Steel Gate, Globe, and Check Valves for Sizes NPS 4 (DN 100) and Smaller for the Petroleum and Natural Gas Industries

API STANDARD 602
NINTH EDITION, OCTOBER 2009

EFFECTIVE DATE: APRIL 1, 2010

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Downstream Segment

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Steel Gate, Globe, and Check Valves for Sizes NPS 4 (DN 100) and Smaller for the Petroleum and Natural Gas Industries

1 Scope

This international standard specifies the requirements for a series of compact steel gate, globe and check valves for petroleum and natural gas industry applications.

It is applicable to valves of:

— nominal pipe sizes NPS 1/4, NPS 3/8, NPS 1/2, NPS 3/4, NPS 1, NPS 1 1/4, NPS 1 1/2, NPS 2, NPS 2 1/2, NPS 3, and NPS 4;

— corresponding to nominal sizes DN 8, DN 10, DN 15, DN 20, DN 25, DN 32, DN 40, DN 50, DN 65, DN 80, and DN 100.

It is also applicable to pressure designations of Class 150, Class 300, Class 600, Class 800 and Class 1500.

Class 800 is not a listed class designation, but is an intermediate class number widely used for socket welding and threaded end compact valves.

It includes provisions for the following valve characteristics.

— Outside screw with rising stems (OS & Y), in sizes $1/4 \leq$ NPS ≤ 4 ($8 \leq$ DN ≤ 100) and pressure designations including Class 800.

— Inside screw with rising stems (ISRS), in sizes $1/4 \leq$ NPS $\leq 2\ 1/2$ ($8 \leq$ DN ≤ 65) and pressure designations of classes ≤ 800.

— Socket welding or threaded ends, in sizes $1/4 \leq$ NPS $\leq 2\ 1/2$ ($8 \leq$ DN ≤ 65) and pressure designations of Class 800 and Class 1500.

— Flanged or butt-welding ends, in sizes $1/2 \leq$ NPS ≤ 4 ($15 \leq$ DN ≤ 100) and pressure designations of Class 150 through Class 1500, excluding flanged end Class 800.

— Bonnet Joint Construction—Bolted, welded and threaded with seal weld for classes ≤ 1500 and union nut for classes ≤ 800.

— Standard and full-bore body seat openings.

— Materials, as specified.

— Testing and inspection.

This publication is applicable to valve end flanges in accordance with ASME B16.5, valve body ends having tapered pipe threads to ASME B1.20.1 or ISO 7-1, valve body ends having socket weld ends to ASME B16.11 and butt-weld connections per the requirements described within this standard. It is applicable to extended body construction in sizes $1/2 \leq$ NPS ≤ 2 ($15 \leq$ DN ≤ 50) and pressure designations of Class 800 and Class 1500, and to bellows and bellows assembly construction as may be adaptable to gate or globe valves in sizes $1/4 \leq$ NPS ≤ 2 ($8 \leq$ DN ≤ 50). It covers bellows stem seal type testing requirements.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Standard 598, *Valve Inspection and Testing*

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

ASME B1.5, *Acme Screw Threads*

ASME B1.8, *Stub Acme Screw Threads*

ASME B1.13M, *Metric Screw Threads: M Profile*

ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ASME B16.5, *Pipe Flanges and Flanged Fittings*

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

ASME B16.11, *Forged Fittings, Socket-welding and Threaded*

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

ASME B31.3, *Process Piping*

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

ASTM A193 [2], *Standard Specification for Alloy-steel and Stainless Steel Bolting Materials for High-temperature Service*

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

ASTM A307, *Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength*

EN 10269 [3], *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties*

ISO 7-1 [4], *Pipe threads where pressure-tight joints are made on the threads—Part 1: Dimensions, tolerances and designation*

ISO 7-2, *Pipe threads where pressure-tight joints are made on the threads—Part 2: Verification by means of limit gauges*

ISO 2902, *ISO metric trapezoidal screw threads—General plan*

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1 ASME International, 3 Park Avenue, New York, New York 10016, www.asme.org.
2 ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
3 European Committee for Standardization, Avenue Marnix 17, B-1000, Brussels, Belgium, www.cen.eu.
4 International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva, Switzerland, www.iso.org.

ISO 2903, *ISO metric trapezoidal screw threads—Tolerances*

ISO 2904, *ISO metric trapezoidal screw threads—Basic dimensions*

ISO 4200, *Plain end steel tubes, welded and seamless*—General tables of dimensions and masses per unit length

ISO 5752, *Metal valves for use in flanged pipe systems—Face-to-face and centre-to-face dimensions*

ISO 9606-1, *Approval testing of welders—Fusion welding—Part 1: Steels*

ISO 14723, *Petroleum and natural gas industries—Pipeline transportation systems—Subsea pipeline valves*

ISO 14732, *Welding personnel—Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*

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

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

ISO 15649, *Petroleum and natural gas industries—Piping*

3 Terms and Definitions

For the purposes of this document, the following 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" do not represent a measurable value and are 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 to be found in tables of pressure/temperature ratings. Prefix "Class" usage is applicable to steel valves bearing NPS nominal size designations.

3.2
diameter nominal
DN
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. Prefix "DN" usage is applicable to steel valves bearing PN designations.

3.3
nominal pipe size
NPS
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. Prefix "NPS" usage is applicable to steel flanges bearing class designations.

4 Pressure/Temperature Ratings

4.1 Valve Ratings

4.1.1 Applicability

The pressure/temperature ratings applicable to valves specified in this standard shall be in accordance with those specified in the tables of ASME B16.34 for standard class for the applicable material specification and class designation.

4.1.2 Applicable Valve Materials

The ASME B16.34 Material Group 1 and Material Group 2 forging and casting ASTM identifications acceptable for valves constructed under this standard are listed in Table 1. The Table 1 notes apply to the applicable valve material where noted.

4.1.3 Interpolated Ratings

The pressure/temperature ratings for Intermediate Class 800 valves shall be as shown in Table 2a and Table 2b. The pressure/temperature ratings in Table 2a and Table 2b are a linear interpolation of Standard Class 600 and Standard Class 900 pressure/temperature ratings listed in ASME B16.34 for the appropriate valve material.

Table 1 ASME B16.34 Material Group 1 and Material Group 2 Forging and Casting Descriptions

Group(s)	Forgings	Castings
1.1	A105 [a b] A350 LF2 [a], A350 LF3 [d], A350 LF6 Cl. 1 [c]	A216 WCB [a]
1.2	A350 LF6 Cl. 2 [c]	A352 LC2 [d], A352 LC3 [d], A216 WCC [a], A352 LCC [d]
1.3	N/A	A352 LCB [d], A217 WC1 [e f], A352 LC1 [d]
1.4	A350 LF1 [a]	N/A
1.5	A182 F1 [e]	N/A
1.7	A182 F2 [g]	A217 WC4 [f g], A217 WC5 [f]
1.9	A182 F11 Cl. 2 [f i]	A217 WC6 [f h]
1.10	A182 F22 Cl. 3 [i]	A217 WC9 [f h]
1.11	A182 F21 [i]	N/A
1.13	A182 F5a	A217 C5 [f]
1.14	A182 F9	A217 C12 [f]
1.15	A182 F91	A217 C12A
1.17	A182 F12 Cl. 2 [f i], A182 F5	N/A
2.1	A182 F304 [j], A182 F304H	A351 CF3 [k], A351 CF8 [j]
2.2	A182 F316 [j], A182 F316H, A182 F317 [j], A182 F317H	A351 CF3M [j], A351 CF8M [j], A351 CF3A [d], A351 CF8A [d], A351 CG8MF [g]
2.3	A182 F304L [k], A182 F316L	N/A
2.4	A182 F321 [g], A182 F321H [l]	N/A
2.5	A182 F347 [g], A182 F347H [l], A182 F348 [g], A182 F348H [l]	N/A
2.7	A182 F310H	N/A
2.8	A182 F44, A182 F51 [m], A182 F53 [m], A182 F55	A351 CK3MCuN, A351 CE8M [m], A351 CD4MCuN [m], A351 CD3MWCuN [m]
2.10	N/A	A351 CH8 [j], A351 CH20 [j]
2.11	N/A	A351 CF8C [j]
2.12	N/A	A351 CK20 [j]

[a] Upon prolonged exposure to temperatures above 800 °F(425 °C), the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800 °F (425 °C).

[b] Only killed steel shall be used above 850 °F (455 °C).

[c] Not to be used over 500 °F (260 °C).

[d] Not to be used over 650 °F (345 °C).

[e] Upon prolonged exposure to temperatures above 875 °F (470 °C), the carbide phase of steel of carbon-molybdenum steel may be converted to graphite. Permissible, but not recommended for prolonged use above 875 °F (470 °C).

[f] Use normalized and tempered material only.

[g] Not to be used over 1000 °F (538 °C).

[h] Not to be used over 1100 °F (595 °C).

[i] Permissible, but not recommended for prolonged use above 1100 °F (595 °C).

[j] At temperatures over 1000 °F (538 °C), use only when the carbon content is 0.04 % or higher.

[k] Not to be used over 800 °F (425 °C).

[l] At temperatures over 1000 °F (538 °C), use only if the material is heat treated by heating to a minimum temperature of 2000 °F (1095 °C).

[m] This steel may become brittle after service at moderately elevated temperatures. Not to be used over 600 °F (315 °C).

Table 2a—800 Class Pressure/Temperature Ratings (USC Units)

ASME B16.34 Material Group 1 (psi)													
Temperature (°F)	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.7**	**1.9**	**1.10**	**1.11**	**1.13**	**1.14**	**1.15**	**1.17**
–20 to 100	1975	2000	1860	1645	1860	2000	2000	2000	2000	2000	2000	2000	2000
200	1810	2000	1760	1505	1860	2000	2000	2000	2000	2000	2000	2000	1965
300	1745	1940	1700	1455	1765	1940	1925	1940	1940	1940	1940	1945	1865
400	1690	1875	1640	1405	1765	1880	1850	1880	1880	1880	1880	1880	1780
500	1610	1775	1565	1340	1710	1775	1775	1775	1775	1775	1775	1775	1725
600	1515	1615	1470	1260	1615	1615	1615	1615	1615	1615	1615	1615	1615
650	1465	1570	1420	1220	1570	1570	1570	1570	1570	1570	1570	1570	1570
700	1415	1480	1365	1180	1515	1515	1515	1515	1515	1515	1515	1515	1515
750	1350	1350	1270	1140	1420	1420	1420	1420	1420	1420	1420	1420	1420
800	1100	1100	1045	980	1355	1355	1355	1355	1355	1355	1355	1355	1355
850	850	850	795	795	1300	1300	1300	1300	1300	1300	1300	1300	1300
900	615	595	540	460	1200	1200	1200	1200	1195	995	1200	1200	995
950	365	365	365	365	750	840	850	1025	750	735	1005	1035	735
1000	225	225	225	225	440	540	575	710	440	530	675	970	530
1050						420	385	465	440	385	460	960	385
1100							255	295	295	265	300	805	255
1150							175	180	220	165	200	595	165
1200							110	110	120	95	140	385	95
1250													
1300													
1350													
1400													
1450													
1500													

Table 2a—800 Class Pressure/Temperature Ratings (USC Units) (Continued)

ASME B16.34 Material Group 2 (psi)										
Temperature (°F)	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.7**	**2.8**	**2.10**	**2.11**	**2.12**
–20 to 100	1920	1920	1600	1920	1920	1920	2000	1790	1920	1790
200	1600	1655	1365	1730	1765	1695	1985	1465	1765	1465
300	1435	1495	1215	1585	1645	1545	1780	1350	1645	1350
400	1325	1370	1120	1470	1535	1445	1640	1295	1535	1295
500	1240	1275	1050	1375	1445	1370	1545	1255	1445	1255
600	1180	1205	990	1300	1375	1320	1485	1215	1375	1215
650	1150	1180	975	1265	1350	1295	1460	1190	1350	1190
700	1125	1160	960	1240	1325	1275	1445	1160	1325	1160
750	1100	1140	940	1220	1310	1255	1420	1125	1310	1125
800	1080	1125	920	1205	1300	1240		1095	1300	1095
850	1055	1115	900	1190	1295	1220		1060	1295	1060
900	1035	1105		1180	1200	1200		1025	1200	1025
950	1020	1030		1030	1030	1030		985	1030	985
1000	945	970		970	970	970		900	970	900
1050	865	960		960	960	940		780	960	865
1100	685	815		830	860	695		595	830	780
1150	545	630		630	735	500		460	555	665
1200	440	495		495	550	365		345	405	545
1250	355	390		375	485	275		265	300	440
1300	300	310		295	365	200		210	200	320
1350	250	255		225	275	155		165	140	220
1400	200	200		175	200	120		120	110	145
1450	155	155		140	155	90		85	85	100
1500	110	110		100	110	65		70	70	70

4.2 Temperature Constraints

4.2.1 The temperature for a corresponding pressure rating is the maximum temperature of the pressure-containing shell of the valve. In general, this temperature is the same as that of the contained fluid. The use of a pressure rating corresponding to a temperature other than that of the contained fluid is the responsibility of the user.

4.2.2 Restrictions of temperature and pressure, e.g. those imposed by special soft seals, special trim materials, packing, or bellows stem seals, shall be marked on the valve identification plate (see 7.4).

