Butterfly Valves: Double-flanged, Lug- and Wafer-type, and Butt-welding Ends

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1 Scope

1.1 This standard covers design, materials, face-to-face dimensions, pressure-temperature ratings, and examination, inspection, and test requirements for gray iron, ductile iron, bronze, steel, nickel-based alloy, or special alloy butterfly valves.

1.2 The following two categories of butterfly valves are included:

a) Category A—Manufacturer’s rated cold working pressure (CWP) butterfly valves, usually with a concentric disc and seat construction. Sizes covered are DN 50 to DN 1500 (NPS 2 to NPS 60) for valves having ASME Class 125 or Class 150 flange bolting patterns.

b) Category B—ASME class and pressure-temperature-rated butterfly valves that have an offset seat and either an eccentric or a concentric disc construction. Sizes covered are listed below:

— for lug and wafer, Classes 150, 300, and 600: DN 50 to DN 1500 (NPS 2 to NPS 60);

— for lug and wafer, Class 900: DN 50 to DN 1200 (NPS 2 to NPS 48);

— for double-flanged short and long pattern, Classes 150, 300, and 600: DN 80 to DN 1500 (NPS 3 to NPS 60);

— for double-flanged short and long pattern, Class 900: DN 80 to DN 1200 (NPS 3 to NPS 48);

— for butt-welding ends, Classes 150, 300 and 600: DN 80 to DN 1500 (NPS 3 to NPS 60);

— for butt-welding ends, Class 900: DN 150 to DN 1200 (NPS 6 to NPS 48)

Information to be specified by the purchaser is shown in Annex B.

1.3 Valve configurations include double-flanged, lug- and wafer-type with facings that permit installation between ASME and MSS flanges and butt-welding ends. Typical valve construction and nomenclature for valve parts are shown in Annex C.

1.4 Users of this standard should refer to API RP 615 for background, guidance and definitions related to butterfly valves."

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Standard 598, *Valve Inspection and Testing*

API Standard 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*

API Recommended Practice 615, *Valve Selection Guide*

API Standard 641, *Type Testing of Quarter-turn Valves for Fugitive Emissions*

ASME B1.1 [1], *Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms)*

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings; Classes 25, 125, and 250*

ASME B16.5, Pipe Flanges and Flanged Fittings: NPS *1/2* through NPS 24, Metric/Inch Standard

ASME B16.10, *Face-to-Face and End-to-End Dimensions of Valves*

ASME B16.20, *Metallic Gaskets for Pipe Flanges*

ASME B16.24, *Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500*

ASME B16.25, *Buttwelding Ends*

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

[1] The American Society of Mechanical Engineers, Two Park Avenue, New York, New York 10016-5990, www.asme.org.

ASME B16.42, *Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300*

ASME B16.47, *Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard*

ASME B31.3, *Process Piping*

ASME B36.10, *Welded and Seamless Wrought Steel Pipe*

ISO 15848-1 [2], Industrial valves – Measurement, test and qualification procedures for fugitive emissions – Part 1: Classification system and qualification procedures for type testing of valves

ISO 28921-1, *Industrial valves — Isolating valves for low-temperature applications — Part 1: Design manufacturing and production testing*

MSS SP-6 [3], *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings*

ANSI/MSS SP-25 [4], *Standard Marking System for Valves, Fittings, Flanges, and Unions*

MSS SP-45, *Drain and Bypass Connections*

MSS SP-67, *Butterfly Valves*

MSS SP-91, *Guidelines for Manual Operation of Valves*

ANSI/MSS SP-134, *Valves for Cryogenic Service, Including Requirements for Body/Bonnet Extensions*

MSS SP-160, *Valves for Hydrogen Fluoride Alkylation Service*

ANSI/NACE MR0103 [5]/*ISO 17945*, Petroleum, petrochemical and natural gas industries—Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments

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

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[2]International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8, CP 401 – 1214 Vernier, Geneva, Switzerland, www.iso.org.

[3]Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park Street, NE, Vienna, Virginia 22180-4602, msshq.org.

[4]American National Standard Institute, Inc. 25 West 43rd Street, Fourth floor, New York, NY 10036-7406, www.ansi.org

[5] Association for Materials Protection and Performance (AMPP), 15835 Park Ten Place, Houston, Texas 77084, www.ampp.org.

3 Terms and Definitions

For the purpose of this document, the following terms and definitions apply.

3.1
Class
An alphanumeric designation that is used for reference purposes relating to valve pressure-temperature capability, taking into account valve material mechanical properties and valve dimensional characteristics. It comprises the letters “Class” followed by a dimensionless whole number. The number following the letters “Class” does not represent a measurable value and is not used for calculation purposes except where specified in this standard. The allowable pressure for a valve having a class number depends on the valve material and its application temperature and is found in tables of pressure-temperature ratings.

3.2
cryogenic service
Unless a different temperature is specified by the purchaser, valves required to operate at or below −73 °C (−100 °F) are in cryogenic service.

3.3
CWP (Cold Working Pressure)
The maximum pressure rating allowed under normal "ambient" temperature conditions, which is usually understood to be up to 38 °C (100 °F).

3.4
dead-end service
A condition that occurs after the companion flange and/or piping are removed from the unpressurized side of a valve.

3.5
DN (Diameter Nominal)
An alphanumeric designation of size that is common for components used in a piping system, used for reference purposes, comprising the letters “DN” followed by a dimensionless number indirectly related to the physical size of the bore or outside diameter of the end connection as appropriate. The dimensionless number following “DN” does not represent a measurable value and is not used for calculation purposes except where specified in this standard.

3.6
NPS (Nominal Pipe Size)
An alphanumeric designation of size that is common for components used in a piping system, used for reference purposes, comprising the letters “NPS” followed by a dimensionless number indirectly related to the physical size of the bore or outside diameter of the end connection as appropriate. The dimensionless number may be used as a valve size identifier without the prefix “NPS”. The dimensionless size identification number does not represent a measurable value and is not used for calculation purposes.

3.7
pressure boundary element
Comprises the shell and related bolting that forms a part of the pressure boundary (see Annex C).

3.8
Shell

Comprises the body, cover, bonnet, bonnet extension, and seat retainer that constitutes the pressure boundary of an API 609 valve.

3.9
Differential Pressure rating
The differential pressure rating is the maximum differential pressure applied across the disc in closed position. “As per API598 design differential pressure”.

4 Pressure-temperature Ratings

4.1 Valve Rating

Category A valves shall have a CWP rating that is the lesser of its shell rating and ~~seat~~ differential pressure rating.

4.2 Shell Rating

4.2.1 Category A valve bodies and related pressure boundary elements shall have the CWP rating assigned by the manufacturer.

4.2.2 Category B valve bodies and related pressure boundary elements shall have the pressure-temperature rating as listed in one of the following standards according to the valve’s body material:

- for gray iron ASME B16.1
- for ductile iron, ASME B16.42;
- for cast copper alloys, ASME B16.24;
- for steel, nickel alloy, or special alloy material, ASME B16.34.

4.3 Differential Pressure Rating

4.3.1 For Category B valves, the valve ~~seat~~ differential pressure ratings for polytetrafluoroethylene (PTFE) or modified PTFE and reinforced polytetrafluoroethylene (RPTFE) or modified RPTFE shall be at least equal to those listed in Table 1. For non-metallic seating materials not listed in Table 1, the ~~seat~~ differential pressure ratings shall be established by the manufacturer.

Table 1—Minimum Differential Pressure Rating Versus Temperature for Category B Valves (Soft seated)

Temperature °C (°F)	Class 150				Class 300				Class 600	
	PTFE or modified PTFE		RPTFE or modified RPTFE		PTFE or modified PTFE		RPTFE or modified RPTFE		RPTFE or modified RPTFE	
	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig
–29 to 38 (–20 to 100)	19.7	285	19.7	285	51.0	740	51.0	740	102.0	1480
66 (150)	18.8	273	18.8	273	48.8	708	48.8	708	89.6	1300
93 (200)	17.9	260	17.9	260	37.9	550	46.5	675	62.1	900
121 (250)	16.9	245	16.9	245	29.3	425	36.5	530	48.3	700
149 (300)	15.9	230	15.9	230	20.7	300	26.9	390	37.9	550
177 (350)	9.7	140	14.8	215	12.1	175	17.2	250	27.6	400
204 (400)	3.4	50	6.9	100	3.4	50	6.9	100	17.2	250

4.3.2 Valves furnished with internal liners, encapsulation, non-PTFE resilient seating materials, or a combination of these features shall have pressure-temperature limits conforming to the valve manufacturer's published specifications. Temperature limits shall be marked on the nameplate as required in 8.3 d).

