Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets

API STANDARD 623
SECOND EDITION, JANUARY 2021

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1 Scope

This API standard specifies the requirements for a heavy-duty series of bolted bonnet steel globe valves for petroleum refinery and related applications where corrosion, erosion, and other service conditions would indicate a need for heavy wall sections and large stem diameters.

This standard sets forth the requirements for the following globe valve features:

— bolted bonnet;

— pressure seal bonnet;

— outside screw and yoke;

— rotating rising stems and nonrotating rising stems;

— rising handwheels and nonrising handwheels;

— straight pattern, y-pattern, right-angle;

— stop-check (nonreturn type globe valves in which the disc may be positioned against the seat by action of the stem but is free to rise as a check valve due to flow from under the disc when the stem is in a full or partially open position);

— plug, narrow, conical, ball, or guided disc;

— metallic seating surfaces;

— flanged or butt-welding ends.

It covers valves of the nominal pipe sizes NPS:

— 2, $2^1/_2$, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24;

corresponding to nominal pipe sizes DN:

— 50, 65, 80, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600;

applies for pressure class designations:

— 150, 300, 600, 900, 1500, 2500.

2 Normative References

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

API Standard 598, *Valve Inspection and Testing*

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

API Standard 624, *Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive Emissions*

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 B1.12, *Class 5 Interference—Fit Thread*

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

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

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

ASME B16.25, *Buttwelding Ends*

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

ASME B18.2.6, *Fasteners for Use in Structural Applications*

ASME B18.2.6M, *Metric Fasteners for Use in Structural Applications*

ASME B31.3, *Process Piping*

ASME B31T, *Standard Toughness Requirements for Piping*

ASTM A307 [2], *Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength*

ASTM A320, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ISO 5210 [3], *Industrial valves—Multi-turn valve actuator attachments*

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

MSS SP-45 [4], *Bypass and Drain Connections*

MSS SP-55, *Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components—Visual Method for Evaluation of Surface Irregularities*

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

MSS SP-102, *Multi-turn Valve Actuator Attachment—Flange and Driving Component Dimensions and Performance Characteristics*

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

MSS SP-144, *Pressure Seal Bonnet Valves*

NACE MR 0103 [5], *Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments*

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1 ASME International, Two Park Avenue, New York, New York 10016-5990, www.asme.org.

2 ASTM International, 100 Barr Harbor Drive, C700, West Conshohocken, Pennsylvania 19428-2959, www.astm.org.

3 International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8, CP 401 -1214 Vernier, Geneva, Switzerland, www.iso.org.

4 Manufacturers Standard Society of the Valve and Fittings Industry, Inc., 127 Park Street, N.E., Vienna, Virginia 22180-4602, www.msshq.org.

5 NACE International (formerly the National Association of Corrosion Engineers), 15835 Park Ten Place, Houston, Texas 77084, www.nace.org.

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 "Class" followed by a dimensionless whole number. The number following "Class" does not represent a measurable value and is not used for calculation purposes except where specified in this standard. The allowable pressure for a valve having a class number depends on the valve material and its application temperature and is to be found in tables of pressure/temperature ratings.

3.2
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.

3.3
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.

3.4
shell
Comprised of the body and bonnet which are parts of the pressure boundary of an API 623 valve.

4 Pressure/Temperature Ratings

4.1 Pressure/temperature ratings shall be in accordance with those specified in the tables of ASME B16.34 for Standard Class for the applicable material specification and the applicable class.

4.2 Restrictions of temperature and concurrent pressure, or pressure and concurrent temperature (e.g. those imposed by special soft seat, packing, or special trim materials), shall be marked on the valve identification plate (see Section 8).

4.3 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.

4.4 For temperatures below the lowest temperature listed in the pressure/temperature tables, the service pressure shall be no greater than the pressure for the lowest-listed temperature. The use of valves at lower temperatures is the responsibility of the user, and consideration should be given to the loss of ductility and impact strength per ASME B31.3 and ASME B31T.

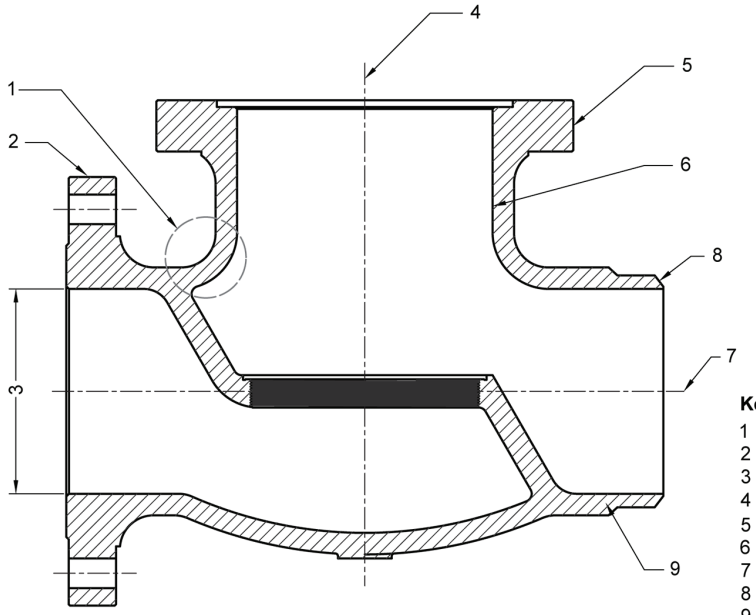
5 Design

5.1 Body Wall Thickness

5.1.1 A valve body schematic is shown as Figure 1. The minimum body wall thickness, t_m, at the time of manufacture shall be as given in Table 1. For ASME B16.34 Group 3 materials, minimum body wall thickness

t_m, at the time of manufacture shall be calculated from an equation in ASME B16.34, with minimum flow diameter (d) per ASME B16.34 for applicable valve DN or NPS and pressure class. Thickness requirements of butt-welding valve ends shall be in accordance with 5.1.3.

5.1.2 Additional metal thickness needed for assembly stresses, stress concentrations, and shapes other than circular shall be determined by individual manufacturers, since these factors vary widely.



Key
1 junction of body run and body neck
2 body end flange
3 body end port inside diameter
4 axis of body neck
5 body/bonnet flange
6 body neck
7 axis of body run
8 butt-welding end
9 body run

Figure 1—Identification of Terms

Table 1—Minimum Wall Thickness for Body and Bonnet

Class Designation	150	300	600	900	1500	2500	Class Designation
Nominal Size DN	Minimum Wall Thickness t_m mm (in.)						Nominal Size NPS
50	8.6 (0.34)	9.7 (0.38)	11.2 (0.44)	13.7 (0.54)	19.1 (0.75)	22.4 (0.88)	2
65	9.7 (0.38)	11.2 (0.44)	11.9 (0.47)	15.5 (0.61)	22.4 (0.88)	25.4 (1.00)	2½
80	10.4 (0.41)	11.9 (0.47)	12.7 (0.50)	19.1 (0.75)	23.9 (0.94)	30.2 (1.19)	3
100	11.2 (0.44)	12.7 (0.50)	16.0 (0.63)	21.3 (0.84)	28.7 (1.13)	35.8 (1.41)	4
150	11.9 (0.47)	16.0 (0.63)	19.1 (0.75)	26.2 (1.03)	38.1 (1.50)	48.5 (1.91)	6
200	12.7 (0.50)	17.5 (0.69)	25.4 (1.00)	31.8 (1.25)	47.8 (1.88)	62.0 (2.44)	8
250	14.2 (0.56)	19.1 (0.75)	28.7 (1.13)	36.6 (1.44)	57.2 (2.25)	67.6 (2.66)	10
300	16.0 (0.63)	20.6 (0.81)	31.8 (1.25)	42.2 (1.66)	66.8 (2.63)	86.6 (3.41)	12
350	16.8 (0.66)	22.4 (0.88)	35.1 (1.38)	46.0 (1.81)	69.9 (2.75)	—	14
400	17.5 (0.69)	23.9 (0.94)	38.1 (1.50)	52.3 (2.06)	79.5 (3.13)	—	16
450	18.3 (0.72)	25.4 (1.00)	41.4 (1.63)	57.2 (2.25)	88.9 (3.50)	—	18
500	19.1 (0.75)	26.9 (1.06)	44.5 (1.75)	63.5 (2.50)	98.6 (3.88)	—	20
600	20.6 (0.81)	30.2 (1.19)	50.8 (2.00)	73.2 (2.88)	114.3 (4.50)	—	24

5.1.3 The weld end preparation in butt-welding end valves (see 5.3.2) shall not reduce the body wall thickness to less than the values specified in 5.1.1 within a region closer than t_m to the outside surface of the body neck, measured along the run direction. The transition to the weld preparation shall be gradual and the section shall be

essentially circular through the entire length of the transition. Sharp discontinuities or abrupt changes in section in areas that infringe into the transition shall be avoided, but test collars or bands, either welded or integral, are allowed. In no case shall the thickness be less than 0.77 t_m at a distance of 2 t_m from the weld end.

