

XOMOX[®]

brands you trust.



Flowseal[®] High-Performance Butterfly Valves

CRANE[®]

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Flowseal® Key Features & Applications

About CRANE

CRANE ChemPharma & Energy is the global integration of trusted brands Centerline®, Krombach®, Resistoflex®, REVO®, Saunders®, WTA® and XOMOX®, among others.

We present our customers with a strong portfolio of proven products and complete fluid handling solutions within the chemical, biotechnology and pharmaceutical industries.

As one CRANE Team, we deliver innovation, financial stability and the industry's best practices to ensure a superior customer experience.

Our Butterfly Valves

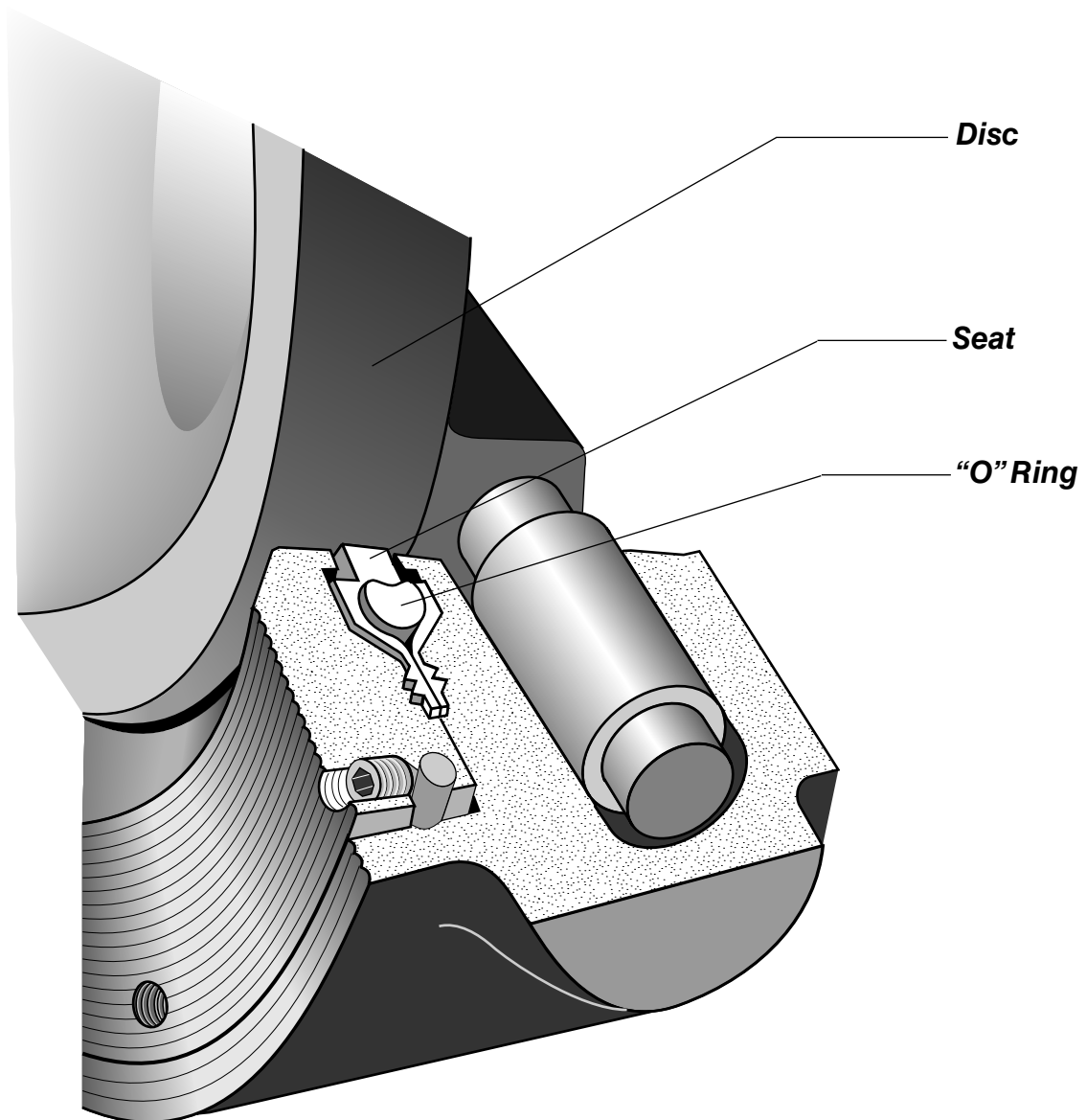
CRANE ChemPharma & Energy is a leading provider of resilient-seated, high-performance, double-offset and triple-offset butterfly valves. Our extensive application expertise and technical knowledge enable us to develop effective, customized solutions that exceed demanding industry requirements.

