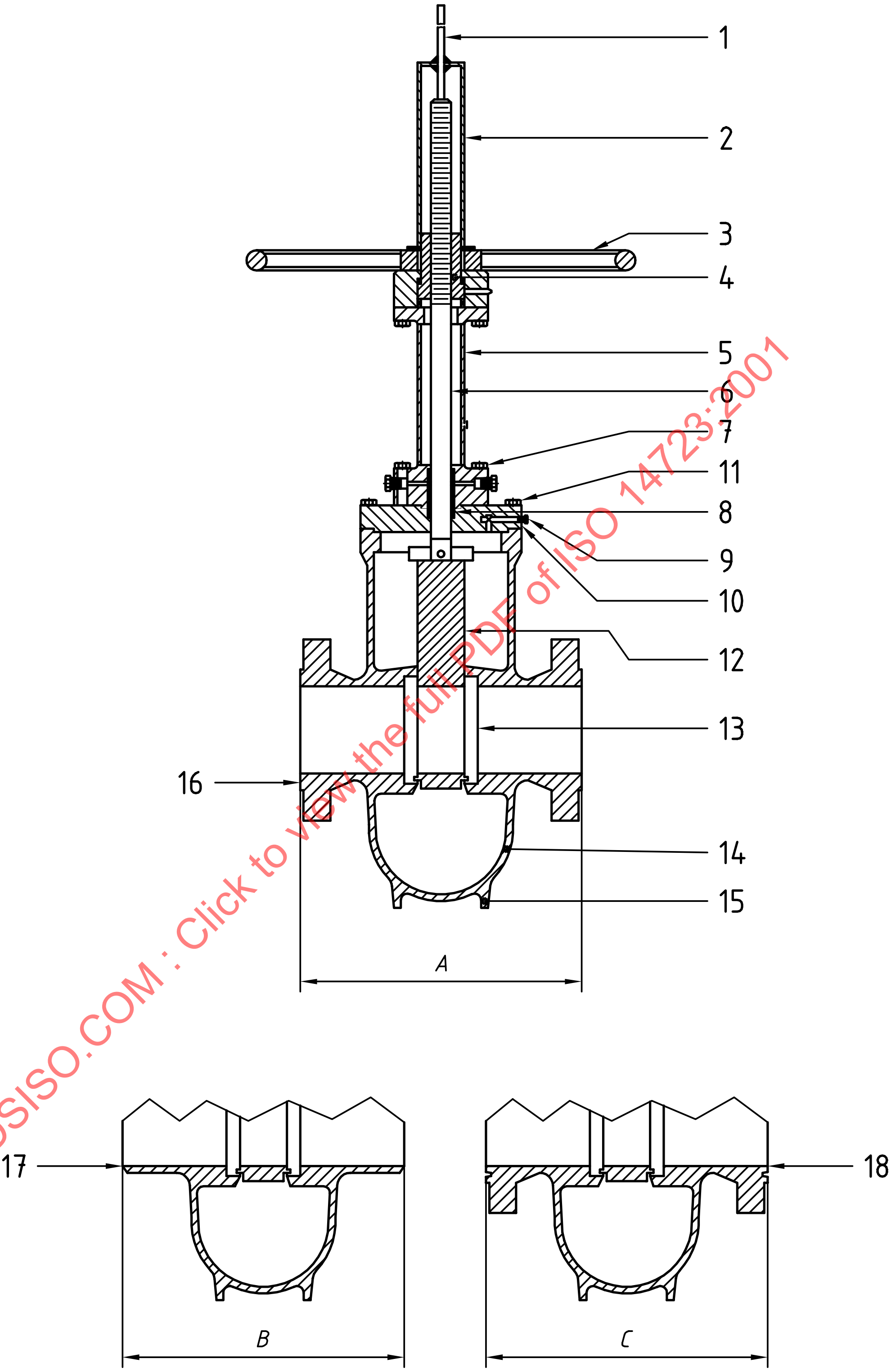


Key

1 Stem indicator
2 Stem enclosure
3 Handwheel
4 Yoke nut
5 Yoke
6 Stem
7 Yoke bolting
8 Stem packing
9 Relief valve
10 Bonnet
11 Bonnet bolting
12 Gate guide
13 Gate assembly
14 Seat ring
15 Body
16 Support ribs or legs
17 Raised face
18 Welding end
19 Ring joint

A Raised-face face-to-face dimension
B Welding-end end-to-end dimension
C Ring-joint end-to-end dimension

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

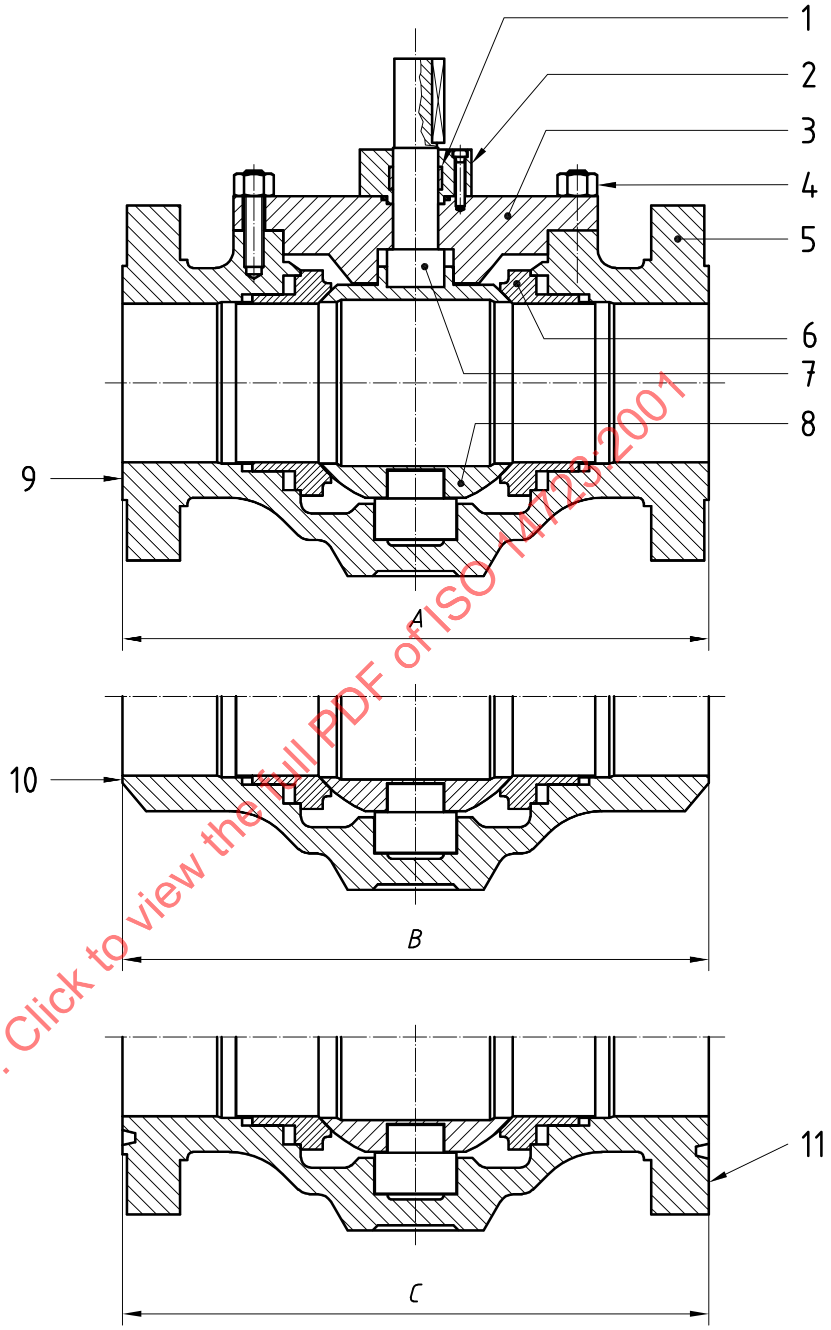


Key

1 Stem indicator
2 Stem enclosure
3 Handwheel
4 Yoke nut
5 Yoke
6 Stem
7 Yoke bolting
8 Stem packing
9 Relief valve
10 Bonnet
11 Bonnet bolting
12 Gate
13 Seat ring
14 Body
15 Support ribs or legs
16 Raised face
17 Welding end
18 Ring joint

A Raised-face face-to-face dimension
B Welding-end end-to-end dimension
C Ring-joint end-to-end dimension