5.2 Bonnet Wall Thickness

The minimum bonnet wall thickness at the time of manufacture, except for the neck extension that contains the packing, shall be t_m as given in Table 1. For the neck extension, the local minimum wall thickness shall be based on the local diameter, e.g. the inside diameter of the stem bore or packing box bore, and shall be in accordance with Table 2. For an inside diameter not listed in Table 2, linear interpolation within the appropriate class designation listing shall be used.

5.3 Body Dimensions

5.3.1 Flanged Ends

5.3.1.1 Body end flanges shall comply with the dimensional requirements of ASME B16.5. Unless otherwise specified, raised face end flanges shall be provided. The purchaser may specify a flange facing finish other than that specified in ASME B16.5.

5.3.1.2 Face-to-face dimensions shall be in accordance with ASME B16.10 or ISO 5752. Body end flanges and bonnet flanges shall be cast or forged integral with the body. However, flanges may be attached by welding when approved by the purchaser.

5.3.1.2.1 Welding a flange to a valve body shall be by full penetration butt-welding. Unless otherwise specified, attachment welds shall conform to ASME B31.3 or ISO 15649 for normal fluid service, including weld quality acceptance criteria and qualifications for the weld procedure and welder or welding operator. Heat treatment shall be performed in accordance with Table 3.

5.3.1.2.2 Integral or other alignment rings (centering backing rings) used to facilitate welding shall be removed after the weld is completed.

5.3.2 Butt-welding Ends

5.3.2.1 Butt-welding ends for valves shall conform to the requirements of ASME B16.25 for the bore specified for use without backing rings. Conversion of a flanged end valve to a butt-welding valve is not permitted except by agreement between the purchaser and manufacturer.

The chemical composition of carbon steel welding ends shall meet the following requirements unless otherwise agreed:

– the carbon content shall not exceed 0.23 % by mass;

– the carbon equivalent, CE, shall not exceed 0.43 as determined by the following formula:

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

where

C	is weight % carbon
Mn	is weight % manganese
Cr	is weight % chromium
Mo	is weight % molybdenum
Ni	is weight % nickel

Cu is weight % copper

V is weight % vanadium

5.3.2.2 End-to-end dimensions for butt-welding end class-designated valves shall be in accordance with ASME B16.10, unless otherwise specified by the purchaser.

5.3.3 Body Seat

5.3.3.1 The inside diameter of the seat opening shall not be less than that specified in Table 4 for the nominal pipe size and pressure class.

5.3.3.2 Integral seats with overlays per Table 8 are permitted. Integral body seats (without overlays) are permitted in austenitic stainless steel and other Group 2 and Group 3 material bodies. An austenitic stainless steel or a hardfacing material may be weld-deposited either directly on the valve body or on a separate body seat ring.

5.3.3.3 Finished thickness of any facing material shall be not less than 1.6 mm (0.06 in.). Where a separate seat ring is provided, it shall be shoulder- or bottom-seated, and either threaded and seal welded or inserted and seal welded in place. Threaded seat rings shall be seal welded; tack welding or stitch welding is not permitted.

5.3.3.4 Body and disc seating surfaces shall be designed to prevent galling.

5.3.3.5 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 of mating threaded surfaces.

Table 2—Minimum Wall Thickness for Bonnet Neck Extension

Class Designation	150	300	600	900	1500	2500
Bonnet Neck Extension Inside Diameter mm (in.)	Minimum Wall Thickness mm (in.)					
32 (1.25)	4.8 (0.189)	4.8 (0.189)	4.8 (0.189)	6.5 (0.256)	8.7 (0.343)	13.5 (0.531)
35 (1.38)	4.8 (0.189)	4.8 (0.189)	5.1 (0.201)	7.1 (0.280)	9.9 (0.382)	14.6 (0.575)
38 (1.50)	4.8 (0.189)	4.8 (0.189)	5.7 (0.224)	7.5 (0.295)	10.2 (0.402)	15.9 (0.625)
45 (1.75)	5.3 (0.210)	5.6 (0.220)	6.1 (0.240)	7.9 (0.310)	11.2 (0.440)	19.1 (0.750)
48 (1.88)	5.3 (0.210)	5.6 (0.220)	6.1 (0.240)	7.9 (0.310)	11.2 (0.440)	19.1 (0.750)
51 (2.00)	5.6 (0.220)	6.4 (0.250)	6.4 (0.250)	7.9 (0.310)	11.7 (0.460)	20.1 (0.790)
57 (2.25)	5.6 (0.220)	6.4 (0.250)	6.6 (0.260)	8.6 (0.340)	12.7 (0.500)	22.2 (0.875)
60 (2.38)	5.6 (0.220)	6.4 (0.250)	6.9 (0.268)	8.9 (0.346)	13.5 (0.530)	23.2 (0.913)
63.5 (2.50)	5.6 (0.220)	6.4 (0.250)	7.1 (0.280)	9.1 (0.362)	14.2 (0.560)	24.1 (0.950)
67 (2.62)	5.6 (0.220)	6.6 (0.260)	7.1 (0.280)	9.5 (0.375)	15.0 (0.590)	25.4 (1.000)
73 (2.87)	5.6 (0.220)	6.9 (0.272)	7.6 (0.300)	10.5 (0.412)	15.9 (0.625)	27.8 (1.093)
82.5 (3.25)	6.1 (0.240)	7.1 (0.280)	8.1 (0.320)	11.2 (0.440)	17.5 (0.687)	30.9 (1.218)
89 (3.50)	6.4 (0.250)	7.5 (0.295)	8.6 (0.340)	11.9 (0.472)	19.1 (0.750)	32.8 (1.290)
92 (3.62)	6.4 (0.250)	7.5 (0.295)	9.1 (0.362)	12.2 (0.480)	19.1 (0.750)	34.0 (1.340)
95 (3.75)	6.4 (0.250)	7.6 (0.300)	9.4 (0.370)	12.5 (0.490)	19.8 (0.780)	34.9 (1.375)
98 (3.87)	6.4 (0.250)	7.6 (0.300)	9.4 (0.370)	12.7 (0.500)	20.6 (0.812)	36.1 (1.420)
108 (4.25)	6.4 (0.250)	8.1 (0.320)	9.9 (0.390)	13.5 (0.528)	21.8 (0.860)	38.4 (1.510)

Table 2—Minimum Wall Thickness for Bonnet Neck Extension (Continued)

Class Designation	150	300	600	900	1500	2500
Bonnet Neck Extension Inside Diameter mm (in.)	Minimum Wall Thickness mm (in.)					
111 (4.38)	6.4 (0.250)	8.1 (0.320)	10.5 (0.412)	14.2 (0.560)	23.2 (0.912)	40.4 (1.590)
118 (4.63)	6.6 (0.260)	8.4 (0.330)	10.7 (0.420)	14.7 (0.580)	24.4 (0.960)	42.8 (1.687)
130 (5.12)	7.1 (0.280)	8.9 (0.346)	11.4 (0.445)	16.3 (0.638)	26.4 (1.043)	47.0 (1.846)
133 (5.25)	7.1 (0.280)	8.9 (0.346)	11.4 (0.445)	16.5 (0.650)	27.2 (1.070)	48.0 (1.890)
137 (5.38)	7.1 (0.280)	9.1 (0.362)	11.7 (0.460)	16.8 (0.660)	27.8 (1.093)	49.2 (1.937)
140 (5.50)	7.1 (0.280)	9.1 (0.362)	11.9 (0.472)	17.3 (0.680)	28.6 (1.125)	50.0 (1.976)
159 (6.25)	7.4 (0.290)	9.9 (0.382)	13.1 (0.515)	19.3 (0.760)	32.0 (1.260)	56.9 (2.240)
168 (6.62)	7.4 (0.290)	10.2 (0.400)	14.2 (0.560)	20.6 (0.810)	34.5 (1.360)	61.5 (2.420)
187 (7.38)	7.6 (0.300)	10.9 (0.430)	15.2 (0.600)	22.1 (0.870)	37.1 (1.460)	66.7 (2.625)

Table 3—Postweld Heat Treatment of Flange-to-Body Weld

Material	Thickness [a] *t* mm (in.)	Temperature Range °C (°F)	Holding Time min/mm (hr./in.)	Weld Hardness HBN Max
Carbon steels	*t* > 19 (0.75)	593 to 649 (1100 to 1200)	2.4 (1) (minimum 1 hr.)	—
Alloy steels: 1/2 % < Cr ≤ 2 %	*t* > 13 (0.50)	704 to 746 (1300 to 1375)	2.4 (1) (minimum 2 hr.)	225
2 1/4 % ≤ Cr ≤ 10 %	All	704 to 760 (1300 to 1400)	2.4 (1) (minimum 2 hr.)	241
Nickel alloy steels	*t* > 19 (0.75)	593 to 635 (1100 to 1175)	1.2 (1/2) (minimum 1 hr.)	—
Austenitic steels [a, b]	All	solution anneal per the material specification		
Other materials	All	per the 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.

