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

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1 Scope

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

1.2 The following two categories of butterfly valves are included:

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

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

— for lug and wafer, class 150 and 300: NPS 2 to NPS 60;

— for lug and wafer, class 600: NPS 3 to NPS 60;

— for double-flanged short and long pattern, class 150, 300, and 600: NPS 3 to NPS 60;

— for butt-welding ends, class 150, 300 and 600: NPS 3 to 60;

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

1.3 Valve configurations include double-flanged, lug- and wafer-type with facings that permit installation between ASME and MSS flanges and butt-welding ends. Configurations conform to the standards and specifications listed in Section 2. Typical valve construction and nomenclature for valve parts are shown in Annex C.

2 Normative References

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

API Standard 598, *Valve Inspection and Testing*

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

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

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

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

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

ASME B16.25, *Buttwelding Ends*

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

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

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

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

ASME B31.3, *Process Piping*

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

MSS SP-6[2] , *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-end Flanges of Valves and Fittings*

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

MSS SP-45, *Bypass and Drain Connections*

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

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

ANSI/NACE MR0103[3] /*ISO 17945, Petroleum, Petrochemical and Natural Gas Industries—Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments*

ANSI/NACE MR0175/*ISO 15156, Petroleum and Natural Gas Industries—Materials for Use in H2S-containing Environments in Oil and Gas Production*

3 Terms and Definitions

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

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

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

3.3
dead-end service
A condition that may occur after the companion flange and/or piping are removed from one side of a valve.

3.4
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

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

[3] NACE, 15835 Park Ten Place, Houston, Texas 77084, www.nace.org.

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.

3.5
pressure boundary element
Comprises the shell and related bolting that forms a part of the pressure boundary (see Annex C).

3.6
shell
Comprises the body, cover, bonnet, bonnet extension, and seat retainer that constitutes the pressure boundary of an API 609 valve (see Annex C).

4 Pressure-temperature Ratings

4.1 Valve Rating

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

4.2 Shell Rating

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

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

— for ductile iron, ASME B16.42;

— for cast copper alloys, ASME B16.24;

— for steel, nickel alloy, or special alloy material, ASME B16.34.

4.3 Seat Rating

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

Table 1—Minimum Seat Pressure-temperature Ratings for Category B Valves

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

4.3.2 Valves furnished with internal liners, encapsulation, resilient seating materials, or a combination of these features shall have pressure-temperature limits conforming to the valve manufacturer's published specifications. Temperature limits shall be marked on the nameplate as required in 8.1 f).

4.4 Differential Pressure Rating

Differential pressure rating shall not exceed the seat pressure rating.

5 Design

5.1 General

5.1.1 Category B Valves

Valves manufactured in accordance with this standard shall meet the requirements of ASME B16.34 for Standard class and any additional requirements as specified in this standard. For materials not listed in ASME B16.34, the applicable requirements and design rules of ASME B16.34 shall be used. In the event of a conflict between ASME B16.34 and this standard, this standard shall prevail.

5.1.2 Fire-tested Valves

If the purchaser specifies fire-tested valves, the valve's design shall have been type tested and certified to meet all performance requirements of API 607. Fire test report shall be made available to purchaser upon request.

5.1.3 Fugitive Emissions Tested Valves

If the purchaser specifies fugitive emission valves, the valve's design shall have been type tested and certified to meet all performance requirements of API 641. Fugitive emission test report shall be made available to purchaser upon request.

5.1.4 Cryogenic Service

Valves required to operate in cryogenic service shall meet the additional requirements specified in ANSI/MSS SP-134.

5.1.5 Lockable Device

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

5.1.6 Disc Position Indication

The indication of the position of the disc shall be integral with the valve shaft and shall be aligned with the valve disc. The indication may be accomplished by a mark on the shaft or by a shaft shape. The design shall ensure that a valve (and/or operator) cannot be assembled to falsely indicate the valve's open and closed positions.

5.1.7 Shaft-to-lever Connections

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

5.1.8 Category B Valves

a) **Bidirectional—Category B valves:** Bidirectional valves shall have a pressure rating of equal value in both directions. The pressure rating shall be marked in accordance with 8.1.

b) **Preferred Direction—Category B valves:** When specified by the purchaser, the valve may have preferred and nonpreferred sealing direction. The pressure ratings of both the preferred and nonpreferred sealing directions shall be marked in accordance with 8.1.

5.1.9 Dead-end Service

All components of lug-type and double-flanged valves designated for dead-end service by the purchaser (see B.1.3.f) shall pass the API 598 high-pressure closure test at 110 % of the valve's differential pressure rating in each direction. When the seat retainer is on the downstream side, the high-pressure closure test shall be performed with the seat retainer fully unrestrained (i.e. no downstream flange). Valves designed for dead-end service in only one installation direction require additional marking per 8.3.

5.2 Body

5.2.1 The minimum body-wall thickness shall comply with the applicable ASME B16 standard listed in Section 2 based on the body material. If the applicable standard covers fittings for a particular material, the valve minimum wall thickness shall be as specified for fittings. The valve design shall be structurally suitable for its stated pressure and temperature limits, taking into account that localized thinning may be necessary between the shaft bore in the body and the adjacent bolt holes. Such sections shall be designed in accordance with the requirements of ASME B16.34.

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

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

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

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

5.3 Face-to-face Dimensions

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

NOTE When valve body liners, sleeves, or O-ring seals act as flange-sealing surfaces, separate gaskets should not be used unless specifically recommended by the manufacturer.

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

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

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

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

Valve Size (NPS)	Face-to-face Dimensions		Maximum Variance ±	
	mm	in.	mm	in.
2	43	1.69	1.5	0.06
2 1/2	46	1.81	1.5	0.06
3	46	1.81	1.5	0.06
4	52	2.06	1.5	0.06
5	56	2.19	1.5	0.06
6	56	2.19	1.5	0.06
8	60	2.38	3.3	0.13
10	68	2.69	3.3	0.13
12	78	3.06	3.3	0.13
14	78	3.06	3.3	0.13
16	102	4.00	3.3	0.13
18	114	4.50	3.3	0.13
20	127	5.00	3.3	0.13
24	154	6.06	3.3	0.13
30	165	6.5	6.4	0.25
36	200	7.88	6.4	0.25
42	251	9.88	6.4	0.25
48	276	10.88	6.4	0.25
50 to 60	— [a]		6.4	0.25

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

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

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

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

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

Valve class	Class 150 [a]		Class 300 [a]		Class 600 [a]		Maximum Variance ±	
(NPS)	mm	in.	mm	in.	mm	in.	mm	in.
3	203	8.00	282	11.12	356	14.00	3.3	0.13
4	229	9.00	305	12.00	432	17.00	3.3	0.13
6	267	10.50	403	15.88	559	22.00	3.3	0.13
8	292	11.50	419	16.50	660	26.00	3.3	0.13
10	330	13.00	457	18.00	787	31.00	3.3	0.13
12	356	14.00	502	19.75	838	33.00	3.3	0.13
14	381	15.00	762	30.00	889	35.00	3.3	0.13
16	406	16.00	838	33.00	991	39.00	3.3	0.13
18	432	17.00	914	36.00	1092	43.00	3.3	0.13
20	457	18.00	991	39.00	1194	47.00	3.3	0.13
24	508	20.00	1143	45.00	1397	55.00	4	0.16
26	559	22.00	1245	49.00	1448	57.00	4	0.16
28	610	24.00	1346	53.00	1549	61.00	4	0.16
30	610	24.00	1397	55.00	1651	65.00	4	0.16
32	660	26.00	1524	60.00	1778	70.00	4	0.16
36	711	28.00	1727	68.00	2083	82.00	5	0.19
38 to 60	— [b]						5	0.19

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

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

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

Valve class	Class 150 [a] or class 300 [a]		Class 300 [b]		Class 600 [b]		Maximum Variance ±	
(NPS)	mm	in.	mm	in.	mm	in.	mm	in.
3	114	4.50	180	7.09	180	7.09	3.3	0.13
4	127	5.00	190	7.48	190	7.48	3.3	0.13
6	140	5.50	210	8.27	210	8.27	3.3	0.13
8	152	6.00	230	9.06	230	9.06	3.3	0.13
10	165	6.50	250	9.84	250	9.84	3.3	0.13
12	178	7.00	270	10.63	270	10.63	3.3	0.13
14	190	7.50	290	11.42	290	11.42	3.3	0.13
16	216	8.50	310	12.20	310	12.20	3.3	0.13
18	222	8.75	330	12.99	330	12.99	3.3	0.13
20	229	9.00	350	13.78	350	13.78	3.3	0.13
24	267	10.50	390	15.35	390	15.35	4	0.16
26	292	11.50	410	16.14	— [c]		4	0.16
28	292	11.50	430	16.93	— [c]		4	0.16
30	318	12.52	450	17.72	— [c]		4	0.16
32	318	12.52	470	18.50	— [c]		4	0.16
36	330	12.99	510	20.08	— [c]		5	0.19
38	410	16.14	530	20.87	— [c]		5	0.19

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

Valve class	Class 150 [a] or class 300 [a]		Class 300 [b]		Class 600 [b]		Maximum Variance ±	
(NPS)	mm	in.	mm	in.	mm	in.	mm	in.
40	410	16.14	550	21.65	— [c]		5	0.19
42	410	16.14	570	22.44	— [c]		6	0.24
48	470	18.50	630	24.80	— [c]		6	0.24
50 to 60	— [c]						6	0.24

NOTE See NOTES TO PURCHASER, B.1.3 d).