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

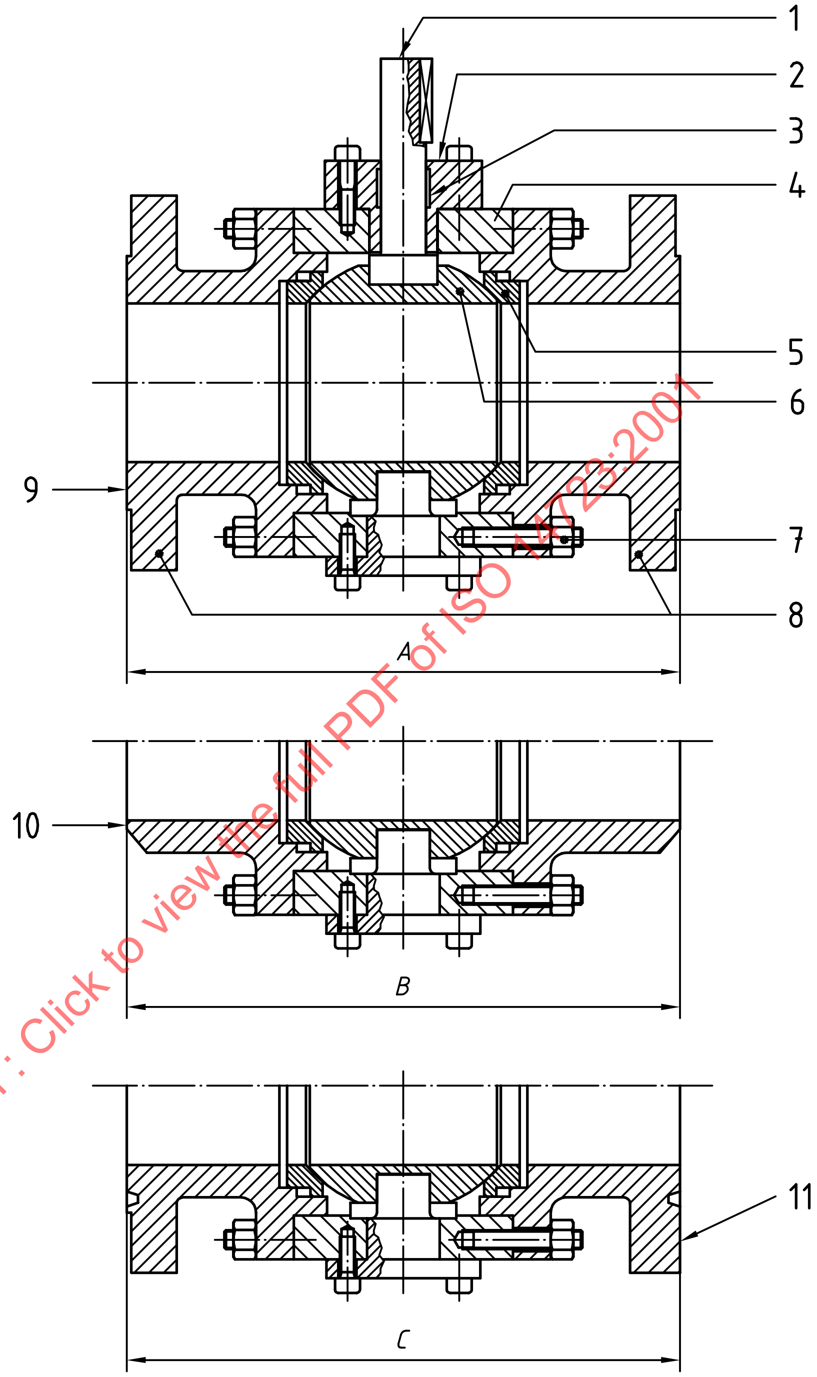


Key

1 Stem seal
2 Bonnet cover
3 Bonnet
4 Body bolting
5 Body
6 Seat ring
7 Stem
8 Ball
9 Raised face
10 Welding end
11 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 — Top-entry ball valve

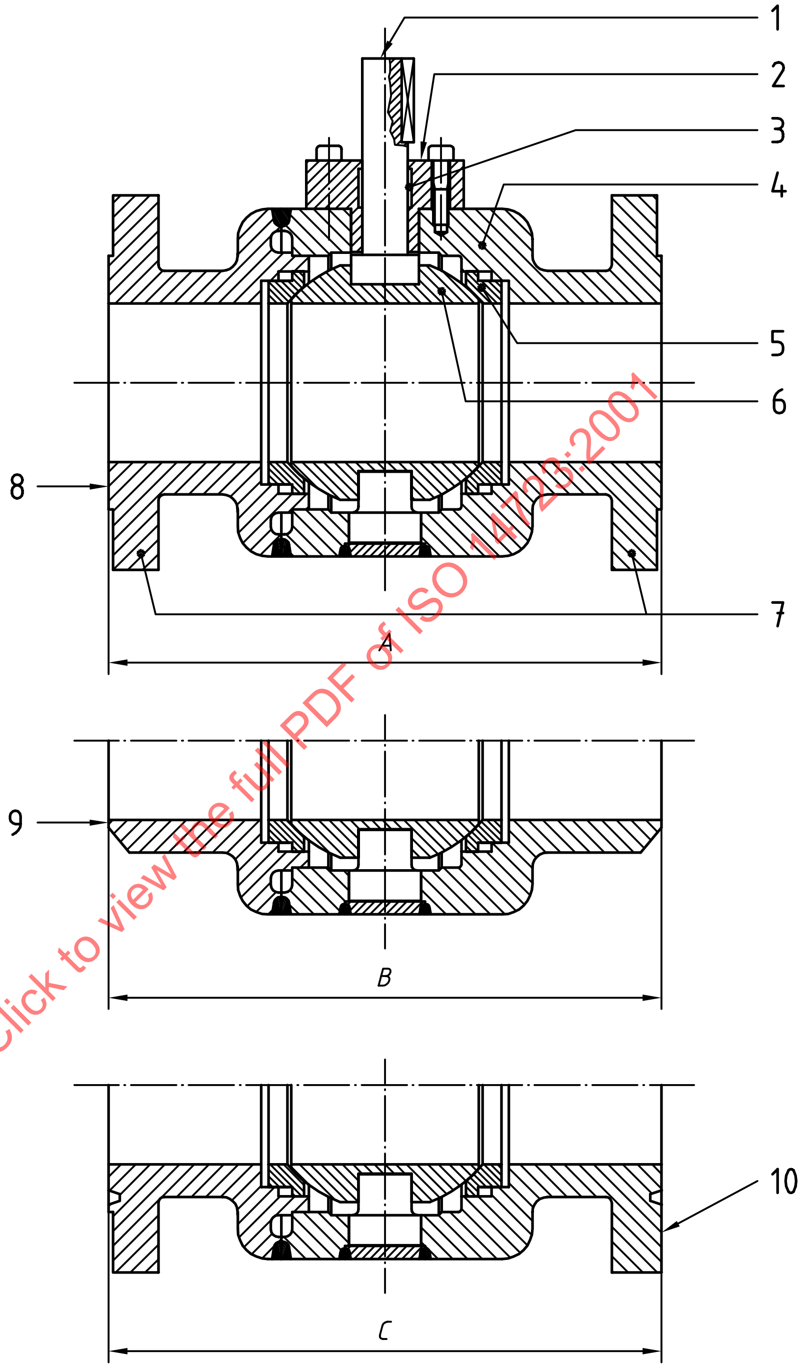


Key

1 Stem
2 Body cover
3 Stem seal
4 Body
5 Seat ring
6 Ball
7 Body bolting
8 Closure
9 Raised face
10 Welding end
11 Ring joint

A Raised-face face-to-face dimension
B Welding-end end-to-end dimension
C Ring-joint end-to-end dimension