Table 4—Minimum Seat Diameter

Class Designation	150		300		600		900		1500		2500		Class Designation
Nominal Size DN	Minimum Seat Diameter mm (in.)												Nominal Size NPS
50	42	(1.65)	42	(1.65)	42	(1.65)	42	(1.65)	42	(1.65)	38	(1.50)	2
65	56	(2.20)	56	(2.20)	56	(2.20)	52	(2.07)	52	(2.07)	47	(1.87)	2 1/2
80	69	(2.71)	69	(2.71)	69	(2.71)	69	(2.71)	63	(2.48)	57	(2.25)	3
100	90	(3.54)	90	(3.54)	90	(3.54)	90	(3.54)	83	(3.26)	73	(2.87)	4
150	135	(5.31)	135	(5.31)	135	(5.31)	132	(5.18)	123	(4.85)	111	(4.37)	6
200	182	(7.17)	182	(7.17)	182	(7.17)	172	(6.76)	160	(6.31)	146	(5.75)	8
250	224	(8.82)	224	(8.82)	222	(8.74)	215	(8.45)	200	(7.88)	184	(7.25)	10
300	275	(10.81)	275	(10.81)	250	(9.84)	250	(9.84)	238	(9.38)	219	(8.62)	12
350	303	(11.93)	303	(11.93)	294	(11.59)	Unlisted		Unlisted		Unlisted		14
400	349	(13.73)	349	(13.73)	Unlisted		Unlisted		Unlisted		Unlisted		16
450	396	(15.60)	Unlisted		Unlisted		Unlisted		Unlisted		Unlisted		18
500	444	(17.47)	Unlisted		Unlisted		Unlisted		Unlisted		Unlisted		20
600	539	(21.21)	Unlisted		Unlisted		Unlisted		Unlisted		Unlisted		24

NOTE Unlisted seat diameter shall be in agreement between the manufacturer and the purchaser.

5.4 Bonnet

5.4.1 When designing the stem, gland, lantern ring or spacer ring (if supplied), and backseat, the manufacturer shall take into account stem guiding and the prevention of packing extrusion.

5.4.2 The bonnet shall include a conical stem backseat in one of the following forms:

— a bushing positively secured by tab, tack, or seal welding against coming loose, i.e. not relying on friction;

— an integral surface in the case of an austenitic stainless steel valve;

— an austenitic stainless steel or hardfaced weld deposit that is a minimum of 1.6 mm (0.06 in.) thick.

5.4.3 Bonnets shall be one-piece castings or forgings. For cryogenic or cold service, the bonnet construction shall be in accordance with MSS SP-134, unless otherwise specified by the purchaser.

5.4.4 The gland bolting shall be secured to the bonnet so that the bolting is retained during repacking. When eyebolts are used, the eyebolt pin shall be anchored on both sides of the eyebolt. The anchors shall not include open slotted holes or be attached by fillet welds.

5.5 Bonnet-to-body Joint

5.5.1 The bonnet-to-body joint shall be a flange and gasket type.

5.5.2 The bonnet-to-body joint shall be one of the following types, as illustrated in ASME B16.5:

— raised face;

— tongue and groove;

— spigot and recess;

— ring joint.

5.5.3 The bonnet flange gasket shall be one of the following:

— solid metal, corrugated, or grooved (profiled) metal gasket with graphite filler;

— metal ring joint;

— spiral wound metal gasket with filler and a centering/compression ring;

— spiral wound metal gasket with filler and without a centering/compression ring, to be used only in 'tongue and groove' or 'spigot and recess' joints that prevent the gasket from unwinding and from buckling damage.

5.5.4 Bonnet-to-body bolt pattern and gasket shall be circular.

5.5.5 Bonnet and body flange nut bearing surfaces shall be parallel to the flange face within ±1°. Spot facing or back-facing required to meet the parallelism requirement shall be in accordance with ASME B16.5.

5.5.6 The bonnet-to-body joint shall be secured by a minimum of four through type stud bolts. The minimum stud bolt size for each valve size shall be as follows:

— either M10 or $^{3}/_{8}$ in. when 50 ≤ DN ≤ 65 (2 ≤ NPS ≤ $2^{1}/_{2}$);

— either M12 or $^{1}/_{2}$ in. when 80 ≤ DN ≤ 200 (3 ≤ NPS ≤ 8);

— either M16 or $^{5}/_{8}$ in. when DN ≥ 250 (NPS ≥10).

5.5.7 The total cross-sectional area of the bolts in valve bonnet bolting shall be in accordance with the requirements of ASME B16.34.

5.5.8 At assembly, gasket contact surfaces shall be free of sealing compounds. A light coating of a lubricant, no heavier than kerosene, may be applied if needed to assist in proper gasket assembly.

5.5.9 If pressure seal bonnet design is specified, the bonnet joint construction shall be in accordance with MSS SP-144 Style B, unless otherwise specified by the purchaser.

5.6 Disc

5.6.1 Typical disc and guiding configuration is illustrated in Figure 2.

5.6.1.1 A one-piece disc design shall be furnished, unless otherwise specified by the purchaser.

5.6.1.2 When assembled, the globe valve disc-to-stem retention 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.

5.6.2 The disc shall be of a design to accommodate proper seating.

5.6.3 Disc guiding by stem alone is not acceptable. The disc shall be body guided throughout its full range of travel to provide disc stability and avoid vibration. Guides shall be hardfaced if specified in the purchase order or when required for proper valve function.

5.6.4 Disc seating surfaces shall be integral or have a facing of weld material. Weld-deposited seating surfaces shall have a minimum finished facing material thickness of 1.6 mm (0.06 in.). A disc of solid metal equal to the trim material is permitted.

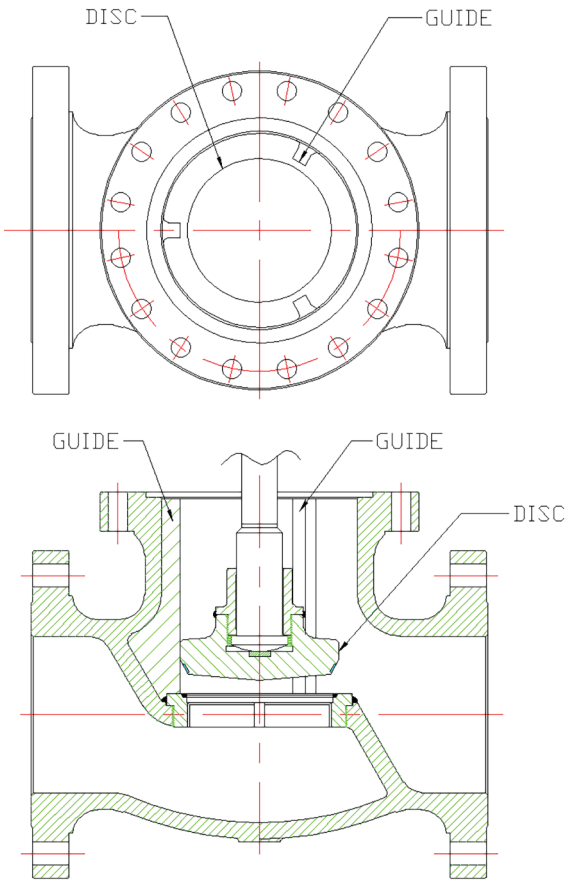


Figure 2—Typical Disc and Guiding

5.6.5 A hardened wear pad may be provided between the disc and stem to prevent wear and galling. The wear pad may be either a separate thrust plate or an integrally welded pad.

5.7 Yoke

5.7.1 The yoke may be either an integral part of the bonnet or a separate part. The yoke shall retain the yoke bushing for rising and rotating stem valves or the stem nut for nonrotating rising stem globe valves.

5.7.2 Yokes that are separate shall have yoke-to-bonnet mating surfaces machined so as to assure a proper bearing assembly interface.

5.7.3 Where used, the yoke-to-stem nut bearing surfaces shall be machined flat and parallel. A lubricating fitting shall be provided for the bearing surfaces.

5.7.4 If the nonrotating stem feature is accomplished by using flat guiding surfaces on the yoke these surfaces shall be machined to provide proper guiding without galling.

5.8 Stem, Stem Nut, and Yoke Bushing

5.8.1 The minimum stem diameter, d_s, shall be as given in Table 5. The minimum stem diameter applies to the stem along the surface area that comes into contact with the packing and to the major diameter of the trapezoidal stem thread. However, the major diameter of the stem thread may be reduced, at the manufacturer's option, by no more than 1.6 mm (0.06 in.). The stem surface area in contact with the packing shall have a surface finish, Ra, of 0.80 µm (32 µin.) or smoother. The actual stem diameter shall take into account the valve design details and the stem material strength characteristics. Note that the stem strength shall be considered when calculating

the maximum input force from the handwheel and gear box (if equipped) in accordance with MSS SP-91 or in accordance with maximum rim pull when specified by the purchaser.