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

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

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

5.4 Valve Body Flange Facings

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

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

5.5 Disc Clearance

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

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

5.6 Shaft and Shaft Seals

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

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

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

5.6.4 For Category B valves, the shaft shall have a surface finish of 0.80 µm (32 µin.) Ra or smoother in the area in contact with the packing, and the stuffing box shall have a surface finish of 3.2 µm (125 µin.) Ra or smoother. Measurement may be by visual and tactile comparison or by use of a stylus-type surface roughness measuring instrument (refer to ASME B46.1).

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

5.7 Piping Connection External Bolt Holes

5.7.1 Unless specified otherwise in the purchase order, lugs of lug-type valves shall be provided with tapped holes for studs or bolts.

5.7.2 Threaded body-flange holes for bolts 1 in. or less in diameter shall be drilled and tapped in accordance with ASME B1.1, coarse-thread series, class 2B. For bolts $1^1/8$ in. or more in diameter, such holes shall be drilled and tapped in accordance with ASME B1.1, eight-thread series, class 2B.

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

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

5.8 Valve Body Seat Retainer—Category B Valves Only

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

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

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

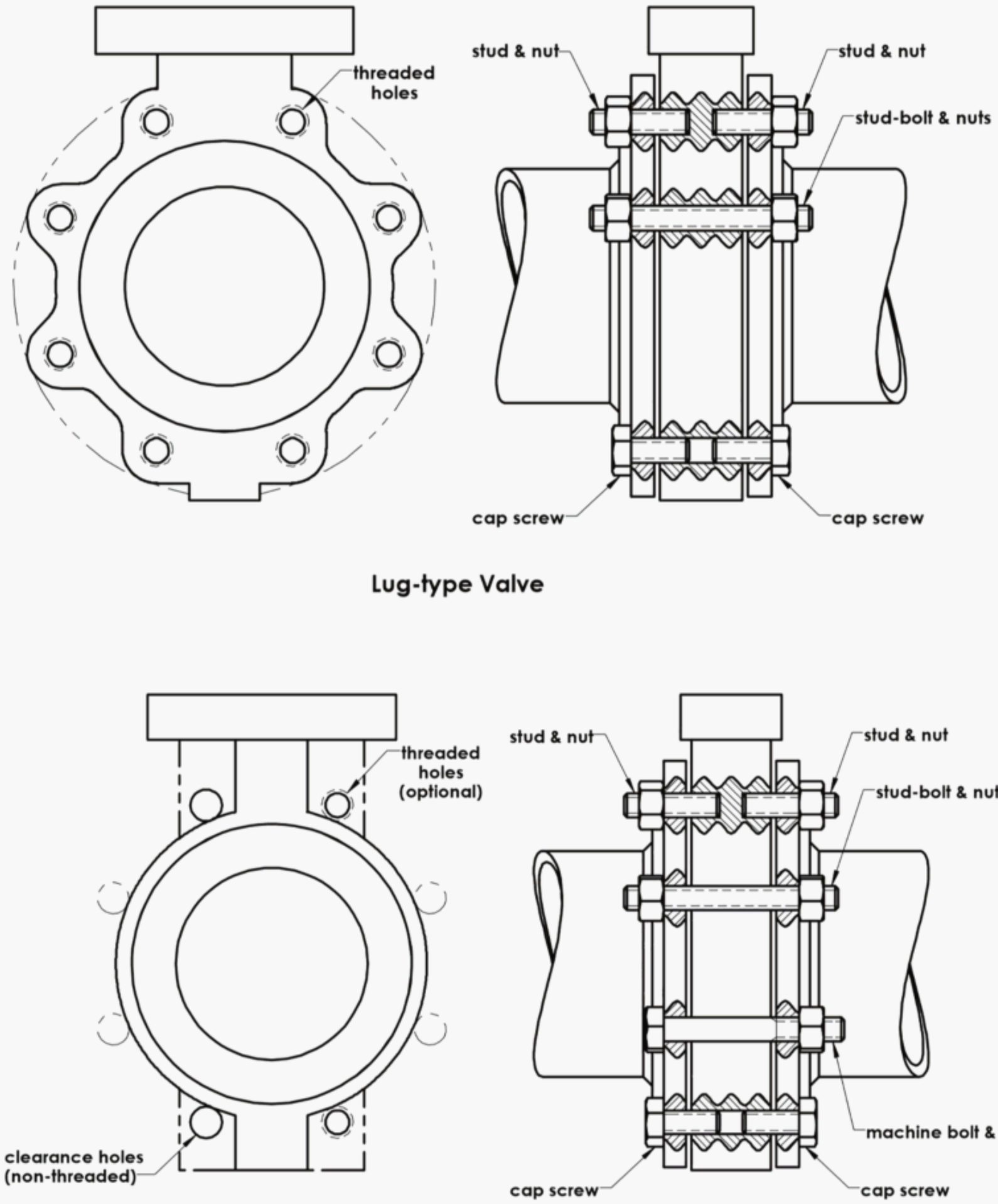
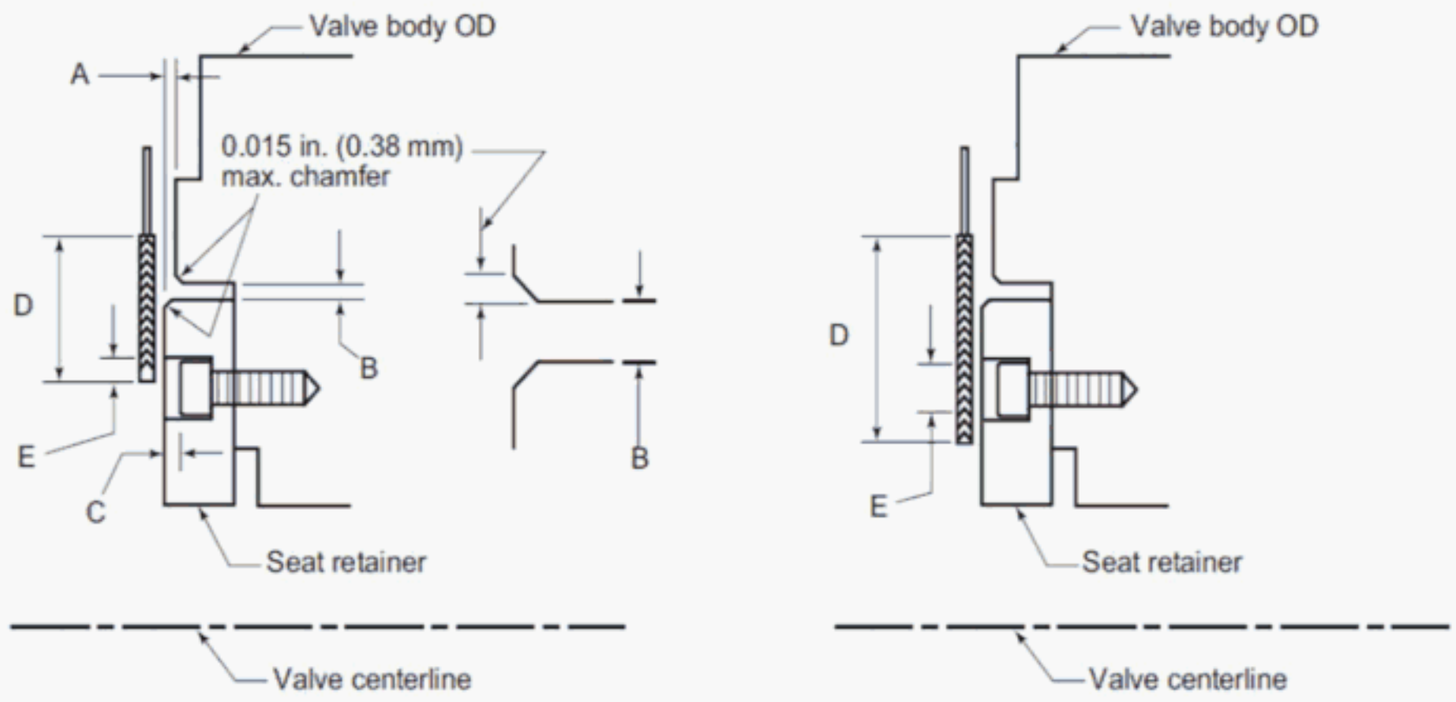


Figure 1—External Bolting Options for Lug- and Wafer-type Valves

WARNING — Some lug-type valves may only be suitable for dead-end service when installed with the seat retainer plate on the pressurized side. Valves with installation limitations for dead-end service are required to be marked by the manufacturer per Section 9. Failure to follow the manufacturer's installation markings may result in downstream leakage or blow-out into the atmosphere, potentially causing property damage and bodily injury.