Figure 4 — Three-piece ball valve

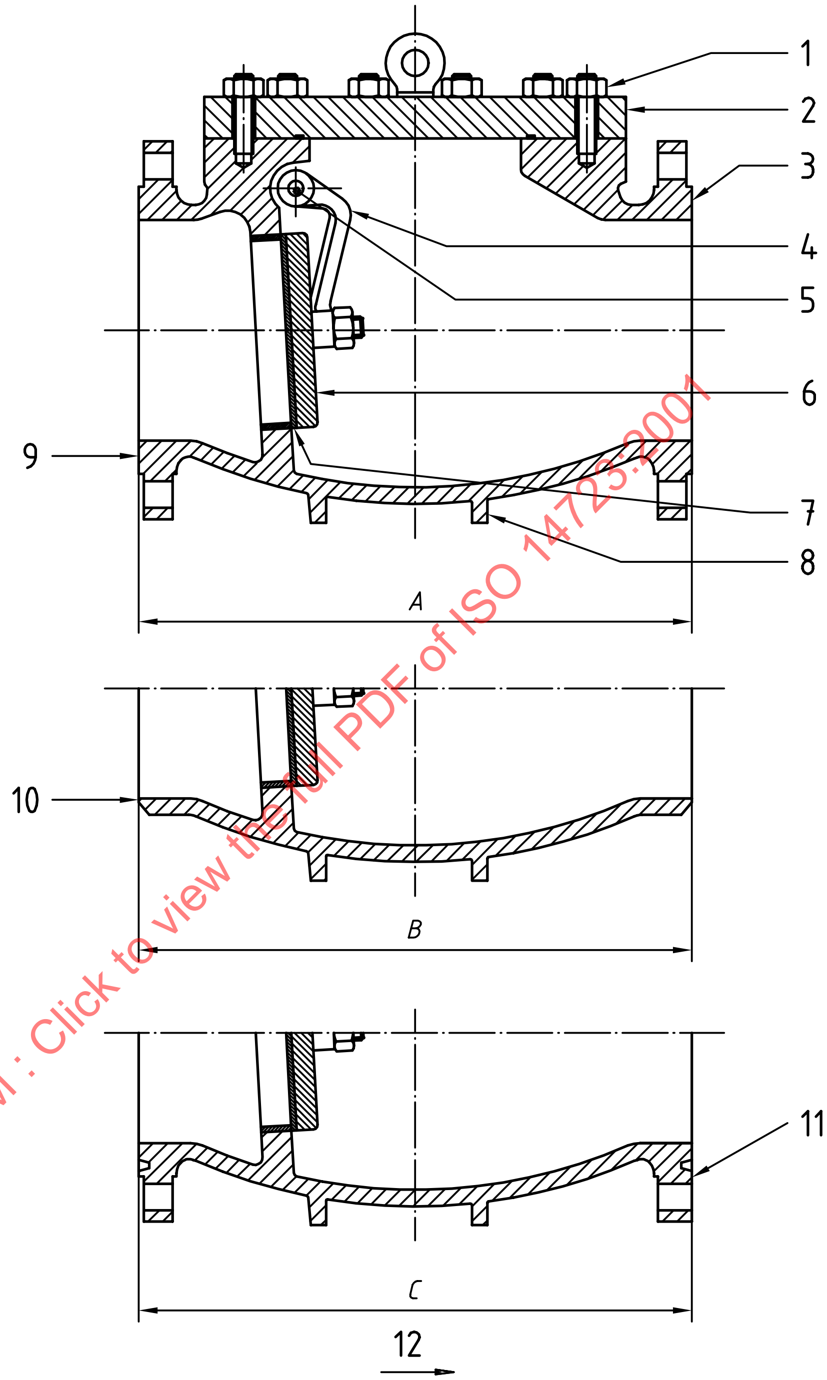


Key

1 Stem
2 Body cover
3 Stem seal
4 Body
5 Seat ring
6 Ball
7 Closure
8 Raised face
9 Welding end
10 Ring joint

A Raised-face face-to-face dimension
B Welding-end end-to-end dimension
C Ring-joint end-to-end dimension

Figure 5 — Welded-body ball valve

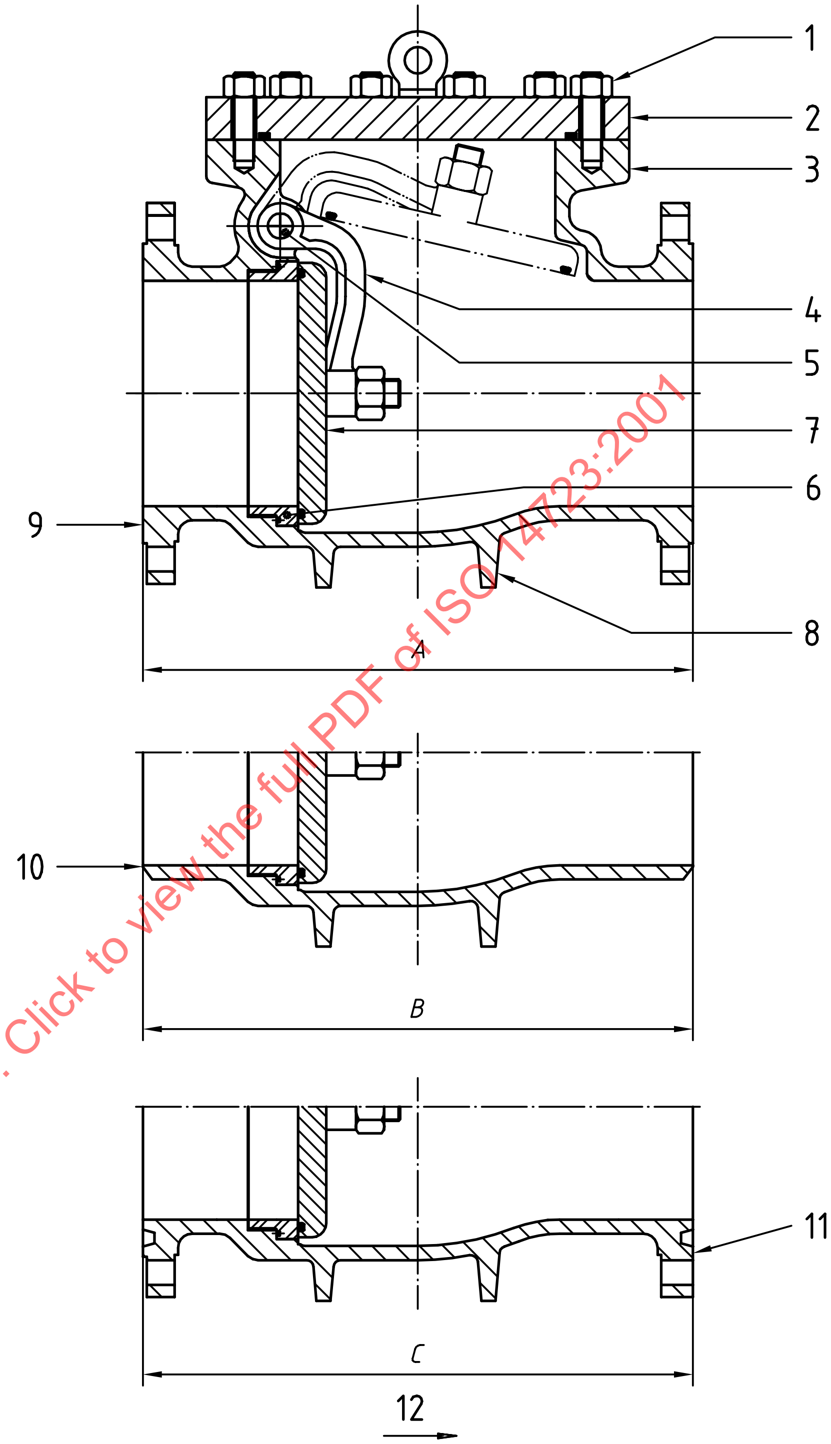


Key

1 Cover bolting
2 Cover
3 Body
4 Clapper disc arm
5 Shaft
6 Clapper disc
7 Seat ring
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 6 — 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 7 — 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