5.8.2 Stems shall have a disc attachment means at one end and an external trapezoidal style thread form at the other. A yoke bushing on rising and rotating stems or a stem nut on nonrotating rising stems shall be provided.

Table 5—Minimum Stem Diameter

Class Designation	150		300		600		900		1500		2500		Class Designation
Nominal Size DN	Minimum Stem Diameter d_s mm (in.)												Nominal Size NPS
50	19	(0.75)	19	(0.75)	22	(0.88)	25	(1.00)	29	(1.13)	38	(1.50)	2
65	22	(0.88)	22	(0.88)	25	(1.00)	35	(1.38)	35	(1.38)	41	(1.62)	2½
80	25	(1.00)	25	(1.00)	29	(1.13)	35	(1.38)	38	(1.50)	44	(1.75)	3
100	29	(1.13)	29	(1.13)	32	(1.25)	44	(1.75)	48	(1.88)	51	(2.00)	4
150	32	(1.25)	35	(1.38)	48	(1.88)	57	(2.25)	70	(2.75)	79	(3.12)	6
200	35	(1.38)	44	(1.75)	64	(2.50)	73	(2.88)	89	(3.50)	102	(4.00)	8
250	38	(1.50)	57	(2.25)	83	(3.25)	89	(3.50)	108	(4.25)	124	(4.88)	10
300	44	(1.75)	67	(2.62)	86	(3.38)	105	(4.12)	127	(5.00)	146	(5.75)	12
350	48	(1.88)	73	(2.88)	98	(3.88)	Unlisted		Unlisted		Unlisted		14
400	57	(2.25)	86	(3.38)	Unlisted		Unlisted		Unlisted		Unlisted		16
450	64	(2.50)	Unlisted		Unlisted		Unlisted		Unlisted		Unlisted		18
500	70	(2.75)	Unlisted		Unlisted		Unlisted		Unlisted		Unlisted		20
600	89	(3.50)	Unlisted		Unlisted		Unlisted		Unlisted		Unlisted		24

NOTE Unlisted minimum stem diameter shall be in agreement between the manufacturer and the purchaser.

5.8.2.1 The yoke bushing shall be threaded internally to engage the stem, and it shall be threaded or otherwise suitably fitted into the yoke. The bushing shall be secured in place using either a lock weld or a positive mechanical lock. Locking by simple metal upsetting such as peening or staking is not permitted.

5.8.3 The stem-to-bushing or stem-to-stem nut threads shall be of trapezoidal form as specified in ASME B1.5 or ASME B1.8, with nominal dimensional variations allowed. Stem threads shall be oriented so that a direct operated handwheel rotated in a clockwise direction closes the valve, regardless of whether the valve is equipped with yoke bushing or with stem nut.

5.8.4 The stem shall be one-piece wrought material. A stem that is a welded fabrication or threaded assembly shall not be provided.

5.8.5 Out of straightness of the entire length of the stem shall not exceed 0.001 mm/mm (0.001 in./in.).

5.8.6 The stem-to-disc connection (except for stop-check valves) shall be designed to prevent disengagement of the stem from the disc in any position of the disc or orientation of the valve. The bottom of the stem shall be contoured with a radial curvature large enough to allow contact with the closure element through any misalignment.

5.8.7 The stem, yoke bushing/stem nut, disc connection, and bonnet shall be designed to withstand the closing of the valve against the full rated pressure under the disc and to withstand the opening of the valve against the full rated pressure with flow over the disc.

5.8.8 The one-piece stem shall include a conical or spherical raised surface that seats against the bonnet backseat when the valve is at its full open position. Alternatively, the backseat may be integral to the disc retainer.

A stem-bonnet backseat is a requirement of this standard and, as such, is not meant to imply a manufacturer's recommendation of its use for the purpose of adding or replacing packing while the valve is under pressure.

5.8.9 The yoke bushing or stem nut design shall allow for the removal of the handwheel while keeping the stem (and disc) in a fixed position.

5.8.10 The stem-to-handwheel attachment shall be through a tapered square interface or another means of equivalent strength. A threaded extension shall be provided at the top of the stem for engaging a handwheel retainer nut. The stem-nut-to-handwheel attachment, where provided, shall be through a hexagonal interface, a round interface having a keyway or another means of equivalent strength.

5.8.11 The stem shall be of sufficient length to ensure that the handwheel stands clear of the yoke bushing or stem nut when the valve is in the "worn closed" position and shall have adequate hand clearance between the handwheel and any part of the yoke.

5.8.12 As a means to determine disc position in both the open and closed positions, the following design criteria shall apply.

— For rotating rising stems with rising handwheels, the following maximum stem exposures shall be met for the following valve sizes:

  a) valve sizes 50 ≤ DN ≤ 80, 12.7 mm: 2 ≤ NPS ≤ 3, 1/2 in. (maximum stem exposure);

  b) valve sizes 100 ≤ DN ≤ 300, 19.1 mm: 4 ≤ NPS ≤ 12, 3/4 in. (maximum stem exposure);

  c) valve sizes 350 ≤ DN ≤ 600, 25.4 mm: 14 ≤ NPS ≤ 24, 1 in. (maximum stem exposure).

— This requirement for nonrotating rising stems with nonrising handwheels is optional if another method to determine the disc position in both the open and closed positions is provided.

— For gear-operated valves, the manufacturer shall provide a means to determine the disc position in both the open and closed positions.

5.8.13 Valves DN ≥ 150 (NPS ≥ 6) with pressure class ≥ 600, shall be furnished with stem nuts having ball or roller bearings. Use of a hammer-blow handwheel on DN 150 thru 300 (NPS 6 thru 12) Class 600 and higher valves is permitted as an option to the use of bearings.

5.8.14 For rotating stem nut for nonrotating stem designs, consideration shall be given to chamfering or radiusing stem nut-bearing surfaces to minimize stress concentration.

5.9 Packing and Packing Box

5.9.1 The packing may be either square, rectangular, or trapezoidal in cross-section. The nominal radial width of the packing, w, shall be in accordance with Table 6.

5.9.2 The nominal depth of the packing box shall accommodate a minimum of five uncompressed rings of packing. Unless otherwise specified by the purchaser, the packing box surface area in contact with the packing material shall have a surface finish, Ra, of 4.5 µm (175 µin.) or smoother.

Table 6—Nominal Radial Width of Packing

Nominal Stem Diameter d_n mm (in.)	Nominal Radial Width of the Packing w mm (in.)	Packing Box Clearance Factor y mm (in.)
19 < d ≤ 27 ($^3/_4$ < d ≤ 1)	6.4 ($^1/_4$)	0.4 ($^1/_{64}$)
27 < d ≤ 37 (1 < d ≤ $1^3/_8$)	7.9 ($^5/_{16}$)	0.4 ($^1/_{64}$)
37 < d ≤ 49 ($1^3/_8$ < d ≤ $1^7/_8$)	9.5 ($^3/_8$)	0.4 ($^1/_{64}$)
49 < d ≤ 56 ($1^7/_8$ < d ≤ $2^1/_8$)	11.1 ($^7/_{16}$)	0.8 ($^1/_{32}$)
56 < d ≤ 74 ($2^1/_8$ < d ≤ $2^7/_8$)	12.7 ($^1/_2$)	0.8 ($^1/_{32}$)
74 < d < 92 ($2^7/_8$ < d ≤ $3^5/_8$)	14.3 ($^9/_{16}$)	0.8 ($^1/_{32}$)
92 < d < 108 ($3^5/_8$ < d ≤ $4^1/_4$)	15.9 ($^5/_8$)	0.8 ($^1/_{32}$)
108 < d < 124 $4^1/_4$ < d ≤ $4^7/_8$)	17.5 ($^{11}/_{16}$)	0.8 ($^1/_{32}$)
124 < d < 146 ($4^7/_8$ < d ≤ $5^3/_4$)	20.6 ($^{13}/_{16}$)	0.8 ($^1/_{32}$)

5.9.3 The nominal bore (inside diameter) of the packing box shall be the sum of the nominal valve stem diameter plus twice the nominal packing width plus a clearance factor, y, i.e. equal to $d_n + 2w + y$. See Table 6 for the required values.

5.9.4 A gland and a separate gland flange shall be provided for packing compression. The gland flange shall have two holes to receive the gland bolting. Slots for gland flange bolts shall not be used. The gland and gland flange shall be self-aligning. The gland shall have a shoulder at its outer edge so as to prevent complete entry of the gland into the packing box.

5.9.5 A lantern ring shall be provided only if so specified by the purchaser. To accommodate the lantern ring, the packing box depth shall be at least equivalent to that of a minimum of three uncompressed rings of packing above the lantern ring and three uncompressed rings of packing below the lantern ring plus the length of the lantern ring. The clearance between the packing box bore (inside diameter) and the outside diameter of the gland and the spacer ring (see Figure B.1) shall be nominally less than the diametrical clearance between the inside diameter of the gland and the stem diameter. The clearance between the spacer ring and the stem shall be sufficient to prevent galling.