4.3.3 Unless otherwise agreed, the differential pressure ratings for metal seated, including combination soft and metal seated (e.g., laminated) valves shall be fully rated to the shell ratings.

5 Design

5.1 General

5.1.1 Valve Categories

a) Category A Valves:

Valves manufactured in accordance with this standard shall meet the requirements of MSS SP-67 or the manufacturer's design and any additional requirements as specified in this standard. In the event of a conflict of requirements between the standards, this standard shall prevail.

b) Category B Valves:

Valves manufactured in accordance with this standard shall meet the requirements of ASME B16.34 and any additional requirements as specified in this standard. For materials not listed in ASME B16.34, the

applicable requirements and design rules of ASME B16.34 shall be used. In the event of a conflict between ASME B16.34 and this standard, this standard shall prevail.

5.1.2 Fire-tested Valves

When a fire-tested butterfly valve is specified in the purchase order, the valve design supplied shall have successfully passed API 607.The test report shall be made available to purchaser upon request

5.1.3 Fugitive Emissions Tested Valves

a) Category A: If the purchaser specifies low fugitive emission valves, the valve's design shall be qualified by type testing to meet the low fugitive emission requirements of API 641

b) Category B: Valves within the scope of API 641 shall be qualified by type testing to meet the low fugitive emission requirements of API 641.

c) Category A and Category B: For valves outside the scope of API 641, other low fugitive emissions type testing such as ISO15848-1 may be specified by the purchaser.

The test report shall be made available to purchaser upon request.

5.1.4 Cryogenic Service

When valves are specified for cryogenic service, the design shall additionally meet the requirements of ANSI/MSS SP-134 unless otherwise specified by purchaser (e.g. ISO 28921-1).

5.1.5 Lockable Device

When specified in the purchase order, valves shall be furnished with a lockable device that accepts a purchaser-supplied lock that enables the valve to be locked in both the open and closed positions. The lockable device shall be designed such that a lock with an 8 mm ($^{5}/_{16}$ in.) diameter shank, not more than 100 mm (4 in.) long, can be inserted directly through appropriate holes and locked. Provisions for a lockable device are permitted even when it is not specified in the purchase order.

5.1.6 Disc Position Indication

The indication of the position of the disc shall be integral with the valve shaft and shall be aligned with the valve disc. The indication may be accomplished by a permanent marking on the shaft or by a shaft shape.

The gearbox and actuator (if installed) shall be provided with a position indicator to indicate the disc position

The design shall ensure that the valve and operator cannot be assembled to falsely indicate the valve's open and closed positions.

5.1.7 Shaft-to-lever Connections

Shaft-to-lever connections shall be designed so that the lever always correctly indicates the disc position. The lever-type handle shall be mounted so that the handle is in parallel with the valve disc.

5.1.8 Category B Valves - Differential Pressure Rating by Direction

Unless otherwise agreed, valve shall be bidirectional, having the same differential pressure rating in both directions. The differential pressure rating shall be marked on the name plate in accordance with 8.3 d).

5.1.9 Dead-end Service

When specified by the purchaser, all components of lug-type and double -flanged valves shall pass the API 598 high-pressure closure test at 110% of the valve's differential pressure rating in each direction.

Valves designed for uni-directional dead-end service shall pass the API 598 high-pressure closure test at 110% of the valve's differential pressure rating in one direction and require additional marking per 8.5.

When the seat retainer is on the downstream side, the high-pressure closure test shall be performed with the seat retainer fully unrestrained (i.e. no downstream flange or clamping of the retainer).

5.1.10 Disc Seal Retention

Removable valve parts and seat rings shall be positively secured against loosening. The application of spring tension pins is not allowed.

5.1.11 Lifting

The manufacturer shall determine the need of lifting points of the valve and provide lifting and handling recommendation for safe lifting operations for valves weighing more than 23 kg (50 lb).

5.2 Body

5.2.1 The minimum body-wall thickness shall comply with the applicable ASME B16 standards listed in Section 2 based on the body material. If the applicable standard covers fittings (i.e., ASME B16.1, ASME B16.24, ASME B16.42) for a particular material, the valve minimum wall thickness shall be as specified for fittings. The valve design shall be structurally suitable for its stated pressure and temperature limits, taking

into account that localized thinning may be necessary between the shaft bore in the body and the adjacent bolt holes. Such sections shall be designed in accordance with the requirements of ASME B16.34.

5.2.2 When a wafer-type valve is installed between piping flanges and the disc is in the closed position, the valve shall be self-centering to the flange bolting pattern, that is, designed to center itself within the bolt circle. Self-centering may be achieved by using the valve's outside diameter or by means of integral or attached alignment devices.

5.2.3

a) End flanges for double-flanged valves shall be integrally cast or forged with the body; however, flanges may be attached by full-penetration butt-welding if agreed to by the purchaser. End flanges attached by welding shall conform to ASME B16.5 or ASME B16.47 as applicable and have butt-welding ends for use without backing rings. Unless otherwise specified by the purchaser specification, welds, welding procedure, and welder or welding operator qualification shall conform to ASME B31.3. The finished weld thickness shall not be less than the minimum body-wall thickness.

b) End flanges for double-flanged valves and bolt hole drilling templates of lugs of lug-type valves shall comply with the dimensional requirements of the applicable ASME B16 standards to the shell rating as per 4.2.

5.2.4 Butt-welding ends shall conform to the requirements of ASME B16.25 with an inside diameter (denoted as "B" in ASME B16.25) tolerance per ASME B16.34.

5.2.5 If drain or bypass connections are specified by the purchaser, they shall conform to ASME B16.34 or MSS SP-45, as applicable.

5.3 Face-to-face Dimensions

5.3.1 Face-to-face dimensions for lug- and wafer-type valves shall be as listed in Table 2 and Table 3a. The as-installed and compressed dimension shall be used for valves that use nonmetallic liners, sleeves, or auxiliary seals extending from or over the body contact faces.

NOTE: When valve body liners, sleeves, or O-ring seals act as flange-sealing surfaces, separate gaskets are typically not required unless specifically recommended by the manufacturer.

5.3.2 Face-to-face dimensions for double-flanged valves shall be as listed in Table 3b for long pattern valves or Table 3c for short pattern valves.

NOTE Table 3c includes two acceptable variations of face-to-face dimensions for Class 300 category B valves.

5.3.3 Face-to-face dimensions in Table 3a and Table 3c apply to flanged valves with raised face and ring joint facings. Special lengths may be provided for valves with ring joint facings when agreed between the manufacturer and purchaser.

5.3.4 Face-to-face dimensions in Table 3b apply to flanged valves with raised face facings. For valves with ring joint facings, ASME B16.10-2022, Table 3.3-1, X dimension shall be added to the face-to-face dimension in Table 3b.

5.3.5 Face-to-face dimensions for butt-welding end valves shall be the manufacturer's standard.

Table 2—Face-to-face Dimensions for Category A Valves (Lug- and Wafer-type)

Valve Size		Face-to-face Dimensions		Maximum Variance ±	
DN	NPS	mm	in.	mm	in.
50	2	43	1.69	1.5	0.06
65	2 1/2	46	1.81	1.5	0.06
80	3	46	1.81	1.5	0.06
100	4	52	2.06	1.5	0.06
125	5	56	2.19	1.5	0.06
150	6	56	2.19	1.5	0.06
200	8	60	2.38	3.3	0.13
250	10	68	2.69	3.3	0.13
300	12	78	3.06	3.3	0.13
350	14	78	3.06	3.3	0.13
400	16	102	4.00	3.3	0.13
450	18	114	4.50	3.3	0.13
500	20	127	5.00	3.3	0.13
600	24	154	6.06	3.3	0.13
750	30	165	6.50	6.4	0.25
900	36	200	7.88	6.4	0.25
1050	42	251	9.88	6.4	0.25
1200	48	276	10.88	6.4	0.25
1250 to 1500	50 to 60	— [a]		6.4	0.25

[a] Dimensions shall be manufacturer's standard or as agreed between purchaser and manufacturer.

Table 3a—Face-to-face Dimensions for Category B Valves (Lug- and Wafer-type)

Valve Size		Class 150		Class 300		Class 600		Class 900		Maximum Variance ±	
DN	NPS	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
50	2	— [a]								3.3	0.13
65	2 1/2	48	1.88	48	1.88	— [a]				3.3	0.13
80	3	48	1.88	48	1.88	54	2.12	— [a]		3.3	0.13
100	4	54	2.12	54	2.12	64	2.50	— [a]		3.3	0.13
150	6	57	2.25	59	2.31	78	3.06	— [a]		3.3	0.13
200	8	64	2.50	73	2.88	102	4.00	— [a]		3.3	0.13
250	10	71	2.81	83	3.25	117	4.62	— [a]		3.3	0.13
300	12	81	3.19	92	3.62	140	5.50	— [a]		3.3	0.13
350	14	92	3.62	117	4.62	155	6.12	— [a]		3.3	0.13
400	16	102	4.00	133	5.25	178	7.00	— [a]		3.3	0.13
450	18	114	4.50	149	5.88	200	7.88	— [a]		3.3	0.13
500	20	127	5.00	159	6.25	216	8.50	— [a]		3.3	0.13
600	24	154	6.06	181	7.12	232	9.13	— [a]		3.3	0.13
650 to 1200	26 to 48	— [a]								6.4	0.25
1250 to 1500	50 to 60	— [a]						—		6.4	0.25

[a] Dimensions shall be manufacturer's standard or as agreed between purchaser and manufacturer.