a) Partial Fastener Overlap

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Dimension	Definition	Range mm	Range in.
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B	Radial width of annular gap between valve body and seat retainer plate (exclusive of chamfer).	0.76 max.	0.030 max.
C	Distance of screw head below face of seat retainer plate.	0.00 to 1.27	0.000 to 0.050
D	Width of sealing area of spiral-wound gasket for valve's size and rating.	—	—
E	Distance gasket sealing area overlaps fastener opening in face of seat retainer plate (may occur at the ID or OD of the gasket).	< NPS 6: < 50 % of D	
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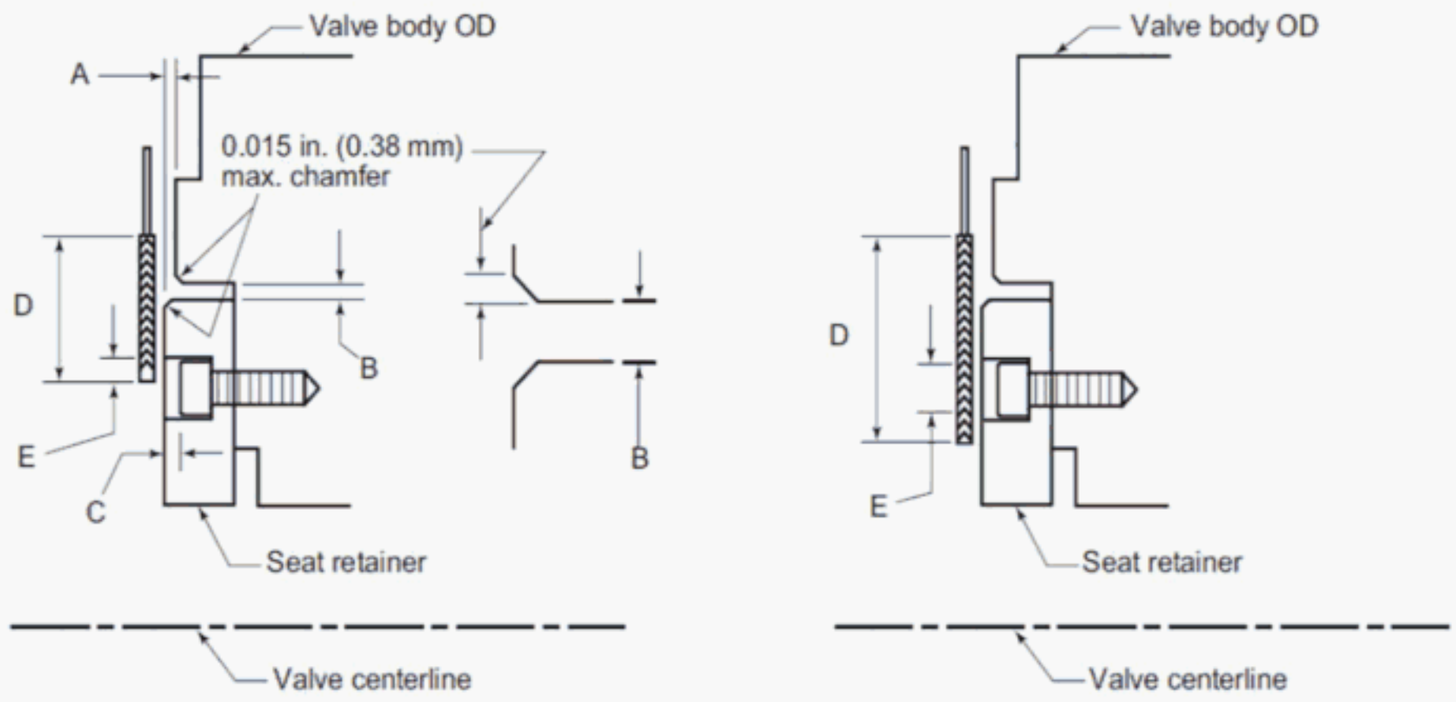

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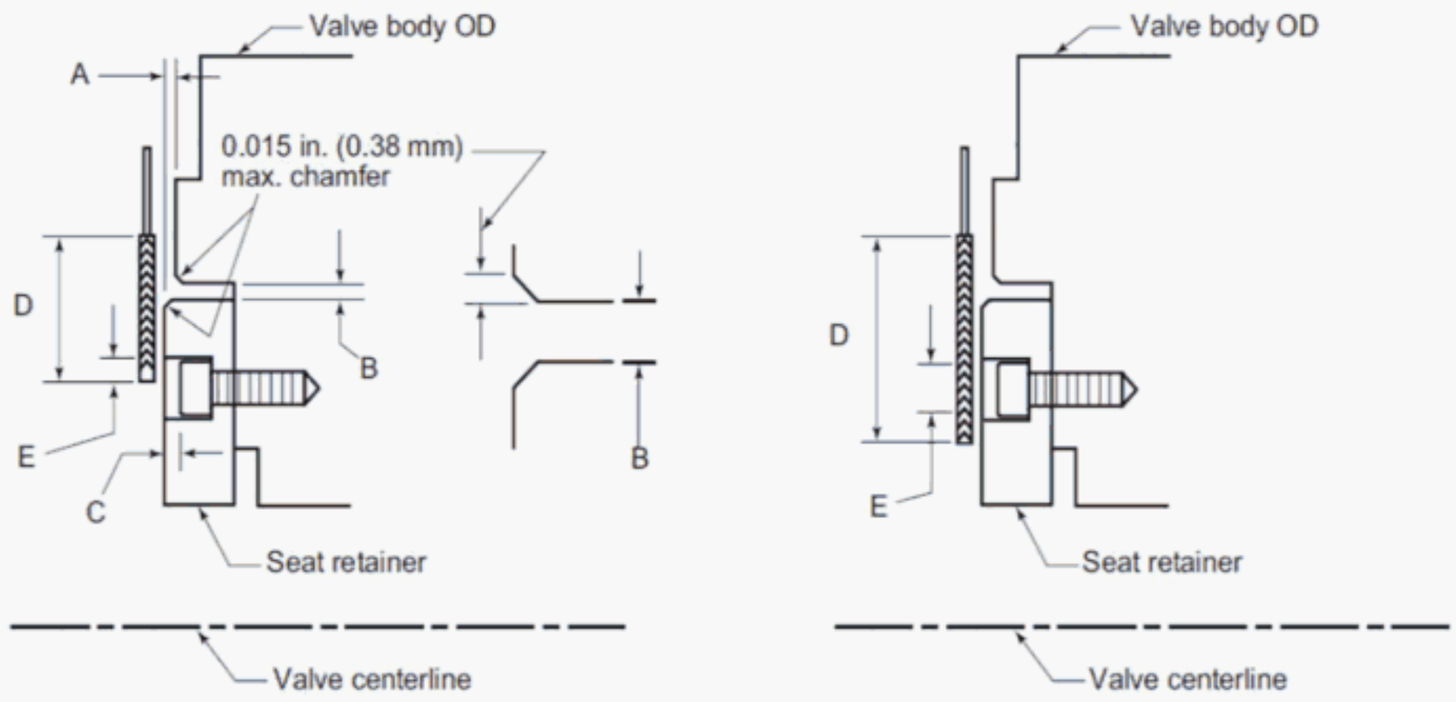

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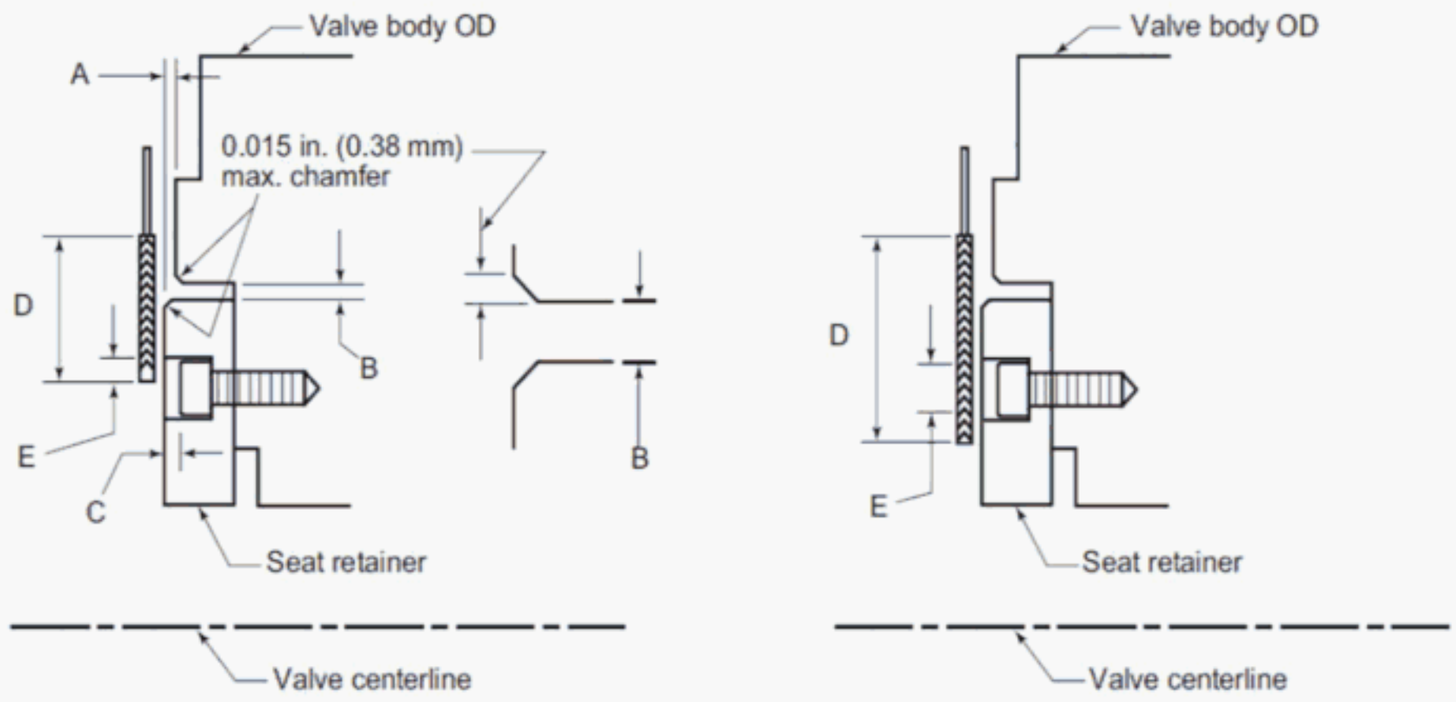