5.10 Bolting

5.10.1 Bolting shall be standard inch series bolting, except if the purchaser specifies metric series bolting. Bolting for the bonnet-to-body joint shall be continuously threaded stud bolts with heavy hexagon nuts that are in accordance with ASME B18.2.6M or ASME B18.2.6.

5.10.2 Body-to-bonnet bolting materials shall meet the requirements of ASME B16.34.

5.10.3 Yoke-to-bonnet bolting shall be either continuously threaded stud bolts or headed bolts with hexagon nuts.

5.10.4 Gland bolts, with hexagonal nuts, shall be hinged eyebolts, headed bolts, stud bolts, or studs.

5.10.5 Bolting with diameters 25 mm (1 in.) and smaller shall have coarse (UNC) threads or the most nearly corresponding metric threads. Bolting with diameters larger than 25 mm (1 in.) shall be 8-thread series (8UN) or the most nearly corresponding metric threads. Bolt threads shall be Class 2A and nut threads shall be Class 2B, in accordance with ASME B1.1. Studs used for gland bolting shall use a Class 5 interference fit conforming to ASME B1.12. When metric bolting is used, metric bolt threads shall be tolerance Class 6g and nuts tolerance Class 6H in accordance with ASME B1.13M.

5.11 Operation

5.11.1 Unless otherwise specified by the purchaser, the valve shall be supplied with a direct operated handwheel that opens the valve when turned in a counter-clockwise direction. “Hammer-blow” handwheels or gear operators may be provided at the manufacturer’s option.

5.11.2 The handwheel shall be a spoke-rim type with a maximum of six spokes and shall be free from burrs and sharp edges. Unless otherwise specified, the handwheel shall be a one-piece casting or forging or a multipiece carbon steel fabrication that includes other carbon steel product forms. Fabricated handwheels shall have strength and toughness characteristics comparable to that of handwheels made as one-piece castings or forgings.

5.11.3 The handwheel shall be marked with the word “OPEN” and an arrow pointing in the direction of opening, except when the handwheel size makes such marking impractical.

5.11.4 The handwheel shall be retained on the stem or stem nut by a threaded handwheel nut.

5.11.5 If operation by a chain wheel, gearbox, or power actuator is to be added to the valve, the purchaser shall specify the following, as applicable:

— for chainwheel operation, the dimension from the centerline of the valve stem to the bottom of the chain loop;

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

— electric, hydraulic, pneumatic, or other actuator type;

— maximum service temperature and pressure differential across the valve disc;

— power supply attributes for power actuators.

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

5.11.6 Valve-to-gear-box or power actuator flange mating dimensions shall be according to ISO 5210 or MSS SP-102 and shall comply with the purchaser’s specifications.

5.11.7 Consider the effects of severe operating conditions, and the effects of orientation in other than stem-vertical positions, in sizing handwheels. Refer to MSS SP-91 and MSS SP-102.

5.12 Stop-check

5.12.1 Stop-check valves shall be provided with a means to equalize pressure in the bonnet above the disc to the downstream side.

5.12.2 Stop-check valves shall have suitable disc or bottom guiding to ensure the disc moves freely during check valve operation.

5.12.3 Stop-check valves shall be tested in accordance with the requirements of API 598 for both globe and check valves and shall meet the acceptance criteria of both types of tests.

5.12.4 Stop-check valves shall be suitable for installation with the stem in the vertical orientation or in an orientation where the stem is within 45° of vertical orientation.

5.13 Bypasses and Other Auxiliary Connections

Auxiliary connections and tapped test openings to the body and/or bonnet, such as drains, shall be furnished only if specified on the purchase order. The design and construction of the joint and the piping of auxiliary connections shall conform to the requirements of ASME B16.34. When required, auxiliary connections shall be sized and

located as specified in ASME B16.34. The size, type, and location of auxiliary connections shall be indicated on the purchase order.

If a bypass is furnished, it shall be of the external type and of a size specified in ASME B16.34 and MSS SP-45. The bypass valve shall conform to API 602 unless otherwise specified in the purchase order, and be of a pressure class equal to or greater than that of the primary valve.

5.14 Fugitive Emission Design Requirement

5.14.1 Valves shall be type tested to the requirements of API 624.

5.14.2 Packing that meets the valve qualification requirements of API 624 shall be used unless otherwise specified by the purchaser. Refer to 8.2 for marking requirements.

6 Materials

6.1 Materials Other Than Trim Materials

Materials for body, bonnet, and valve parts other than trim items shall be selected from Table 7.

6.2 Trim

6.2.1 The trim comprises the following:

a) stem;

b) body seating surface;

c) disc seating surface;

d) bushing, or a deposited weld, for the backseat;

e) small internal parts that normally contact the service fluid, including split rings and other disc-to-stem retaining components, are considered part of the trim.

6.2.2 The trim material, except as stated in a) through e) below, shall be the manufacturer's standard material for the type listed in Table 8 for the trim number specified in the purchase order. The typical specifications included in Table 8 represent some acceptable grades.

a) If a trim number listed in Table 8 is specified, then an alternative trim number as shown in Table 9 may be furnished with approval of the purchaser.

b) If a single trim (e.g. trim 5) is furnished, both the seating surface of the body seat ring and the seating surface of the disc shall be made of the type of material shown in Table 8.

c) If a combination trim (e.g. trim 8) is furnished, the seating surface of the body seat ring shall be made of one of the two types of material shown in Table 8, and the seating surface of the disc shall be made of the other type of material shown.

d) The stem, backseat, and stem hole guide, and the small internal parts (see 6.2.1 e) shall be of the type of material and hardness listed in Table 8. The stem shall be a wrought material.

e) Hardfacing of both the seat ring and disc seating surface is required for Class 900 and higher-rated valves.

6.2.3 The base material of the valve disc and separate body seat ring, when used, shall be of a nominal material composition at least equal to the body or to that of the stem material, except for disc material made of solid trim material as allowed by 5.6.4.

Table 7—Materials for Parts

Part	Material
Body and bonnet	As selected from ASME B16.34, Group 1, Group 2, and Group 3.
Disc	Steel, at least equal in corrosion resistance to that of the body material.
Yoke, separate	Carbon steel, stainless steel, or same material as the bonnet.
Bolting: body-to-bonnet	Unless other materials are agreed between the purchaser and manufacturer, the bolting material listed in Annex C is recommended. Bolting shall be selected to satisfy valve pressure and temperature range. However, for service temperatures below −29 °C (−20 °F) or above 454 °C (850 °F), the purchase order shall specify the bolting material.
Bonnet gasket	For temperature range from −29 °C to 427 °C (−20 °F to 800 °F). The metallic portion exposed to the service environment shall be of a material that has a corrosion resistance at least equal to that of the body material. Purchaser may specify alternate material.
Bolting: gland and yoke	Bolting material at least equal to ASTM A307—Grade B.
Seat ring	As in Table 8 except the base material of the seat ring, if used, and the base weld material of seal welds, strength welds, or weld deposit facings shall be of nominal material composition equal to the body material or the stem material (see 6.2.3).
Gland flange	Austenitic stainless steel or same nominal chemical composition as the body.
Gland	Material having a corrosion resistance at least equal to that of the body material and with melting point above 955 °C (1750 °F).
Packing	Graphitic material suitable for steam and petroleum fluids for temperature range from −29 °C to 427 °C (−20 °F to 800 °F)[a]. Shall contain a corrosion inhibitor. Purchaser may specify alternate material.
Lantern ring or spacer ring	Material having corrosion resistance at least equal to that of the stem material and with melting point above 955 °C (1750 °F)
Stem nut or yoke bushing	Austenitic ductile iron or copper alloy with melting point above 955 °C (1750 °F).
Handwheel	Malleable iron, carbon steel, or ductile iron.
Handwheel nut (retaining)	Steel, malleable iron, ductile iron, or nonferrous copper alloy.
Pipe plugs	Nominal composition shall be the same as the shell material. Cast iron plugs shall not be used.
Bypass piping and valves	Nominal composition shall be the same as the shell material.
Identification plate	Austenitic stainless steel or nickel alloy attached to the valve by corrosion-resistant fasteners or by welding.

[a] Effective low emissions performance may be limited to lower temperatures.

7 Testing, Inspection, and Examination

7.1 Inspection and Examination

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

7.1.2 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.

7.2 Pressure Tests

Each valve shall be pressure tested by the manufacturer as specified in API 598.