Table 3b—Face-to-face Dimensions for Category B Valves (Double-flanged Long Pattern)

Valve Size		Class 150 [a]		Class 300 [a]		Class 600 [a]		Class 900 [a]		Maximum Variance ±	
DN	NPS	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
80	3	203	8.00	282	11.12	356	14.00	— [b]		3.3	0.13

100	4	229	9.00	305	12.00	432	17.00	— [b]		3.3	0.13
150	6	267	10.50	403	15.88	559	22.00	610	24.00	3.3	0.13
200	8	292	11.50	419	16.50	660	26.00	737	29.00	3.3	0.13
250	10	330	13.00	457	18.00	787	31.00	838	33.00	3.3	0.13
300	12	356	14.00	502	19.75	838	33.00	965	38.00	3.3	0.13
350	14	381	15.00	762	30.00	889	35.00	1029	40.50	3.3	0.13
400	16	406	16.00	838	33.00	991	39.00	1130	44.50	3.3	0.13
450	18	432	17.00	914	36.00	1092	43.00	1219	48.00	3.3	0.13
500	20	457	18.00	991	39.00	1194	47.00	1321	52.00	3.3	0.13
600	24	508	20.00	1143	45.00	1397	55.00	1549	61.00	4.0	0.16
650	26	559	22.00	1245	49.00	1448	57.00	— [b]		4.0	0.16
700	28	610	24.00	1346	53.00	1549	61.00	— [b]		4.0	0.16
750	30	610	24.00	1397	55.00	1651	65.00	— [b]		4.0	0.16
800	32	711	28.00	1524	60.00	1778	70.00	— [b]		4.0	0.16
850	34	— [b]								4.0	0.16
900	36	711	28.00	1727	68.00	2083	82.00	— [b]		5.0	0.19
950 to 1200	38 to 48	— [b]								5.0	0.19
1250 to 1500	50 to 60	— [b]						—		5.0	0.19

[a] Dimensions listed agree with ASME B16.10 for flanged gate valves.

[b] Dimensions shall be manufacturer's standard or as agreed between purchaser and manufacturer.

Table 3c—Face-to-face Dimensions for Category B Valves (Double-flanged Short Pattern)

Valve Size		Class 150 [a] or Class 300 [a]		Class 300 [b]		Class 600 [b]		Class 900 [c]		Maximum Variance ±	
DN	NPS	mm	in.	mm	in.	mm	in.	mm	in.	Mm	in.
80	3	114	4.50	180	7.09	180	7.09	— [d]		3.3	0.13
100	4	127	5.00	190	7.48	190	7.48	— [d]		3.3	0.13
150	6	140	5.50	210	8.27	210	8.27	225	8.86	3.3	0.13
200	8	152	6.00	230	9.06	230	9.06	275	10.83	3.3	0.13
250	10	165	6.50	250	9.84	250	9.84	325	12.80	3.3	0.13
300	12	178	7.00	270	10.63	270	10.63	375	14.76	3.3	0.13

350	14	190	7.50	290	11.42	290	11.42	425	16.73	3.3	0.13
400	16	216	8.50	310	12.20	310	12.20	475	18.70	3.3	0.13
450	18	222	8.75	330	12.99	330	12.99	500	19.69	3.3	0.13
500	20	229	9.00	350	13.78	350	13.78	575 [e]	22.64 [e]	3.3	0.13
600	24	267	10.50	390	15.35	390	15.35	675 [e]	26.58 [e]	4.0	0.16
650	26	292	11.50	410	16.14	410 [e]	16.14 [e]	— [d]		4.0	0.16
700	28	292	11.50	430	16.93	430	16.93	— [d]		4.0	0.16
750	30	318	12.52	450	17.72	450 [e]	17.72 [e]	— [d]		4.0	0.16
800	32	318	12.52	470	18.50	470	18.50	— [d]		4.0	0.16
850	34	— [d]								4.0	0.16
900	36	330	12.99	510	20.08	510	20.08	— [d]		5.0	0.19
950	38	410	16.14	530	20.87	530 [e]	20.87 [e]	— [d]		5.0	0.19
1000	40	410	16.14	550	21.65	550	21.65	— [d]		5.0	0.19
1050	42	410	16.14	570	22.44	570 [e]	22.44 [e]	— [d]		6.0	0.24
1100 to 1150	44 to 46	— [d]								6.0	0.24
1200	48	470	18.50	630	24.80	630	24.80	— [d]		6.0	0.24
1250 to 1500	50 to 60	— [d]						—		6.0	0.24

NOTE: See NOTES TO PURCHASER, B.1.3.e).

[a] The dimensions listed agree with ISO 5752 Basic Series 13, EN 558 and EN 593, where applicable.

[b] The dimensions listed agree with ISO 5752 Basic Series 14, EN 558 and EN 593, where applicable.

[c] The dimensions listed agree with ISO 5752 Basic Series 8a up to DN 450 (NPS 18).

[d] Dimensions shall be manufacturer's standard or as agreed between purchaser and manufacturer.

[e] Special lengths may be provided by agreement between the purchaser and manufacturer.

5.4 Valve Body Flange Facings

5.4.1 Body contact faces of gray iron, ductile iron, and cast copper alloy valves that require separate gaskets shall be finished as specified in MSS SP-6

5.4.2 Body contact faces of steel or alloy valves that require separate gaskets shall be finished as specified in ASME B16.5 or ASME B16.47 as applicable.

5.5 Disc Clearance

The manufacturer shall design the valve to provide clearance between the disc and the inside diameter of the connecting pipe or flange as specified in Annex D, in accordance with the ASME class rating for the valve.

NOTE For lug- and wafer-type valves and some double-flanged designs, the disc will protrude beyond the body faces when the valve is open.

5.6 Shaft and Shaft Seals

5.6.1 The shaft-to-disc connection and all parts of the shaft within the pressure boundary shall, under torsional load, exceed the strength of the shaft that lies outside the pressure boundary by more than 10 %. Determination of the shaft strength and the shaft-to-disc connection strength shall be by calculation or testing.

5.6.2 The design shall ensure that with an unbroken shaft or shaft-to-disc connection, the shaft cannot be removed from the valve by disassembly or removal of the gland bolting, gearbox, actuator, or gearbox/actuator mounting hardware.

5.6.3 The shaft shall be an anti-blowout design to ensure that if failure of the shaft occurs within the pressure boundary, no portion of the shaft can be ejected from the valve by internal pressure. The design may use the gland and gland bolting to retain a broken shaft. The design shall not rely on actuation components (e.g. gear operators, actuators, levers, mounting hardware, etc.) to prevent shaft ejection.

5.6.4 Category B valves shall have adjustable shaft packing. The packing mechanism shall allow packing adjustment while the valve is pressurized with line fluid.

5.7 Piping Connection External Bolt Holes

5.7.1 Unless specified otherwise in the purchase order, lugs of lug-type valves shall be provided with threaded holes for studs or bolts. Threaded through holes may be fully or partially threaded through the lug.

5.7.2 Threaded bolt holes shall allow full thread engagement to a depth at least equal to the nominal bolt diameter; however, when the bolt hole is adjacent to the shaft, engagement to a depth of 67 % of the nominal bolt diameter is acceptable.

5.7.3 Threaded body-flange holes for bolts 1 in. or less in diameter shall be drilled and tapped in accordance with ASME B1.1, coarse-thread series, Class 2B. For bolts $1\frac{1}{8}$ in. or more in diameter, such holes shall be drilled and tapped in accordance with ASME B1.1, eight-thread series, Class 2B.