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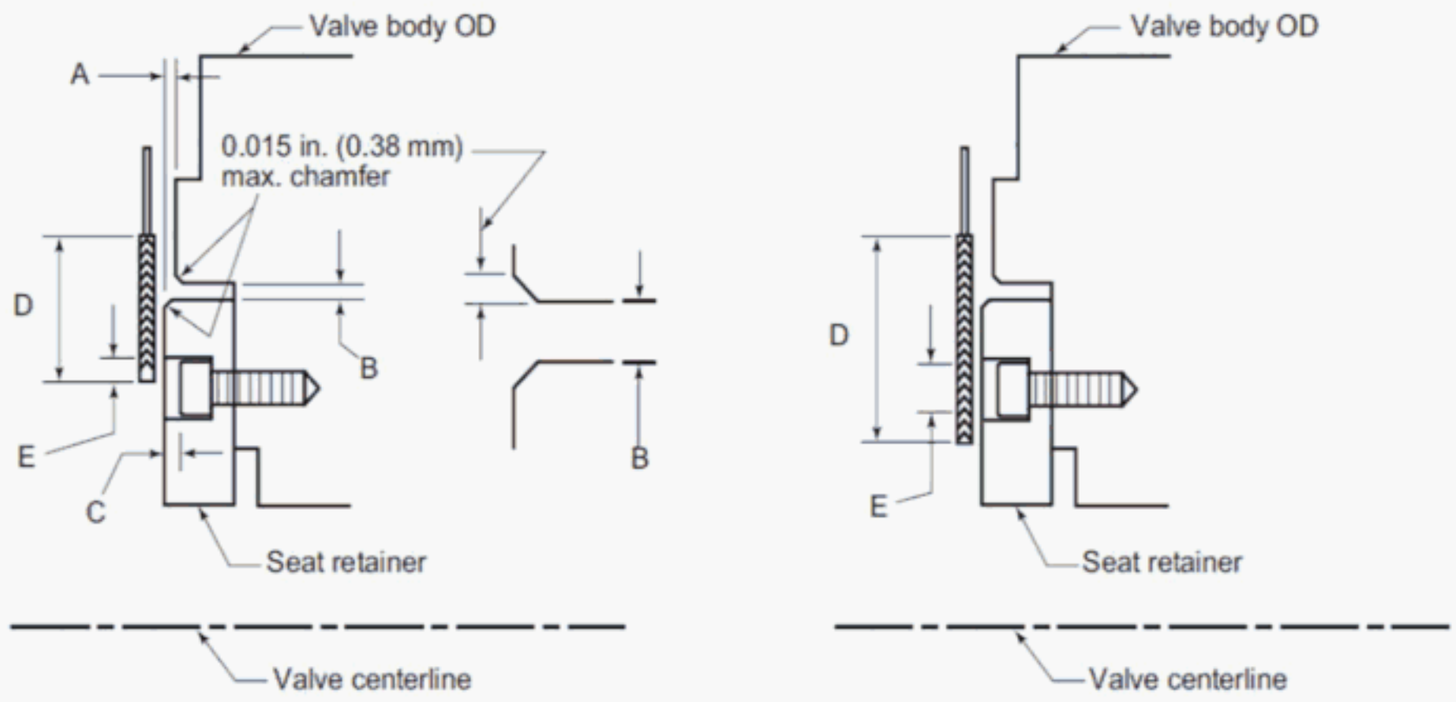

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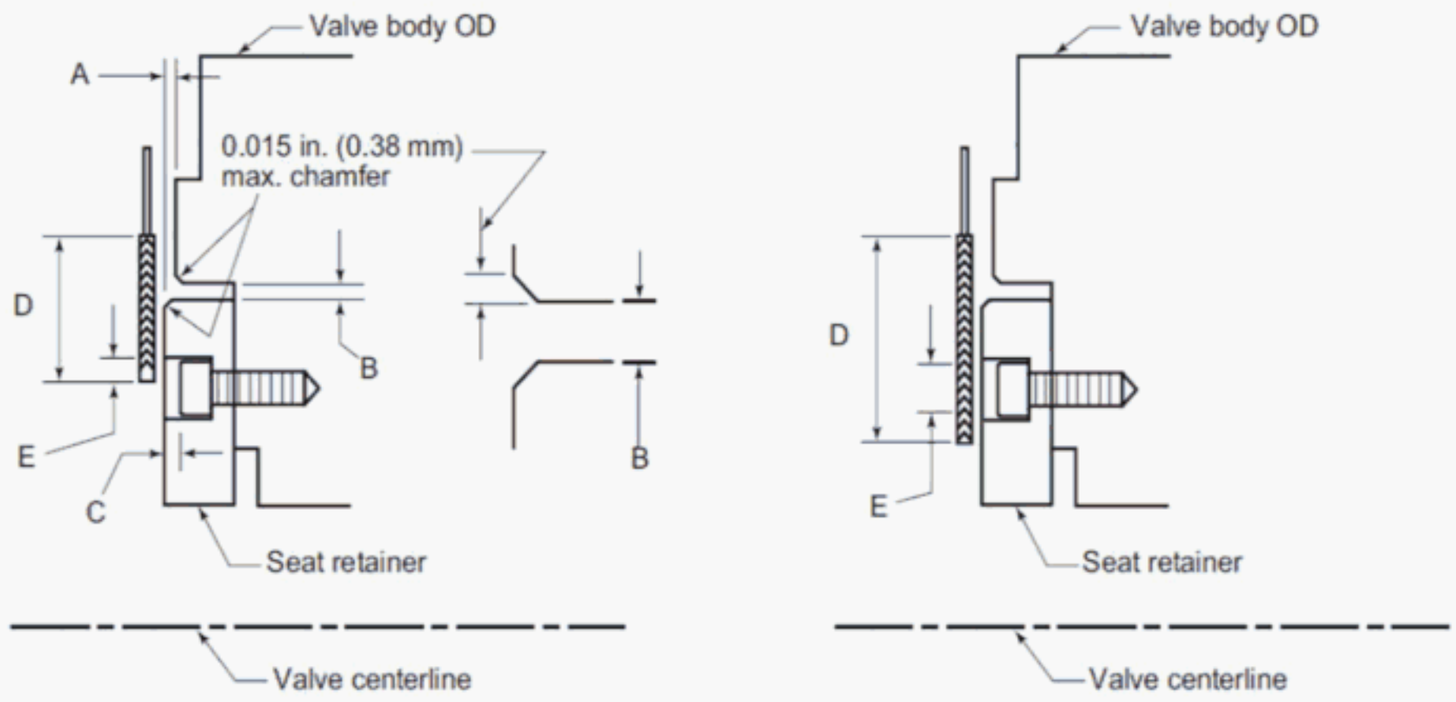