Table 2b—800 Class Pressure/Temperature Ratings (SI Units)

ASME B16.34 Material Group 1 (MPa)													
Temperature (°C)	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.7**	**1.9**	**1.10**	**1.11**	**1.13**	**1.14**	**1.15**	**1.17**
–29 to 38	13.62	13.79	12.81	11.35	12.81	13.79	13.79	13.79	13.79	13.79	13.79	13.79	13.79
50	13.37	13.79	12.66	11.14	12.81	13.79	13.79	13.79	13.79	13.79	13.79	13.79	13.73
100	12.43	13.74	12.09	10.36	12.78	13.74	13.73	13.74	13.74	13.74	13.74	13.74	13.45
150	12.02	13.38	11.72	10.02	12.62	13.38	13.26	13.38	13.38	13.38	13.38	13.38	12.85
200	11.68	12.96	11.34	9.71	12.21	12.96	12.79	12.96	12.96	12.96	12.96	12.96	12.34
250	11.18	12.36	10.87	9.31	11.87	12.36	12.36	12.36	12.36	12.36	12.36	12.36	11.95
300	10.62	11.43	10.32	8.85	11.43	11.43	11.43	11.43	11.43	11.43	11.43	11.43	11.43
325	10.32	11.02	10.02	8.60	11.02	11.02	11.02	11.02	11.02	11.02	11.02	11.02	11.02
350	10.02	10.67	9.71	8.33	10.73	10.73	10.73	10.73	10.73	10.73	10.73	10.73	10.73
375	9.70	10.09	9.32	8.10	10.35	10.35	10.35	10.35	10.35	10.35	10.35	10.35	10.35
400	9.26	9.26	8.70	7.82	9.76	9.76	9.76	9.76	9.76	9.76	9.76	9.76	9.76
425	7.67	7.67	7.28	6.87	9.34	9.34	9.34	9.34	9.34	9.34	9.34	9.34	9.34
450	6.13	6.13	5.76	5.70	9.02	9.02	9.02	9.02	9.02	9.02	9.02	9.02	9.02
475	4.65	4.56	4.18	3.76	8.45	8.45	8.45	8.45	8.45	7.43	8.45	8.45	7.43
500	3.14	3.09	2.95	2.75	6.42	7.12	6.86	7.53	6.28	5.70	7.53	7.53	5.70
538	1.57	1.57	1.57	1.57	3.02	3.72	3.97	4.92	3.02	3.65	4.67	6.68	3.65
550						3.36	3.39	4.17	3.02	3.21	4.00	6.65	3.21
575						1.91	2.35	2.81	2.68	2.17	2.79	6.38	2.35
600							1.63	1.84	1.89	1.66	1.91	5.20	1.62
625							1.14	1.19	1.41	1.07	1.32	3.89	1.07
650							0.76	0.76	0.82	0.63	0.94	2.65	0.63
675													
700													
725													
750													
775													
800													

Table 2b—800 Class Pressure/Temperature Ratings (SI Units) (Continued)

ASME B16.34 Material Group 2 (MPa)										
Temperature (°C)	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.7**	**2.8**	**2.10**	**2.11**	**2.12**
–29 to 38	13.24	13.24	11.03	13.24	13.24	13.24	13.79	12.36	13.24	12.36
50	12.75	12.83	10.67	12.95	13.00	12.90	13.79	11.86	13.00	11.86
100	10.90	11.25	9.28	11.80	12.08	11.57	13.51	10.01	12.08	10.01
150	9.87	10.27	8.37	10.93	11.32	10.67	12.25	9.31	11.32	9.31
200	9.19	9.51	7.78	10.21	10.65	10.03	11.38	8.94	10.65	8.94
250	8.67	8.90	7.32	9.61	10.08	9.54	10.79	8.69	10.08	8.69
300	8.24	8.43	6.95	9.10	9.63	9.19	10.36	8.46	9.63	8.46
325	8.06	8.24	6.79	8.88	9.43	9.03	10.18	8.32	9.43	8.32
350	7.90	8.09	6.68	8.69	9.27	8.88	10.04	8.15	9.27	8.15
375	7.74	7.97	6.60	8.54	9.12	8.76	9.96	7.96	9.12	7.96
400	7.58	7.85	6.48	8.43	9.04	8.65	9.76	7.76	9.04	7.76
425	7.47	7.77	6.36	8.30	8.96	8.57		7.56	8.96	7.56
450	7.31	7.69	6.24	8.22	8.92	8.45		7.36	8.92	7.36
475	7.18	7.64		8.14	8.45	8.33		7.13	8.45	7.13
500	7.07	7.53		7.53	7.53	7.53		6.89	7.53	6.89
538	6.52	6.68		6.68	6.68	6.68		6.22	6.68	6.22
550	6.28	6.65		6.65	6.65	6.65		5.84	6.65	6.12
575	5.56	6.38		6.38	6.38	5.91		4.93	6.38	5.78
600	4.50	5.31		5.40	5.71	4.47		3.87	5.28	5.17
625	3.68	4.21		4.21	4.88	3.33		3.05	3.70	4.49
650	3.00	3.38		3.37	3.77	2.50		2.37	2.75	3.75
675	2.49	2.75		2.63	3.35	1.93		1.86	2.12	3.07
700	2.14	2.23		2.11	2.65	1.47		1.51	1.49	2.34
725	1.80	1.87		1.69	2.06	1.16		1.22	1.06	1.69
750	1.54	1.56		1.33	1.56	0.91		0.93	0.83	1.19
775	1.21	1.21		1.06	1.21	0.71		0.68	0.66	0.84
800	0.93	0.93		0.84	0.93	0.55		0.54	0.54	0.61

Table 3 Minimum Diameter of Equivalent Flow Passageway for Standard [a] Bore Valves

NPS	Minimum Diameter in. (mm)			DN
	Class 150, Class 300, Class 600, Class 800	Class 1500		
	Gate, Globe, or Check Valves	Gate Valves	Globe or Check Valves	
1/4	1/4 (6)	1/4 (6)	3/16 (5)	8
3/8	1/4 (6)	1/4 (6)	3/16 (5)	10
1/2	3/8 (9)	3/8 (9)	5/16 (8)	15
3/4	1/2 (12)	1/2 (12)	3/8 (9)	20
1	11/16 (17)	5/8 (15)	9/16 (14)	25
1 1/4	15/16 (23)	7/8 (22)	13/16 (20)	32
1 1/2	1 1/8 (28)	1 1/16 (27)	1 (25)	40
2	1 7/16 (36)	1 3/8 (34)	1 1/16 (27)	50
2 1/2	1 3/4 (44)	1 1/2 (38)	1 3/8 (34)	65
3	2 (50)	1 7/8 (47)	1 11/16 (42)	80
4	2 3/4 (69)	2 1/2 (63)	2 5/16 (58)	100

[a] The minimum diameter dimensions shown in this table are identical to the inch dimensions shown in API 602, Seventh Edition, and identical to the millimeter dimensions shown in API 602, Eight Edition.

4.2.3 For temperatures below the lowest temperature listed in the pressure/temperature rating tables (see 4.1), the service pressure shall be no greater than the pressure for the lowest listed temperature. The use of valves at lower than the lowest listed temperature is the responsibility of the user. Consideration shall be given to the loss of ductility and toughness of many materials at low temperature.

5 Design

5.1 Reference Design

5.1.1 The reference design (the design to be provided when the purchaser does not specify otherwise or does not use Annex E) for sizes NPS ≤ 4 (DN ≤ 100) is for standard bore, bolted-bonnet or cover construction, an outside stem thread for gate and globe valves and, for globe valves, has a conical disc. The reference design for threaded-end valves uses taper pipe threads in accordance with ASME B1.20.1. In addition, for valves NPS ≤ 2 (DN ≤ 50), the reference design is to have a body and bonnet or cover of forged material. Valve parts are identified in Annex D.

5.1.2 Other configurations and types of material may be provided when specified in accordance with Annex E. Requirements for extended body valves are given in Annex A and those for bellows stem seals in Annex B and Annex C.

5.2 Flow Passageway

5.2.1 The flow passageway includes the seat opening and the body ports leading to that opening. The body ports are the intervening elements that link the seat opening to the end connection (e.g. socket or flange).

5.2.2 The minimum cross-sectional area requirement for the standard bore flow passageway applies for both the valve body ports and the seat opening in the absence of the valve disc. The minimum flow passageway cross-sectional area shall not be less than that obtained using the diameters in Table 3.

Table 4 Minimum Diameter of Equivalent Flow Passageway for Full-bore Valves

NPS	Minimum Diameter in. (mm)			DN
	Class 150, Class 300, Class 600, Class 800	Class 1500		
	Gate, Globe, or Check Valves	Gate Valves	Globe or Check Valves	
1/4	1/4 (6)	1/4 (6)	3/16 (4)	8
3/8	3/8 (9)	3/8 (9)	5/16 (7)	10
1/2	1/2 (12)	1/2 (12)	3/8 (9)	15
3/4	11/16 (17)	5/8 (15)	9/16 (14)	20
1	15/16 (22)	7/8 (22)	13/16 (19)	25
1 1/4	1 1/8 (28)	1 1/16 (26)	1 (25)	32
1 1/2	1 7/16 (35)	1 3/8 (34)	1 1/16 (26)	40
2	1 3/4 (44)	1 1/2 (38)	1 3/8 (34)	50
2 1/2	2 (50)	1 7/8 (47)	1 11/16 (42)	65
3	2 3/4 (69)	2 1/2 (63)	2 5/16 (58)	80
4	3 3/4 (95)	3 5/8 (92)	3 7/16 (87)	100

5.2.3 The minimum cross-sectional area requirement for the full-bore flow passageway (except extended body valves) applies for both the valve body ports and the seat opening in the absence of the valve disc. The minimum flow passageway cross-sectional area shall not be less than that obtained using the diameters in Table 4. This standard does not provide for extended body valves (see Annex A) with full-bore openings.

5.3 Wall Thickness

5.3.1 Except as provided for in 5.3.2.and 5.3.3, the minimum wall thickness values for valve bodies, bonnets and check valve covers are given in Table 5. The manufacturer, taking into account such factors as bonnet bolting loads, rigidity needed for stem alignment, valve design details and the specified operating conditions, is responsible for determining if a larger wall thickness is required.

5.3.2 Valve body end connection minimum wall thickness shall be in accordance with 5.4.2, 5.4.3, 5.4.4, or 5.4.5 as applicable. Valves identified as extended body valves shall have body extension minimum wall thickness in accordance with A.3. Valves having bellows stem seals with a bellows enclosure shall have a bellows enclosure extension minimum wall thickness in accordance with B.4.

5.3.3 The bonnet minimum wall thickness for gate or globe valves, except for the neck extension that forms the packing chamber entryway, shall be in accordance with Table 5. The packing chamber extension shall have a local minimum wall thickness as specified in Table 6, based on the local inside diameter of the packing and stem hole.

5.4 Valve Body

5.4.1 General

Requirements for a basic valve body and associated end connections are given here. See Annex A for requirements for gate valve bodies having extended ends.

Table 5 Minimum Wall Thickness for Valve Bodies, Bonnets, and Check Valve Covers

NPS	Minimum Wall Thickness in. (mm)		DN
	Class 150, Class 300, Class 600, Class 800	Class 1500	
1/4	0.12 (3.1)	0.15 (3.8)	8
3/8	0.13 (3.3)	0.17 (4.3)	10
1/2	0.16 (4.1)	0.19 (4.8)	15
3/4	0.19 (4.8)	0.24 (6.1)	20
1	0.22 (5.6)	0.28 (7.1)	25
1 1/4	0.23 (5.8)	0.33 (8.4)	32
1 1/2	0.24 (6.1)	0.38 (9.7)	40
2	0.28 (7.1)	0.47 (11.9)	50
2 1/2	0.33 (8.4)	0.56 (14.2)	65
3	0.38 (9.7)	0.65 (16.5)	80
4	0.47 (11.9)	0.84 (21.3)	100

NOTE Wall thickness values listed for Class 150, Class 300, and Class 600 are those required for Class 800 on the assumption that flanged end and butt-welding end valve bodies of these lower nominal pressures would have extensions added (integral or welded) to Class 800 valve bodies.

5.4.2 Socket-welding Ends

5.4.2.1 Socket-welding-end preparation, including the internal ends of extended-body valves, shall conform to ASME B16.11. The bottom of the socket shall be square and flat. The minimum wall thickness of internal socket-welding ends shall be in accordance with the Class 800 or Class 1500 requirements of Table 4 of ASME B16.34.

5.4.2.2 End-to-end dimensions for socket-welding end valves shall be established by the manufacturer.

Table 6 Minimum Wall Thickness for Bonnet Extensions and Bellows Enclosures

Extension Inside Diameter in. (mm)	Class 150	Class 300	Class 600	Class 800	Class 1500
	Minimum Wall Thickness in. (mm)				
0.60 (15)	0.12 (3.1)	0.13 (3.3)	0.14 (3.6)	0.16 (4.0)	0.19 (4.8)
0.63 (16)	0.125 (3.2)	0.13 (3.4)	0.15 (3.8)	0.17 (4.3)	0.20 (5.1)
0.67 (17)	0.125 (3.2)	0.13 (3.4)	0.15 (3.8)	0.17 (4.3)	0.20 (5.1)
0.71(18)	0.13 (3.3)	0.14 (3.5)	0.15 (3.9)	0.17 (4.4)	0.21 (5.3)
0.75 (19)	0.13 (3.4)	0.14 (3.6)	0.16 (4.0)	0.18 (4.6)	0.22 (5.5)
0.78 (20)	0.13 (3.4)	0.14 (3.6)	0.16 (4.1)	0.19 (4.7)	0.22 (5.7)
0.98(25)	0.15 (3.8)	0.16 (4.1)	0.18 (4.5)	0.21 (5.4)	0.26 (6.7)
1.18 (30)	0.165 (4.2)	0.18 (4.6)	0.20 (5.0)	0.24 (6.0)	0.31 (7.9)
1.38 (35)	0.18 (4.6)	0.20 (5.1)	0.21 (5.4)	0.25 (6.4)	0.35 (9.0)
1.57 (40)	0.19 (4.9)	0.22 (5.5)	0.22 (5.7)	0.26 (6.7)	0.39 (9.9)

Table 6 Minimum Wall Thickness for Bonnet Extensions and Bellows Enclosures (Continued)

1.97 (50)	0.22 (5.5)	0.25 (6.3)	0.25 (6.3)	0.29 (7.3)	0.46 (11.8)
2.36 (60)	0.22 (5.7)	0.26 (6.6)	0.26 (6.6)	0.32 (8.1)	0.54 (13.6)
2.75 (70)	0.23 (5.9)	0.27 (6.9)	0.29 (7.3)	0.35 (9.0)	0.61 (15.5)
3.15 (80)	0.24 (6.1)	0.28 (7.2)	0.31 (8.0)	0.39 (9.9)	0.68 (17.3)
3.54 (90)	0.25 (6.3)	0.30 (7.5)	0.34 (8.6)	0.42 (10.8)	0.75 (19.1)
3.94 (100)	0.26 (6.5)	0.31 (7.8)	0.36 (9.3)	0.46 (11.8)	0.83 (21.0)
4.33 (110)	0.26 (6.5)	0.31 (8.0)	0.40 (10.0)	0.50 (12.7)	0.89 (22.8)
4.72 (120)	0.26 (6.7)	0.32 (8.3)	0.42 (10.7)	0.54 (13.6)	0.97 (24.7)
5.12 (130)	0.27 (6.8)	0.34 (8.7)	0.45 (11.4)	0.57 (14.5)	1.02 (26.5)
5.51 (140)	0.28 (7.0)	0.35 (9.0)	0.47 (12.0)	0.61 (15.5)	1.12 (28.4)
NOTE For bellows enclosures, see B.4.					

5.4.3 Threaded Ends

5.4.3.1 The threaded end thread axis shall coincide with the end entry axis. The minimum wall thickness at the threaded end shall be in accordance with Table 4 of ASME B16.34. An approximate 45° lead-in chamfer, having an approximate depth of one-half the thread pitch, shall be applied at each threaded end.

5.4.3.2 The end threads shall be taper pipe threads meeting the requirements of ASME B1.20.1. When specified in the purchase order, taper pipe threads in accordance with ISO 7-1 may be substituted and must be noted on the identification plate.

5.4.3.3 Threads shall be gauged in accordance with ASME B1.20.1 or ISO 7-2, as applicable.

5.4.3.4 End-to-end dimensions for threaded end valves shall be established by the manufacturer.

5.4.4 Flanged Ends

5.4.4.1 End flanges shall comply with the dimensional requirements of ASME B16.5. Unless otherwise specified, raised face end flanges shall be provided. This standard does not provide for flanged ends for Class 800 valves.