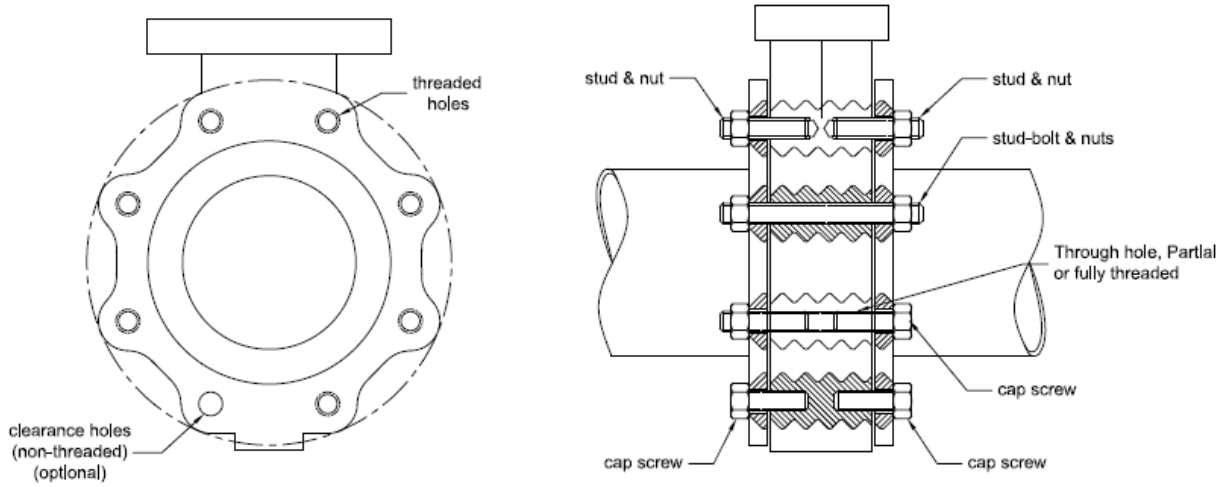
5.7.4 Typical bolting options for lug- and wafer-type valves are shown in Figure 1.

5.8 Valve Body Seat Retainer—Category B Valves Only

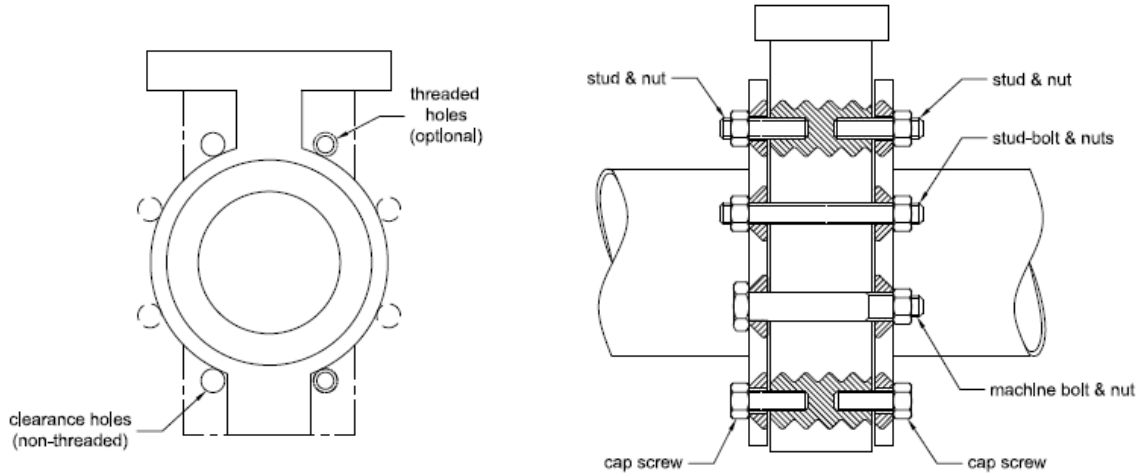
5.8.1 Seat retainer plate is a separate part intended to retain and compress the valve seat. When mechanically fastened to the valve body, retaining fasteners shall be recessed to or below the flange gasket surface (see Figure 2). Seat retainer, bolting design, and materials shall comply with ASME B16.34.

5.8.2 For gasket seating surface interruptions, interruptions in the seating area of a centered ASME B16.20 spiral-wound gasket shall not exceed the limitations given in Figure 2.

NOTE The degree of interruption may affect the sealability of a spiral-wound gasket.



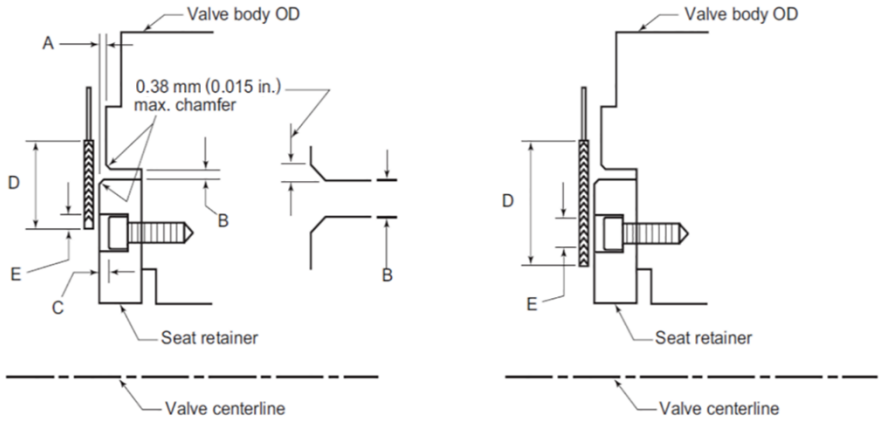
Lug-type Valve



Wafer-type Valve

Figure 1—External Bolting Options for Lug- and Wafer-type Valves

WARNING — Some lug-type valves may only be suitable for dead-end service when installed with the seat retainer plate on the pressurized side. Valves with installation limitations for dead-end service are required to be marked by the manufacturer per Section 8. Failure to follow the manufacturer's installation markings may result in downstream leakage or blow-out into the atmosphere, potentially causing property damage and bodily injury.



NOTE Seat retainer shown with socket head cap screws. Other screw types are permissible.

Dimension	Definition	Range mm	Range in.
A	Protrusion of seat retainer plate above valve body face (after being compressed by mating flange). Negative value denotes insert below valve body face.	+0.00 to –0.25	+0.000 to –0.010
B	Radial width of annular gap between valve body and seat retainer plate (exclusive of chamfer).	0.76 max.	0.030 max.
C	Distance of screw head below face of seat retainer plate.	0.00 to 1.27	0.000 to 0.050
D	Width of sealing area of spiral-wound gasket for valve's size and rating.	—	—
E	Distance gasket sealing area overlaps fastener opening in face of seat retainer plate (may occur at the ID or OD of the gasket).	<DN 150 (NPS 6): < 50 % of D	
		≥DN 150 (NPS 6): < 35 % of D	

Figure 2—Limitations for Flange Face Interruptions That Fall Within the Gasket Seating Area

5.9 Operating Mechanisms

5.9.1 Levers, gear operators, handwheel, and power actuators shall be equipped with provisions to prevent movement of the disc from the desired set position during normal operating conditions. Normal operating conditions include throttling service when specified by the purchaser.

5.9.2 Valves shall be closed by turning the shaft and attached operating device (such as a handle) in the clockwise direction.

5.9.3 The operating mechanism (lever or gear) shall be designed such that the operator input force applied to handle or handwheel required to operate the valve at the manufacturer's published torque requirement does not exceed the operator input force capability values given in MSS SP-91, using a position multiplier of 0.5. For handle lengths and handwheel diameters outside the scope of MSS SP-91, the input force shall not exceed 360 N (80 lb).

5.9.4 Lever lengths shall not exceed the following values:

Valve Size	Maximum Lever Length
Sizes less than or equal to DN 80 (NPS 3)	360 mm (14 in.)
Sizes DN 100 and 125 (NPS 4 and 5)	460 mm (18 in.)
Sizes DN 150 (NPS 6) and larger	560 mm (22 in.)

Note: The lever length is measured from the stem axis centerline to the end of the lever.

5.9.5 Handwheel diameter shall not exceed the following:

Valve Size	Maximum Handwheel diameter
Sizes less than or equal to DN 150 (NPS 6)	4 times the valve size
Sizes DN 200 and 250 (NPS 8 and 10)	3 times the valve size
Sizes DN 300 (NPS 12) and larger	900 mm (36 in.)

5.10 Antistatic Design

When Antistatic design specified in the purchase order, valves shall incorporate an antistatic feature that ensures electrical continuity between the disc, shaft and body. The antistatic feature shall have electrical continuity across the discharge path with a resistance not exceeding 10 ohms from a power source not exceeding 12-volt direct current (Vdc).

NOTE: See 7.3 for information on optional testing of electrical resistance.

5.11 Packing Gland Bolting—Category B Valves Only

5.11.1 Gland bolting shall pass through holes in the gland flange. The use of open slots is not permitted in the cover flange, cover, or gland.