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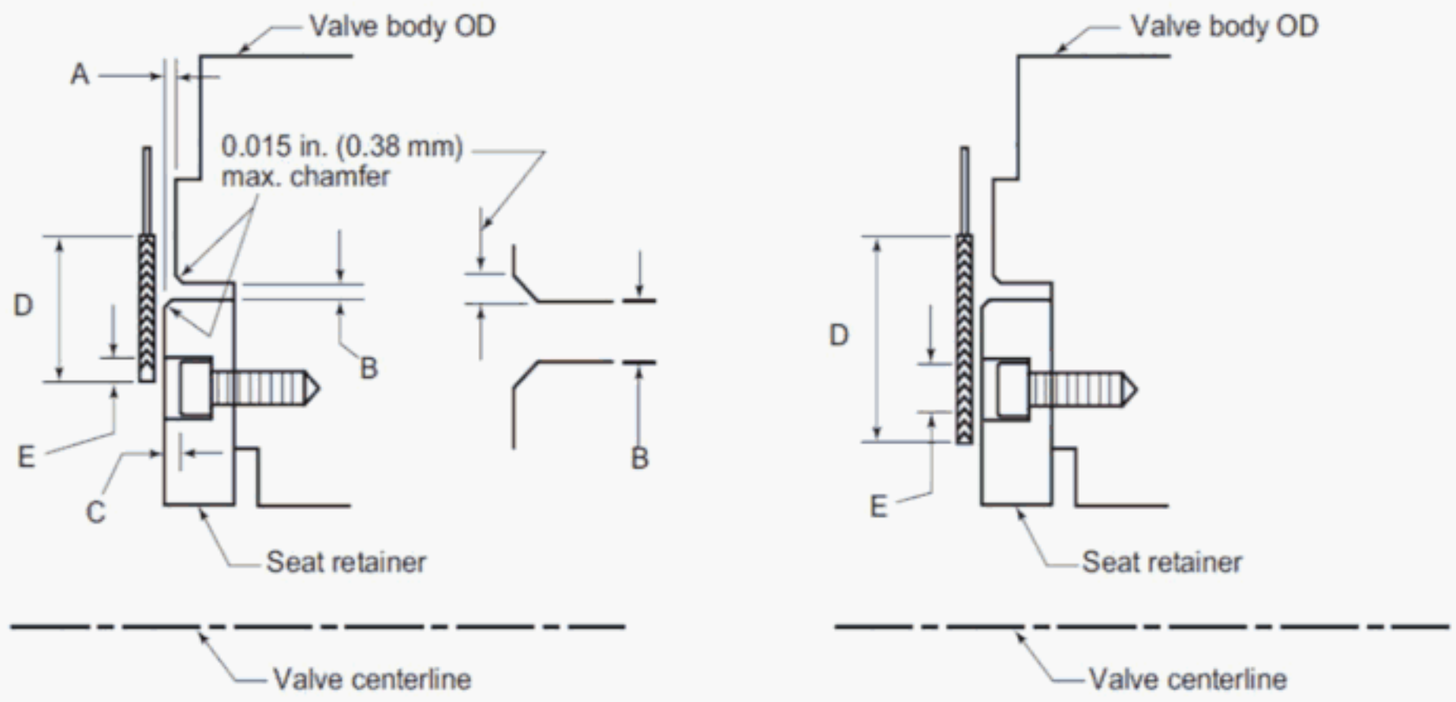

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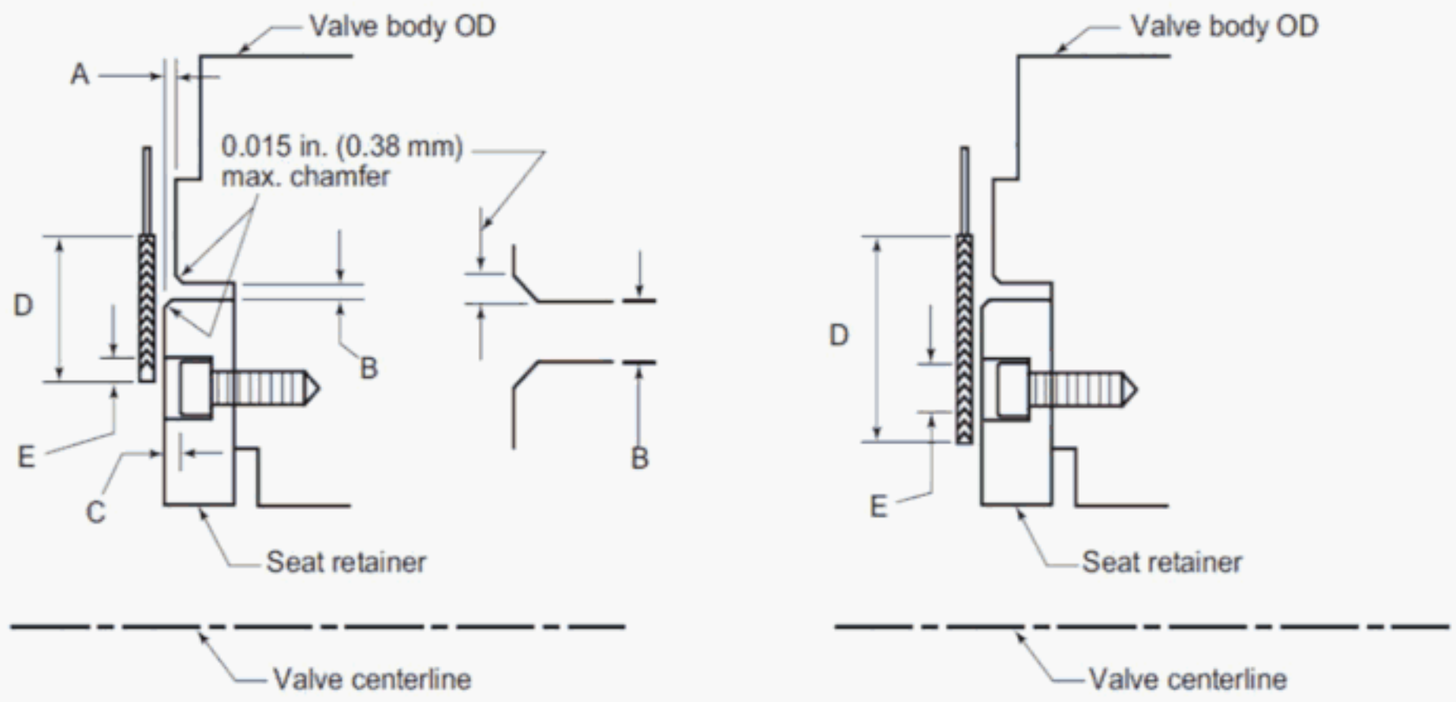

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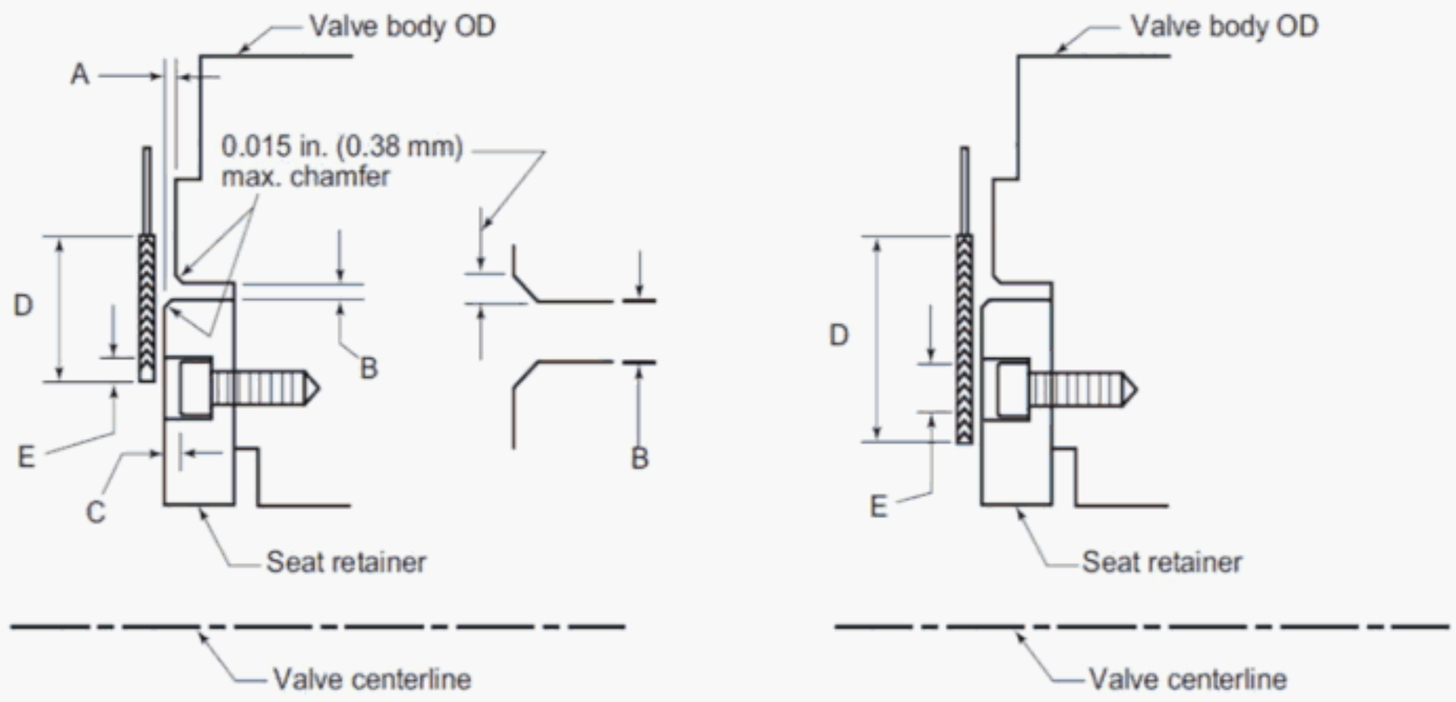