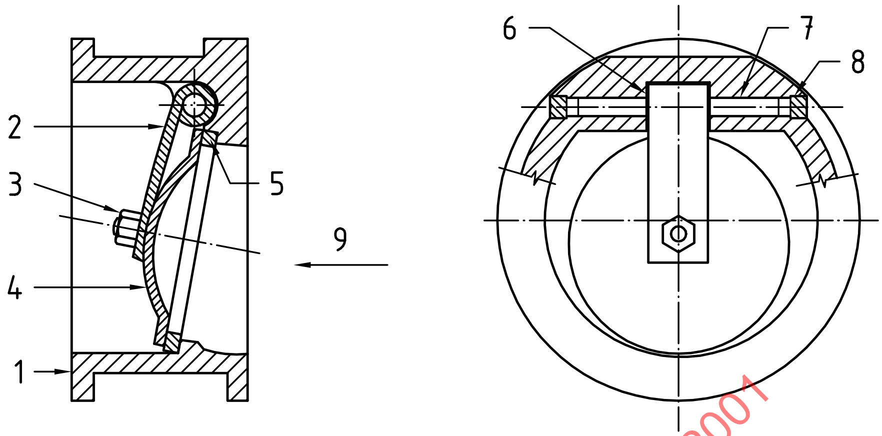
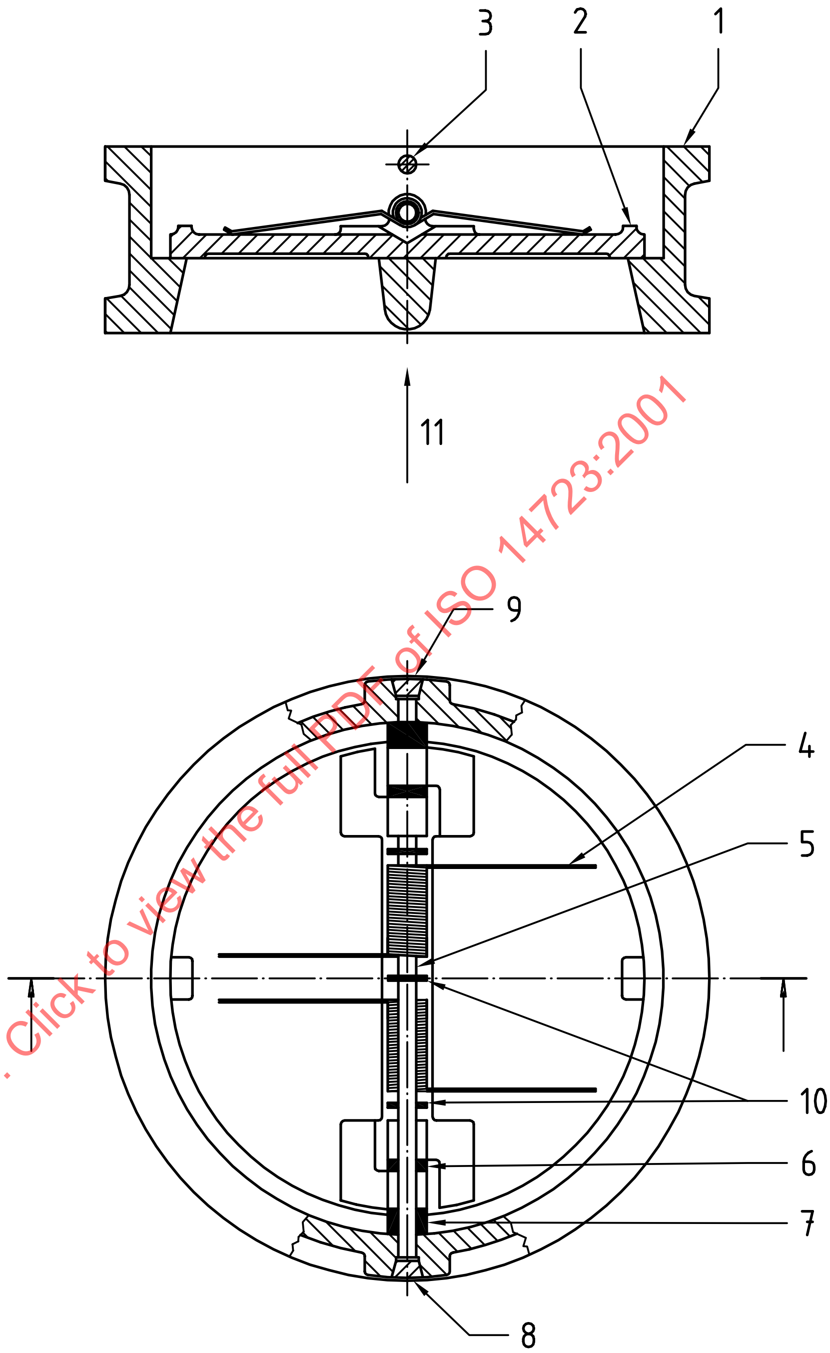


Figure 8 — Single-plate wafer-type check valve, long pattern



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

6 Design

6.1 Design codes and calculations

Pressure-containing parts including bolting shall be designed with materials specified in clause 7. The pressure-containment design and calculations shall be in accordance with an agreed pressure vessel design standard, for example ASME Section VIII Division 1 or Division 2, or BS 5500. The allowable stress values shall be consistent with the pressure vessel design standard.

If design standards have test pressures less than 1,5 times the design pressure, then the design pressure for the body calculation shall be increased such that the hydrostatic test pressure in 10.2 can be applied.

6.2 Pressure and temperature ratings

The purchaser shall specify whether the PN class or the ANSI class shall be used for the specification of the required pressure class.

Valves to which this International Standard is applicable 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 and the pipeline system design.

The purchaser may specify intermediate design pressures and temperatures for a 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, for example ASME Section VIII Division 1 or Division 2, or BS 5500.

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

The minimum design temperature shall be 0 °C unless otherwise specified by the purchaser.

6.3 Cavity relief

The manufacturer shall determine whether fluid can become trapped in the body cavity in the open and/or closed position. If fluid trapping is possible, then valves shall be provided with an automatic cavity pressure relief unless otherwise specified by the purchaser. External cavity relief shall not be used.

6.4 External pressure and loads

Valves shall be designed for loads other than internal pressure and temperature (see 6.2), if specified by the purchaser. The purchaser shall specify any other construction, test, functional or accidental load combinations or external pressures which shall be accounted for in the design.

NOTE ISO 13623 specifies construction, functional and accidental loads and provides examples of such loads for consideration by the purchaser.

6.5 Sizes

All valves, except for reduced-opening valves, shall be furnished in the DN sizes listed in Tables 2 to 5. 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 parentheses.

Except for reduced-opening valves, valve sizes shall be specified by DN or 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.

EXAMPLE 1 A DN 400 (NPS 16) valve with a reduced 334-mm-diameter circular opening through the obturator is 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”.

EXAMPLE 2 A reduced-bore valve with DN 400 (NPS 16) end connections and a 381 × 305 mm rectangular opening through the obturator is specified as 400R.

6.6 Face-to-face and end-to-end dimensions

Face-to-face and end-to-end dimensions of valves shall be in accordance with Tables 2 to 5 for the *A*, *B* and *C* dimensions corresponding to Figures 1 to 7, unless otherwise agreed.

Face-to-face and end-to-end dimensions for valve sizes not specified in Tables 2 to 5 shall be in accordance with ASME B16.10. Face-to-face and end-to-end dimensions not shown in Tables 2 to 5 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, unless otherwise agreed.

The nominal size and face-to-face or end-to-end dimensions shall be stated on the nameplate.

Table 2 — Gate valves — Face-to-face and end-to-end dimensions

Dimensions in millimetres

DN	NPS	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	$2^{1}/_{2}$	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	$2^{1}/_{2}$	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 (*continued*)

DN	NPS	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	$2^1/_2$	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	$2^1/_2$	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			

[a] Through-conduit valves shall be 650 mm.
[b] Through-conduit valves shall be 800 mm.

NOTE For dimensions *A*, *B* and *C* see Figures 1 and 2.

Table 3 — Ball valves — Face-to-face and end-to-end dimensions

Dimensions in millimetres

DN	NPS	Full-bore and reduced-bore			Short-pattern, full-bore and reduced-bore		
		Raised face *A*	Welding end *B*	Ring joint *C*	Raised face *A*	Welding end *B*	Ring joint *C*
		PN 20 (Class 150)					
50	2	178	216	191	—	—	—
65	2 1/2	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 3 *(continued)*

DN	NPS	Full-bore and reduced-bore			Short-pattern, full-bore and reduced-bore		
		Raised face *A*	Welding end *B*	Ring joint *C*	Raised face *A*	Welding end *B*	Ring joint *C*
		PN 50 (Class 300)					
50	2	216	216	232	—	—	—
65	$2^1/_2$	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 3 *(continued)*

DN	NPS	Full-bore		
		Raised face *A*	Welding end *B*	Ring joint *C*
		PN 64 (Class 400)		
50	2	—	—	—
65	$2^1/_2$	—	—	—
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	—	—	—

DN	NPS	Full-bore		
		Raised face *A*	Welding end *B*	Ring joint *C*
		PN 100 (Class 600)		
50	2	292	292	295
65	$2^1/_2$	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 3 (*continued*)

DN	NPS	Full-bore Raised face *A*	Full-bore Welding end *B*	Full-bore Ring joint *C*
		PN 150 (Class 900)		
50	2	368	368	371
65	$2^{1}/_{2}$	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 250 (Class 1500)		
50	2	368	368	371
65	$2^{1}/_{2}$	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

DN	NPS	Full-bore Raised face *A*	Full-bore Welding end *B*	Full-bore Ring joint *C*
		PN 420 (Class 2500)		
50	2	451	451	454
65	$2^{1}/_{2}$	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

NOTE For dimensions *A*, *B* and *C* see Figures 3, 4 and 5.