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

Trim Number	Nominal Trim	Seat Surface Hardness (HB) Minimum [a]	Seat Surface Material Type [b]	Seat Surface Typical Specifications Grade			Stem/Bushing		Stem Hardness (HB)	Backseat Bushing Hardness (HB)
				Cast	Forged	Welded [c]	Material Type [b]	Typical Specifications Type		
1	F6	TRIM NUMBER 1 IS OBSOLETE								
2	304	Note [d]	18Cr-8Ni	ASTM A351 (CF8)	ASTM A182 (F304)	AWS A5.9 ER308	18Cr-8Ni	ASTM A276-T304	Note [d]	Note [d]
3	F310	Note [d]	25Cr-20Ni	NA	ASTM A182 (F310)	AWS A5.9 ER310	25Cr-20Ni	ASTM A276-T310	Note [d]	Note [d]
4	Hard F6	750 [e]	Hard 13Cr	NA	Note [f]	NA	13Cr	ASTM A276-T410 or T420	200 min 275 max	250 min
5	Hardfaced	350 [e]	Co-Cr A [g]	NA	NA	AWS A5.13 ECoCr-A or AWS A5.21 ERCoCr-A	13Cr	ASTM A276 T410 or T420	200 min 275 max	250 min
5A	Hardfaced	350 [e]	Ni-Cr	NA	NA	Note [h]	13Cr	ASTM A276 T410 or T420	200 min 275 max	250 min
6	F6 and Cu-Ni	250 [i] 175 [i]	13Cr and Cu-Ni	ASTM A217 (CA 15) NA	ASTM A182 (F6a) Note [k]	AWS A5.9 ER410 NA	13Cr	ASTM A276 T410 or T420	200 min 275 max	250 min
7	F6 and Hard F6	250 [i] 750 [i]	13Cr and Hard 13Cr	ASTM A217 (CA 15) NA	ASTM A182 (F6a) Note [f]	AWS A5.9 ER410 NA	13Cr	ASTM A276 T410 or T420	200 min 275 max	250 min
8	F6 and Hardfaced	250 [i] 350 [i]	13Cr and Co-Cr A [g]	ASTM A217 (CA 15) NA	ASTM A182 (F6a) NA	AWS A5.9 ER410 AWS A5.13 ECoCr-A or AWS A5.21 ERCoCr-A	13Cr	ASTM A276 T410 or T420	200 min 275 max	250 min
8A	F6 and Hardfaced	250 [i] 350 [i]	13Cr and Ni-Cr	ASTM A217 (CA 15) NA	ASTM A182 (F6a) NA	AWS A5.9 ER410 Note [h]	13Cr	ASTM A276 T410 or T420	200 min 275 max	250 min
9	Monel ™ [j]	Note [d]	Ni-Cu Alloy	NA	MFG Standard	NA	Ni-Cu Alloy	MFG Standard	Note [d]	Note [d]
10	316	Note [d]	18Cr-8Ni-Mo	ASTM A351 (CF8M)	ASTM A183 (F316)	AWS A5.9 ER316	18Cr-8Ni-Mo	ASTM A276-T316	Note [d]	Note [d]

Table 8—Nominal Seating Surface, Stem, and Backseat Bushing or Weld Deposited Materials and Hardness (Continued)

Trim Number	Nominal Trim	Seat Surface Hardness (HB) Minimum [a]	Seat Surface Material Type [b]	Seat Surface Typical Specifications Grade			Stem/Bushing		Stem Hardness (HB)	Backseat Bushing Hardness (HB)
				Cast	Forged	Welded [c]	Material Type [b]	Typical Specifications Type		
11	Monel ™ [j] and Hardfaced	Note [d] 350 [i]	Ni-Cu Alloy and Trim 5 or 5A	NA	MFG Standard	NA See Trim 5 or 5A	Ni-Cu Alloy NA	MFG Standard NA	Note [d]	Note [d]
12	316 and Hardfaced	Note [d] 350 [i]	18Cr-8Ni-Mo and Trim 5 or 5A	ASTM A351 (CF8M)	ASTM A182 (F316)	AWS A5.9 ER316 See Trim 5 or 5A	18Cr-8Ni-Mo NA	ASTM A276-T316 NA	Note [d]	Note [d]
13	Alloy 20	Note [d]	19Cr-29Ni	ASTM A351 (CN7M)	ASTM B473	AWS A5.9 ER320	19Cr-29Ni	ASTM B473	Note [d]	Note [d]
14	Alloy 20 and Hardfaced	Note [d] 350 [i]	19Cr-29Ni and Trim 5 or 5A	ASTM A351 (CN7M) NA	ASTM B473 NA	AWS A5.9 ER320 See Trim 5 or 5A	19Cr-29Ni NA	ASTM B473 NA	Note [d]	Note [d]
15	Hardfaced	350 [e]	Co-Cr A [g]	NA	NA	AWS A5.13 ECoCr-A or AWS A5.21 ERCoCr-A	18Cr-8Ni	ASTM A276-T304	Note [d]	Note [m]
16	Hardfaced	350 [e]	Co-Cr A [g]	NA	NA	AWS A5.13 ECoCr-A or AWS A5.21 ERCoCr-A	18Cr-8Ni-Mo	ASTM A276-T316	Note [d]	Note [m]
17	Hardfaced	350 [e]	Co-Cr A [g]	NA	NA	AWS A5.13 ECoCr-A or AWS A5.21 ERCoCr-A	18Cr-10Ni-Cb	ASTM A276-T347	Note [d]	Note [m]
18	Hardfaced	350 [e]	Co-Cr A [g]	NA	NA	AWS A5.13 ECoCr-A or AWS A5.21 ERCoCr-A	19Cr-29Ni	ASTM B473	Note [d]	Note [m]
19	Nickel [l]	Note [d]	Ni Alloy	MFG Standard [l]	MFG Standard [l]	MFG Standard	Ni Alloy [l]	MFG Standard [l]	Note [d]	Note [m]

Table 8—Nominal Seating Surface, Stem, and Backseat Bushing or Weld Deposited Materials and Hardness (Continued)

Trim Number	Nominal Trim	Seat Surface Hardness (HB) Minimum [a]	Seat Surface Material Type [b]	Seat Surface Typical Specifications Grade			Stem/Bushing		Stem Hardness (HB)	Backseat Bushing Hardness (HB)
				Cast	Forged	Welded [c]	Material Type [b]	Typical Specifications Type		
19A	Alloy 625	Note [d]	Alloy 625	ASTM A494 (CW6MC)	ASTM B564 UNS N06625	AWS A5.14 ERNiCrMo-3	Alloy 625	ASTM B564 UNS N06625	Note [d]	Note [m]
19B	Alloy C276	Note [d]	Alloy C276	ASTM A494 (CW2M)	ASTM B564 UNS N10276	AWS A5.14 ERNiCrMo-4	Alloy C276	ASTM B564 UNS N10276	Note [d]	Note [m]
19C	Alloy 825	Note [d]	Alloy 825	ASTM A494 (CU5MCuC)	ASTM B564 UNS N08825	AWS A5.14 ERNiCrMo-3	Alloy 825	ASTM B564 UNS N08825	Note [d]	Note [m]
20	Nickel [l] and Hardfaced	Note [d]	Ni Alloy	MFG Standard [l]	MFG Standard [l]	NA	Ni Alloy [l]	MFG Standard [l]	Note [d]	Note [m]
		350 [i]	CoCr-A [g]	NA	NA	AWS 5.13 ECoCr-A or AWS 5.21 ECoCr-A				
20A	Alloy 625 and Hardfaced	Note [d]	Alloy 625	ASTM A494 (CW6MC)	ASTM B564 UNS N06625	AWS A5.14 ERNiCrMo-3	Alloy 625	ASTM B564 UNS N06625	Note [d]	Note [m]
		350 [i]	CoCr-A [g]	NA	NA	AWS 5.13 ECoCr-A or AWS 5.21 ECoCr-A				

Table 8—Nominal Seating Surface, Stem, and Backseat Bushing or Weld Deposited Materials and Hardness (Continued)

Trim Number	Nominal Trim	Seat Surface Hardness (HB) Minimum [a]	Seat Surface Material Type [b]	Seat Surface Typical Specifications Grade			Stem/Bushing		Stem Hardness (HB)	Backseat Bushing Hardness (HB)
				Cast	Forged	Welded [c]	Material Type [b]	Typical Specifications Type		
20B	Alloy C276 and Hardfaced	Note [d]	Alloy C276	ASTM A494 (CW2M)	ASTM B564 UNS N10276	AWS A5.14 ERNiCrMo-4	Alloy C276	ASTM B564 UNS N10276	Note [d]	Note [m]
		350 [i]	CoCr-A [g]	NA	NA	AWS 5.13 ECoCr-A or AWS 5.21 ECoCr-A				
20C	Alloy 825 and Hardfaced	Note [d]	Alloy 825	ASTM A494 (CU5MCuC)	ASTM B564 UNS N08825	AWS A5.14 ERNiCrMo-3	Alloy 825	ASTM B564 UNS N08825	Note [d]	Note [m]
		350 [i]	CoCr-A [g]	NA	NA	AWS 5.13 ECoCr-A or AWS 5.21 ECoCr-A				
21	Hardfaced [l]	350 [e]	Co-Cr A [g]	NA	NA	AWS 5.13 ECoCr-A or AWS 5.21 ECoCr-A	Ni Alloy [l]	MFG Standard [l]	Note [d]	Note [m]

NOTE Cr = chromium; Ni = nickel; Co = cobalt; Cu = copper; NA = not applicable.