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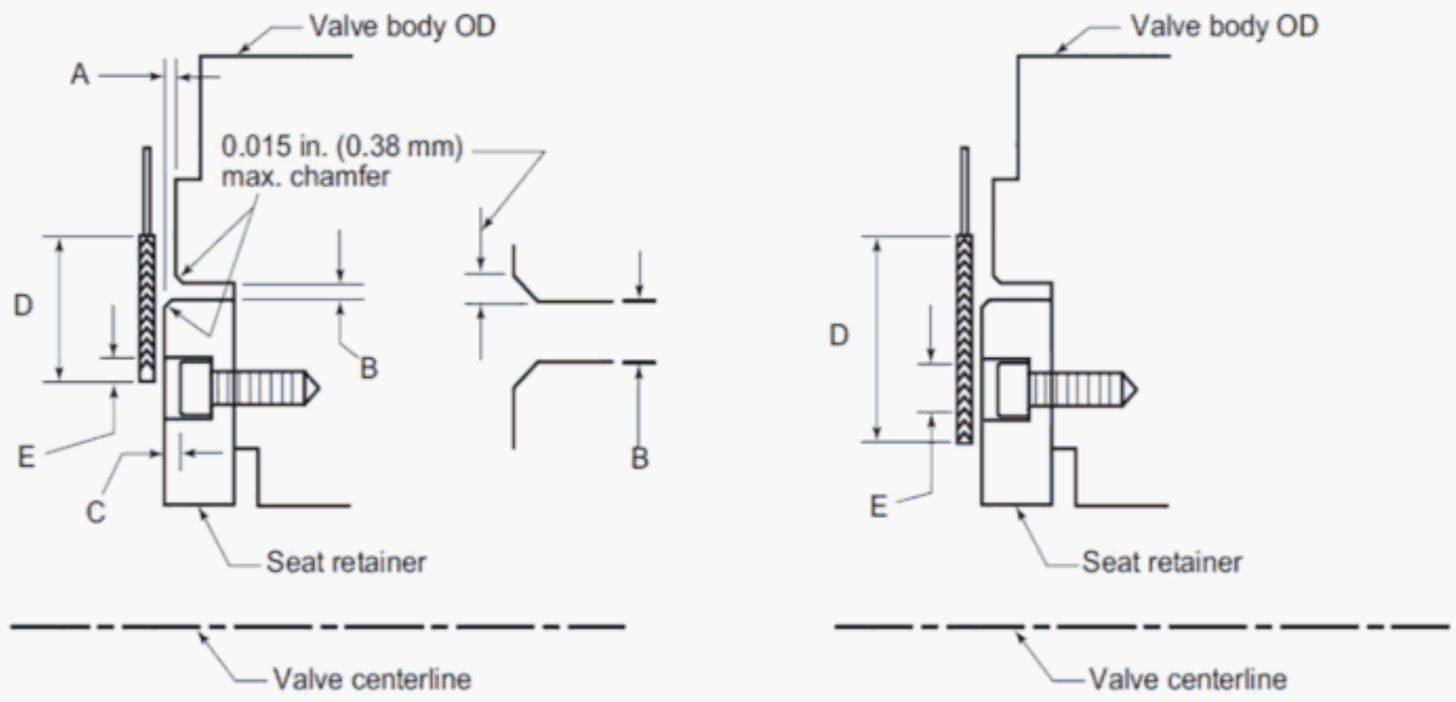

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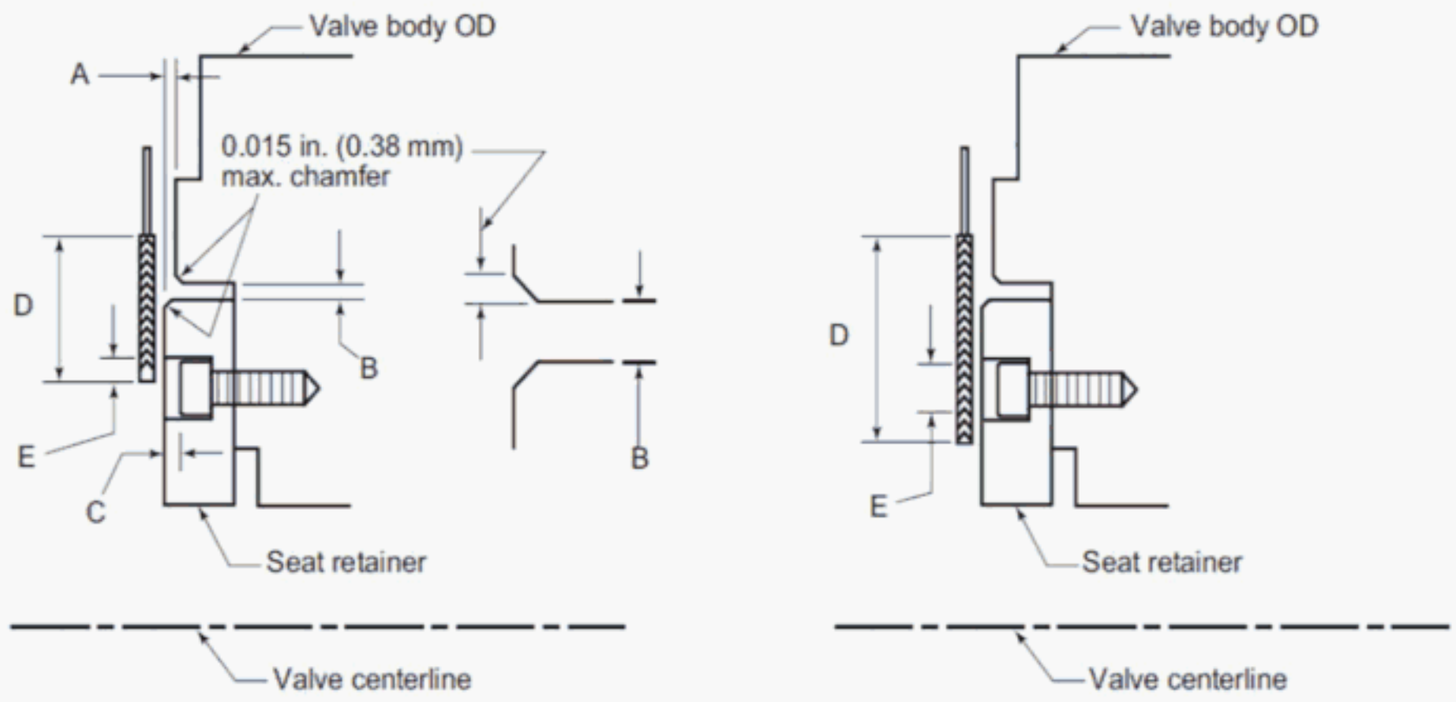

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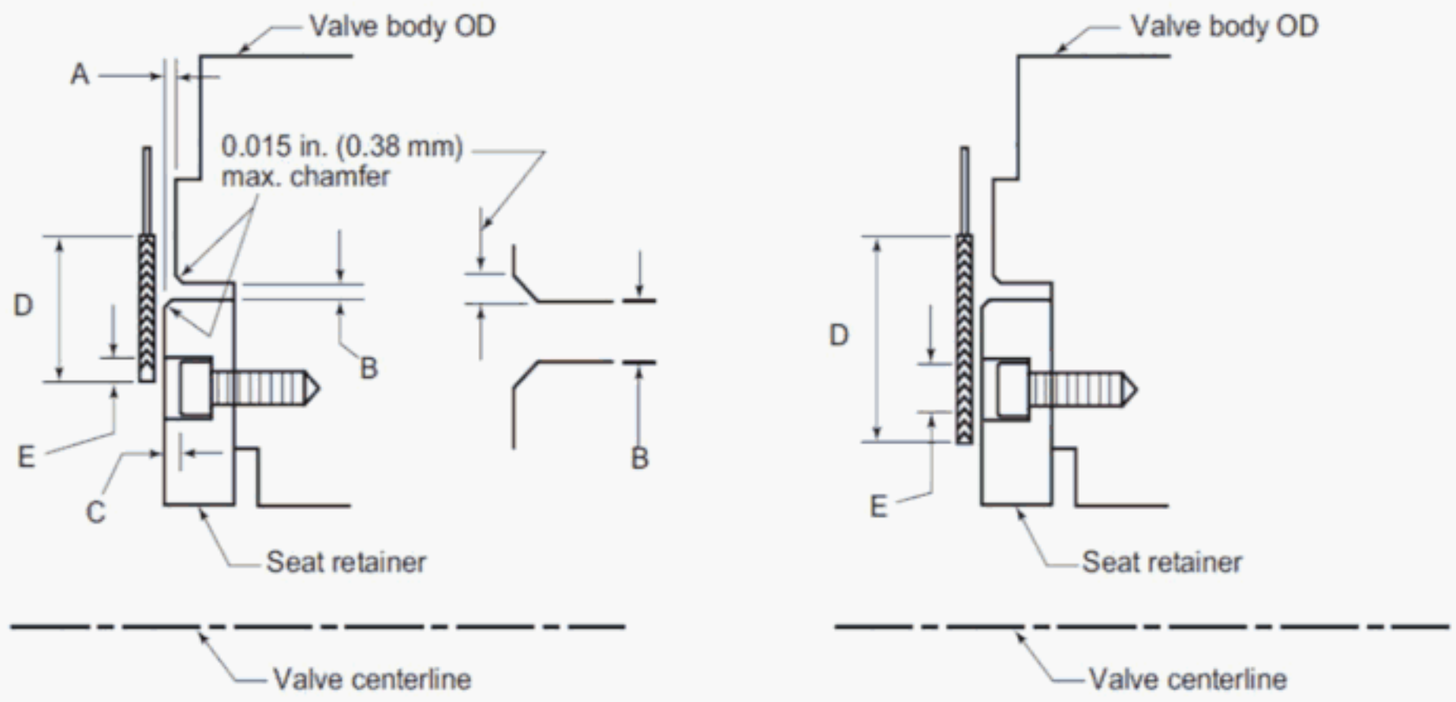