5.4.4.2 End flanges and bonnet flanges shall be cast or forged integral with, or inertial [5] welded to, the body, except that cast or forged end flanges attached by full penetration butt-welding may be used when approved by the purchaser. When a flange is attached by welding, the welding operator and welding procedure shall be qualified in accordance with ASME *BPVC* Section IX or welders shall be qualified to ISO 9606-1, welding operators to ISO 14732, and welding procedures prepared in accordance with ISO 15607 based on welding procedure qualification test in accordance with ISO 15614-1. The weld quality shall meet the examination acceptance standards requirements of ASME B31.3 or ISO 15649 as specified for normal fluid service [6].

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[5] The inertia welding process was originally approved under Code Case 1609 of the ASME *BPVC*. These requirements have been refined and incorporated into ASME *BPVC* Section IX. QW 262, *Inertia and Continuous Drive Friction Welding*, and QW 362, *Electron Beam Welding (EBW), Laser Beam Welding (LBW), and Friction Welding (FRW)*, cover welding variables for the inertia welding specification (WPS) and welding operator qualifications.

[6] Normal fluid service is one of several application categories specified in the ISO 15649 by reference to the ASME B31.3 piping code.

5.4.4.3 Alignment rings (centering backing rings), integral or loose, used to facilitate welding shall be completely removed after welding.

5.4.4.4 The final wall thickness of the flange attachment weld shall not be less than that required for the body per Table 5.

5.4.4.5 Heat treatment following welding, to ensure that the valve body and flange materials are suitable for the full range of service conditions, shall be performed as required by Table A.4, unless otherwise specified by the purchaser.

5.4.4.6 The finished weld shall be free of cracks and shall show no indication of lack of fusion or incomplete penetration. The finished weld shall be ground, or otherwise finished to provide a smoothly contoured surface, and have a surface finish of Ra ≤ 500 μin. (Ra ≤ 12.5 μmm).

5.4.4.7 Face-to-face dimensions for flanged end valves, Class 150, Class 300, and Class 600, shall be in accordance with either ASME B16.10 or ISO 5752 Basic Series 3, Series 4, and Series 5 for gate valves; and Series 5 and Series 10 for Class 150 and Class 600 globe and check valves. Face-to-face dimensions for Class 1500 valves shall be in accordance with ASME B16.10. The tolerance for face-to-face dimensions shall be ±0.062 in. (±1.6 mm).

5.4.5 Butt-welding Ends

5.4.5.1 Unless otherwise specified by the purchaser, butt-welding ends shall be in accordance with Figure 1 and Table 7. The inside and outside surfaces of valve welding ends shall be machine-finished overall. The contour within the envelope is at the option of the manufacturer unless specifically ordered otherwise. Intersections should be slightly rounded. For nominal outside diameters and wall thickness of standard steel pipe, see ISO 4200.

5.4.5.2 End-to-end dimensions for butt-welding end valves, with either integral or fabricated stub ends, shall be in accordance with ASME B16.10 except that Class 800 shall be established by the manufacturer.

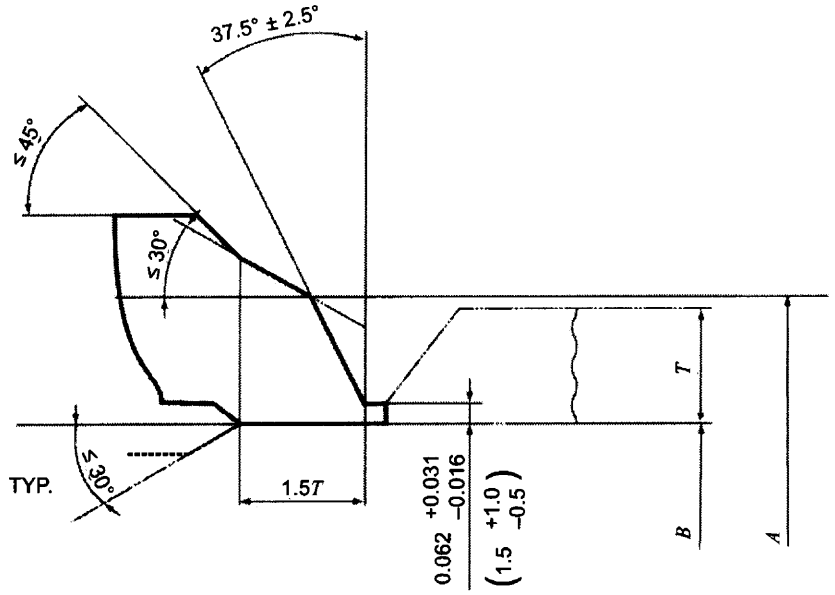
5.4.5.3 For welding stub ends to a valve body, the welding qualifications, heat treatment, and examination requirements shall be in accordance with 5.4.4.2.

5.4.6 Body Seats

5.4.6.1 Integral seats with overlays per Table 12 (CN) are permitted. Integral body seats (without overlays) are permitted in austenitic stainless steel and other Group 2 material bodies. An austenitic stainless steel or a hard facing material may be weld-deposited either directly on a valve body or on a separate body seat ring. For gate valve seat rings where the hard facing is applied by a plasma arc or a laser process, seating surfaces shall have a minimum finished facing material thickness of 0.020 in. (0.5 mm). All other weld-deposited seating surfaces shall have a minimum finished facing material thickness of 0.039 in. (1 mm). Body seating surfaces shall not have sharp corners, e.g. corners with an edge disposed to cause damage in conjunction with gate or disc seating surfaces at either the inner or outer seat circumference.

5.4.6.2 Except as provided in 5.4.6.1, valve bodies shall have separate removable seat rings that are threaded, rolled or pressed in place, however, rolled or pressed seat rings shall not be used with globe valves or lift check valves unless they are seal welded. Sealing compounds or greases shall not be used when assembling seat rings, however, a light lubricant having a viscosity no greater than kerosene may be used to prevent galling when assembling mating surfaces.

5.4.6.3 The inside diameter of the body seat flow passageway shall be in accordance with Table 3 for standard bore valves and Table 4 for full-bore valves.



where

A is the nominal outside diameter of the welding end;
B is the nominal inside diameter of the pipe;
T is the nominal wall thickness of the pipe.

Figure 1 Butt-welding Ends

Table 7 Butt-welding End Diameters

NPS (DN)	*A* in. (mm)
1/4 (8)	0.540 (13.7)
3/8 (10)	0.675 (17.1)
1/2 (15)	0.840 (21.3)
3/4 (20)	1.050 (26.7)
1 (25)	1.315 (33.4)
1 1/4 (32)	1.660 (42.2)
1 1/2 (40)	1.900 (48.3)
2 (50)	2.375 (60.3)
2 1/2 (65)	2.875 (73.0)
3 (80)	3.500 (88.9)
4 (100)	4.500 (114.3)
NOTE 1 The tolerance for diameter *A* shall be ±0.032 in. (±1 mm) for NPS ≤ 3/4 (DN ≤ 20) and ±0.09/ 0.032 in. (+2.5/ 1 mm) for NPS ≥ 1 (DN ≥ 25) (see Figure 1).	
NOTE 2 The tolerance for diameter B shall be ±0.032 in. (±1 mm) (see Figure 1).	

5.5 Valve Bonnet or Cover

5.5.1 The bonnet of a gate or globe valve or the cover of a check valve shall be secured to the body, subject to the requirements of 5.5.2 to 5.5.8, by one of the following methods:

— bolting;

— welding;

— threaded with a seal weld;

— threaded union nut, provided the valve is of Class ≤ 800.

5.5.2 Gasketed joints shall be of a design that confines the gasket and prevents its over-compression. At assembly, all gasket contact surfaces shall be free of heavy oils, grease and sealing compounds. A light coating of lubricant, no heavier than kerosene, may be applied if needed to assist in proper gasket assembly.

5.5.3 Unless otherwise specified in the purchase order, the bonnet joint shall be fitted with a spiral wound gasket of type 304, 304L, 316, or 316L stainless steel winding and filler material suitable for a valve operating temperature range of –20 °F to 1000 °F (–29 °F to 540 °F).

5.5.4 Bonnet and body flange bolting bearing surfaces shall be parallel to the flange face within 1°. Spot facing or back facing required to meet this requirement shall be in accordance with ASME B16.5.

5.5.5 A bonnet or cover bolted to the body shall be secured by a minimum of four cap screws, studs or stud bolts. Internal socket head cap screws shall not be used. The minimum bolt size permitted is $^{3}/_{8}$ in. or M10. Standard inch series bolting threads in accordance with Class 2A (external) or Class 2B (internal) of ASME B1.1 shall be used except if the purchaser specifies metric series bolting. When metric threads are used they shall meet Class 6H (internal) or Class 6G (external) of ASME B1.13M.

5.5.6 Bolted bonnet and bolted cover joints, and threaded bonnet or threaded cover joints shall be in accordance with the requirements of ASME B16.34, Paragraph 6.4.

5.5.7 Bonnets welded directly to valve bodies shall be secured by a full strength weld having two or more welding passes (layers), unless otherwise specified by the purchaser. The thickness of the deposited weld shall be not less than the required wall thickness of the valve body per the requirements of Table 5. The weld quality shall meet the examination acceptance standards requirements of ASME B31.3 or ISO 15649 as specified for normal fluid service [7].

The welding operator and welding procedure qualifications, heat treatment and examination requirements shall be in accordance with 5.4.4.2. Bonnet to body full strength welds and seal welds shall be postweld heat treated in accordance with the provisions of 5.4.4.2 and Table A.4, except that:

a) seal welds of P4 and P5 materials [8] are exempt when a procedure is used that provides a weld hardness that is ≤ 235 HB, and

b) all welds are exempt from solution annealing requirements.

[7] Normal fluid service is one of several application categories specified in the ISO 15649 by reference to the ASME B31.3 piping code.
[8] For materials designated P4 and P5, see ASME B31.3 or ISO 15649.

5.6 Wedge or Disc

5.6.1 Seating Surfaces

Wedge or disc seating surfaces shall be integral or have a facing of weld metal. Weld-deposited seating surfaces shall have a minimum finished facing material thickness of 1 mm. A wedge or disc of solid metal equal to the trim material (CN) is permitted (see 6.1.4).

5.6.2 Gate Valve Wedges

5.6.2.1 Gate valves shall be provided with a one-piece wedge gate. The installed wedge gate outer seating surfaces shall be free of sharp edges so as not to score or gouge the body seating surfaces during opening or closing.

5.6.2.2 A slot near the top of the wedge gate shall be provided to receive the button or tee-head stem connection. The wedge gate shall be guided in the body in a manner that prevents rotation and leads the gate re-entry between the seats.

5.6.2.3 The wedge gate shall be designed to account for seat wear. The dimensions that fix the position of the wedge gate seats relative to the body seats shall be such that the wedge gate, starting from the time when the valve is new, can move into the seats, should the seats wear, a distance defined as wear travel. Wear travel is in a direction parallel with the valve stem. The required minimum wear travel, h_w, varies with valve size in accordance with Table 8.

Table 8 Wear Travel for Gate Valves

NPS	Minimum Wear Travel Distance h_w in. (mm)	DN
1/4 ≤ NPS ≤ 3/4	0.039 (1)	8 ≤ DN ≤ 20
1 ≤ NPS ≤ 1 1/4	0.06 (1.5)	25 ≤ DN ≤ 32
1 1/2 ≤ NPS ≤ 2 1/2	0.08 (2)	40 ≤ DN ≤ 65
3 ≤ NPS ≤ 4	0.12 (3)	80 ≤ DN ≤ 100

5.6.3 Globe Valve Disc

5.6.3.1 Globe valves shall be provided with discs that are nonintegral with the stem. The disc shall have a conical (plug) seating face or, when specified by the purchaser, a flat seating face.

5.6.3.2 When assembled, the globe valve disc-to-stem retaining design shall be such that the disc cannot become detached from the stem as a result of flow-induced vibrations or attached piping movement. The means of disc-to-stem retention shall be of a design that allows the disc to align with the valve seat.

5.6.4 Check Valve Disc

5.6.4.1 Check valves shall be provided with piston, ball or swing type discs.

5.6.4.2 Piston type and ball type check valve discs shall be guided over the full length of their travel. The guide and disc combination shall be designed so that a damping of the movement occurs towards the top end of the disc travel.

5.6.4.3 Piston check and ball check valves shall be designed so that, when in the fully opened position, the net flow area between the disc and the body seat is greater than or equal to that of the seat opening corresponding to the seat diameter shown in Table 1.

5.6.4.4 Disc-to-hinge retaining nuts shall be positively secured by mechanical means.

5.7 Stem

5.7.1 Stems are designated as either inside screw (ISRS) or outside screw (OS & Y). The reference standard design is OS & Y. Stems with inside screw shall be limited to gate and globe valves having pressure designation Class ≤ 800 in the nominal size range 1/4 ≤ NPS ≤ 2 1/2 (8 ≤ NPS 65).

5.7.2 The minimum stem diameter, d_s, for standard bore gate and globe valves, measured where the stem passes through the packing, shall be in accordance with Table 9. These are specified minimum values, not design minimum values. The manufacturer, taking into account the stem material, the valve design and the specified operating conditions, is responsible for determining if a larger diameter stem is required.

5.7.3 The minimum stem diameter, d_s, for full-bore gate and globe valves shall be per Table 10.

Table 9 Minimum Stem Diameter for Standard Bore Valves

NPS	Minimum Stem Diameter d_s in. (mm)			DN
	Class 150, Class 300, Class 600, Class 800	Class 1500		
	Gate or Globe Valves	Gate Valves	Globe Valves	
1/4	9/32 (7.0)	13/32 (10.0)	13/32 (10.0)	8
3/8	9/32 (7.0)	13/32 (10.0)	13/32 (10.0)	10
1/2	11/32 (8.5)	13/32 (10.0)	13/32 (10.0)	15
3/4	3/8 (9.5)	7/16 (11.0)	7/16 (11.0)	20
1	7/16 (11.0)	9/16 (14.0)	9/16 (14.0)	25
1 1/4	1/2 (12.5)	5/8 (15.5)	5/8 (15.5)	32
1 1/2	9/16 (14.0)	5/8 (15.5)	5/8 (15.5)	40
2	5/8 (15.5)	21/32 (16.5)	21/32 (16.5)	50
2 1/2	11/16 (17.5)	3/4 (19.0)	—	65
3	3/4 (19.0)	1 (25.0)	—	80
4	7/8 (22.0)	1 1/8 (28.5)	—	100

5.7.4 The stem shall be one-piece wrought material. Stems fabricated by welding are not permitted. The stem surface that passes through the packing shall have a surface finish value of Ra ≤ 32 μin. (0.80 μm)

5.7.5 The stem threads shall be of trapezoidal form in accordance with ASME B1.5 and ASME B1.8 or ISO 2902, ISO 2903 and ISO 2904, with nominal dimensional variations allowed. Stem threads shall be such that a direct-operated handwheel rotated in a clockwise direction will close the valve. The major diameter of the stem threads shall not be less than 0.059 in. (1.5 mm) below that of the actual stem diameter (see 5.7.2).