Backed by more than 150 years of experience with proven performance in the chemical, petrochemical, oil and gas, and power industries, CRANE ChemPharma & Energy provides highly-engineered butterfly valves to meet your specific application needs.

Select The Best Product For Your Application

	XOMOX® Flowseal® HPBV	XOMOX® Tuflin® HPBV
Typical Applications	Hydrocarbon processing Marine and commercial shipbuilding Power and utilities Pulp and paper HVAC	Chemical processing Air separation Oxygen Seawater Steam
Available Range	Sizes up to 48" ASME Classes 150, 300 and 600 Bidirectional shutoff Wafer and lug body styles; double dead end service (DDES) available with lug body style	Sizes up to 48" ASME Classes 150, 300 and 600 Bidirectional shutoff Wafer and lug body styles; double dead end service (DDES) available with lug body style
Soft Seat Feature	Meets the zero leakage shutoff requirements of MSS SP-61 and API 598	Meets the zero leakage shutoff requirements of MSS SP-61 and API 598
	Can achieve rating of 2 x 10 ⁻² mm Hg (absolute) with reversed PTFE packing	Can achieve rating of 1 x 10 ⁻⁶ mm Hg (absolute) with reversed PTFE packing and special cleaning
	Can achieve temperature rating of 400°F (204°C) with silicone o-ring	Can achieve temperature rating of 600°F (316°C) with XeniTh seats and high temperature trim
	O-ring provides flexible sealing	Fiberglass membrane provides energized sealing and longer seat life
Metal Seat Feature	Rated to ANSI / FCI 70-2 Class IV shutoff	Tighter shutoff: rated to 10% of ANSI / FCI 70-2 Class IV shutoff
	Can achieve temperature rating of 900°F (482°C) with Inconel 718 shaft	Can achieve temperature rating of 1,200°F (482°C) with Inconel 718 shaft
Fire-tested Seat Feature	Meets the zero leakage shutoff requirements of MSS SP-61 and API 598	Meets the zero leakage shutoff requirements of MSS SP-61 and API 598
	Can achieve temperature rating of 400°F (204°C) with silicone o-ring	Can achieve temperature rating of 600°F (316°C) with XeniTh fire tested seats
Options for Design and Service	Vacuum service, fugitive emissions control, marine	Vacuum service, steam, oxygen and chlorine, steam jacketed and/or internally steam traced, fugitive emissions control, cryogenic, rail tank car

Flowseal[®] Unique Valve Seat Design **Soft Seat**



Flowseal is one of the world's leading manufacturers of high-performance butterfly valves. Based on many years of research, development, and field experience, the Flowseal design is superior to, and more versatile than, the high-performance butterfly valve design offered by other manufacturers.

The Flowseal soft seat valve provides a bi-directional bubble-tight shutoff (zero leakage) by the use of a patented seat. This unique seat design creates a self-energized seal in vacuum to low-pressure applications.

Under higher-pressure conditions, the seat is also designed to permit, confine and direct movement of the soft seat against the disc edge, up to the full ASME Class 150, 300 and 600 Cold Working Pressures.