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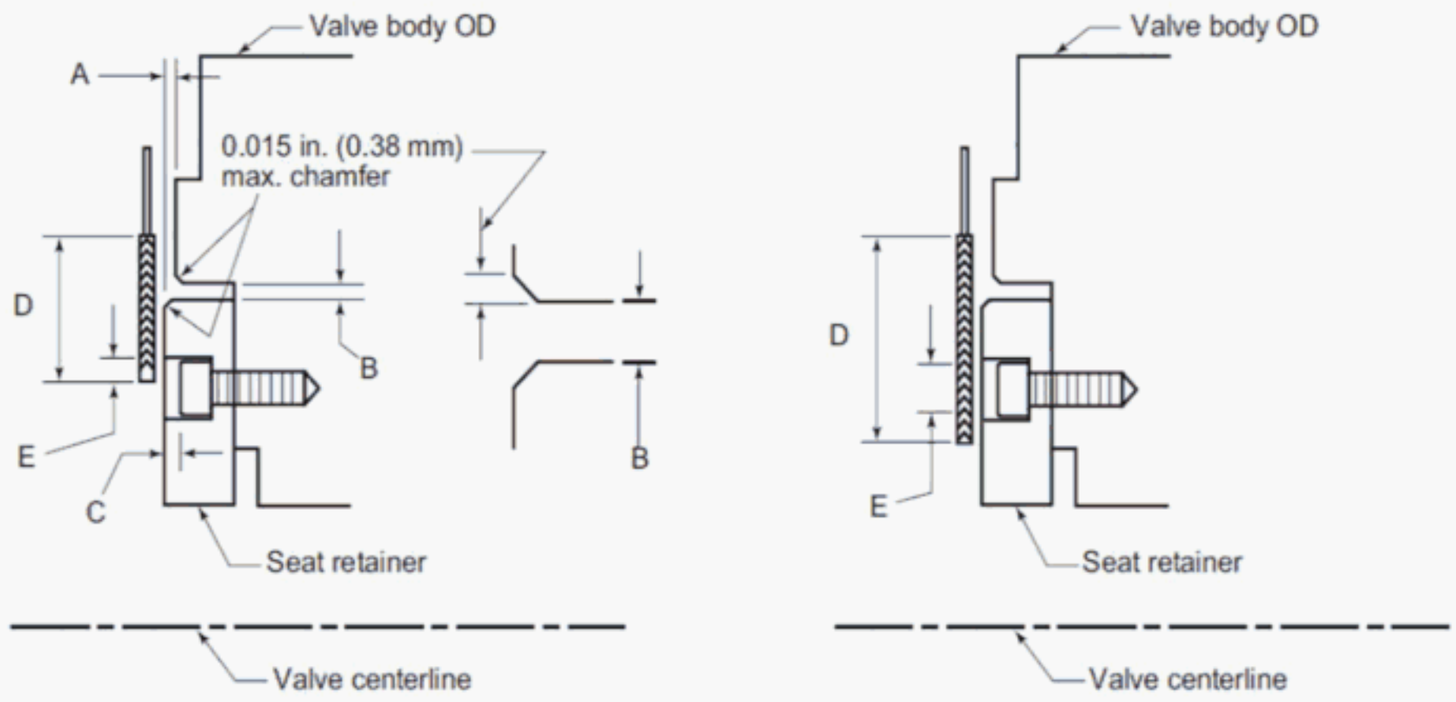

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C	Distance of screw head below face of seat retainer plate.	0.00 to 1.27	0.000 to 0.050
D	Width of sealing area of spiral-wound gasket for valve's size and rating.	—	—
E	Distance gasket sealing area overlaps fastener opening in face of seat retainer plate (may occur at the ID or OD of the gasket).	< NPS 6: < 50 % of D	
		≥ NPS 6: < 35 % of D	

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

5.9 Operating Mechanisms

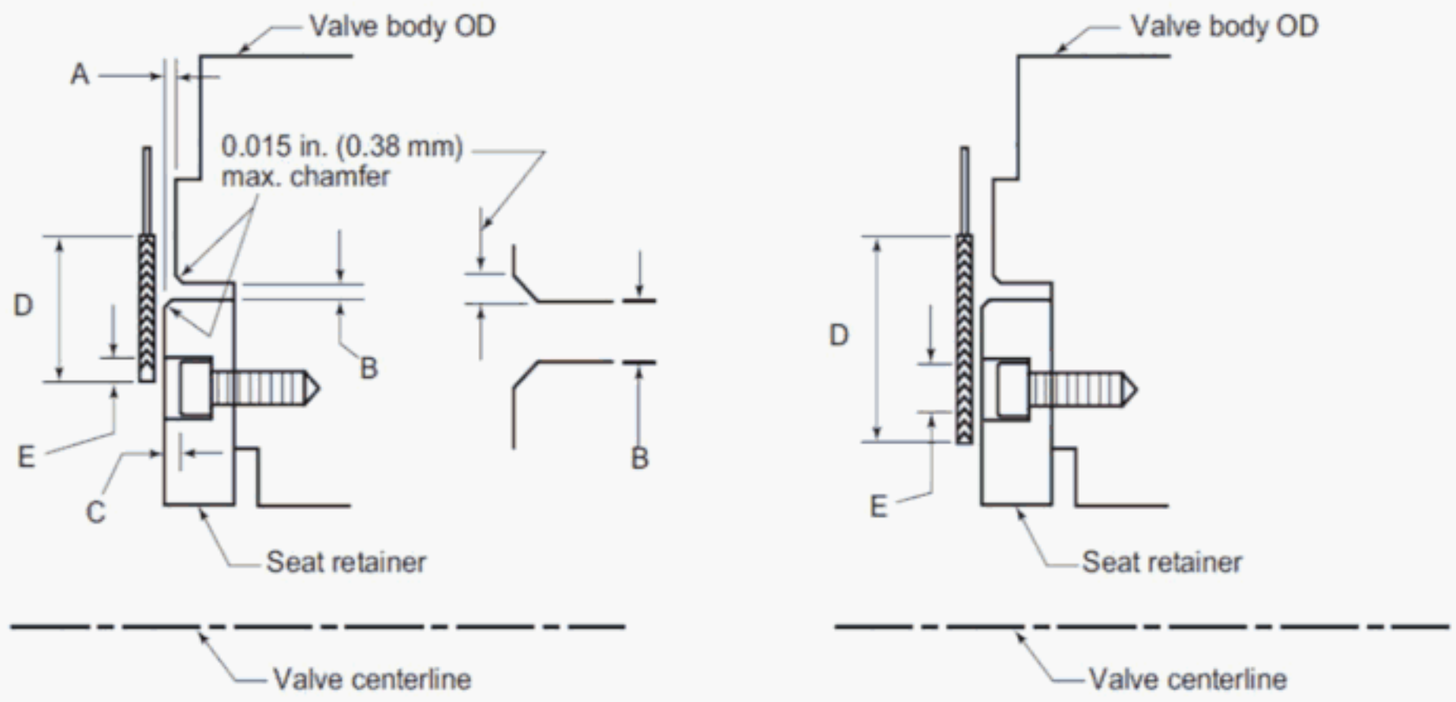
5.9.1 Levers, gear operators, handwheel, and power actuators shall be equipped with provisions to prevent movement of the disc from the desired set position during normal operating conditions. Normal operating conditions include throttling service when specified by the purchaser.