5.7.6 The means of stem-to-wedge/disc attachment shall be designed so as to prevent the stem from becoming disengaged from the wedge/disc while the valve is in service. For attachment to the wedge/disc, the stem shall have

Table 10 Minimum Stem Diameter for Full-bore Valves

NPS	Minimum Stem Diameter, d_s, in. (mm)			DN
	Class 150, Class 300, Class 600, Class 800	Class 1500		
	Gate or Globe Valves	Gate Valves	Globe Valves	
1/4	9/32 (7.0)	13/32 (10.0)	13/32 (10.0)	8
3/8	11/32 (8.5)	13/32 (10.0)	13/32 (10.0)	10
1/2	3/8 (9.5)	7/16 (11.0)	7/16 (11.0)	15
3/4	7/16 (11.0)	9/16 (14.0)	9/16 (14.0)	20
1	1/2 (12.5)	5/8 (15.5)	5/8 (15.5)	25
1 1/4	9/16 (14.0)	5/8 (15.5)	5/8 (15.5)	32
1 1/2	5/8 (15.5)	21/32 (16.5)	21/32 (16.5)	40
2	11/16 (17.5)	3/4 (19.0)	—	50
2 1/2	3/4 (19.0)	1 (25.0)	—	65
3	7/8 (22.0)	1 1/8 (28.5)	—	80
4	1 (25.4)	1 1/8 (28.5)	—	100

an integral tee for outside stem thread gate valves and an integral cylindrical button for inside stem thread gate valves and for all globe valves. Threaded or pinned stem attachment means shall not be used.

5.7.7 Valve stems, except those used in globe valves where the backseat function is with a disk component, shall include a conical or spherical raised surface that will seat against the bonnet backseat when the wedge/disc is at its full open position. A back seating arrangement is a requirement for all gate and globe valves and, as such, is not meant to imply a manufacturer's recommendation for its use for the purpose of adding or replacing packing while the valve is under pressure.

5.7.8 Gate valve stem design shall be such that, for valves with outside screw stems, the strength of the stem-to-wedge gate connection and the part of the stem within the valve pressure boundary shall, under axial load, exceed the strength of the stem at the root of the operating thread. For both outside and inside screw valves, the design of the stem, wedge gate and stem connection to the wedge gate shall be such that, were mechanical failure to occur, it would do so at a stem section outside the valve pressure boundary.

5.7.9 The means of stem disk attachment in globe valves shall be such that the disk articulates in order to permit alignment with the seat. The stem thrust point against the disk shall be rounded and the disk components making up the means of disk-to-stem assembly attachment shall be positively secured to prevent loosening due to fluid or piping induced vibration.

5.8 Stem Nut or Stem Bushing

5.8.1 The internal thread in the stem nut (yoke sleeve or stem bushing) shall be of trapezoidal form in accordance with ASME B1.5 and ASME B1.8 or ISO 2902, ISO 2903, and ISO 2904 with nominal dimensional variations permitted.

5.8.2 The fixed stem nut used in globe valves shall be threaded or otherwise fitted onto the yoke and positively locked in position.

5.9 Packing, Packing Chamber, and Gland

5.9.1 The minimum uncompressed total height of the installed packing, h_p, shall be in accordance with Table 11. The packing height values in Table 11 are directly related to the stem diameters shown in Table 9 and Table 10. When a stem diameter greater than that of Table 9 and Table 10 is used, the manufacturer shall determine if the uncompressed packing height needs to be increased.

Table 11 Minimum Uncompressed Packing Height

NPS	Minimum Uncompressed Packing Height h_p in. (mm)		DN
	Class 150, Class 300, Class 600, Class 800	Class 1500	
1/4	0.47 (12)	0.87 (22)	8
3/8	0.47 (12)	0.87 (22)	10
1/2	0.60 (15)	0.87 (22)	15
3/4	0.60 (15)	0.98 (25)	20
1	0.98 (25)	1.18 (30)	25
1 1/4	0.98 (25)	1.50 (38)	32
1 1/2	1.10 (28)	1.50 (38)	40
2	1.10 (28)	1.50 (38)	50
2 1/2	1.22 (31)	1.73 (44)	65
3	1.50(38)	1.85 (47)	80
4	1.73 (44)	1.97 (50)	100

5.9.2 The packing chamber bore shall have a surface finish, Ra of 125 μin. (3.2 μm) or smoother. The bottom of the packing chamber shall be flat.

5.9.3 A gland shall be provided for packing compression. The gland may be either a self-aligning gland or an integral part of the gland flange. The outer end of a separate gland shall have a lip whose outer diameter exceeds the diameter of the packing chamber bore so as to block its entry into the bore.

5.9.4 Packing in the form of a single-piece spiral shall not be used.

5.10 Packing Retention

5.10.1 Packing and packing gland retention for valves with outside screw stems shall be by bolting through two holes in a gland flange that is either separate from, or integral to, the gland. Open gland flange bolt slots shall not be used.

5.10.2 Gland flange bolts shall be hinged eyebolts, headed bolts, stud bolts or studs. Hexagon nuts shall be used.

5.10.3 The gland bolting for gate and globe valves shall not be anchored to the bonnet or yoke through a fillet welded attachment or stud welded pins.

5.10.4 Packing and packing gland retention for valves with inside screw stems shall be by a packing nut threaded directly onto the valve bonnet or in accordance with 5.10.1, 5.10.2, and 5.10.3. For application restrictions applying to inside screw stem threads, see 5.7.

5.11 Handwheel

5.11.1 Gate and globe valves shall be supplied with direct operated handwheels that close the valve when turned in a clockwise direction.

5.11.2 The handwheel shall be a spoke and rim design that makes an effective grip possible.

5.11.3 The handwheel shall be secured to the stem or stem nut by a threaded handwheel nut.

6 Materials

6.1 Trim Materials

6.1.1 Trim items include the stem, the wedge/disc seat surfaces and the body or seat ring seat surfaces. The trim combination number (CN) identifies both the stem material and the associated seating surface material. Except as noted in 6.1.2 and 6.1.3 or when otherwise agreed between the purchaser and manufacturer, the trim material combinations shall be in accordance with Table 12. Standard trim material usage is specific to the valve body and body to bonnet or cover bolting material. Standard trim recommendations are given in Annex F. Valves with other CN trim requirements shall be specified in the purchase order.

6.1.2 Trims of free machining materials, e.g. 13Cr steel grades containing additions of elements such as lead, selenium or sulphur to enhance machinability, are intentionally not listed in Table 12. They may be used only when specified by the purchaser, in which case they shall be identified by the appropriate trim number from Table 12 plus 100. The affected trim CN numbers would thus be identified as, e.g. CN 101, 104, 105, 106, 107, and 108. Correspondingly, hardfacing or other material overlays shall not be applied to free machining grades of base materials unless so specified by the purchaser.

6.1.3 The trim material shall correspond to a listed CN taking account of the recommendations of Annex F, except that an alternative CN may be furnished in accordance with Table 13. When an alternative CN from Table 13 is specified by a purchaser, a Table 12 listed CN shall not be substituted.

6.1.4 The base material of the valve wedge/disc and separate body seat ring, when used, shall be of a nominal material composition equal to the body or to that of the stem material; except for wedge or disc material made of solid trim material as allowed by 5.6.1.

Trim Number (CN)	Nominal Trim (p)	Seat Surface Hardness (HB) minimum (a)	Seat Surface Material Type (b)	Seat Surface Typical Specifications Grade			Stem		
				Cast/Bar	Forged	Welded	Material Type (b)	Typical Specifications Type	Stem Hardness (HB)
1	F6	(c)	13Cr	ASTM A217 (CA15) or A743 (CA40)/A276 (410), A276 (420), or A479 (410)	ASTM A182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276 (410) or (420)	200 min. 275 max.
2	304	(d)	18Cr-8Ni	ASTM A351 (CF8)/A276 (304), A312 (TP304), or A479 (304)	ASTM A182 (F304)	AWS A5.9 ER308	18Cr-8Ni	ASTM A276 (304)	(d)
3	F310	(d)	25Cr-20Ni	A276 (310)	ASTM A182 (F310)	AWS A5.9 ER310	25Cr-20Ni	ASTM A276 (310)	(d)
4	Hard F6	750 (e)	Hard 13Cr	ASTM A217 (CA15) or A743 (CA40)/A276 (410), A276 (420), or A479 (410)	ASTM A182 (F6a)		13Cr	ASTM A276 (410) or (420)	200 min. 275 max.
5	Hardfaced	350 (e)	Co-Cr A (g)			AWS 5.21 ER CoCrA	13Cr	ASTM A276 (410) or (420)	200 min. 275 max
6	F6 and	250 (i)	13Cr and	ASTM A217 (CA15) or A743 (CA40)/A276 (410), A276 (420), or A479 (410)	ASTM A182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276 (410) or (420)	200 min. 275 max
	Cu-Ni	175 (i)	Cu-Ni		(k)				
7	F6 and	250 (i)	13Cr and	ASTM A217 (CA15) or A743 (CA40)/A276 (410), A276 (420), or A479 (410)	ASTM A182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276 (410) or (420)	200 min. 275 max.
	Hard F6	750 (i)(f)	Hard 13Cr	ASTM A217 (CA15) or A743 (CA40)/A276 (410), A276 (420), or A479 (410)	ASTM A182 (F6a)				
8	F6 and	250 (i)	13Cr and	ASTM A217 (CA15) or A743 (CA40)/A276 (410), A276 (420), or A479 (410)	ASTM A182 (F6a)	AWS A5.9 ER410	13Cr	ASTM A276 (410) or (420)	200 min. 275 max.
	Hardfaced	350 (i)	Co-Cr A (g)			AWS 5.21 ER CoCrA			
9	Monel	(d)	Ni-Cu Alloy		MFG Standard		Ni-Cu Alloy	MFG Standard	(d)
10	316	(d)	18Cr-8Ni-Mo	ASTM A351 (CF8M)/A276 (316), A312 (TP316), or A479 (316)	ASTM A182 (F316)	AWS A5.9 ER316	18Cr-8Ni-Mo	ASTM A276 (316)	(d)
11	Monel and	(d)	Ni-Cu Alloy and		MFG Standard		Ni-Cu Alloy	MFG Standard	(d)
	Hardfaced	350 (i)	Co-Cr A (g)			AWS 5.21 ER CoCrA			
12	316 and	(d)	18Cr-8Ni-Mo and	ASTM A351 (CF8M)/A276 (316), A312 (TP316), or A479 (316)	ASTM A182 (F316)	AWS A5.9 ER316	18Cr-8Ni-Mo	ASTM A276 (316)	(d)
	Hardfaced	350 (i)	Co-Cr A (g)			AWS 5.21 ER CoCrA			
13	Alloy 20	(d)	35Ni-35Fe-20Cr-Cb	ASTM A351 (CN7M)/B464 (N08020) or B473 (N08020)	ASTM B462 (N08020)	AWS A5.9 ER320	35Ni-35Fe-20Cr-Cb	ASTM B473 (N08020)	(d)
14	Alloy 20 and	(d)	35Ni-35Fe-20Cr-Cb	ASTM A351 (CN7M)/B464 (N08020) or B473 (N08020)	ASTM B462 (N08020)	AWS A5.9 ER320	35Ni-35Fe-20Cr-Cb	ASTM B473 (N08020)	(d)
	Hardfaced	350 (i)	Co-Cr A (g)			AWS 5.21 ER CoCrA			
15	Hardfaced	350 (e)	Co-Cr A (g)			AWS 5.21 ER CoCrA	18Cr-8Ni	ASTM A276 (304)	(d)
16	Hardfaced	350 (e)	Co-Cr A (g)			AWS 5.21 ER CoCrA	18Cr-8Ni-Mo	ASTM A276 (316)	(d)
17	Hardfaced	350 (e)	Co-Cr A (g)			AWS 5.21 ER CoCrA	18Cr-10Ni-Cb	ASTM A276 (347)	(d)
18	Hardfaced	350 (e)	Co-Cr A (g)			AWS 5.21 ER CoCrA	35Ni-35Fe-20Cr-Cb	ASTM B473 (N08020)	(d)

NOTE Cr = Chromium; Ni = Nickle; Co = Cobalt; Cu = Copper; (a) = HB (formerly BHN) is the symbol for the Brinell hardness per ASTM E10; (b) = Free machining grades of 13Cr are prohibited; (c) = Body seat(s) and wedge/disc seat surfaces should be 250 HB minimum with a 50 HB minimum differential between the body seat(s) and wedge/disc seat surfaces; (d) = Manufacturer's standard hardness; (e) = Differential hardness between the body seat(s) surface(s) and wedge/disc seat surfaces is not required; (f) = Case hardness by nitriding to a thickness of 0.13 millimeters (0.005 inch) minimum; (g) This classification includes such trademark materials as Stellite 6™ *, Stoody 6™ * and Wallex 6™ *, the use of CoCr is an acceptable substitute for CoCrA in globe and check valves; (i) Hardness differential between the body seat(s) surface(s) and wedge/disc seat surfaces shall be the manufacturer's standard; (k) = Manufacturer's standard with 30 Ni minimum; (n) = Per manufacturer's standard if not hardfaced, 250 HB minimum if hardfaced; (p) when HF trim is specified, the gate,globe or check valve wedge/disc may be solid cast CoCr alloy.

* This term is used as an example only, and does not constitute an endorsement of this product by API.

Table 12 Nominal Seating Surfaces, Stem, or Weld-deposit Materials and Hardness

Table 13 Alternative CNs

Specified CN	Alternative CN
2	10
8	5
15	16

Table 14 Materials for Valve Parts Other Than Trim Items

Part	Material
body and bonnet [a b c]	a forging or casting material as selected from ASME B16.34, Group 1 and Group 2
cover plate [a b c]	a forging, casting, or plate material as selected from ASME B16.34, Group 1 or Group 2
bonnet extension and union nut [c]	a material of the same nominal composition as the bonnet as selected from the list of material from which the body was selected
bellows	see B.6
bellows fittings	attachment rings and other bellows fittings shall be of materials suitable for attachment welding of the bellows to the valve body, bonnet or stem as applicable
wedge/disc	the base material of the wedge/disc shall be of a nominal material composition equal to the body material or the stem material (see 6.1.4)
yoke, separate	carbon steel or similar material composition as the bonnet
bolting: body-to-bonnet and body-to-cover	unless other materials are agreed between the purchaser and manufacturer the bolting material shall be in accordance with Annex F
bolting: gland and yoke	bolting materials of a Type 300 or Type 400 series stainless steel. Also, material at least equal to either ASTM A307-Grade B or EN 10269-C35E (1.1181) may be used for yoke bolting
seat ring	the base material of the seat ring, when used, shall be of a nominal material composition equal to the body material or the stem material (see 6.1.4)
gland flange	steel
packing nut	steel
gland	material with a melting point above 1750 °F (955 °C)
packing	nonasbestos material suitable for steam and petroleum fluids over a temperature range of –20 °F to 1000 °F (–29 °C to 540 °C) and containing a corrosion inhibitor
gaskets	see 5.5.3
stem nut or stem bushing	austenitic ductile iron, 13Cr steel, or copper alloy having a melting point above 1750 °F (955 °C)
misc. internal parts (i.e. spring, hinge pin, disc nut)	similar material composition as would be used for a valve stem, based on the valve trim requirement
handwheel	malleable iron, carbon steel, or ductile iron
identification plate	a corrosion resistant metal

[a] A preference for body and bonnet or cover material form (e.g. forging or casting) requires specification by the purchaser (see Annex E).