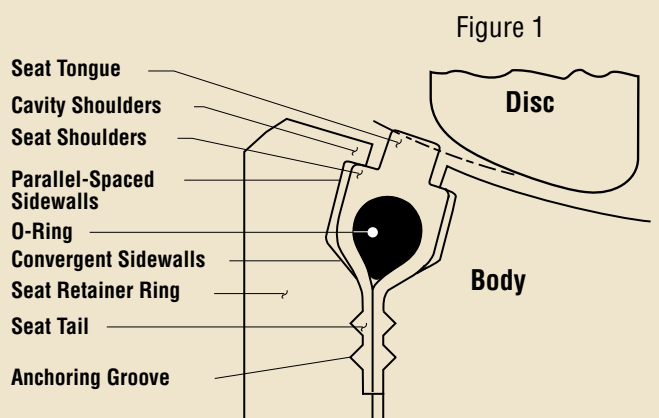
The soft seat is designed for high services with minimal wear and low torque. Seat replacement is a simple operation, requiring no special tools.

Flowseal® Principle of Seat Sealing Soft Seat

DISC OPEN

In Figure 1, the disc and seat are not engaged. In this position, the shoulders of the seat are forced against the cavity shoulders by the compression of the o-ring.

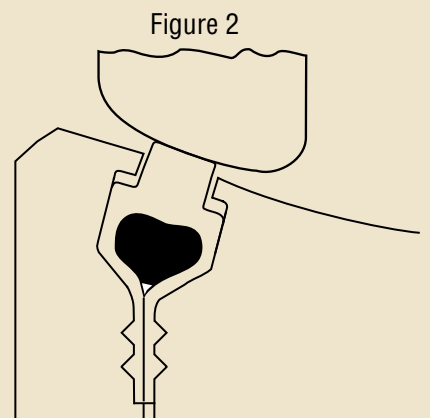
The seat is recessed inside the seat cavity and acts as a gasket in the anchoring groove area. The seat cavity is sealed from exposure from the process fluid and protects the seat from abrasion and wear. The o-ring, which is completely encapsulated by the seat, is also isolated from exposure to the process fluid.



DISC CLOSED, Self-energized Seal

In Figure 2, the Flowseal disc and seat are engaged, and the process fluid is under low pressure. The edge of the disc, with a larger diameter than the seat tongue, directs movement of the seat radially outward, causing the seat to compress against the convergent sidewalls of the cavity. The elastomeric o-ring imparts a mechanical pre-load between the disc and seat tongue as it is compressed and flattened by the disc; this is the self-energized mode for sealing at vacuum-to-60 psig.

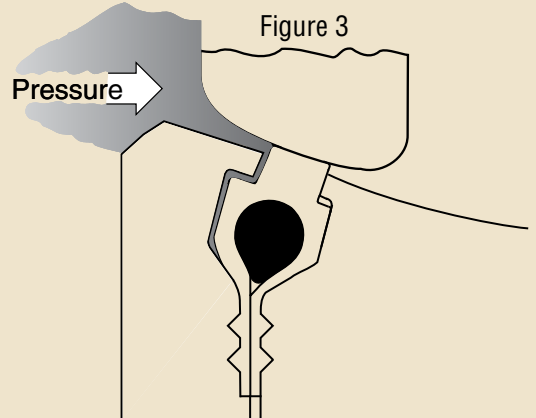
As the seat moves radially outward, the seat shoulders move away from the cavity shoulders and open the cavity to the process media.



DISC CLOSED, Pressure-energized Seal (Seat Upstream)

As line pressure increases, the process fluid enters the sidewall area and applies a load against the parallel-spaced sidewall and convergent sidewall of the seat. The seat and cavity design permits the seat to move axially to the downstream sidewall, but confines the movement and directs the movement radially inward towards the disc; the higher the line pressure, the tighter the seal between the disc and seat. Because the o-ring is elastic, it is able to flex and deform under loads and return to original shape after removal of the load; it is the rubber which deforms, not the thermoplastic material.