5.11.2 Packing gland bolts shall be designed so that the bolt stresses shall not exceed one-third ($^1/3$) of the minimum ultimate tensile strength of the bolt with a packing stress of 38 MPa (5500 psi) and a gland bolt temperature of 38 °C (100 °F).

6 Materials

6.1 Body

Bodies of butterfly valves shall be made of a material conforming to a purchaser-selected material specification permitted in ASME B16.1, ASME B16.24, ASME B16.34, or ASME B16.42.

6.2 Pressure Boundary Elements

All materials for pressure boundary elements shall be the manufacturer’s standard and shall have equal or better corrosion resistance as the body. Purchaser may specify materials other than the manufacturer's standard. The design of pressure boundary elements and materials selected shall comply with the body pressure-temperature rating.

6.3 Process Wetted Parts

6.3.1 All process wetted parts, metallic and nonmetallic, shall be the manufacturer’s standard unless otherwise agreed upon between the manufacturer and the purchaser.

6.3.2 Seats in the body and on the disc may be either separate or integral. Facings, overlays, and hard coatings may be applied to valve bodies, discs, or both as deposited metal, integral metal, mechanically retained metal, or resilient materials.

6.3.3 Process wetted parts shall not be welded to gray iron, ductile iron or cast copper alloy.

6.3.4 When sour service is specified on the purchase order, wetted parts shall meet the requirements of ANSI/NACE MR0103/ISO 17945 or ANSI/NACE MR0175/ISO 15156, whichever is specified by the purchaser.

6.4 Packing or Shaft Seal Materials

Packing or shaft seal materials shall be suitable for the specified service at the valve’s pressure-temperature rating and shall be the manufacturer’s choice, unless otherwise specified in the purchase order.

6.5 Gland Bolting

Gland bolts shall be at least intermediate strength as defined in ASME B16.5, to allow interchangeability of packing requiring higher bolt stress.

6.6 Operating Mechanisms—Category B Valves Only

Materials for the valve handle or gear box operator shall have a melting temperature of 760 °C (1400 °F) or higher.

7 Testing, Inspection, and Examination

7.1 Inspection and Examination

7.1.1 The manufacturer shall examine each valve to assure compliance to this standard.

7.1.2 If inspection is specified in the purchase order, inspection shall be in accordance with API 598 and purchase order requirements.

7.2 Pressure Tests

7.2.1 Each valve shall be pressure tested as specified in API 598.

7.2.2 ~~In addition to pressure testing per 7.2.1,~~ When specified by the purchaser, valves for cryogenic service shall be low temperature tested per ANSI/MSS SP-134 or ISO 28921-1, as applicable. ~~unless otherwise agreed by the purchaser.~~

7.3 Antistatic Testing

7.3.1 When specified, antistatic testing shall be performed.

7.3.2 The electrical resistance shall be tested with a power source not exceeding 12 V across the discharge path listed in 5.10 to not exceed 10 ohm on a dry valve.

7.4 Repair of Defects

7.4.1 When examination, inspection, or testing reveals a defect in the body of a steel, alloy, or nonferrous valve, the defect shall be repaired as permitted by the material specification to which the valve was manufactured.

7.4.2 Welding, brazing, plugging, peening, or impregnation to repair defects in gray iron, ductile iron, or copper alloy castings is not permitted.

8 Markings

8.1 Category B valves of steel, nickel alloy, or special alloy shall be marked in accordance with the requirements of ASME B16.34. All other butterfly valves shall be marked in accordance with ANSI/MSS SP-25.

8.2 A nameplate shall be attached to a steel or alloy body by welding or with pins made of a material similar to that permitted for the nameplate. For other valve body materials, a nameplate shall be attached to the body by suitable pins. The nameplate shall be made of austenitic stainless steel or nickel alloy. ~~and~~

8.3 The nameplate shall include the following information:

a) manufacturer's name;

b) catalog reference number;

c) size (DN or NPS);

d) rating designation;

Category A:

- the lesser of the shell or differential pressure ratings that represents both directions shall be marked, for both temperature conditions listed below
  - CWP rating [i.e., pressure rating up to 38 °C (100 °F)]
  - pressure rating at maximum allowable temperature

Category B:

- ASME body (shell) pressure rating class designation
- the lesser of the shell or differential pressure ratings shall be marked for both temperature conditions listed below. If the lesser rating is not same in both directions, then the rating for each direction shall be marked.
  - pressure rating at 38 °C (100 °F)
  - pressure rating at maximum allowable temperature

e) identification of materials (ASTM, EN or UNS number) except as noted in ASME B16.34 and/or MSS SP-25, including those used in the body, shaft, disc, seat, disc seating surface, body seating surface, and any internal liner or encapsulation (see 4.3.2);

f) the marking "API 609A E10" (Category A valves) or "API 609B E10" (Category B valves) if the valve complies with this standard;

g) the marking "API 641" if the valve is qualified in accordance with API 641.

8.4 Valves having a manufacturer's preferred installation direction in the closed position and uni-directional valves shall be clearly and permanently marked "High-pressure side", "HP Side" or "HP" on the appropriate side in a location that is visible after the valve is installed. If a marking plate is used it shall conform to the requirements of 8.2.

8.5 Valves designed for dead-end service in only one direction shall be clearly and permanently marked "For Unidirectional Dead-end Service Only" and "High-pressure Side" per 8.4.

8.6 Unless otherwise specified by the purchaser an arrow mark to indicate high-pressure side or flow direction should not be used.

9 Packaging and Shipping

9.1 Coatings

9.1.1 Machined surfaces of materials that are not rust resistant shall be coated with easily removable rust preventive.

9.1.2 Unmachined exterior surfaces of a tested and inspected valve of ferrous materials shall be primed and coated in accordance with the manufacturer's standard practice unless otherwise specified.

9.1.3 Nonferrous and austenitic stainless steel valves need not be primed and coated unless otherwise specified.

9.2 Shaft Packing

Valves shall be shipped with the shaft packing installed.

NOTE Adjustment of the packing glands may be required before the valves are placed in service.

9.3 Packaging

9.3.1 Unless otherwise specified by the purchaser, valve ends shall be fully covered to protect the sealing surfaces and valve internals during shipment and storage. The protective covers shall be wood, wood fiber, plastic, or metal and shall be securely attached to the valve ends by bolting, straps, clips, or suitable friction-locking devices. Covers shall not be of pressed cardboard (hardboard). Covers shall be designed so that the valves cannot be installed without the complete removal of the covers. Valves packaged in close-fitting corrugated cartons do not require additional end protection.

9.3.2 When export packaging is not specified in the purchase order, valves may be shipped loose, palletized, or packed in a box or crate. Valves shall be packaged to prevent potential damage during shipment.

9.3.3 When export packaging is specified in the purchase order, valves shall be packed in a wooden or corrugated cardboard box or crate suitable for overseas transport by ship. Valves shall be packed individually or collectively in a manner that will prevent shifting and potential damage during shipment.

9.3.4 Valves shipped with mounted actuators shall be packaged to prevent damage during transit.

9.3.5 All valves shall be drained of any test fluids and dried in conformance with manufacturers documented procedures prior to packaging or shipping.

9.4 Spare Parts

When specified in the purchase order, the vendor shall submit a complete list of recommended spare parts. The list shall include cross-sectional or assembly-type drawings for the purpose of part number identification.

10 Special Services

When specified in the purchase order, valves in Hydrogen Fluoride (HF) Alkylation Service shall additionally meet the requirements of MSS SP-160.

Annex A

The information in this annex has been intentionally removed. See Annex A of API Specification Q1 or the API website for information pertaining to the API Monogram Program and use of the API Monogram on applicable products.

Annex B

(Normative)

Information to be Specified by Purchaser

B.1 Purchase Order

B.1.1 General

If no exceptions are to be taken to this standard, the purchase order need only refer to API 609 and specify the items listed in B.1.3 and any optional items listed in B.1.4.

B.1.2 Deviating Requirements

If the purchaser requires a butterfly valve that deviates from this standard, the deviating requirements shall be stated in the purchase order.