[b] For valve sizes NPS ≤ 2 (DN ≤ 50), the reference standard design specifies forging material for the body and bonnet, or cover (see 5.1).

[c] Bonnet nuts, welded, and threaded and seal welded bonnets, and bonnets of ISRS valves may be made from bar stock. The bar stock shall be listed and meet the requirements of Table 1, Group 1 and Group 2 of ASME B16.34, including the notes, for the appropriate material group. Free machining material shall not be used.

6.2 Materials Other Than Trim

6.2.1 Materials for valve parts other than trim items shall be in accordance with Table 14.

6.2.2 Defects in the cast or forged valve pressure shell materials revealed during manufacturing operations or testing may be repaired as permitted by the most nearly applicable specification for forgings or castings. All repair welding shall be in accordance with a written procedure. Filler rods used for repairs shall be such as to produce a repair weld having characteristics similar to the parent metal. Repairs shall be heat treated after repair welding in accordance with the material specification.

7 Marking

7.1 Legibility

Each valve identified as being in accordance with this standard shall be clearly marked as such on the body and/or on an identification plate in accordance ASME B16.34 and the following. In the event of conflict, the requirements of the present clause shall apply.

7.2 Body Marking

7.2.1 Valve bodies shall be marked with the following information:

— manufacturer's name or trademark;

— body material identification;

— pressure class designation number (e.g. Class 1500);

— nominal size, as either, NPS number [e.g. 2 or the DN followed by the appropriate size number (e.g. DN 50)];

— an arrow on globe valve bodies to indicate the preferred direction for which the valve is intended to be installed;

— an arrow on check valve bodies to indicate the flow direction for which the valve is intended to be installed.

7.2.2 For valves NPS < 1 (DN < 25), if the size or shape of the valve body precludes the inclusion of all the required markings, one or more may be omitted provided that they are shown on the identification plate. The sequence of omission shall be as follows:

a) nominal size,

b) pressure class designation,

c) body material.

7.3 Ring Joint Groove Marking

Body end flanges require special marking when the end flanges are grooved for ring type joint assembly. When so grooved, the ring joint gasket groove number, e.g. R25, shall be stamped on the rim of both end flanges. Ring joint gasket groove numbers are given in ASME B16.5.

7.4 Identification Plate Marking

Each valve shall be provided with at least one identification plate. The identification plate marking, as applicable, shall include but is not limited to:

— the manufacturer's name;

— compliance marking (i.e. "API 602/ASME B16.34);

— pressure class designation (e.g. Class 800);

— manufacturer's identification number (e.g. catalog number);

— trim identification for the stem, seat, and disk;

— maximum pressure at 100 °F (38 °C) using either psi units at 100 °F, bar units at 38 °C or MPa units at 38 °C;

— limiting temperature, if applicable;

— limiting pressure, if applicable; and

— any special use limitation.

7.5 Weld Fabrication Marking

When extensions for stub ends, flanges, extended body ends or bellows enclosures are welded to a valve or a valve body-to-bonnet is fabricated by welding or seal welding, the identification plate, the extension, body or bonnet shall be marked as follows.

— The letters "WLD."

— The material grade designation for the extension if other than that of the body (or bonnet) of the attachment.

— The postweld heat treatment employed using the following identification letters: "SR" when stress relieved, "SA" when solution annealed, "A" when annealed, "N" when normalized, "NT" when normalized and tempered, "QT" when quenched and tempered. When the aforementioned symbols do not apply symbols consistent with the specifications for the materials joined are to be used.

These identification markings shall be located so as to avoid confusion with other required markings.

8 Testing and Inspection

8.1 Pressure Tests

Each assembled valve shall be pressure tested in accordance with the requirements of API 598.

8.2 Inspection

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

8.2.2 If inspection by the purchaser is specified in the purchase order, inspection shall be in accordance with API 598. Examination by the manufacturer shall be as specified in API 598.

9 Preparation for Dispatch

9.1 After testing, the test fluid shall be drained from each valve in preparation for despatch.

9.2 Stem packing shall be in place and the remaining packing adjustment, with the gland tight, shall be greater than one packing width. Packing gland bolting shall not be loosened for shipment, unless so specified by the purchaser.

9.3 Except for austenitic stainless steel valves, unmachined exterior valve body and bonnet surfaces shall have a rust-preventative coating.

9.4 Except for austenitic stainless steel valves, machined or threaded surfaces shall be coated with an easily removable rust inhibitor.

9.5 Protective covers or caps of wood, wood fibre, plastic or metal shall be securely affixed to valve ends of flanged and butt-welding end valves in order to safeguard the gasket surfaces and weld end preparations. The cover design shall be such that the valve cannot be installed in a pipeline with the protective cover in place.

9.6 Protective end plugs of wood, wood fibre, plastic or metal shall be securely inserted into the valve ends of socket welding and threaded end valves. The protective plug design shall be such that the valve cannot be installed in a pipeline with the plug in place.

9.7 At the time of shipment, the wedge/disc of a gate or a globe valve shall be in the closed position.

9.8 When special packaging is necessary, the purchaser shall specify the requirements in the purchase order.

Annex A
(normative)

Requirements for Extended Body Gate Valve Bodies

A.1 Scope

This annex specifies design, materials, fabrication, and examination requirements for gate valve bodies to be used in valve assemblies identified as extended body valves. The valve body requirements stipulated in this annex, in combination with related gate valve requirements in the body of this standard, constitute the requirements applicable to extended body valves. An extended valve body has one end fitted with either a conventional internal taper pipe thread connection or a conventional internal socket welding connection. The opposite body end is a prolongation i.e. it is fitted with an extension that has an external end connection that is either an external taper pipe thread or an external weld end preparation.

A.2 Applicability

A.2.1 Extensions with external taper pipe threads are designated only for Class 800 in nominal sizes $^3/_4 \leq$ NPS ≤ 2 ($20 \leq$ DN ≤ 50).

A.2.2 Extensions with external weld end preparations are designated only for Class 800 and Class 1500 in nominal sizes $^1/_2 \leq$ NPS ≤ 2 ($15 \leq$ DN ≤ 50). Weld end preparations covered include both socket welding and butt-welding types.

A.2.3 Internal socket welding ends or internal taper pipe thread ends are designated only for Class 800 and Class 1500 in nominal sizes $^1/_2 \leq$ NPS ≤ 2 ($15 \leq$ DN ≤ 50).

A.2.4 Extended bodies covered by this standard are for valves whose end connections have the same nominal size for both the internal and the external ends, except that an extended valve body may be furnished with a NPS $^3/_4$ (DN 20) external end and a NPS $^1/_2$ (DN 15) internal end when the assembled valve otherwise meets all requirements for a NPS $^1/_2$ (DN 15) valve.

A.3 Body Configuration

A.3.1 The length of the extension or protrusion, L, required for an extended body, is the distance from the axis of the valve stem to the outer end of the extension's external end preparation. The maximum values for L are specified in Table A.1 and Table A.2. The minimum valve handwheel clearance, the distance between the outer end of the external end preparation, and the outer diameter of the valve handwheel, shall be 2.25 in. (57 mm).

Table A.1 Threaded End Extension for Class 800

NPS	Maximum Length L in. (mm)	Maximum Inside Diameter ID in. (mm)	Minimum Outside Diameter OD in. (mm)	Minimum Wall Thickness T in. (mm)	Maximum Transition Length A in. (mm)	DN
$^3/_4$	4.5 (115)	0.65 (16.5)	1.02 (25.9)	0.19 (4.8)	0.92 (23.4)	20
1	7.0 (180)	0.84 (21.3)	1.28 (32.5)	0.22 (5.6)	1.11 (28.2)	25
1 $^1/_2$	9.0 (230)	1.50 (38.1)	1.87 (47.5)	0.24 (6.1)	1.15 (29.2)	40
2	10.0 (255)	1.87 (47.5)	2.34 (59.4)	0.28 (7.1)	1.18 (30)	50

Table A.2 Welding End Extension for Class 800 and Class 1500

NPS	Length of Welding End *L* in. (mm)		Minimum Outside Diameter *OD* in. (mm)	Minimum Wall Thickness *T* in. (mm)		DN
	Socket	Butt		Class 800	Class 1500	
1/2	≤ 4.0 (≤ 100)	≤ 4.0 (≤ 100)	0.91 (23.1)	0.22 (5.5)	0.22 (5.6)	15
1/2	4.1 to 6.5 (105 ≤ *L* ≤ 165)	4.1 to 6.5 (105 ≤ *L* ≤ 165)	1.06 (26.9)	0.25 (6.3)	0.25 (6.3)	15
1/2	—	6.6 to 8.0 (170 ≤ *L* ≤ 205)	1.25 (31.7)	0.25 (6.3)	0.25 (6.3)	15
3/4	≤ 5.5 (≤ 140)	≤ 5.5 (≤ 140)	1.02 (25.9)	0.19 (4.8)	0.24 (6.1)	20
3/4	5.6 to 8.0 (145 ≤ *L* ≤ 205)	5.6 to 8.0 (145 ≤ *L* ≤ 205)	1.25 (31.7)	0.30 (7.5)	0.30 (7.5)	20
1	≤ 9.0 (≤ 230)	≤ 9.0 (≤ 230)	1.28 (32.5)	0.22 (5.6)	0.28 (7.1)	25
1 1/2	≤ 9.0 (≤ 230)	≤ 9.0 (≤ 230)	1.87 (47.5)	0.25 (6.2)	0.38 (9.7)	40
2	≤ 10.0 (≤ 255)	≤ 10.0 (≤ 255)	2.34 (59.4)	0.30 (7.6)	0.47 (11.9)	50

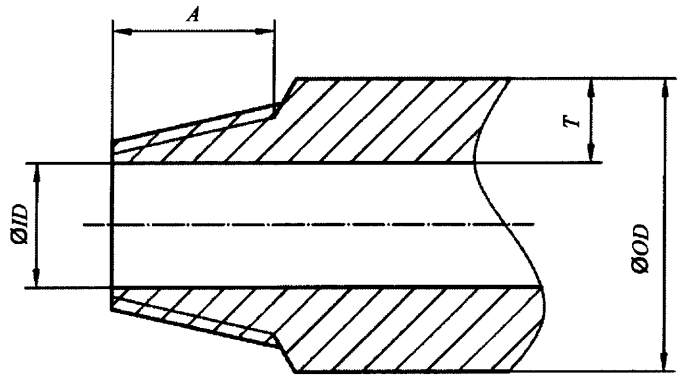


Figure A.1 Threaded End Extension for Class 800

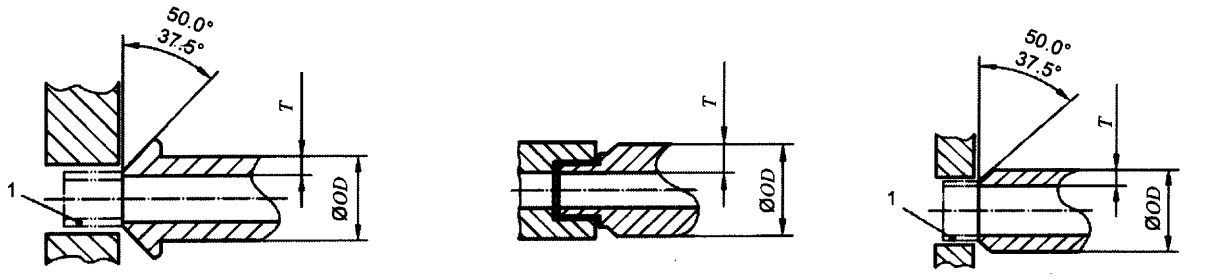
A.3.2 The minimum wall thickness and maximum length for extensions having threaded ends and the dimensions for threaded end preparations for Class 800 extended body valves shall be in accordance with Figure A.1 and Table A.1. The external end threads shall be in accordance with 5.4.3.2 and 5.4.3.3.

A.3.3 The minimum wall thickness and maximum length for Class 800 and Class 1500 valve extensions having either socket welding or butt-welding ends and the dimensions for butt-welding end preparations for extended body valves shall be in accordance with Figure A.2 and Table A.2. The dimensions for socket welding end preparations shall be in accordance with Figure A.3 and Table A.3. The integral backing (centering) ring illustrated in Table A.2 for butt-welding ends is provided at the manufacturer's option. Its length shall not be included when measuring the required length of the extension.

A.3.4 Integrally reinforced extensions, Figure A.2 a), shall have weld ends designed to meet the reinforcing requirements of ASME B31.3.

A.4 Materials

An extension welded to a valve body shall be of a material having a nominal chemical composition corresponding to that of the body material and be listed in ASME B16.34. If a tubular form is used it shall be of seamless construction.



a) Integrally Reinforced End for Welding **b) Socket-welded End** **c) Beveled End for Welding**

Key
1 optional integral backing ring

Figure A.2 Welding End Extension for Class 800 and 1500

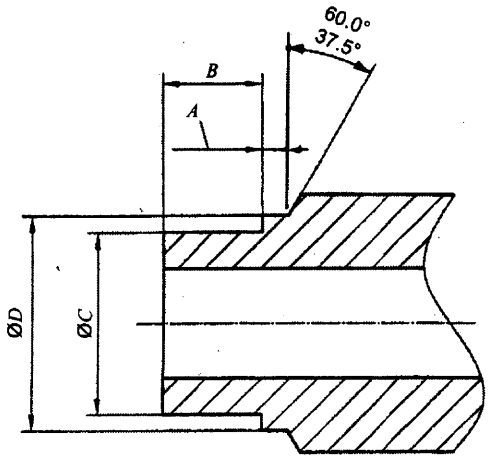


Figure A.3 Socket Welding End Preparation for Class 800 and Class 1500

A.5 Body Extension Construction

A.5.1 An extension shall be cast or forged integral with, or inertial welded to, the body, except that a cast or forged extension attached by full penetration butt-welding may be used when approved by the purchaser. When an extension is attached by welding, the welding operator and welding procedure shall be qualified in accordance with ASME *BPVC* Section IX or welders shall be qualified to ISO 9606-1, welding operators to ISO 14732, and welding procedures prepared in accordance with ISO 15607 based on welding procedure qualification test in accordance with ISO 15614-1. The weld quality shall meet the examination acceptance standards requirements of ASME B31.3 or ISO 15649 as specified for normal fluid service [9].

[9] Normal fluid service is one of several application categories specified in the ISO 15649 by reference to the ASME B31.3 piping code.