[a] HB (formerly BHN) is the symbol for the Brinell hardness per ASTM E10.

[b] Free machining grades of 13Cr are prohibited.

[c] Typical backseat weld deposit material.

[d] Manufacturer's standard hardness.

[e] Differential hardness between the body and disc seat surfaces is not required.

[f] Case hardness by nitriding to a thickness of 0.13 mm (0.005 in.) minimum.

[g] AWS 5.13 ECoCr-A or AWS 5.21 ERCoCr-A. This classification includes trademark materials. For plasma transfer arc welding (PTAW), process powder with the metallurgy equivalent to UNS R30006 can also be used. CoCr-E may be used only with purchaser approval, and typical CoCr-E alloys include AWS A5.13 ECoCr-E or AWS A5.21 ERCoCr-E.

[h] Manufacturer's standard hardfacing with a maximum iron content of 25 %.

[i] Hardness differential between the body and disc seat surfaces shall be the manufacturer's standard.

[j] Monel is used strictly as an example of any nickel-copper alloy 400 matching UNS N04400 specifications. It does not constitute any endorsement of any specific product or company by API.

[k] Manufacturer's standard with 30 Ni minimum.

[l] Trim materials, including stem and base material for HF trim items, shall have a corrosion resistance and temperature limit at least equal to the valve body's corrosion resistance and pressure temperature rating.

[m] Per manufacturer's standard if not hardfaced, 250 HB minimum if hardfaced.

Table 9—Trim Numbers and Alternative Trim Numbers

Specified Trim Number	Alternative Trim Number
2	10
5A	5
8A	8
10	12 or 16
13	14
12	16

7.3 Inspection of Castings

Body and bonnet castings shall meet the inspection criteria of MSS SP-55.

7.4 Repairs of Casting Defects

Defects in the shell of a cast valve that are revealed by inspection or testing shall be repaired as permitted per the applicable ASTM cast material specification listed in ASME B16.34.

8 Marking

8.1 General

Valves shall be marked in accordance with the requirements of ASME B16.34, except that the nameplate shall include the designation “API 623” in addition to the designation “ASME B16.34.”

8.2 Specific Markings

8.2.1 The direction of flow shall be marked with a flow direction arrow that is cast, forged, or stamped into the valve body outer wall, or with a separate identification plate permanently attached to the valve body that indicates flow direction.

8.2.2 Valves equipped with packing complying to API 624 shall be marked in accordance with API 624.

8.2.3 Valves equipped with packing not complying with API 624 shall not be marked in accordance with API 624. Such valves shall have a tag attached indicating the packing material (e.g. “PTFE Packing” or “Graphite Packing”).

9 Preparation for Shipment

9.1 Coatings

9.1.1 Unmachined exterior surfaces of the shell shall be painted per the manufacturer’s standard paint with an aluminum or silver color unless otherwise agreed. Austenitic stainless steel valves shall not be painted, unless otherwise agreed.

9.1.2 Machined or threaded surfaces (except those on austenitic stainless steel materials) shall be coated with an easily removable rust preventative. The stem does not need to be coated if the stem packing contains a corrosion inhibitor.

9.2 Openings

9.2.1 Valve end flanges and welding ends shall be blanked to protect the gasket surfaces or welding ends and the valve internals during shipment and storage. The protective covers shall be made of wood, wood fiber, plastic,

or metal and shall be securely attached to the valve ends by bolts, steel, straps, steel clips, or suitable friction-locking devices. Covers shall be designed so that the valve cannot be installed without removal of protective cover.

9.2.2 Tapped connections shall be fitted with securely tightened, leak-tight threaded plugs. Use of anti-galling compounds is permissible. Thread sealants are not permitted unless allowed by the purchaser. The material used for plugs for tapped connections shall have the same nominal chemical composition as the shell material (see 5.13 and Table 7).

9.3 Disc Position

The valve shall be shipped with the disc closed.

9.4 Stem Packing

The valve shall be shipped with the lantern ring, if specified, and the packing installed and tightened to the manufacturer's specified gland load. The remaining adjustment length of the packing gland shall be greater than one and a half times the packing width specified in Table 6.

9.5 Packaging

9.5.1 Unless export packaging is specified in the purchase order, valves may be shipped loose, palletized, or packed in a box or crate.

9.5.2 When export packaging is specified in the purchase order, valves shall be shipped individually or collectively in wooden boxes or crates in a manner that will prevent shifting within the package.

Annex A
(normative)

Information to be Specified by the Purchaser

1) Supplemental requirements of this standard shall be specifically stated in the purchase order.

2) If no supplemental requirements are to be taken to this standard, the purchase order just needs to refer to API 623 and to specify the items in the following list that are marked with an asterisk (*). The items listed below without an asterisk are options that may also be specified:

   a) valve size *;

   b) pressure class *;

   c) flanged ends, including flange facing finish; or welding ends, including bore *;

   d) pressure seal bonnet;

   e) auxiliary connections, types, locations, and openings;

   f) valve orientation;

   g) additional hardfacing of body and/or disc guides;

   h) bonnet gasket and/or bonnet flange facing;

   i) tapped openings;

   j) type of disc, if required *;

   k) lantern ring;

   l) chainwheel and chain;

   m) gear operation, including type and arrangement, and the design maximum pressure differential across the valve;

   n) power operation, including type of power and power unit, and the design maximum pressure differential across the valve;

   o) bypass—specify bypass valve type;

   p) material of the valve shell *;

   q) nominal trim material *;

   r) any required exceptions to manufacturer’s permissible options (e.g. NACE MR 0103);

   s) handwheels;

   t) safety shield;

   u) chainwheel and safety cables, if furnished as original equipment;

v) alternate stem packing material;

w) bonnet bolting material;

x) inspection by purchaser;

y) low-pressure closure test;

z) supplementary examination and testing;

aa) export packaging.

Annex B
(informative)

Identification of Valve Terms

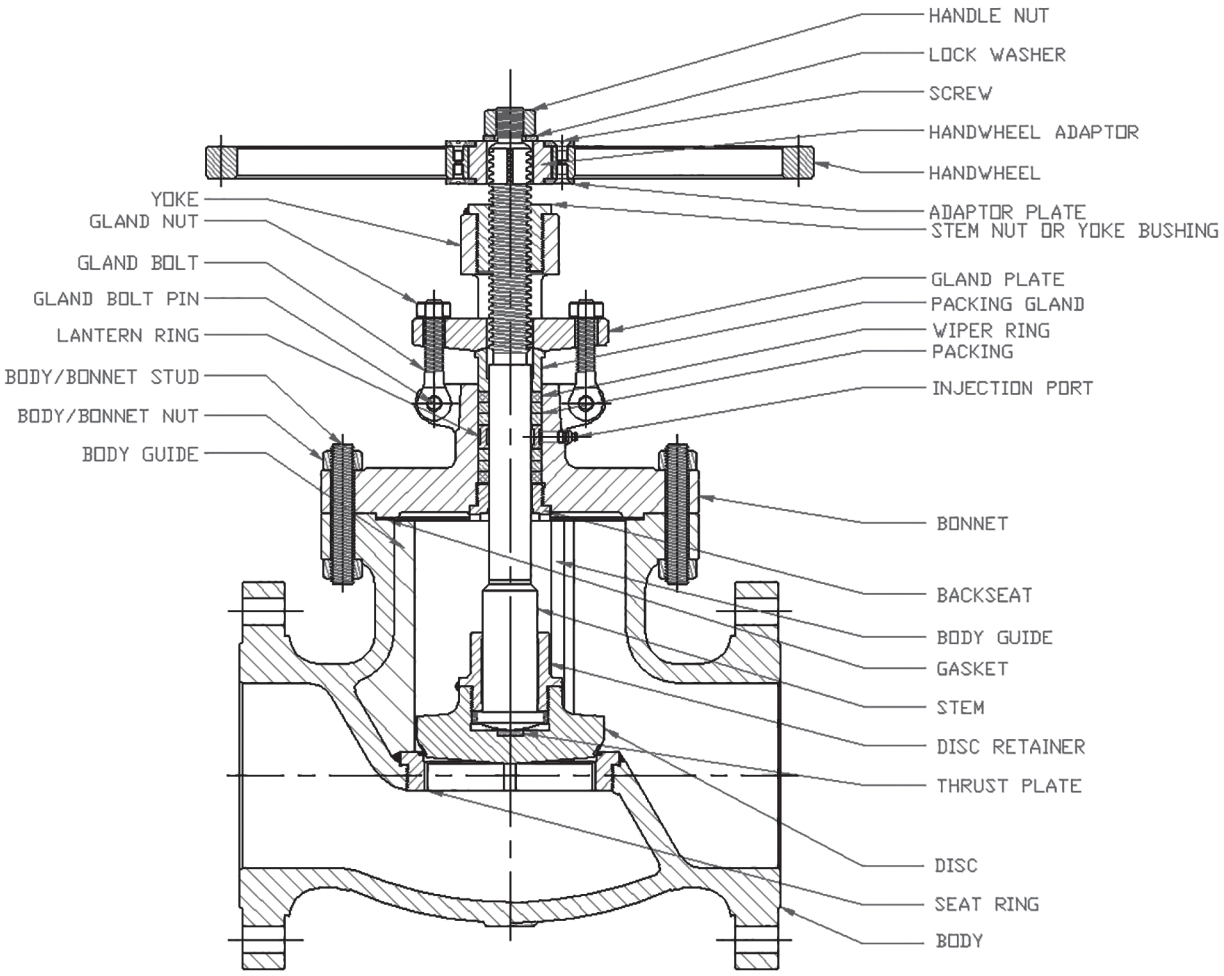


Figure B.1—Valve Nomenclature

Annex C
(informative)