B.1.3 Required on the Purchase Order

The following items are required on the purchase order:

a) valve size and class (see 1.2);

b) valve category: A or B (see 1.2);

c) type of body style (double-flanged, lug- or wafer-type, or butt-welding) (see 1.2);

NOTE For double-flanged valves, specify long pattern or short pattern (see Table 3b and Table 3c);

d) facing requirements for Category B valves (raised, ring joint) (see 5.3.3 and 5.3.4);

e) Class 300 double-flanged short pattern has two sets of dimensions (purchaser shall specify which is required [see Table 3c]);

f) operator type: lever or other (see 5.9);

g) materials of construction, including those for pressure boundary elements, process wetted parts and those for packing or shaft seals (see Section 6);

h) Body end connections (see 5.2.2, 5.2.3 and 5.2.4);

- If applicable, series A or B of ASME B16.47 as required

- butt weld bevel end type and wall thickness

B.1.4 Optional Items That ~~May~~ Can Be Specified

The following items can be specified on the purchase order:

a) conformance with API 607 for applications where a fire-tested valve is required (see 5.1.2);

b) conformance with API 641 for applications where compliance with low fugitive emissions is required (see 5.1.3);

c) lockable device (see 5.1.5);

d) end flanges attached by welding (see 5.2.3 a);

e) drain or bypass connections (see 5.2.5);

f) through drilling or special tapping of lug-bolt holes (see 5.7.1);

g) antistatic feature (see 5.10);

h) antistatic testing (see 7.3);

i) on-off or throttling service (see 5.9.1);

j) operating conditions including maximum operating temperature, flow rate or line velocity, maximum pressure drop, fluid media, and specific gravity;

k) materials for wetted parts to be suitable for sour service per ANSI/NACE MR0103/ISO17945 or ANSI/NACE MR0175/ISO15156 (see 6.3.4);

l) packing or shaft seal materials (see 6.4);

m) inspection by the purchaser (see 7.1.2);

n) end protection (see 9.3.1) export packaging (see 9.3.3);

o) special external coating (see 9.1.2);

p) recommended spare parts information (see 9.4);

q) type of mating flange (slip-on, welding-neck, or other), mating flange specification, and flange bore or pipe inside diameter, as applicable;

r) special tagging/marking requirements;

s) additional documentation requirements to be shipped with order such as MTR's, certificate of conformance or other;

t) use of welded on body extensions;

u) face-to-face dimension for valve sizes indicated as manufacturer's standard or as agreed between purchaser and manufacturer in Tables 2, 3a, 3b, or 3c;

v) refer to API 598 for additional items that may need to be specified, including supplementary examination, the extent of inspection by the purchaser, the inspector's address, and optional high-pressure closure test;

w) For category B Valves the purchaser may specify type of offset - (single, double, triple, etc) refer Annex C;

x) For operation by a chainwheel the purchaser shall specify- the following, as applicable:

- the dimension from the centerline of the gearbox shaft to the bottom of the chain loop;

- spur or bevel gear and the position of gearing handwheel relative the pipe axis;

NOTE Chainwheels may present a risk of injury or damage if not properly designed, installed, secured, operated, and maintained.

y) For operation by electric, hydraulic, pneumatic, or other actuator type;

— maximum operating temperature and pressure differential across the valve disc in each direction;

z) dead end service (see 5.1.9);

aa) cryogenic service (see 3.2, 5.1.4, and 7.2.2);

Annex C

(informative)

Typical Butterfly Valve Construction and Nomenclature

Figure C.1 shows the typical construction and part nomenclature for a Category A concentric disc-type butterfly valve. Figure C.2 shows the typical construction and part nomenclature for a Category B offset disc-type butterfly valve. Figure C.3 depicts variations in disc offset constructions from concentric disc with no offset to triple offset.

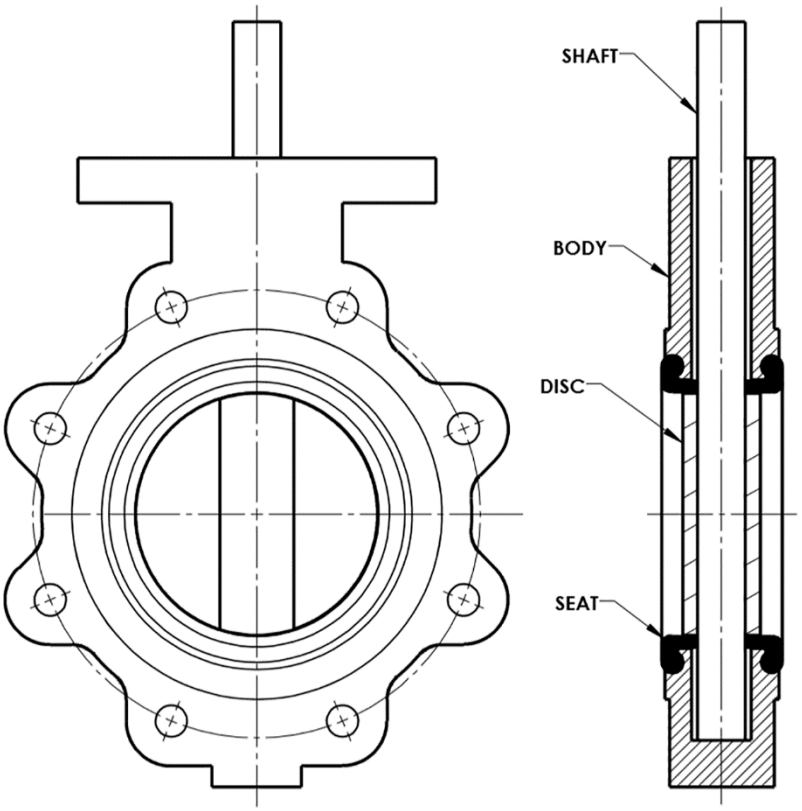
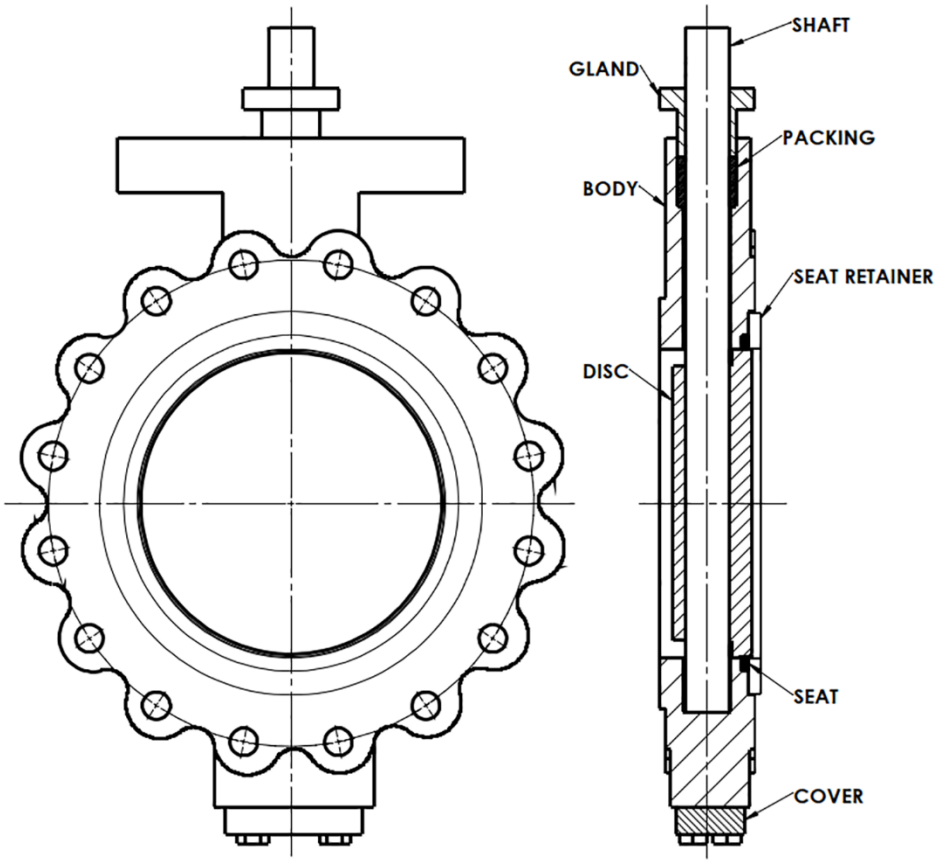
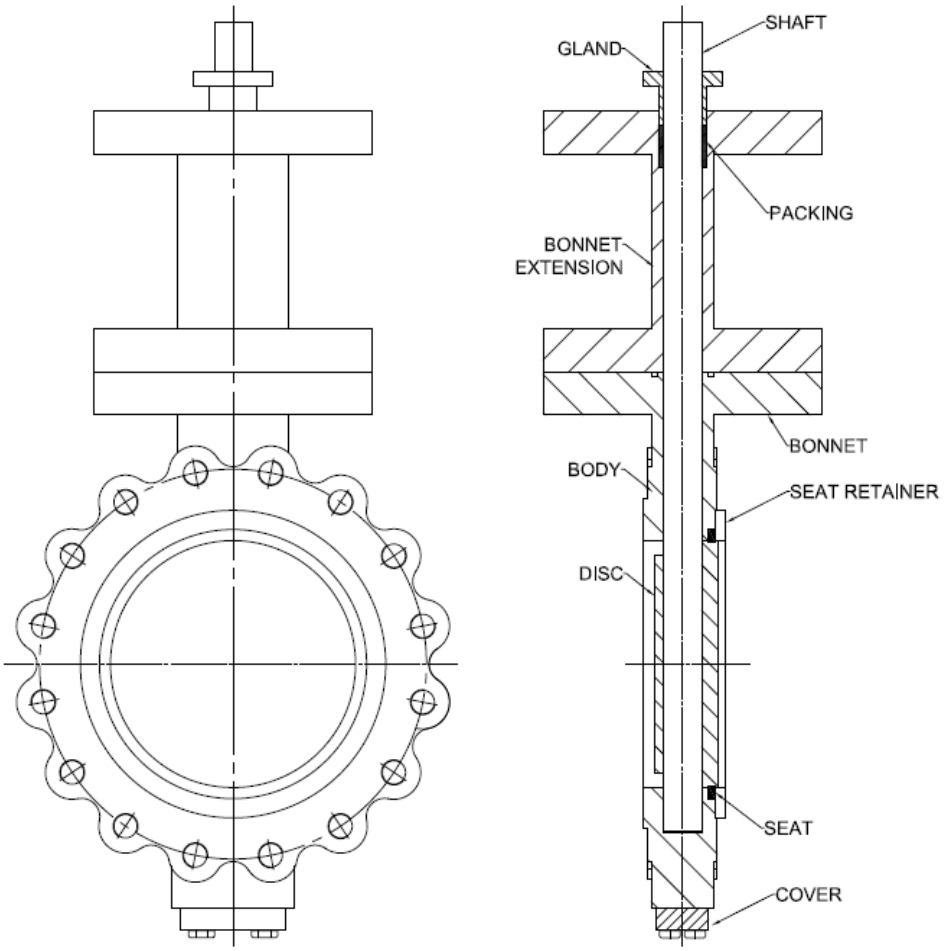