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

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

5.10 Antistatic Design (Electrical Continuity Between Disc, Shaft, and Body)

When specified in the purchase order, valves shall incorporate an antistatic feature that ensures electrical continuity between the shaft, body, and disc (see 7.3).



a) Partial Fastener Overlap

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

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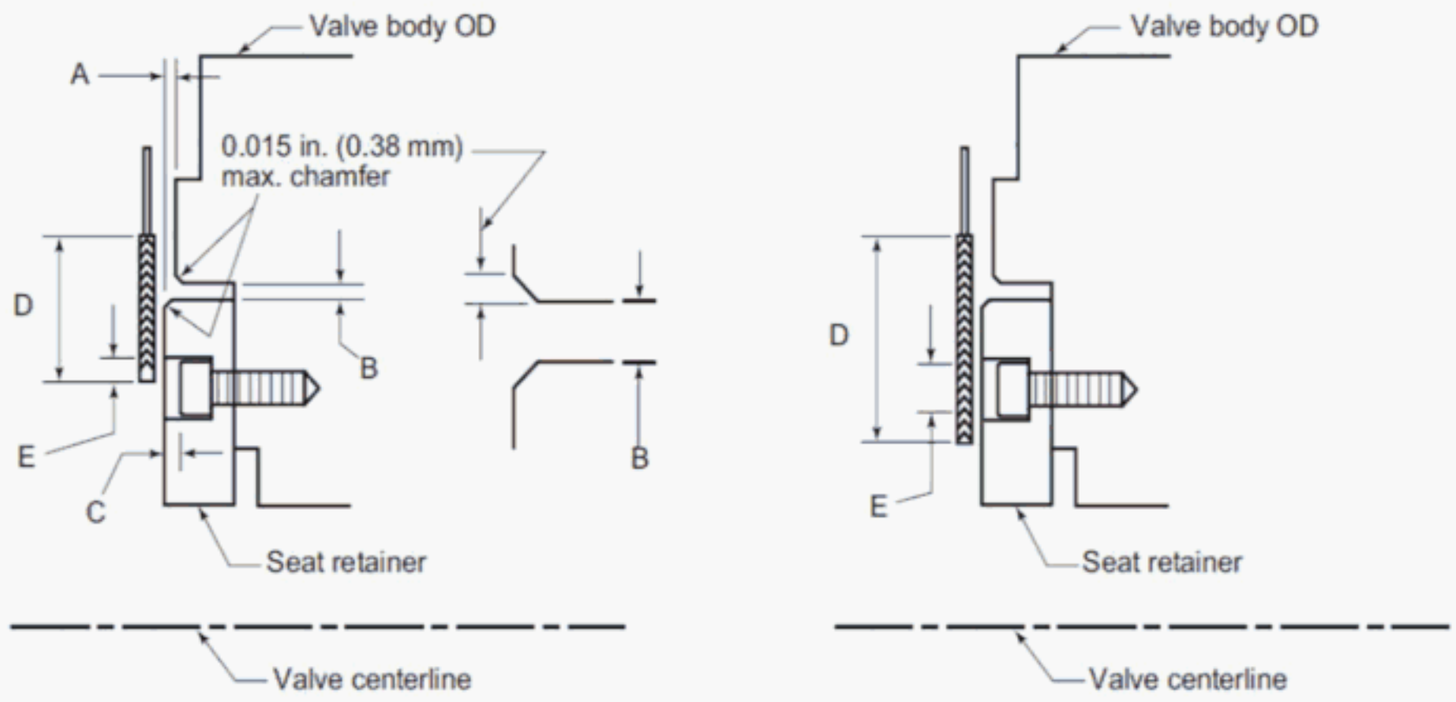

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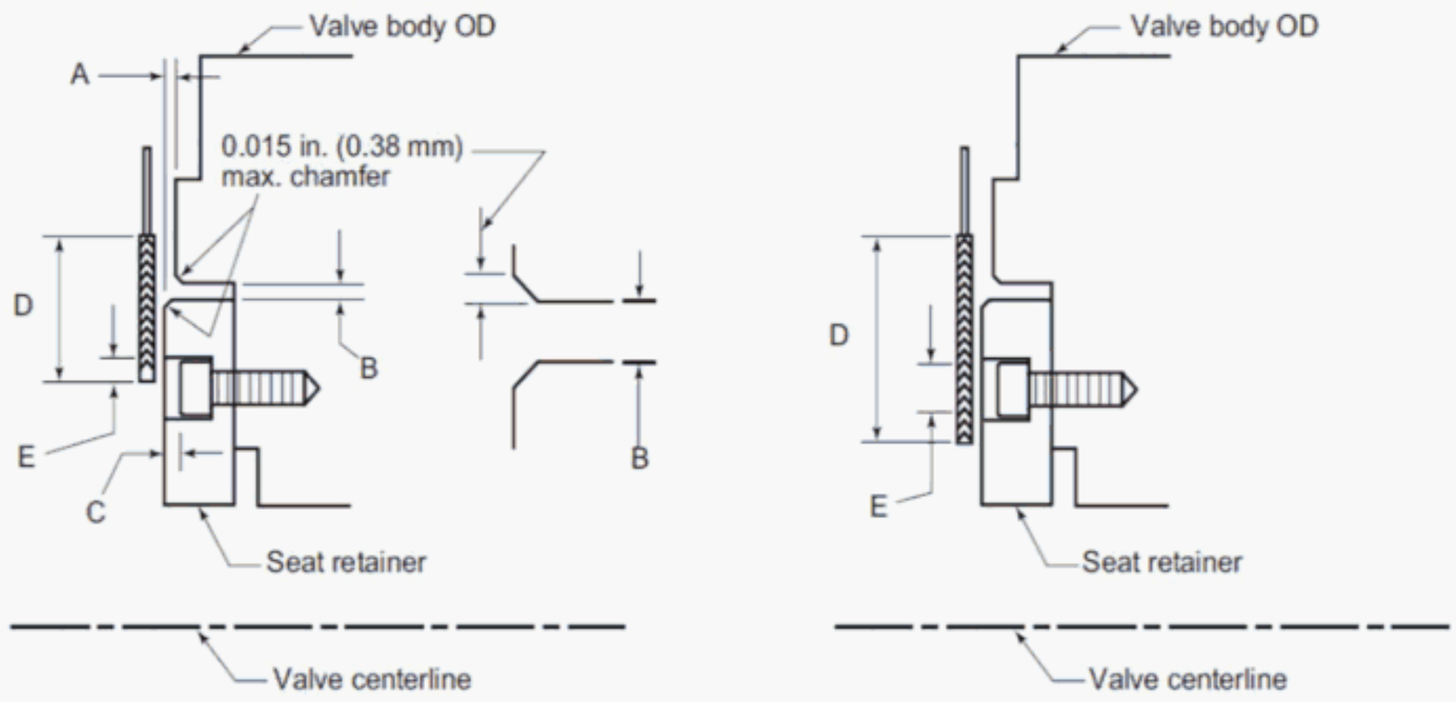

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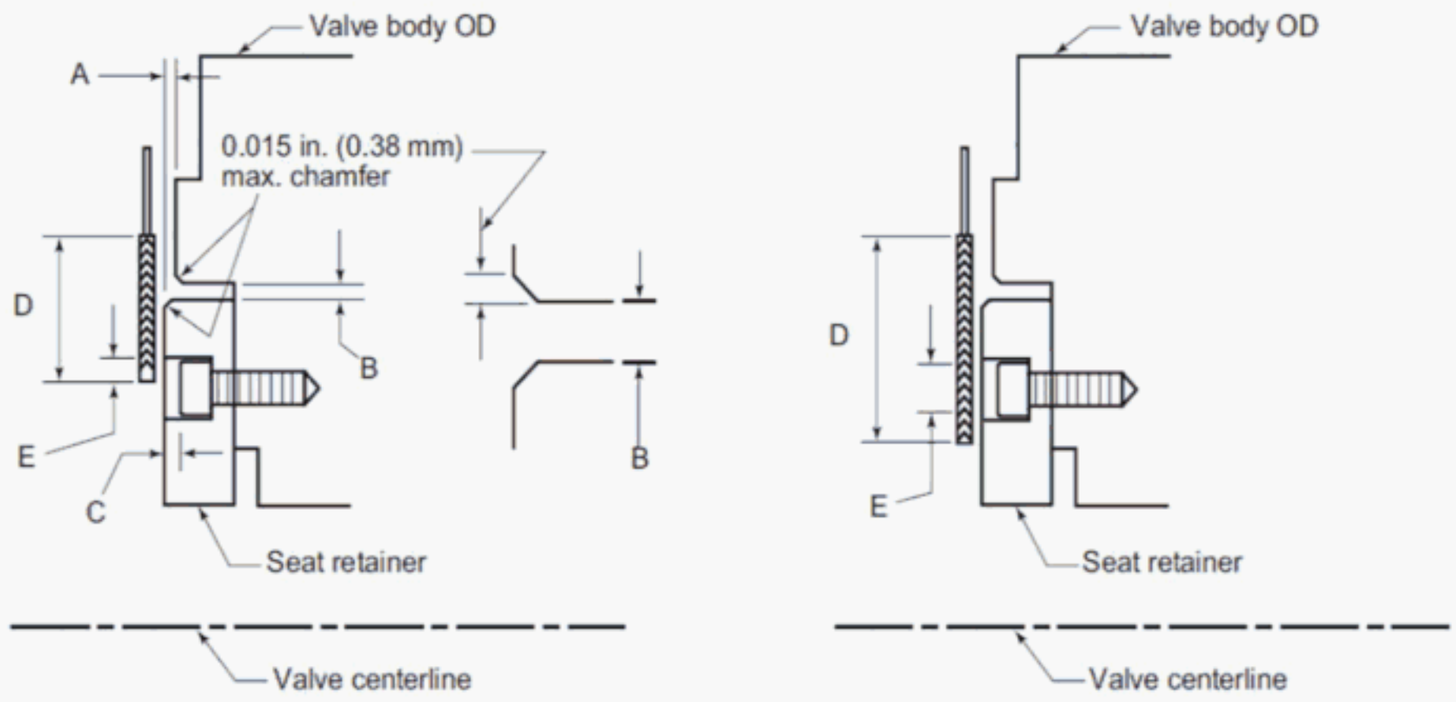

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