Table 4 — Swing check valves, reduced- and full-opening types — Face-to-face and end-to-end dimensions

Dimensions in millimetres

DN	NPS	PN 20 (Class 150)			PN 50 (Class 300)			PN 64 (Class 400)			PN 100 (Class 600)		
		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*	Raised face A	Welding end *B*	Ring joint *C*
50	2	203	203	216	267	267	283	292	292	295	292	292	295
65	$2^1/_2$	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 4 *(continued)*

DN	NPS	PN 150 (Class 900)			PN 250 (Class 1500)			PN 420 (Class 2500)		
		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*
50	2	368	368	371	368	368	371	451	451	454
65	$2^1/_2$	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	—	—	—
NOTE For dimensions *A*, *B* and *C* see Figures 6 and 7.										

Table 5 — Single- and dual-plate, wafer-type check valves — Face-to-face dimensions

Dimensions in millimetres

DN	NPS	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)
50	2	60	60	60	60	70	70	70
65	$2^1/_2$	67	67	67	67	83	83	83
80	3	73	73	73	73	83	83	86
100	4	73	73	79	79	102	102	105
150	6	98	98	137	137	159	159	159
200	8	127	127	165	165	206	206	206
250	10	146	146	213	213	241	248	250
300	12	181	181	229	229	292	305	305
350	14	184	222	273	273	356	356	—
400	16	191	232	305	305	384	384	—
450	18	203	264	362	362	451	468	—
500	20	219	292	368	368	451	533	—
600	24	222	318	394	438	495	559	—
750	30	—	—	—	—	—	—	—
900	36	—	—	—	—	—	—	—
1 100	42	—	—	—	—	—	—	—
1 200	48	—	—	—	—	—	—	—
1 400	54	—	—	—	—	—	—	—
1 500	60	—	—	—	—	—	—	—

NOTE For dimensions *A*, *B* and *C* see Figures 8 and 9.

6.7 Minimum bore full-opening valves

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

6.8 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 6.2 for material at 38 °C (100 °F) shall be the MPD.

The manufacturer shall specify the following data to the purchaser:

— the flowrate coefficient q_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.

6.9 Pigging

The purchaser shall specify the requirements for piggability of the valves.

NOTE Guidance on this aspect is given in annex A.

6.10 Valve ends

6.10.1 Flanged ends

Standard end flanges shall be furnished with 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.

6.10.2 Welding ends

Welding ends shall conform to Figures 434.8.6 (a) (1) and (2) in ASME B31.4:1998 or Figures 14 and 15 of ASME B31.8:1999 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 B16.25:1997.

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

6.10.3 Special flanges and mechanical joints

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

6.11 Bypass, drain and vent connections

The use of bypass, drain and vent connections should be avoided.

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.

Connection sizes shall be in accordance with Table 6. Thread forms shall be in accordance with ISO 228-1 or ISO 228-2 or ISO 7-1 for metric sizes and ASME B1.1 or ASME B1.20.1 for US Customary (USC) sizes.

Table 6 — Minimum nominal sizes for bypass, drain and vent connections

Nominal valve size		Connection size
DN	NPS	mm (in)
50 to 100	2 to 4	15 ($^1/_2$)
150 to 200	6 to 8	20 ($^3/_4$)
⩾ 250	⩾ 10	25 (1)

6.12 Handwheels and wrenches

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 180 N.

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

Handwheel diameter(s) should 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. Spokes shall not extend beyond the perimeter of the handwheel unless otherwise agreed. For manual or ROV-operated valves, the manufacturer shall state the required number of turns to fully operate the valve.

6.13 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 valves shall be designed to lock the valve in the open and/or closed position.

6.14 Position indicators

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

For ball valves, the wrench and/or 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 alignments with the operator/actuator removed.

6.15 ROV interface

The purchaser shall specify the ROV interface requirements.

NOTE Typical ROV interfaces are provided in ISO 13628-4.

6.16 Sealant injection

Seat and/or stem sealant injection shall be provided when specified. All sealant injection ports shall be provided with a double barrier. The first (inner) barrier shall be a check valve located within the valve body. The second barrier shall be either a check valve with a pressure-retaining cap or an isolation valve.

6.17 Lifting lugs

Valves in size DN 200 (NPS 8) and larger shall be provided with lifting lugs or eyes unless otherwise agreed. The valve manufacturer shall verify the suitability of the lugs to lift the valve and operator assembly.

Local requirements may specify special design, manufacturing and testing of lifting lugs or eyes.

6.18 Actuators/gearbox

The selection of the actuator power source shall be by agreement.

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 (for example with gaskets or O-rings) to prevent external contaminants from entering the assembly. The hydrostatic head pressure shall be taken into account when designing the actuator/gearbox.

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

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

For valves fitted with a gearbox, a torque-limiting device, such as a shear pin, shall be provided on the handwheel or ROV connection input shaft to prevent damage to the drive train. The manufacturer shall state the maximum permissible torque which will not result in activation of the torque-limiting device.

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

6.19 Drive trains

6.19.1 Design thrust or torque

The minimum design thrust or torque for all design calculations shall be at least two times the valve manufacturer's predicted breakaway maximum design thrust or torque of any operating condition for a new valve at the MPD at 38° C or at an operational temperature and/or pressure causing the highest thrust or torque. Design factors other than two times may be used by agreement.

For applications where the valve operation is critical, such as SSIV, the minimum design thrust or torque shall be based on the operating mode that requires the greatest value of thrust or torque. The manufacturer shall identify which of the following operating modes requires the greatest thrust or torque:

— close to open, with a pressure differential equal to MPD;

— close to open, with MPD on both sides of the obturator and with the valve at atmospheric pressure;

— open to close, with the MPD in the valve bore and the valve cavity at atmospheric pressure.

6.19.2 Allowable stresses

Stresses in the drive train components, including adapter, bolting, etc. required to interface the operator to the valve, shall not exceed the following limits when delivering the design thrust or torque:

— 67 % of SMYS for tensile stresses (excluding bolting);

— 60 % of SMYS for tensile stress of bolting;

— 40 % of SMYS for shear stresses;

— 90 % of SMYS for bearing stresses.

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

6.19.3 Maximum allowable thrust or torque

The maximum thrust or torque which can be delivered by the operator shall not cause stresses higher than 1,5 times the allowable stresses in 6.19.2.

For manually operated valves, a manual input force of 540 N shall be assumed for calculation purposes.

6.19.4 Drive train bolting

Bolting in the drive train shall be designed to accommodate direct loading applied by the full actuator/gearbox output and, where applicable, loads from pressure. The gearbox/actuator output should be resisted by dowels for joints subjected to torsion.

6.19.5 Stem retention

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

6.20 Stem shaft protector

If specified by the purchaser, the design shall have provision for fitting a stem shaft protector or cap. If the protector or cap could contain pressure, the protector or cap and method of attachment shall be designed and tested for the pressure class of the valve. The protector or cap shall have provisions for venting prior to removal and during fitting.

6.21 Hydraulic lock

If valves or valve components are designed for subsea maintenance, provisions shall be made for venting of all enclosed cavities to ensure that entrapped fluid does not prevent the disassembly, or subsequent reassembly of the components.

6.22 Corrosion/erosion

If corrosive conditions are specified by the purchaser, during or prior to operation, the manufacturer shall take precautions in the valve design and material selection to ensure that corrosion will not affect the correct functioning of the valve over its design life. Such precautions may include corrosion-resistant overlay in sealing areas, gasket contact areas or all process-wetted surfaces. Commissioning and hydrostatic test conditions shall also be considered and may require corrosion protection.

If a specific corrosion/erosion allowance is specified, the manufacturer shall also ensure that design thickness calculations include a loss of thickness equal to the corrosion/erosion allowance specified.

Soft-seated valves can be unsuitable for highly erosive service, for which metal-seated valves with or without hard facing shall be considered.

6.23 Hyperbaric performance

The manufacturer shall demonstrate that the valve and/or operator is suitable for the required water depth. Hyperbaric testing shall be performed if the manufacturer cannot demonstrate the suitability of the valve and/or operator for the required water depth (see C.6 for hyperbaric test requirements).

6.24 Design document review

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

7 Material

7.1 Material specification

Specifications for metallic parts shall, as a minimum, be developed by the manufacturer and include the requirements for

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

Metallic pressure-containing parts, except stems, shafts and gaskets, shall be of materials listed in ASME B16.34. If materials are not listed in ASME B16.34, materials shall be selected by agreement.

All austenitic and duplex stainless steels shall be solution-treated and water-quenched.

Free-machining resulfurized or similar steels shall not be used for any purpose.