Table A.3 Socket Welding End Preparation for Class 800 and Class 1500

NPS	Shoulder Minimum *A* in. (mm)	Socket Length *B* in. (mm)	Socket Diameter *C* in. (mm)	Step Diameter *D* in. (mm)	DN
1/2	0.12 (3)	0.31 (7.9)	0.84 (21.3)	0.90 (22.9)	15
3/4	0.12 (3)	0.44 (11.2)	1.05 (26.7)	1.11 (28.2)	20
1	0.12 (3)	0.44 (11.2)	1.31 (33.3)	1.38 (35.1)	25
1 1/2	0.12 (3)	0.44 (11.2)	1.90 (48.3)	1.96 (49.8)	40
2	0.12 (3)	0.56 (14.2)	2.37 (60.2)	2.44 (62.0)	50
NOTE Tolerances for dimensions *B*, *C*, and *D*: +0.2/ 0.8 for 15 ≤ DN ≤ 40 and ±0.8 for DN 50.					

A.5.2 Alignment rings (centring backing rings), integral or loose, used to facilitate welding shall be completely removed after welding. The welded extension and attachment weld shall have no internal tapers, nor other internal discontinuities, where the taper exceeds a four-to-one ratio in the axial to radial directions.

A.5.3 The final wall thickness of the extension attachment weld shall not be less than that required for the extension by Table A.1 or Table A.2, as applicable.

A.5.4 Heat treatment following welding, to ensure that the valve body and extension materials are suitable for the full range of service conditions, shall be performed as required by Table A.4, unless otherwise specified by the purchaser.

Table A.4 Postweld Heat Treatment

Material	Thickness [a] *t* in. (mm)	Temperature Range °F (°C)	Holding Time [d] hr/in. (min/mm)	Weld Hardness HBN max.
carbon steels	$t > 0.75$ ($t > 19$)	1100 to 1200 (593 to 649)	1 (2.4)	—
alloy steels:				
1/2 % < Cr ≤ 2 %	$t \leq 1/2$ (≤ 13) and TS ≤ 71 ksi	none	—	—
1/2 % < Cr ≤ 2 %	all other	1300 to 1375 (704 to 746)	1 (2.4)	225
2 1/4 % < Cr ≤ 10 %	$t \leq 1/2$ (≤ 13) [c]	none	—	—
2 1/4 % < Cr ≤ 10 %	all other	1300 to 1400 (704 to 760)	1 (2.4)	241
nickel alloy steels	$t > 0.75$ ($t > 19$)	1100 to 1175 (593 to 635)	1 (2.4)	—
austenitic steels [b]	All	solution anneal per material specification		
other materials	All	follow material specification		

[a] Thickness, *t*, is the greater thickness of the pieces being joined by welding.

[b] Except when materials being welded are L-grades or stabilized grades.

[c] For material with Cr ≤ 3 % and C ≤ 0.15 %.

[d] Minimum holding times shall be per ASME B31.3.

A.5.5 The finished weld shall be free of cracks and shall show no indication of lack of fusion or incomplete penetration. The finished weld shall be ground, or otherwise finished to provide a smoothly contoured surface, and have a surface finish of Ra ≤ 500 μin. (Ra ≤ 12.5 μm).

A.6 Marking

Valves that have valve bodies with welded end extensions shall be marked with the fabrication markings in accordance with 7.5. In addition, the body marking shall include the material identification for the extension, if different from the body material.

Annex B
(normative)

Requirements for Valves with Bellows Stem Seals

B.1 Scope

This annex specifies design, materials, fabrication, testing and examination requirements for gate and globe valves having bellows stem seals. The requirements stipulated in this annex, in combination with related gate and globe valve requirements in the body of this standard, constitute the total requirements for bellows stem seal valves. These requirements are applicable for valves in nominal sizes $^1/_2 \leq$ NPS ≤ 2 ($15 \leq$ DN ≤ 50).

B.2 Design

B.2.1 Bellows stem seals do not eliminate the need for providing the stem packing required by 5.9 and 5.10 or the backseat required by 5.7.6. The packing shall be placed so that it functions as the stem seal in the event that bellows seal leakage occurs (see Figure D.3).

B.2.2 One end of the bellows shall be attached to the stem just above the gate or to the disk linkage by welding. The opposite bellows end shall be welded either directly to the valve bonnet, to the valve body or to an intervening ring which in turn is either clamped or welded to the bonnet or body. When needed to accommodate large stem strokes, individual bellows may be welded in series.

B.2.3 Stems in bellows-equipped valves shall be provided with the means to prevent stem rotation and thereby avoid transmitting torsional loads to the bellows.

B.2.4 Valve-to-bellows assemblies shall be designed so that the bellows convolutions or leaves do not buckle or come into rubbing contact with the surrounding body, the bonnet extension or the enclosed stem.

B.2.5 The stem shall be designed to provide the strength necessary to accommodate the 100 °F (38 °C) pressure rating taking into consideration any additional pressure area loads imposed by the inclusion of the bellows. The manufacturer shall determine if the stem diameter needs to be increased over that required by 5.7.2.

B.2.6 A stem-to-gate connection for bellows seal gate valves shall have either a button or T-head end that is designed to fit into a disc slot. Stems shall be constructed in one-piece. Welding or otherwise joining two or more stem pieces is not an acceptable construction.

B.3 Pressure/Temperature Ratings

B.3.1 The bellows assembly for a bellows stem seal valve shall be designed to meet the valve pressure rating at 100 °F (38 °C) with the capability of accommodating a pressure test at 1.5 times the 100 °F (38 °C) pressure rating, while preserving the ability to meet the bellows life cycle requirements of Annex C.

B.3.2 For fluid service above 100 °F (38 °C), the bellows design may limit the valve pressure rating to pressures less than those specified by 4.1 or the temperature to a value less than the maximum specified in 4.1. When this occurs, the valve manufacturer shall publish applicable pressure/temperature ratings and provide these to the user.

B.3.3 Restrictions of temperature or pressure imposed by the bellows assembly design shall be marked on the identification plate (see 7.4).

B.3.4 A bellows stem seal valve shall be limited to applications where temperatures are below the creep range of the bellows material. The definition for temperature for the onset of creep shall be in accordance with ASME B16.34, Annex F.

B.4 Extensions for Bellows Enclosure

B.4.1 The cylindrical bonnet or body extension required to enclose a bellows stem seal (see Annex D) shall have a minimum wall thickness the greater of either the body minimum wall thickness specified in Table 3 or the wall thickness specified in Table 5, using two-thirds of the actual local inside diameter of the extension. In the event that the material selected for the extension has a pressure/temperature rating less than the body material, considering the entire material temperature range, the minimum wall thickness of the extension shall be increased, as necessary, so that its pressure/temperature rating equals or exceeds that of the body.

B.4.2 The bonnet or body extension that envelops the bellows shall be integral, attached by a threaded connection that is seal welded or attached by welding.

B.4.3 The weld for an extension that is welded directly to the bonnet or body shall be a full penetration butt weld. The welding operator and welding procedure shall be qualified in accordance with ASME *BPVC* Section IX or welders shall be qualified to ISO 9606-1, welding operators to ISO 14732, and welding procedures prepared in accordance with ISO 15607 based on welding procedure qualification test in accordance with ISO 15614-1. Heat treatment following welding, to ensure that the bonnet and extension materials are suitable for the full range of service conditions, shall be performed as required by Table A.4. The weld quality shall meet the examination acceptance standards requirements of ASME B31.3 or ISO 15649 as specified for normal fluid service.

B.5 Type Testing

B.5.1 The adequacy of each design of bellows and its means of attachment, including attachment welds, shall be verified by type testing in accordance with Annex C.

B.5.2 A bellows assembly design change that alters cyclic life demonstrated by a type test (e.g. a change in bellows material, bellows thickness, number of plies, welding geometry, or welding procedure) requires an entirely new life cycle type test.

B.5.3 When the bellows or bellows assembly manufacturer is changed, or there is a change in the method of manufacture of the bellows or bellows assembly, an entirely new life cycle type test is required.

B.5.4 A change in the number of convolutions of a qualified bellows (increasing or decreasing the overall bellows height) is not of itself cause for a new life cycle test, provided that the installed bellows travel ratio for compression and extension is less than or equal to that of the qualified bellows. These ratios are defined as:

$$R_c = \frac{h_f - h_c}{h_f}$$

and

$$R_e = \frac{h_e - h_f}{h_f}$$

where

R_c is the bellows compression ratio;

R_e is the bellows extension ratio;

h_f is the unrestrained (free) bellows height;

h_c is the installed compressed bellows height;

h_e is the installed extended bellows height.

B.5.5 A bellows valve shall be designed such that the qualified extension and compression ratios cannot be exceeded.

B.6 Materials

B.6.1 Typical materials for bellows are listed in Table B.1. Some services may require special bellows materials. When specified by the purchaser, materials other than those listed in Table B.1 may be selected for the bellows.

Table B.1 Bellows Material Chart

Material Type	Typical Specification
304 Stainless	ASTM 240/ASTM A312
304L Stainless	ASTM 240/ASTM A312
316 Stainless	ASTM 240/ASTM A312
316L Stainless	ASTM 240/ASTM A312
321 Stainless	ASTM 240/ASTM A312
347 Stainless	ASTM A240/ASTM A312
Alloy 600	ASTM B167/ASTM B168
Alloy 625	ASTM B443
Alloy 718	ASTM B670
Alloy 400	ASTM B127/ASTM B165
Alloy C22	ASTM B575/ASTM B622
Alloy C276	ASTM B575/ASTM B622

B.6.2 Fabrication welding operations related to bellows or bellows assemblies shall be performed by qualified welding operators using qualified welding procedures. The welding operator and welding procedure shall be qualified in accordance with ASME BPVC Section IX or welders shall be qualified to ISO 9606-1, welding operators to ISO 14732, and welding procedures prepared in accordance with ISO 15607 based on welding procedure qualification test in accordance with ISO 15614-1.

B.6.3 The attachment welds of bellows and/or bellows end fittings to the valve body or bonnet shall be exempt from postweld heat treatment requirements

B.6.4 Bellows material shall not be repaired by welding.

B.6.5 The bellows material shall be either seamless or longitudinally butt-welded unless otherwise specified by the purchaser.

B.6.6 The bellows shall be of multi-ply construction unless otherwise specified by the purchaser.

B.6.7 Bellows assemblies, as received from the bellows manufacturer, shall be contained in individual packages so as to prevent damage from handling or moisture prior to assembly.

B.7 Pressure Tests

B.7.1 Prior to assembly, each bellows or bellows assembly shall be tested for leakage using a mass spectrometer leakage testing device having a sensitivity of 6.1×10^{-8} in.^{3}/s (10^{-3} mm^3/s) of helium at standard atmospheric pressure and 70 °F(20 °C), and shall show no detectable leakage, or other means that the manufacturer can demonstrate to be of equal leakage detection sensitivity.

B.7.2 Pressure tests for bellows stem seal valves, with the manufacturer taking into account the consequences of a bellows failure during pressure testing, shall be without stem packing installed or with the stem packing adjustment bolting loosely assembled so as to not effect a stem seal.

B.7.3 When water is used as the test fluid for pressure testing valves having austenitic stainless steel bellows, the chloride content of the test water shall not exceed 100 ppm.

B.7.4 A backseat test is not required for a valve with a bellows stem seal.

B.8 Marking

B.8.1 Each bellows assembly shall have a material identification marking.

B.8.2 The bellows material marking shall appear on the valve identification plate.

B.9 Preparation for Dispatch

After testing, special care shall be taken to drain test fluid from the bellows chamber.

Annex C
(normative)

Type Testing of Bellows Stem Seals

C.1 Scope

This annex specifies type testing for the purpose of qualifying bellows and bellows assemblies to be used in gate or globe valves in accordance with this standard. Included are requirements for testing, examination, and acceptability.

C.2 General Requirements

C.2.1 The bellows is the expandable metal part that acts as the initial stem seal preventing the contained fluid from escaping into the atmosphere surrounding the valve. A bellows assembly includes the bellows and related end fittings. The end fittings may be in the form of rings, caps or flanges attached to the bellows by welding.

C.2.2 Each bellows assembly design and each bellows material shall be qualified by type testing. Type testing includes both ambient temperature and high-temperature testing. The ambient temperature tests shall be carried out at a pressure at least equal to the rated valve pressure for 100 °F (38 °C). The high-temperature tests shall be carried out at a pressure at least equal to the rated valve pressure for either a temperature at least equal to 800 °F (427 °C) or the maximum temperature for which the bellows is designated.

C.2.3 A successful qualification requires that three bellows assemblies of the same design and material be type tested at ambient conditions and three more be tested at the high temperature conditions, and that all six meet the qualification acceptance requirements. The six bellows assemblies for testing shall be randomly selected from a regular bellows assembly production lot.

C.3 Test Procedure

C.3.1 Pretest Examination

C.3.1.1 The bellows assemblies to be tested shall be clean.

C.3.1.2 The unrestrained (free) height of each bellows shall be measured and recorded along with the compressed and extended heights for which the qualification applies. The compressed and extended ratios (see B.5.4) shall be calculated and recorded in the test report.

C.3.1.3 All bellows assembly welds shall be examined using a liquid dye penetrant. Any indication of a crack or any other weld defect shall be cause for rejection.

C.3.1.4 Each bellows assembly shall be subjected to a helium leakage test. The assembly shall show no detectable leakage when tested with an instrument with a sensitivity of 10^{-3} mm^3/s of helium.

C.3.2 Pressure Test

C.3.2.1 Each bellows assembly shall be pressure tested.

C.3.2.2 The pressure test fluid shall be water containing less than 100 ppm of chlorides.

C.3.2.3 For the pressure test, the bellows shall be positioned at its compressed design height corresponding to the valve full open position. Positioning may be either in a valve assembly or in a test fixture duplicating the intended valve assembly.

C.3.2.4 The test fluid pressure shall be applied in the same direction (externally or internally) for which the bellows assembly is to be qualified.

C.3.2.5 The test fluid pressure shall be not less than 1.5 times the rated pressure of the valve at 100 °F (38 °C).

C.3.2.6 The minimum pressure test duration shall be five minutes.

C.3.2.7 Any visually detectable leakage over the test duration shall be cause for rejection.

C.3.3 Cycle Test

C.3.3.1 Each bellows assembly shall be cycle tested.

C.3.3.2 For the cycle test, the bellows assembly shall be installed in either a completely assembled valve (with the packing removed) or a test fixture that simulates the intended bellows valve installation and incorporates its maximum possible extension and compression.

C.3.3.3 The frequency of cycling shall not exceed one cycle per second.

C.3.3.4 One complete cycle is defined as movement of the bellows from the design compressed position to the design extended position and return to the compressed position corresponding to the valve open-closed-open positions.

C.3.3.5 The ambient cycle test cycling shall be carried out at ambient temperature and with the bellows subjected to a water pressure, as a minimum, equal to the 100 °F (38 °C) intended valve pressure rating. The high-temperature cycle test shall be carried out at a temperature at least the greater of 800 °F (427 °C) or the maximum bellows assembly rated temperature, and with the bellows subjected to a pressure, as a minimum, equal to the intended valve pressure rating at the test temperature. The test fluid for the high temperature test may be liquid or gas, at the manufacturer's option.