Figure C.1—Typical Part Nomenclature for Category A Concentric Disc Type



(a) design without bonnet extension



(b) design with bonnet extension

Figure C.2— Typical Part Nomenclature for Category B Offset Disc Type

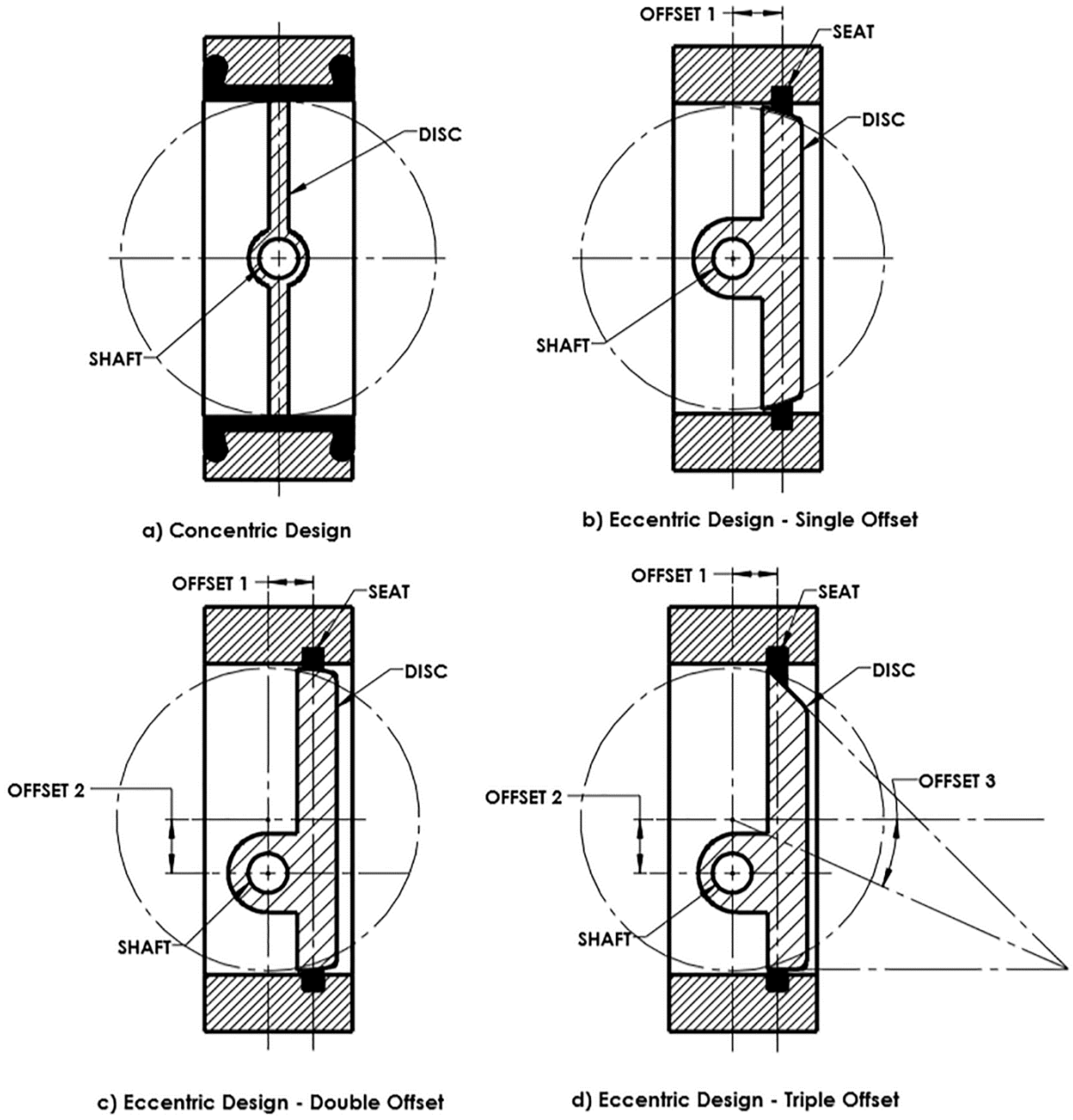


Figure C.3—Typical Offset-type Constructions

Annex D

(normative)

Disc-to-pipe Clearances

The maximum diameter of a concentric-type disc for a given size of valve and a given inside diameter of the connecting pipe or flange shall be determined as follows.

First, calculate the chord of the disc with the following equation:

$$a = d - 2c$$

Then use the result to determine the maximum disc diameter with the following equation:

$$D = \sqrt{W^2 + a^2}$$

where

a is the chord of the disc in an open position, in millimeters (inches), as determined by the intersection of a plane through the installed face of the valve body (see Figure D.1);

c is the nominal radial clearance between the disc and the inside of the pipe or flange, in millimeters (inches), when the disc and valve are concentrically located (see Table D.1 and Figures D.1 and D.2);

d is the inside diameter of the connecting pipe or flange, in millimeters (inches), (see Figure D.1);

NOTE The inside diameter of the steel pipe may be determined by subtracting twice the nominal wall thickness from the outside diameter, using the appropriate dimensions listed in ASME B36.10.

D is the maximum disc diameter, in millimeters (inches), (see Figure D.1);

W is the minimum installed face-to-face dimension of the valve, in millimeters (inches), (see Figure D.1).

The calculation above assumes concentric location of the disc and shaft in the valve body. Equivalent nominal radial clearances shall be provided for eccentric or offset shaft construction at all angles of disc rotation.

Figure D.1 shows dimensional location for concentric disc-type construction. Figure D.2 shows the nomenclature and depicts offset disc-type construction. Table D.2 indicates the relationship of unlined steel pipe schedules to valve category, size, and ASME Class.

CAUTION ——Purchaser shall ensure the proper disc-to-pipe clearance when a greater pipe wall thickness and/or an internal lining is being used. Failure to do so may cause the disc edge to come into contact with the pipe, causing damage to the disc and pipe.