The chemical composition, mechanical properties and heat treatment and testing of complex alloys (e.g. duplex stainless steels) including welds, require special consideration and shall be subject to agreement.

Corrosion tests to demonstrate corrosion resistance of the heat, and heat-treatment batch combination, of high alloy steels used for the manufacturing of the valve should be specified by the purchaser.

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.

External components shall be suitable for the subsea environment and/or be suitably protected.

Care shall be taken to avoid galvanic couples in situations where water or another electrolyte may be present.

Specific measures shall be taken to prevent the galling of moving and mating parts, for example by ensuring a differential hardness of 30 HBW minimum or by applying surface coating.

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

Graphite should not be used for stem packing, seals or gaskets which may be in contact with sea water.

7.3 Forged parts

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

7.4 Composition limits

7.4.1 Flanged end valves

The chemical composition of carbon steel parts which may be subjected to welding shall meet the following requirements unless otherwise agreed:

- the carbon content shall not exceed 0,25 % mass fraction;
- the content of both sulfur and phosphorus shall each not exceed 0,03 % mass fraction.

7.4.2 Welding end valves

a) The chemical composition of carbon steel for welding ends shall meet the following requirements.

1) The carbon content shall not exceed 0,21 % mass fraction in the ladle (heat) analysis or 0,23 % mass fraction in the product (check) analysis.

2) The maximum content of both sulfur and phosphorus shall not exceed 0,03 % mass fraction;

3) The carbon equivalent (CE) shall not exceed 0,43 in the ladle (heat) analysis or 0,45 in the product (check) analysis. CE shall be calculated in accordance with the following formula:

$$CE = \%\,C + \frac{\%Mn}{6} + \frac{(\%Cr + \%Mo + \%\,V)}{5} + \frac{(\%Cu + \%Ni)}{15}$$

b) The chemical composition of austenitic stainless steels for welding ends shall meet the following requirements.

1) The carbon content shall not exceed 0,03 % mass fraction, except under the conditions outlined in 2) and 3) below.

2) A carbon content of up to 0,08 % mass fraction is permissible provided the material is stabilized with niobium and the niobium content is at least ten times the mass of the carbon.

3) For steels stabilized with niobium, titanium or tantalum, the combined mass of niobium, titanium and tantalum shall be at least eight times the mass of the carbon.

c) Requirements for the chemical composition of welding ends 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 0 °C (32 °F) shall be impact-tested using the Charpy V-notch technique in accordance with ISO 148 or ASTM A 370. Other materials that may be subjected to brittle fracture (e.g. duplex stainless steel, 13 % Cr steels, 17-4 Ph steel), when used at design temperatures below 0 °C, shall be impact-tested, which shall be by agreement.

NOTE Design standards or local requirements may specify impact testing for minimum design temperatures higher than 0 °C (32 °F) and/or increased impact test toughness values.

A minimum of one impact test, comprising a set of three test 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;

— the hot-work ratio for size reduction of a forging test specimen shall not exceed the hot-work ratio for size reduction of the part(s) it qualifies.

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.

Impact test results for full-size specimens shall meet the requirements of Table 7.

Table 7 — Charpy V-notch impact requirements

Specified minimum yield strength MPa	Average of 3 specimens J	Minimum of single specimen J
⩽ 276	28	21
277 to 299	30	23
300 to 321	32	24
⩾ 322	37	28

7.6 Bolting

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

Impact test results for bolting material shall meet the requirements of ASTM A 320. Bolting material with hardness exceeding 325 HV_{10} shall not be used for valve applications where hydrogen embrittlement can occur, unless otherwise agreed.

NOTE Hydrogen-induced cracking (HIC) can occur in cathodically protected subsea pipelines.

7.7 Sour service

7.7.1 Sulfide stress cracking

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

7.7.2 Hydrogen-induced cracking

Process-wetted and pressure-controlling parts for valves in sour service applications and manufactured from plate shall be resistant to HIC.

Resistance shall be demonstrated by HIC testing in accordance with NACE TM 0284, per heat, per heat-treatment batch combination.

Defects shall not exceed the following limits unless otherwise agreed:

a) maximum crack sensitivity ratio (CSR) = 1,5 %;

b) maximum crack length ratio (CLR) = 15 %;

c) maximum crack thickness ratio (CTR) = 5 %;

d) maximum crack length in any one section = 5 mm.

8 Welding

8.1 Qualifications

Welding, including weld overlays and 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.

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

The results of all qualification tests shall be documented in a PQR.

PWHT shall be performed in accordance with the relevant material specification and/or design standard.

NOTE Some pipeline welding standards, such as ISO 13847, 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 form part of the welding procedure qualification for valves having a minimum design temperature below 0 °C (32 °F).

NOTE Design code and/or local regulations may specify impact testing at minimum design temperatures above 0 °C (32 °F).

A set of three weld metal impact specimens shall be taken from the WM at the location shown in Figure 10. 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 HAZ at the location shown in Figure 11. The notch shall be placed perpendicular 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.

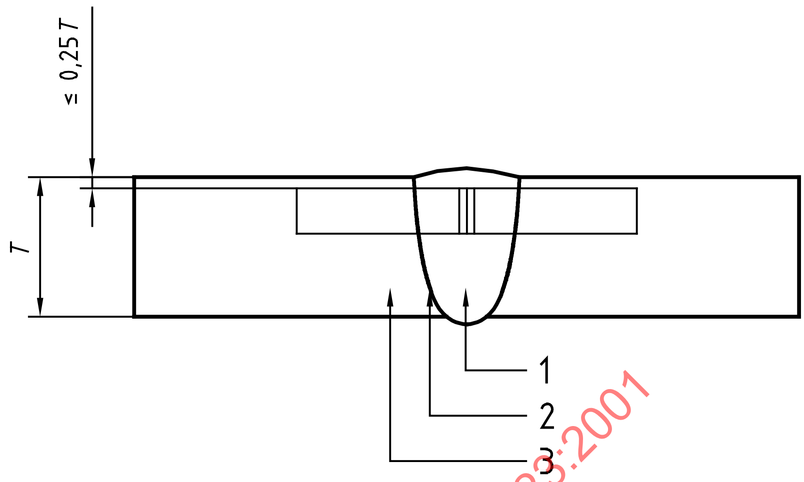
The impact test temperature for welds and heat-affected zones shall be at or below the minimum design temperature specified for the valve.

Impact test results for full-size specimens shall meet the requirements of Table 7.

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.

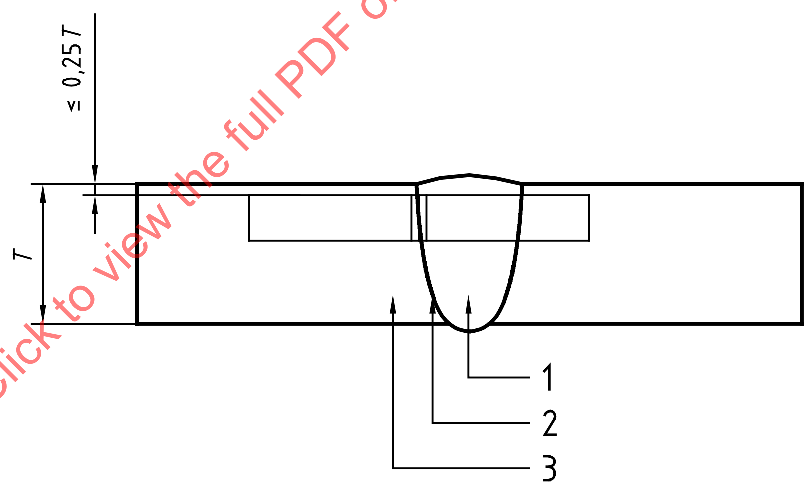
Hardness surveys shall be performed on BM, WM and HAZ as indicated in Figure 12 using the HRC or HV_{10} method.



Key

1 Weld metal
2 Heat-affected zone
3 Base metal

Figure 10 — Charpy V-notch weld metal (WM) specimen location

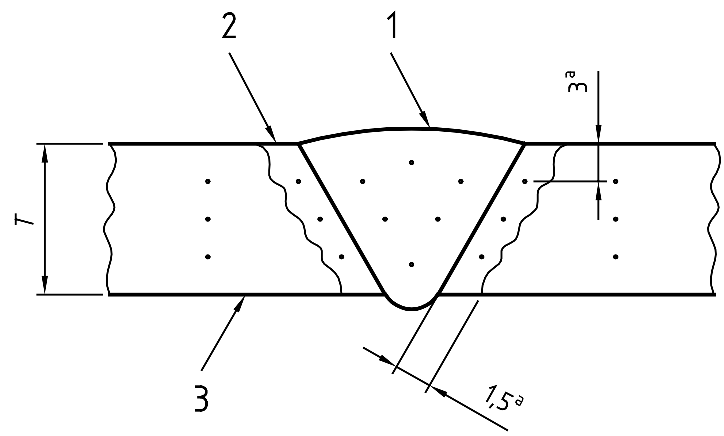


Key

1 Weld metal
2 Heat-affected zone
3 Base metal

Figure 11 — Charpy V-notch heat-affected zone (HAZ) specimen location

Dimensions in millimetres



Key

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

Figure 12 — Hardness survey specimen location

9 Quality control

9.1 General

The purchaser shall specify which NDE requirement QL1 or QL2 (see annex E) 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 written specification.