C.3.3.6 Water containing less than 100 ppm of chlorides shall be used.

C.3.3.7 The minimum number of test cycles required for qualification for each bellows assembly shall be in accordance with Table C.1.

Table C.1 Bellows Test Cycles

Valve Rating	Test Cycles Minimum	
	Gate Valve	Globe Valve
Class ≤ 800	2000	5000
Class > 800	2000	2000

C.3.4 Post Test Examination

C.3.4.1 Upon completion of the cycle test, repeat the liquid dye penetrant examination of C.3.1.3.

C.3.4.2 After the liquid dye penetrant examination, each bellows assembly shall be tested for leakage in accordance with either:

a) submerging the bellows assembly in water for a period of five minutes while applying air at a pressure greater than 80 psig (5.6 bar), or

b) performing a helium leakage test using an instrument that has a sensitivity of 10^{-3} mm^3/s of helium.

C.3.4.3 Any detectable leakage either from the bellows or the bellows assembly welds shall be cause for failure.

C.4 Acceptability

Acceptance of the bellows assembly design and construction shall be based on all six assemblies meeting the qualification test requirements.

C.5 Test Report

A test report shall be prepared and be available at the valve manufacturer's facility for review upon purchaser request when such provision is included in the purchase order.

Annex D
(informative)

Identification of Valve Parts

The purpose of Figure D.1 to Figure D.8 is to identify part names only.

Key

1 handwheel
2 identification plate
3 handwheel nut
4 stem nut
5 stem
6 gland bolting
7 gland flange
8 gland
9 packing
10 bonnet bolting
11 bonnet
12 gasket
13 seat ring
14 gate
15 body

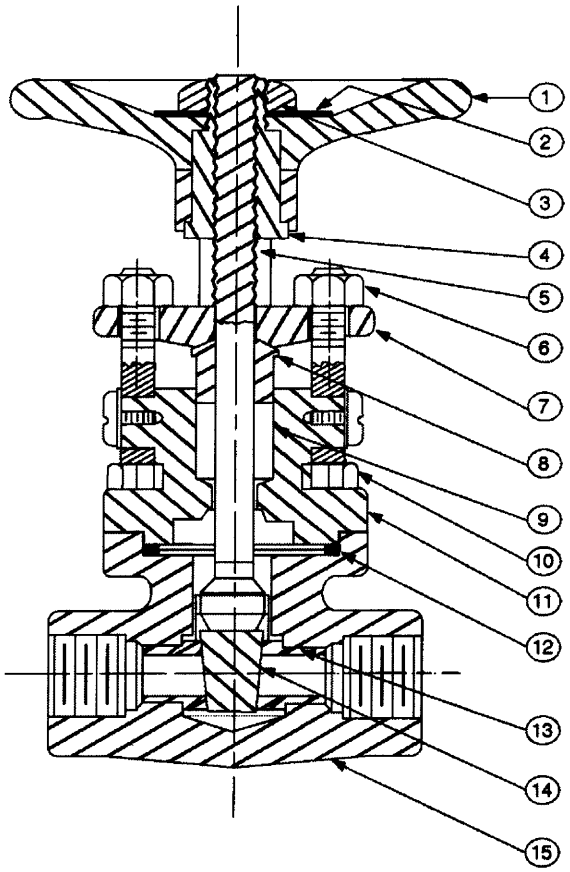


Figure D.1 Outside Screw and Yoke Bolted Bonnet Gate Valve

Key

1 handwheel
2 identification plate
3 handwheel nut
4 stem
5 packing nut
6 gland
7 packing
8 packing ring (optional)
9 bonnet
10 bonnet bolting
11 gasket
12 seat ring
13 gate
14 body

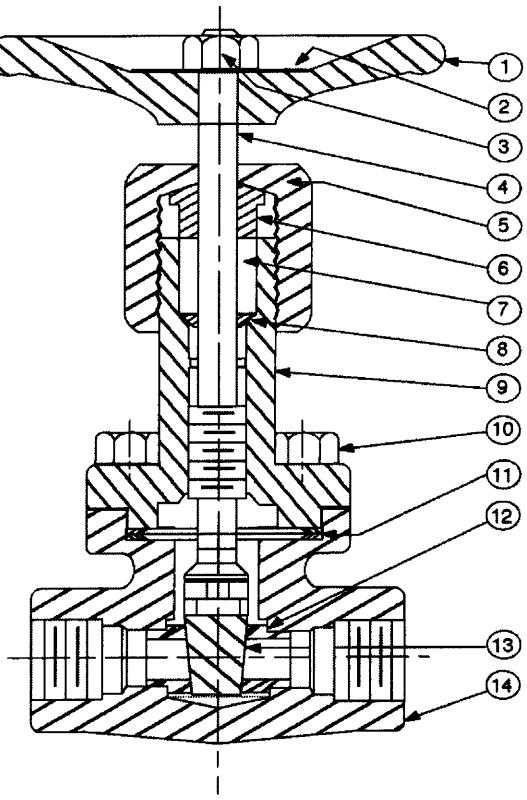


Figure D.2 Inside Screw Gate Valve

Key

1 handwheel
2 identification plate
3 handwheel nut
4 stem nut
5 stem
6 gland bolting
7 gland
8 packing
9 bonnet
10 bellows end fitting
11 bellows
12 body/bonnet extension
13 seat ring
14 gate
15 body

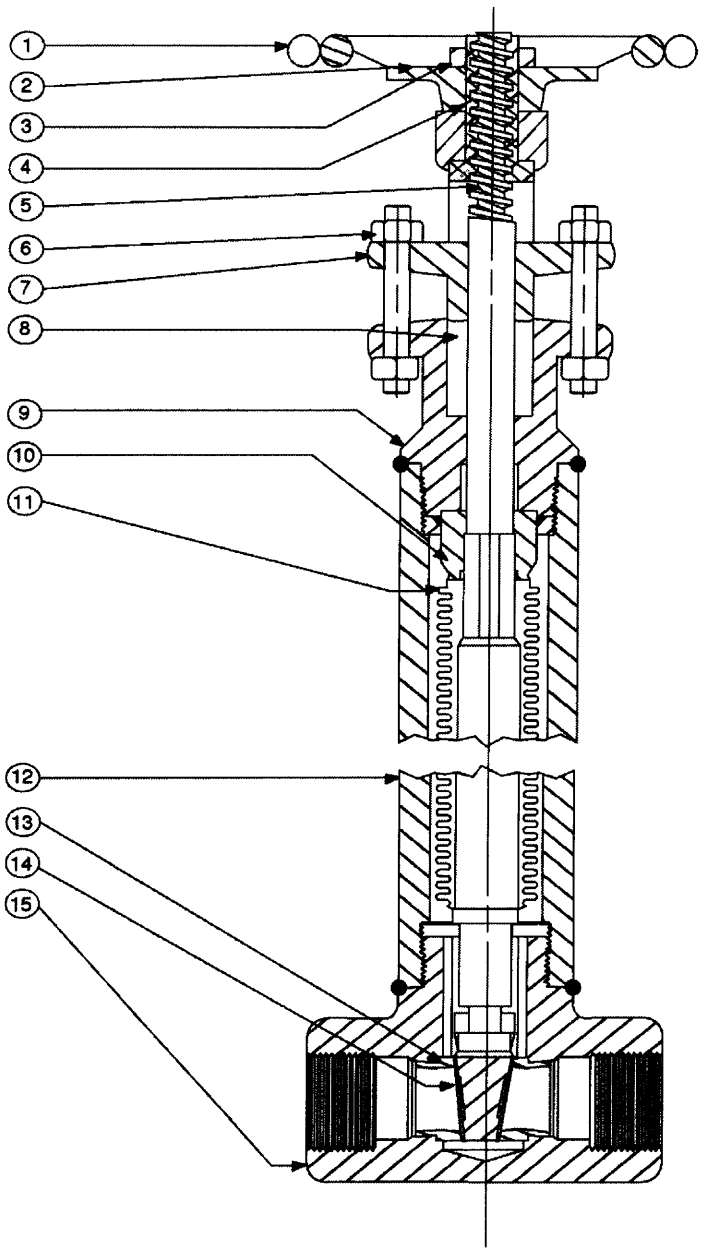


Figure D.3 Bellows Stem Seal Gate Valve

Key

1 jam nut
2 identification disc
3 handwheel
4 yoke nut
5 bearing ring for yoke nut
6 yoke
7 gland bolting
8 packing gland
9 packing
10 stem
11 bonnet
12 solid wedge
13 body
14 seats

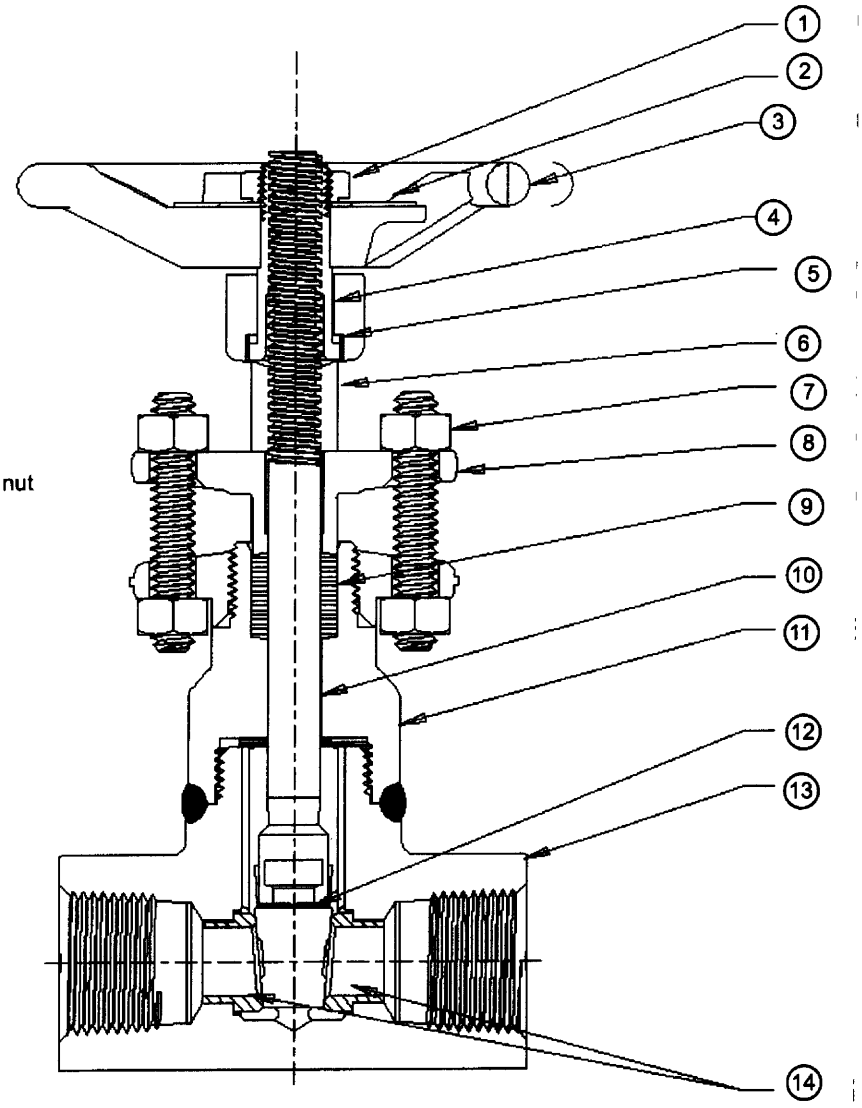


Figure D.4 Welded Bonnet Gate Valve

Key

1 jam nut
2 identification disc
3 handwheel
4 yoke nut
5 yoke
6 gland bolting
7 packing gland
8 packing
9 stem
10 bonnet
11 gasket
12 disc nut
13 disc
14 body
15 integral seat

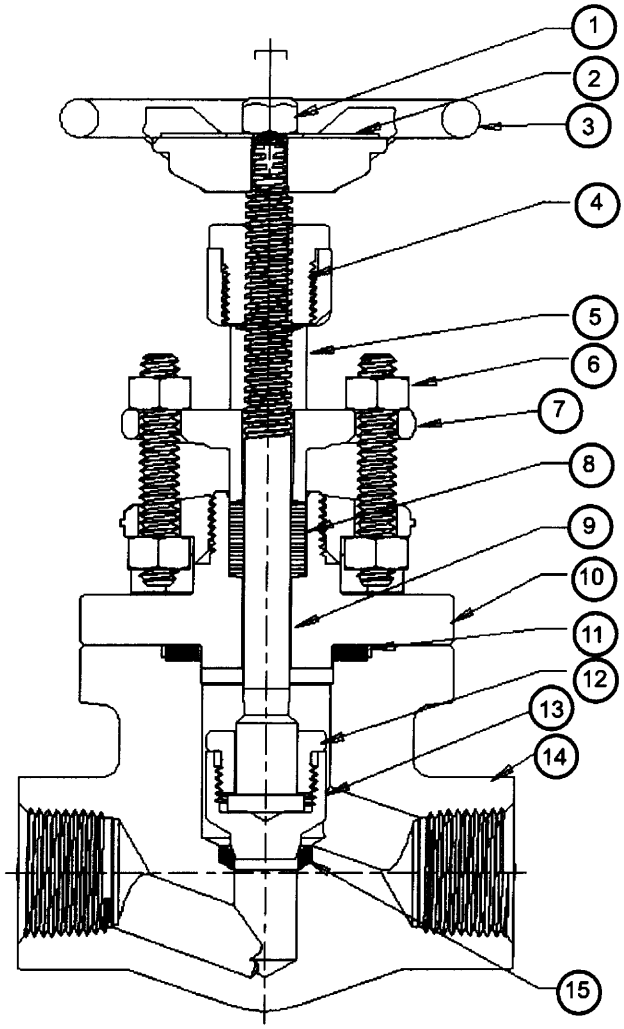


Figure D.5 Outside Screw and Yoke Globe Valve

Key

1 handwheel nut
2 identification disc
3 handwheel
4 stem
5 packing nut
6 packing gland
7 packing
8 packing ring
9 bonnet
10 bonnet nut
11 gasket
12 body
13 disc nut
14 disc
15 integral seat