Valve Material Combinations

Table C.1, Table C.2, and Table C.3 list valve body, bonnet, and cover materials (ASME B16.34, Material Groups 1, 2, and 3) along with associated valve trim materials (trim numbers, Table 8) and ASTM A193 and ASTM A194 specification bolting materials. For ASTM A193 and ASTM A194 listed bolting materials in Table C.1 and Table C.2, corresponding bolting materials listed in EN 10269 may be substituted in accordance with Table C.4. Materials other than those listed in Table C.1, Table C.2, Table C.3, or Table C.4 are outside the scope of this standard (see 6.2).

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

NOTE For bolting materials in accordance with EN 10269, see Table C.4.

[a] Temperature limitations on bolting are as follows: Gr B7, 538 °C (1000 °F); Gr L7, 427 °C (800 °F); Gr B16, 595 °C (1100 °F); Gr B8-CL1, Gr B8A-CL1A, Gr B8M-CL1, and Gr B8MA-CL1A, 816 °C (1500 °F); Gr B8-CL2, Gr B8M-CL2, Gr B8M2-CL2B and Gr B8M3-CL2C, 538 °C (1000 °F).

[b] ASTM A320, Gr L7 bolts and ASTM A194, Gr 7 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 is a suitable substitute, provided that the requirements of 5.5.7 are met.

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

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

Table C.2—Material Combinations for Group 2 Body, Bonnet, and Cover Materials

Material Group ASME B16.34	Body/Bonnet Material Abbreviation	Body, Bonnet, and Cover ASTM Specification	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	Note [b]	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	8Cr-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 A351-CK3MCuN A182-F51 A182-F53 A351-CE8MN A351-CD4MCu A351-CD3MWCuN A182-F55	Note [b]	B8M-CL2/8M [c d]
2.10	25Cr-12Ni	A351-CH8 A351-CH20	Note [b]	B8M-CL2/8M [c d]
2.11	18Cr-10Ni-Cb	A351-CF8C	Note [b]	B8M-CL2/8M [c d]
2.12	25Cr-20Ni	A351-CK20	Note [b]	B8M-CL2/8M [c d]

[a] Temperature limitations on bolting are as follows: Gr B7, 538 °C (1000 °F); Gr L7, 427 °C (800 °F); Gr B16, 595 °C (1100 °F); Gr B8-CL1, Gr B8A-CL1A, Gr B8M-CL1, and Gr B8MA-CL1A, 816 °C (1500 °F); Gr B8-CL2, Gr B8M-CL2, Gr B8M2-CL2B and Gr B8M3-CL2C, 538 °C (1000 °F).

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

[c] ASTM A193, Gr B8-CL1, Gr B8A-CL1A, Gr B8M-CL1, Gr B8MA-CL1A, Gr B8M2-CL2B, and Gr B8M3-CL2C bolting is a suitable substitute, provided that the requirements of 5.5.7 are met.

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

Table C.3—Material Combinations for Group 3 Body, Bonnet, and Cover Materials

Material Group ASME B16.34	Body/Bonnet Material Abbreviation	Body, Bonnet, and Cover ASTM Specification	Trim Material CN Designation	Body-to-Bonnet and Body-to-Cover Bolting ASTM Specification [a]
3.1	35Ni-35Fe-20Cr-Cb	B462 N08020	13, 14	B425 N08825
3.2	99Ni	B564 N02200	19, 20	B160 N02200
3.4	67Ni-30Cu 67Ni-30Cu-S	B564 N04400/A494 M-35–1 A494 M-35–2	9, 11	F468 N04400/ F467 N04400 [b]
3.5	72Ni-15Cr-8Fe	B564 N06600	19, 20	B166 N06600
3.6	33Ni-42Fe-21Cr	B564 N08800	19, 20	B408 N08800
3.7	65Ni-28Mo-2Fe 64Ni-29.5Mo-2Cr-2Fe-Mn-W	B462 N10665 B462 N10675	19, 20	F468 N04400/ F467 N04400 [b]
3.8	54Ni-16Mo-15Cr 60Ni-22Cr-9Mo-3.5Cb 42Ni-21.5Cr-3Mo-2.3Cu 55Ni-21Cr-13.5Mo 55Ni-23Cr-16Mo-1.6Cu	B462 N10276 B564 N06625 B564 N08825 B462 N06022 B462 N06200	19B,20B 19A, 20A 19C, 20C 19, 20 19, 20	F468 N10276/ F467 N10276 [c] B446 N06625 B425 N08825 F468 N10276/ F467 N10276 [c]
3.12	46Fe-24Ni-21Cr-6Mo-Cu-N 58Ni-33Cr-8Mo	B462 N08367/A351 CN3MN B462 N06035	19, 20	B425 N08825 B446 N06625
3.13	Ni-Fe-Cr-Mo-Cu-Low C	B564 N08031	19, 20	B425 N08825
3.14	40Ni-29Cr-15Fe-5Mo	B462 N06030	19, 20	B425 N08825
3.15	33Ni-42Fe-21Cr Ni-Mo Ni-Mo-Cr	B564 N08810 A494 N-12MV A494 CW-12MW	19, 20	B408 N08800 B425 N08825
3.17	29Ni-20 1/2Cr-3 1/2Cu- 2 1/2 Mo	A351 CN7M	19, 20	B425 N08825
3.19	57Ni-22Cr-14W-2Mo-La	B564 N06230	19, 20	B408 N08800

NOTE For bolting materials in accordance with EN 10269, see Table C.4.

[a] Temperature limitations on bolting are as follows: Gr B7, 538 °C (1000 °F); Gr L7, 427 °C (800 °F); Gr B16, 595 °C (1100 °F); Gr B8-CL1, Gr B8A-CL1A, Gr B8M-CL1, and Gr B8MA-CL1A, 816 °C (1500 °F); Gr B8-CL2, Gr B8M-CL2, Gr B8M2-CL2B and Gr B8M3-CL2C, 538 °C (1000 °F).

[b] ASTM F467 and ASTM F468 cover bolting dimensions from 1/4" (M6) up to 1 1/2 (M36), for greater size consider ASTM B164 N04400.

[c] ASTM F467 and ASTM F468 cover bolting dimensions from 1/4" (M6) up to 1 1/2 (M36), for greater size consider ASTM B574 N10276.

Table C.4—Alternative Body-to-Bonnet Bolting Materials

As Related to Table C.1 and Table C.2		As Related to Table Notes in Table C.1 and Table C.2	
ASTM Bolting Material	**EN 10269 Bolting Material Grade**	**ASTM Bolting Material**	**EN 10269 Bolting Material Grade**
A193 B7 A193 B16	42CrMo4 (1.7225)—QT 40CrMoV4–6 (1.7711)—QT	A193 B8M2, CL 2B A193 B8M3, CL 2C	X5CrNiMo 17–12–2 (1.4401)—C700 X5CrNiMo 17–12–2 (1.4401)—C700
A193 B8M, CL 2 A194 2H	X5CrNiMo 17–12–2 (1.4401)—C700 45E (1.1191)—QT	A193 B8M, CL 1 A193 B8MA, CL 1A	X5CrNiMo 17–12–2 (1.4401)—AT X5CrNiMo 17–12–2 (1.4401)—AT
A194 8M	X5CrNiMo 17–12–2 (1.4401)—AT	A193 B8, CL 1 A193 B8A, CL 1A	X5CrNi 18–10 (1.4301)—AT X5CrNi 18–10 (1.4301)—AT
		A193, B8 CL 2 A320, L7	X5CrNi 18–10 (1.4301)—C700 42CrMo4 (1.7225)—QT
		A194 GR 8 A194 GR 7	X5CrNi 18–10 (1.4301)—AT 42CrMo4 (1.7225)—QT
		A194 GR 7	42CrMo4 (1.7225)—QT

NOTE Temperature limitations applicable for ASTM bolting materials, table notes for Table C.1, Table C.2, and Table C.3 also apply for corresponding substitute EN bolting materials.

Bibliography

[1] API RP 615, *Valve Selection Guide*

[2] ASTM A193, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

[3] ASTM A194, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

[4] ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

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