9.2.2 Pressure-measuring devices

9.2.2.1 Type and accuracy

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

9.2.2.2 Gauge range

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

9.2.2.3 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.

9.2.3 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 ISO 9712.

Personnel performing visual examinations shall have passed an annual eye examination in accordance with ISO 9712.

9.3.2 Welding inspectors

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

9.4 NDE

The extent, method and acceptance criteria for NDE shall be in accordance with annex E, which specifies two levels of NDE requirements (QL1 and QL2) to assist the purchaser with the selection of a set of requirements appropriate for the intended valve duty. The extent of NDE for QL2 is more stringent than for QL1. The purchaser shall specify the NDE level considering the following risk-of-failure factors:

- service fluid;
- size/pressure/temperature;
- location;
- material of construction;
- criticality and function.

All NDE of weldments shall be carried out in the final heat-treated condition and shall be performed in accordance with written procedures.

9.5 NDE of repair welding

After defect removal, the excavated area shall be examined by MT or 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 NDE requirements in annex E, if specified by the purchaser, shall also apply to repair welding.

10 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.

Tests shall be performed in the sequence used in this clause for specifying the test requirements. Shell pressure tests 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 for gas service shall also be subjected to a gas test in accordance with C.4.

Valves shall be tested with the obturator or seat faces free from sealant and lubricant. A light lubricant, of maximum viscosity SAE 10W, may be used to aid assembly of other components.

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 provided when valve body connections are not available for direct monitoring.

An adequate stabilization period shall be allowed for all pressure tests. After stabilization, the pressure source shall be isolated from the valve.

A chart recorder shall be used for all pressure tests above 1 MPa (10 bar).

Pressure tests shall be performed in accordance with documented procedures.

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

10.2 Hydrostatic shell test

Perform hydrostatic shell testing on the fully assembled valve, including pipe pups if applicable, prior to painting.

Close off valve ends and place the obturator in the partially opened position during the test. The method of closing the ends shall permit the transmission of the full-pressure force acting on the end blanks to the valve body, unless otherwise agreed. If present, remove external relief valves and plug their connections.

The test pressure shall be 1,5 or more times the pressure rating determined in accordance with 6.2 for materials at 38 °C (100 °F). The duration shall not be less than that specified in Table 8.

Table 8 — Minimum duration of hydrostatic shell tests

Valve size		Test duration
DN	**(NPS)**	h
50 to 100	2 to 4	2
150 to 250	6 to 10	4
⩾ 300	⩾ 12	6

No visible leakage is permitted during the hydrostatic shell test. There shall be no variation in pressure that cannot be accounted for by temperature fluctuations.

If the pressure rating of the pipe pups is insufficient for the hydrostatic shell test pressure, then the pups shall be welded to the valve following the valve shell test and the valve and pup(s) tested at a pressure to be specified by the purchaser.

Pressure protectors or caps shall be tested at a pressure no less than the hydrostatic shell test pressure. The test duration shall be a minimum of 2 h.

10.3 Operational/functional test

10.3.1 Manual valves

Operate each manual or ROV-operated valve, excluding check valves, two times while subjecting to the differential pressure specified in 6.8. Operate the valve for each appropriate condition defined in 10.4. Valves requiring input forces exceeding that specified in 6.12 or that fail to seal after operation shall be rejected.

10.3.2 Power-operated/actuated valves

Operate power-operated/actuated valves, excluding check valves, two times while subjecting to the differential pressure specified in 6.8. Operate the valve for each appropriate condition defined in 10.4 and measure the thrust or torque. Values for thrust or torque shall not exceed the predicted manual or power values specified in 6.19.1.

10.3.3 Check valves

Operate each check valve fitted with an operating mechanism close-open-close five times while the entire body cavity is subjected to the rated pressure listed in 6.2. Valves that fail to operate or fail to seal after cycling shall be rejected.

10.3.4 Sequence of testing

Operational/functional tests may be performed in conjunction with hydrostatic seat testing specified in 10.4. Seat sealing integrity shall be verified after all operational/functional testing.

10.4 Hydrostatic seat test

10.4.1 Preparation

Remove lubricants from seats and obturator sealing surfaces, unless otherwise agreed.

10.4.2 Test pressure and duration

The test pressure for all seat tests shall not be less than 1,1 times the pressure rating as determined in accordance with 6.2 for material at 38 °C (100 °F). The test duration shall be in accordance with Table 9.

Table 9 — Minimum duration of seat tests

Valve size		Test duration min
DN	**NPS**	
50 to 100	2 to 4	5
⩾ 150	⩾ 6	15

10.4.3 Acceptance criteria

Leakage for soft-seated 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 10.4.4.5.2 shall not be more than two times ISO 5208 Rate D. Other leakage rates shall be by agreement. The test procedures for various types of block valves are given in 10.4.4.

10.4.4 Test procedures for block valves

10.4.4.1 Uni-directional valve

With the valve half open, completely fill the valve and its cavity with test fluid. Then close the valve and apply test pressure to the appropriate end of the valve.

Monitor leakage from each seat via the valve body cavity vent or drain connection, where provided. For valves without body cavity or drain connection, or downstream seated valves, monitor seat leakage at the respective downstream end of the valve (the valve end downstream of the pressurized test fluid).

10.4.4.2 Bi-directional valve

With the valve half-open, completely fill the valve and its cavity with test fluid. Then close the valve and apply test pressure successively to both ends of the valve.

Monitor seat leakage from each seat via the valve body cavity vent or drain connection, where provided. For valves without body cavity vent or drain connection, monitor seat leakage from the respective downstream end of the valve.

10.4.4.3 Twin-seat valve, both seats bi-directional

Test each seat in both directions.

Remove cavity relief valves, if fitted. Fill the valve and cavity 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, close the valve. Apply the test pressure successively to each valve end to test each seat separately from the upstream side. Monitor leakage via the valve cavity pressure relief, body cavity drain or vent connection.

Thereafter, test each seat as a downstream seat. Drain both ends of the valve and fill the valve cavity with test fluid. Apply pressure while monitoring leakage through each seat at both ends of the valve.

10.4.4.4 Twin-seat valve, one seat uni-directional and one seat bi-directional

10.4.4.4.1 Uni-directional seat

With the valve half-open, fill the valve and the test cavity completely with test fluid until fluid overflows through the valve cavity vent connection. Then close the valve and open the vent valve on the test closure to allow fluid to overflow, or remove the test closure on the downstream end of the valve. Then apply the test pressure to the upstream end (uni-directional seat end) and monitor leakage from the cavity connection. If leakage is also occurring through the downstream seat, take the upstream seat leakage as the sum of the leakage measured from the cavity and the downstream connections.

10.4.4.4.2 Bi-directional seat

Repeat the test in 10.4.4.4.1 to test the bi-directional seat in its upstream-sealing direction.

To test the bi-directional seat in its downstream-sealing direction, blank off both ends of the valve. With the valve half-open, completely fill the valve with test fluid and pressurize to the test pressure. Then close the valve and allow test fluid to overflow from a connection on the test closure fitted to the end of the valve at the bidirectional seat end (i.e. downstream of the bi-directional seat). Maintain the test pressure on the cavity connection while monitoring seat leakage of the bi-directional seat at the overflow connection on the downstream test closure.

10.4.4.5 Double-block-and-bleed valves

10.4.4.5.1 Single-seat test

With the valve half-open, completely fill the valve and its cavity with test fluid. Then close the valve and open the valve body vent valve to allow excess test fluid to overflow from the valve cavity test connection. Then apply the test pressure to one end of the valve and release the pressure at the other end. Repeat this test for the other valve end.

Monitor seat tightness during each test via overflow from the valve cavity connection.

10.4.4.5.2 Double-block seat test

With the valve half open, completely fill the valve and its cavity. Then close the valve and open the valve body vent valve to allow excess test fluid to overflow from the valve cavity test connection. Apply the test pressure simultaneously from both valve ends.