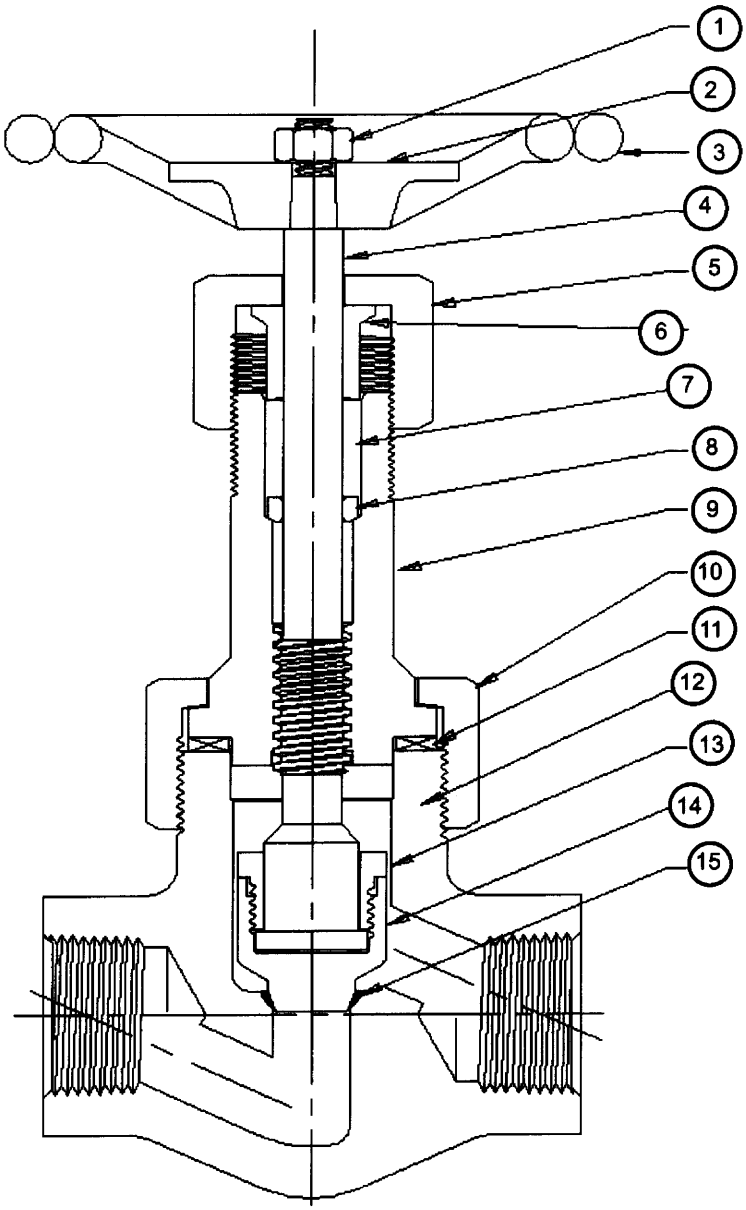


Figure D.6 Union Bonnet Globe Valve

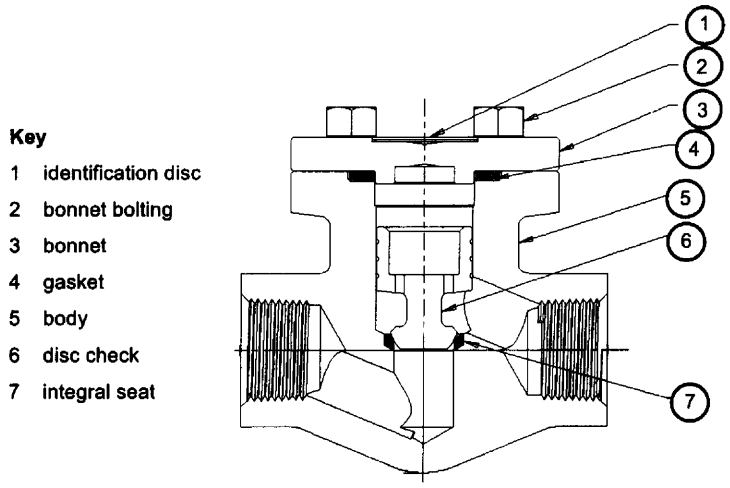


Figure D.7 Piston Check Valve

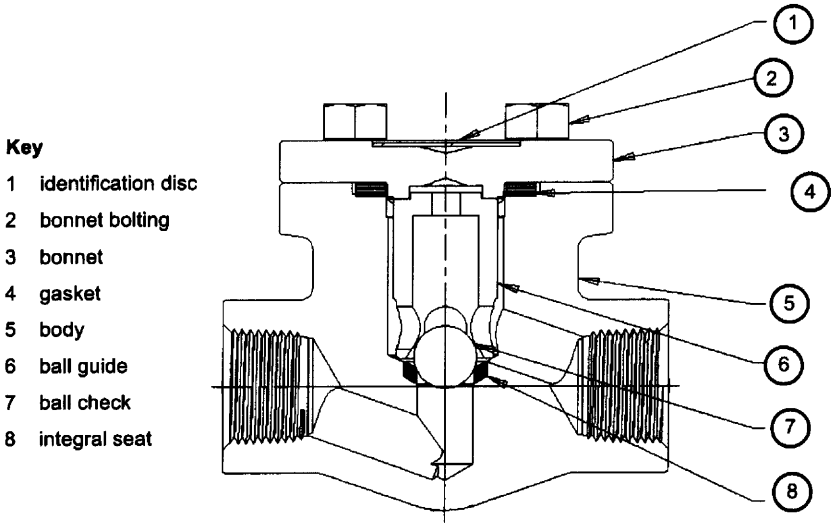


Figure D.8 Ball Check Valve

Annex E
(informative)

Information to be Specified by the Purchaser

References in square brackets are to clauses or subsections in this standard.

a) Valve type [1] (gate, globe or check) (standard bore is the reference standard design, full bore is to be specified) [5.1].

b) Gate or globe valve type [5.7] (OS & Y is the reference standard design, ISRS to be specified) [5].

c) Nominal size [1] (NPS or DN).

d) Pressure class designation [1] (class number).

e) Body ends [5.4]:

1) threaded (pipe threads ASME B1.20.1 or ISO 7-1) [5.4.3.2];

2) flange facing:

— raised face or ring joint [5.4.4.1],

— facing finish if other than standard [5.4.4.1];

3) socket welding [5.4.2];

4) butt-welding [5.4.5].

f) Extended body ends [A.1]:

1) external:

— butt-welding [A.3.3],

— socket welding [A.3.3],

— threaded [A.3.2];

2) internal:

— threaded [A.2.3],

— socket welding [A.2.3].

g) Material [6]:

1) pressure-containing shell [Table 1 and Table 14];

2) forging material is the reference standard design for NPS ≤ 2 (DN ≤ 50), other materials may be specified [5.1.2];

3) bellows [B.7.1].

h) Trim [6.1]:

1) combination number [6.1.1],

2) trim using free-machining materials [6.1.2],

3) alternative trim [6.1.3],

4) bonnet bolting [Table 14 and Annex F],

5) gasket [5.5.3],

6) packing [Table 14].

i) Globe valve seat design [5.6.3.1].

j) Optional high-pressure closure test [see API 598].

k) Alternative backseat test method [see API 598].

l) Flanges attached by welding [5.4.4.2].

m) Metric or inch series body to bonnet bolting [5.5.5].

n) Extended body extensions attached by welding [A.5.1].

o) Seamless or welded bellows material [B.6.5].

p) Multiply or other bellows construction [B.6.6].

q) Special packaging [9.8].

Annex F
(informative)

Valve Material Combinations

Table F.1 and Table F.2 list valve body, bonnet and cover materials (ASME B16.34, Material Group 1 and Group 2) along with associated valve trim materials (CN designations, Table 14) and ASTM A193 and ASTM A194 specification bolting materials. For ASTM A193/ASTM A194 listed bolting materials in Table F.1 and Table F.2, corresponding bolting materials listed in EN 10269 may be substituted in accordance with Table F.3. Body materials other than those listed in Table F.1, Table F.2, or Table F.3, are outside the scope of this standard (see 6.1.3 and 6.2.1).

Table F.1 Material Combinations for Group 1 Body, Bonnet, and Cover Materials

Material Group ASME B16.34	Body/Bonnet Material Abbreviation	Body, Bonnet, and Cover ASTM Specification	Typical Trim Material CN Designation	Body-to-bonnet and Body-to-cover Bolting ASTM Specification [a]
1.1	C-Si	A105 or A216-WCB	8	B7/2H
	C-Mn-Si	A350-LF2-CL1	8	B7/2H [b]
	C-Mn-Si-V	A350-LF6-CL1	10	B8M-CL2/8M [b c d]
	3 1/2Ni	A350-LF3	10	B8M-CL2/8M [b c d]
1.2	C-Mn-Si	A216-WCC	8	B7/2H
		A352-LCC	8	B7/2H [b]
	C-Mn-Si-V	A350-LF6-CL2	10	B8M-CL2/8M [b c d]
	2 1/2Ni	A352-LC2	10	B8M-CL2/8M [b c d]
	3 1/2Ni	A352-LC3	10	B8M-CL2/8M [b c d]
1.3	C-Si	A352-LCB	8	B7/2H [b]
	C-1/2Mo	A217-WC1	8	B7/2H
		A352-LC1	10	B8M-CL2/8M [b c d]
1.4	C-Mn-Si	A350-LF1	8	B7/2H [b]
1.5	C-1/2Mo	A182-F1	8	B7/2H
1.7	1/2Cr-1/2Mo	A182-F2	8	B7/2H
	Ni-1/2Cr-1/2Mo	A217-WC4		
	3/4Ni-3/4Cr-1Mo	A217-WC5		
1.9	1 1/4Cr-1/2Mo	A217-WC6	8	B16/8M [e]
	1 1/4Cr-1/2Mo-Si	A182-F11-CL2		
1.10	2 1/4Cr-1Mo	A182-F22-CL3	8	B16/8M [e]
		A217-WC9		
1.13	5Cr-1/2Mo	A182-F5a or A217-C5	8	B16/8M [e]
1.14	9Cr-1 Mo	A182-F9 or A217-C12	8	B16/8M [e]
1.15	9Cr-1Mo-V	A182-F91 or A217-C12A	8	B16/8M [e]
1.17	1Cr-1/2Mo	A182-F12-CL2	8	B16/8M [e]
	5Cr-1/2Mo	A182-F5		

NOTE 1 For Table F.1 table notes, see Table F.2.

NOTE 2 For bolting materials in accordance with EN 10269, see Table F.3.

Table F.2 Material Combinations for Group 2 Body to Bonnet Materials

Material Group ASME B16.34	Body/Bonnet Material Abbreviation	Body, Bonnet, and Cover ASTM Specification	Typical Trim Material CN Designation	Body-to-bonnet and Body-to-cover Bolting ASTM Specification [a]
2.1	18Cr-8Ni	A182-F304/A351-CF3 A182-F304H/A351-CF8	2	B8M-CL2/8M [c d]
2.2	16Cr-12Ni-2Mo 18Cr-8Ni 18CR-13Ni-3Mo 19Cr-10Ni-3Mo	A182-F316 or A351-CF3M, A182-F316H or A351-CF8M A351 CF3A A182-F317 or A182-F317H or A351 CF8A A351-CG8M	10	B8M-CL2/8M [c d]
2.3	18Cr-8Ni 16Cr-12Ni-2Mo	A182-F304L A182-F316L	10	B8M-CL2/8M [c d]
2.4	18Cr-10Ni-Ti	A182-F321 A182-F321H	10	B8M-CL2/8M [c d]
2.5	18Cr-10Ni-Cb	A182-F347H A182-F347 A182-F348 A182-F348H	10	B8M-CL2/8M [c d]
2.7	25Cr-20Ni	A182-F310	10	B8M-CL2/8M [c d]
2.8	20Cr-18Ni-6Mo 22Cr-5Ni-3Mo-N 25Cr-7Ni-4Mo-N 24Cr-10Ni-4Mo-V 25Cr-5Ni-2Mo-3Cu 25Cr-7Ni-3.5MO-W-Cb 25Cr-7Ni-3.5Mo-N-Cu-W	A182-F44 or A351-CK3MCuN A182-F51 A182-F53 A351-CE8MN A351-CD4MCu A351-CD3MWCuN A182-F55	f	B8M-CL2/8M [c d]
2.10	25Cr-12Ni	A351-CH8 A351-CH20	f	B8M-CL2/8M [c d]
2.11	18Cr-10Ni-Cb	A351-CF8C	f	B8M-CL2/8M [c d]
2.12	25Cr-20Ni	A351-CK20	f	B8M-CL2/8M [c d]

NOTE For bolting materials in accordance with EN 10269, see Table F3.

[a] Temperature limitations on bolting are as follows: Gr B7, 1000 °F (538 °C); Gr L7, 1000 °F (538 °C) Gr B16, 1100 °F (595 °C); Gr B8-CL1, Gr B8A-CL1A, Gr B8M-CL1, and Gr B8MA-CL1A, 1500 °F (816 °C) Gr B8-CL2, Gr B8M-CL2, Gr B8M2-CL2B and Gr B8M3-CL2C, 1000 °F (538 °C).

[b] ASTM A320, Gr L7 bolts, and ASTM A194, Gr 4 nuts may also be used.

[c] ASTM A193, Gr B8-CL1, Gr B8A-CL1A, Gr B8M-CL1, Gr B8MA-CL1A, Gr B8M2-CL2B, and Gr B8M3-CL2C bolting are suitable substitutes provided that the requirements of 5.5.6 are met.

[d] ASTM A193, Gr B8-CL2 bolts may also be used.

[e] ASTM A194, Gr 7 nuts may also be used.

[f] Trim material is not specified, however, trim material shall have corrosion resistance equal to the corrosion resistance of the valve body material.

Table F.3 Substitute Body to Bonnet Bolting Materials

As Related to Table F.1 and Table F.2		As Related to Table Notes in Table F.1 and Table F.2	
ASTM Bolting Material	**EN 10269 Bolting Material Grade**	**ASTM Bolting Material**	**EN 10269 Bolting Material Grade**
A193 B7	42CrMo4 (1.7225)-QT	A193 B8M2, CL 2B	X5CrNiMo 17-12-2 (1.4401)-C700
A193 B16	40CrMoV4-6 (1.7711)-QT	A193 B8M3, CL 2C	X5CrNiMo 17-12-2 (1.4401)-C700
A193 B8M, CL 2	X5CrNiMo 17-12-2 (1.4401)-C700	A193 B8M, CL 1	X5CrNiMo 17-12-2 (1.4401)-AT
A194 2H	C45E (1.1191)-QT	A193 B8MA, CL 1A	X5CrNiMo 17-12-2 (1.4401)-AT
A194 8M	X5CrNiMo 17-12-2 (1.4401)-AT	A193 B8, CL 1	X5CrNi 18-10 (1.4301)-AT
		A193 B8A, CL 1A	X5CrNi 18-10 (1.4301)-AT
		A193, B8 CL 2	X5CrNi 18-10 (1.4301)-C700
		A320, L7	42CrMo4 (1.7225)-QT
		A194 GR 8	X5CrNi 18-10 (1.4301)-AT
		A194 GR 4	42CrMo4 (1.7225)-QT
		A194 GR 7	42CrMo4 (1.7225)-QT

NOTE Temperature limitations applicable for ASTM bolting materials, table notes for Table F.2, also apply for corresponding substitute EN bolting materials.

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	Std 600, Steel Gate Valves - Flanged and Butt-welding Ends, Bolted Bonnets		$115.00	
	Std 609, Butterfly Valves: Double-flanged, Lug- and Wafer-type		$89.00	
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