Table D.1—Nominal Radial Clearances

Valve Size		Nominal Radial Clearance (*c*)	
DN	**NPS**	**mm**	**in.**
50 to 150	2 to 6	1.5	0.06
200 to 500	8 to 20	3.0	0.12
600 to 1500	24 to 60	6.4	0.25

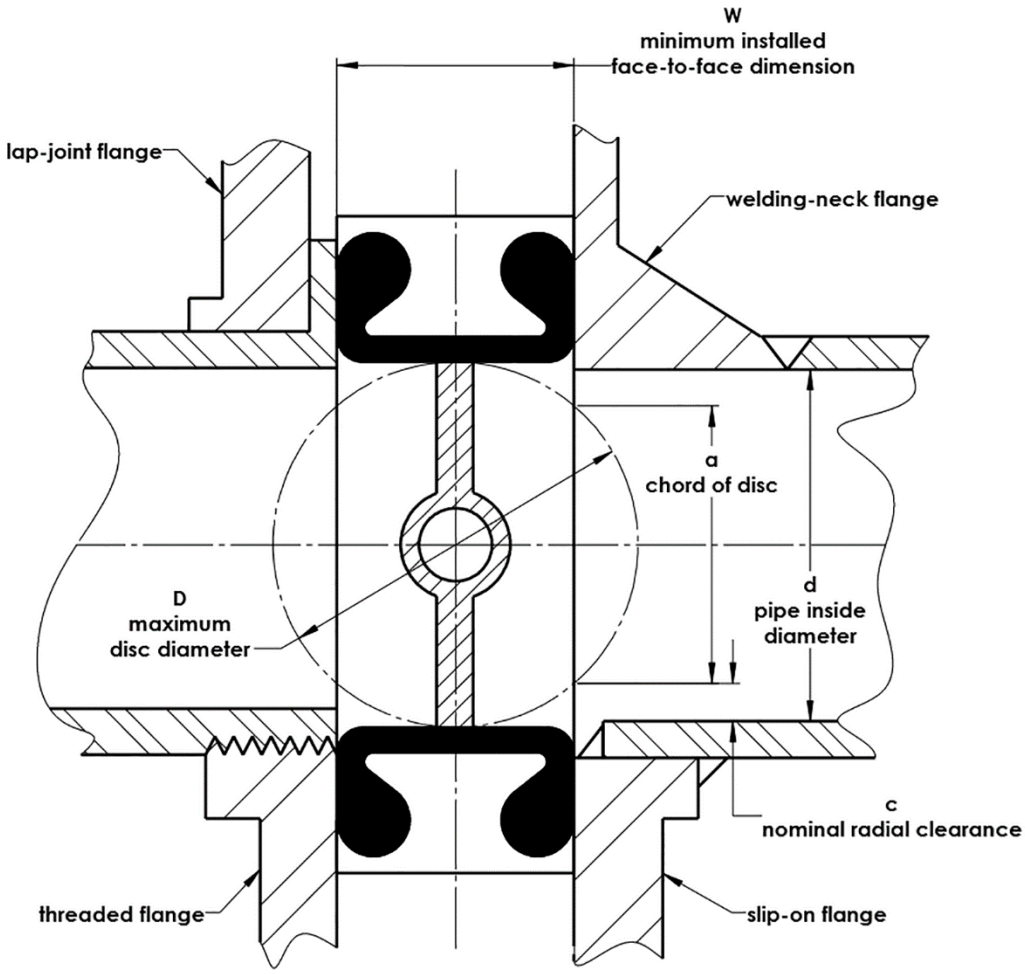


Figure D.1—Disc-to-pipe Clearance for Category A Concentric Disc Type

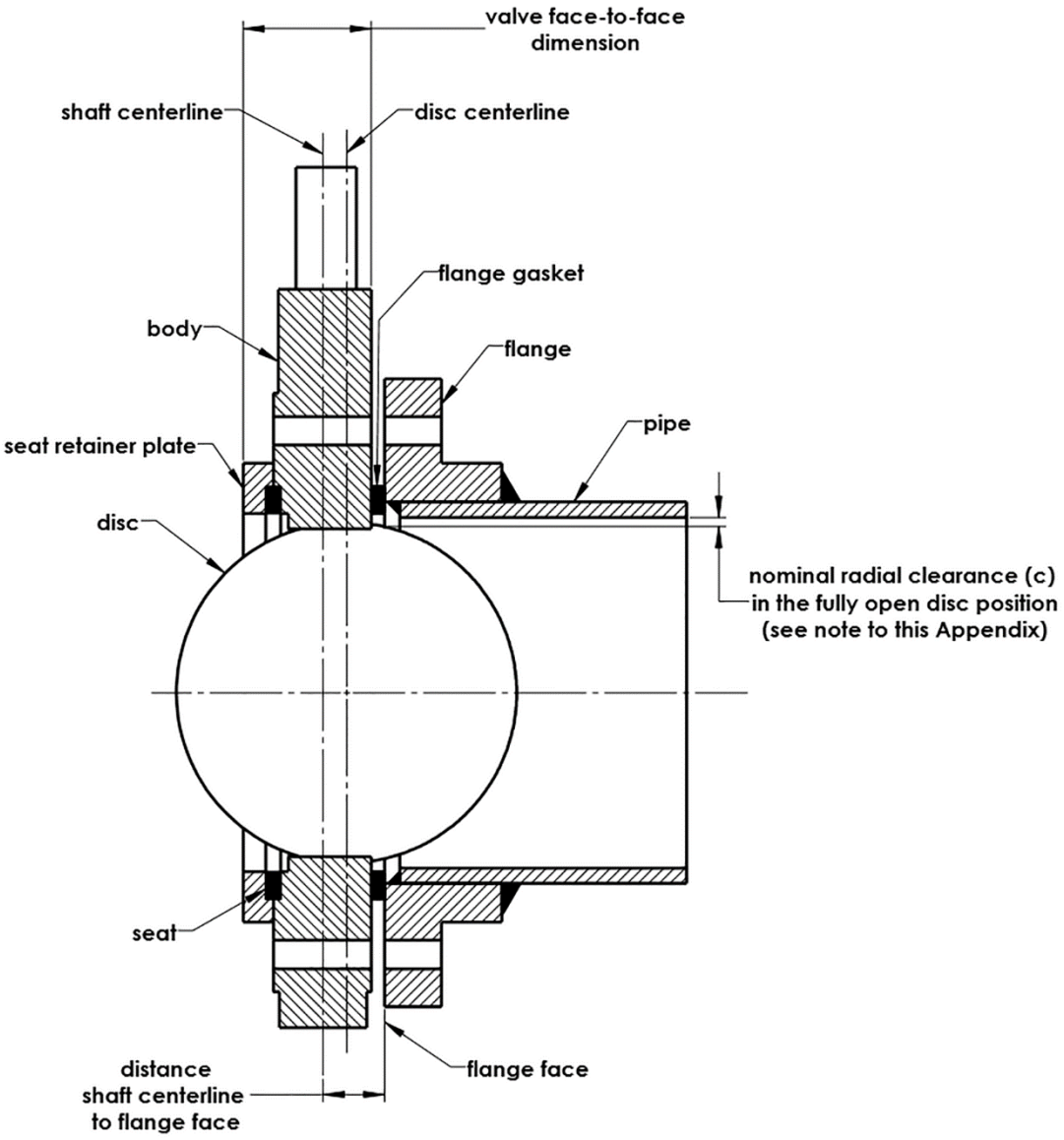


Figure D.2—Disc-to-pipe Clearance for Category B Offset Disc Type

Table D.2—Relationship of Unlined Steel Pipe Schedule to Valve Category, Size, and ASME Class

Valve Size		Category A	Category B		
DN	NPS		Class 150	Class 300	Class 600
50 to 65	2 to 2 1/2	Standard weight	Standard weight	Extra strong	Not applicable
80 to 100	3 to 4				Extra strong
125	5		Not applicable		

<table>
<tr><td>150</td><td>6</td><td rowspan="3"></td><td rowspan="3">Standard weight</td><td rowspan="2">Extra Strong</td><td>Extra strong</td></tr>
<tr><td>200 to 350</td><td>8 to 14</td><td rowspan="2">Schedule 100</td></tr>
<tr><td>400</td><td>16</td><td rowspan="2">Schedule 40</td></tr>
<tr><td>450 to 600</td><td>18 to 24</td><td></td></tr>
<tr><td>650 to 950</td><td>26 to 38</td><td>Extra strong</td><td>Extra strong</td><td>— [a]</td><td>— [a]</td></tr>
<tr><td>1000 to 1500</td><td>40 to 60</td><td>— [a]</td><td>— [a]</td><td>— [a]</td><td>— [a]</td></tr>
<tr><td colspan="6">NOTE This table considers full flange rating for ASTM A106 Grade B pipe with a mill tolerance of –12.5 % and a corrosion allowance of 3.175 mm (0.125 in.) except as noted below.</td></tr>
<tr><td colspan="6">[a]There are no standard pipe schedules available for the required wall thickness. Pipe wall thicknesses are calculated for actual operating conditions rather than the full flange rating.</td></tr>
</table>

Bibliography

[1] EN 558 ,[6] *Industrial valves—Face-to-face and centre-to-face dimensions of metal valves for use in flanged pipe systems—PN and Class-designated Valves*

[2] EN 593, *Industrial valves—Metallic butterfly valves for general purposes*

[3] ISO 5752, *Metal valves for use in flanged pipe systems—Face-to-face and center-to-face dimensions*

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

[5] MSS SP-68, *High pressure butterfly valves with offset design*

[6] European Committee for Standardization, CEN-CENELEC Management Centre, Avenue Marnix 17, B-1000 Brussels, Belgium, www.cen.eu.