Monitor seat tightness via overflow through the valve cavity connection.

The tests in 10.4.4.5 may be performed in any order by the manufacturer.

10.4.4.6 Check valves

Apply the pressure in the direction of the required flow blockage.

10.4.4.7 Installation of body connections after testing

On completion of the testing, fit pressure-containing parts, such as vent or drain plugs and cavity relief valves, in accordance with documented procedures.

10.5 Cavity relief test

10.5.1 General

If a body cavity relief test is specified by the purchaser, each valve shall be tested in the closed position. If the cavity over-pressure protection in both open and closed position is achieved by a hole in the obturator, or a hole around a seat seal, cavity testing is not required.

10.5.2 Closed position test

Fill the valve in the half-open position with water. Close the valve and allow water to overflow from the test connection at each end of the valve. Apply pressure to the valve cavity until one seat relieves the cavity pressure into the valve end, noting the pressure at which the cavity relieved. Close the test connection at this end, and continue to apply pressure to the cavity until the second seat relieves, noting the relieving pressure. Failure to relieve at a cavity pressure between 0,1 and 0,33 times the valve pressure rating as determined in accordance with 6.2 for material at 38 °C (100°F) is cause for rejection.

NOTE The second seat relief is not possible with certain valve types (e.g. gate valves and ball valves where one seat is bi-directional).

10.6 Pneumatic seat test

10.6.1 General

The seat test in 10.4 shall be repeated at a test pressure of (550 ± 50) kPa [(5,5 ± 0,5) bar]. The test medium shall be air or nitrogen. For soft-seated valves, the leakage rate shall not exceed ISO 5208 Rate A (no visible leakage). For metal-seated valves, the leakage rate shall not exceed ISO 5208 Rate D.

The valve shall be drained of test fluid prior to the start of the pneumatic seat test.

10.6.2 Test duration

The seat test duration shall be as specified in Table 9.

11 Marking

Valves shall be marked in accordance with Table 10.

All markings on body, bonnet/cover or end connections shall be low-stress steel stamped or cast.

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.

For valves with one seat uni-directional and one seat bi-directional only, the sealing directions of both seats shall be specified on a separate identification plate as illustrated in Figure 13. In Figure 13, one symbol indicates the bi-directional seat and the other symbol indicates the uni-directional seat.

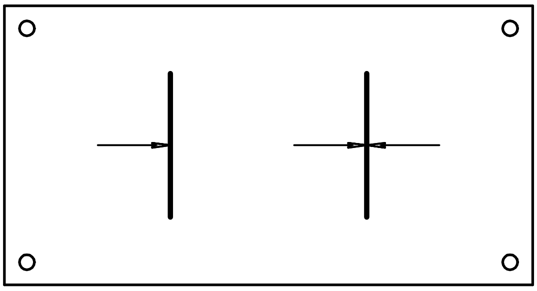


Figure 13 — Typical identification plate for valve with one seat uni-directional and one seat bi-directional

Table 10 — Valve marking

Item No.	Marking	Location
1	Manufacturer's name or trademark	On both body and nameplate
2	Pressure class	On both body and nameplate
3	Maximum water depth	On nameplate
4	Pressure/temperature rating	On nameplate
	a) Maximum operating pressure at the maximum operating temperature	
	b) Maximum operating pressure at the minimum operating temperature	
5	Face-to-face/end-to-end dimensions (6.6)...............................	On nameplate
6	Body material designation [a]:	
	Material symbol, e.g. ISO, ASME or ASTM	On both body and nameplate. Melt identification (e.g. cast or heat number) on nameplate only
7	Bonnet/cover material designation:	
	Material symbol, e.g. ISO, ASME or ASTM	On bonnet/cover [including melt identification (e.g. heat number)]
8	Trim identification [b]:	
	Symbols indicating material of stem and sealing faces of closure members, if different from that of body	On nameplate
9	Nominal valve size..	On body or nameplate or both (where practicable)
	a) Full-opening valves: nominal valve size	
	b) Reduced-opening valves: shall be marked as specified in 6.5	
10	Ring joint groove number	On valve flange edge
11	SMYS and minimum wall thickness..	On body weld bevel ends
12	Flow direction (for check valves only)......................................	On body of uni-directional valves only
13	Seat sealing direction..	Separate identification plate on valve body
14	Unique serial number	On body and nameplate
15	Date of manufacture (month and year)....................................	On nameplate
16	ISO 14723..	On nameplate

[a] When the body is fabricated of more than one type of steel, the end connection material governs marking.

[b] MSS SP-25 gives guidance for marking.

EXAMPLE To illustrate the requirements for marking in this International Standard, a 200 mm carbon steel check valve with welding ends, a 660 mm face-to-face dimension, a maximum operating pressure rating of 10 MPa (100 bar), 13 % chromium steel trim and manufactured in June 2001 shall be marked as follows:

On body	**Item from Table 10**
ABCO	(Item 1: name of manufacturer)
PN 100	(Item 2: pressure class)
LCC	(Item 6: body material)
DN 200	(Item 9: nominal valve size [a]).
275 MPa/22,2 mm	(Item 11: SMYS and wall thickness on an end bevel)
→	(Item 12: Flow direction for check valve only)
12345	(Item 14: serial number)
On bonnet/cover	
LF2 / 6789	(Item 7: bonnet/cover material grade and melt identification)
On nameplate	
ABCO	(Item1: manufacturer)
PN 100	(Item 2: pressure class)
150 m	(Item 3: water depth)
10 MPa (100 bar) at −29 °C	(Item 4: maximum operating pressure at minimum operating temperature
9 MPa (90 bar) at 121 °C	maximum operating pressure at maximum operating temperature)
660 mm	(Item 5: face-to-face dimension)
LCC	(Item 6: body material)
Stem CR13	(Item 8: trim identification)
Disc CR13	
Seat CR13	
or	
CR13 CR13 CR13	
or	
CR13	
CR13	
CR13	
DN 200	(Item 9: nominal valve size for full-opening valve)
or	
DN 200 × 150	(Item 9: nominal valve size for reduced-bore valve)
or	
DN 200R	(Item 9: nominal valve size for reduced-bore valve)
12345	(Item 14: serial number)
6-2001 or 6/2001	(Item 15: date of manufacture)
ISO 14723	(Item 16: number of this International Standard)

[a] May also be marked on nameplate or on both body and nameplate.

12 Storing and shipping

12.1 Painting

Painting requirements shall be by agreement. Non-corrosion-resistant valves shall be blast-cleaned, primed and/or painted externally in accordance with a procedure approved by the purchaser prior to shipment.

Stainless steel valves shall be blast-cleaned with sand or other non-ferrous medium prior to shipment.

Flange faces, weld bevel ends, exposed stems, shafts and sealant injection fittings shall be protected during blast cleaning and shall not be painted.

12.2 Corrosion prevention

Prior to shipment, parts and equipment which have bare metallic surfaces, shall be protected with a rust preventive which will provide protection at temperatures up to 50 °C (122 °F).

12.3 Protection

Valve flanged ends and welding ends shall be blanked off to protect the gasket surfaces, welding ends and valve internals during shipment and storage. Protective covers shall be made of wood, wood fibre, plastic or metal and shall be securely attached to the valve ends by bolting, steel straps, steel clips or suitable friction-locking devices. The design of the covers shall prevent the valves from being installed unless the covers have been removed.

Ball and gate valves shall be shipped in the fully open position, unless fitted with a fail-to-close actuator.

Check valves shall be shipped with the disc supported or secured during transit.

13 Documentation

The documentation for valves shall include

— design documentation,

— WPS,

— PQR,

— WQR,

— qualification records of NDE personnel,

— records of test equipment calibration,

— melt identification certificates for body, bonnet, covers and end connectors traceable to the unique valve serial number,

— serial number for tracing the valve bill of materials,

— test results (pressure, torque, thrust, etc.).

Documentation to be supplied with each valve shall include

- certification of conformance to this International Standard,
- test report (including pressure, test duration, leakage rate, ROV input torque/thrust and test medium) including test charts,
- painting and/or plating certification,
- material certification for pressure-containing and pressure-controlling parts,
- statement of Quality Level applied to NDE records,
- certificate stating the maximum allowable torque/thrust value for the drive train (ball and gate valves only).

Documentation shall be provided by the manufacturer in legible, retrievable and reproducible form, and free of damage.

Documentation required by this International Standard shall be retained by the manufacturer for a minimum of five years following the date of manufacture.

The purchaser shall specify which, if any, particular supplementary documentation requirements in annex D shall be provided.