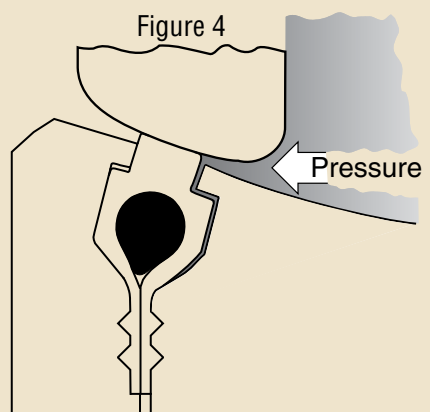
This dynamic seal, patented by Flowseal, is totally unique among high performance butterfly valves.



DISC CLOSED, Pressure-energized Seal (Seat Downstream)

The Flowseal valve is bi-directional (in some instances, modifications may be required to operate this arrangement for dead end service). The cavity and seat sidewalls are symmetrically designed to permit, confine and direct movement of the seat to the disc to dynamically seal with line pressure in the reverse direction. The disc edge is the segment of a sphere, and the seat is angled towards the disc edge to seal with pipeline pressure in either direction.

Recommended installation direction is "SUS" (seat upstream), as in Figure 3.



Flowseal® Valve Components Soft Seat

KEY

Square key valve-to-operator connection provides an externally controlled failure point upon over-torquing.

GLAND FLANGE

Applies load against packing gland to prevent external leakage. Fully adjustable.

PACKING

Chevron design TFE prevents external leakage out valve neck to full ASME hydrostatic shell test pressures (150% of C.W.P.).

WEDGE RING

Stainless steel band wedged between valve body and retainer ring by set screws to lock seat and retainer ring in position on valve sizes 2" through 30". Socket head cap screws are used on valve sizes 36" and larger.

SET SCREWS

Cone point screws force wedge ring outward to lock seat retainer in position on valve sizes 2" through 30" wafer. Socket head cap screws are used on valve sizes 36" and larger and all DDES lug valves.

OVERTRAVEL STOP

Prevents disc from rotating into the wrong quadrant.

SOFT-SEAT

Patented bi-directional seat with encapsulated elastomeric o-ring core for resiliency. Common seat materials include TFE, RTFE and UHMWPE.

BLOW OUT PROOF SHAFT

Solid shaft provides alignment and rigid support for disc.

PACKING GLAND

Separate part from gland flange, preventing uneven load distribution against packing.

BEARINGS

Both above and below the disc, bearings are of composite design: PTFE bonded to epoxy-glass filament wound ring. Used to align shaft, with high capacity, low wear, and low friction coefficient.

DISC SPACERS

Disc is centered by use of thrust spacers around shaft in sizes 2" to 5". Disc position stops or thrust bolt arrangements are used for larger valve sizes.

WEDGE PINS

Provide positive mechanical attachment of disc to shaft.

BODY

ASME B16.34 design in either wafer or lug configuration.

DISC

360° uninterrupted spherical edge for sealing. Profile is designed for maximum flow and equal percentage control.

RETAINER RING

Retains seat in valve. Standard surface finish is 125 to 200 AARH and is compatible with both standard gaskets and spiral wound gasket designs. Outside diameter is recessed within gasket sealing surface to prevent external leakage.

End Seal Variation

The ASME 150 14" through 30" sizes feature a two-piece shaft design. The lower shaft utilizes an end seal in the body to prevent external leakage.

The component parts include an end seal, an end cap and end cap bolts.

END SEAL

END CAP

BOLTS

Lower Packing Variation

The ASME 150 14" through 48"; ASME 300 14" through 30"; ASME 600 10" through 16" sizes feature a two-piece shaft design which utilizes a lower packing seal in the valve body to prevent external leakage.

The component parts are of the same design used in the packing assembly in the top of the valve body neck.

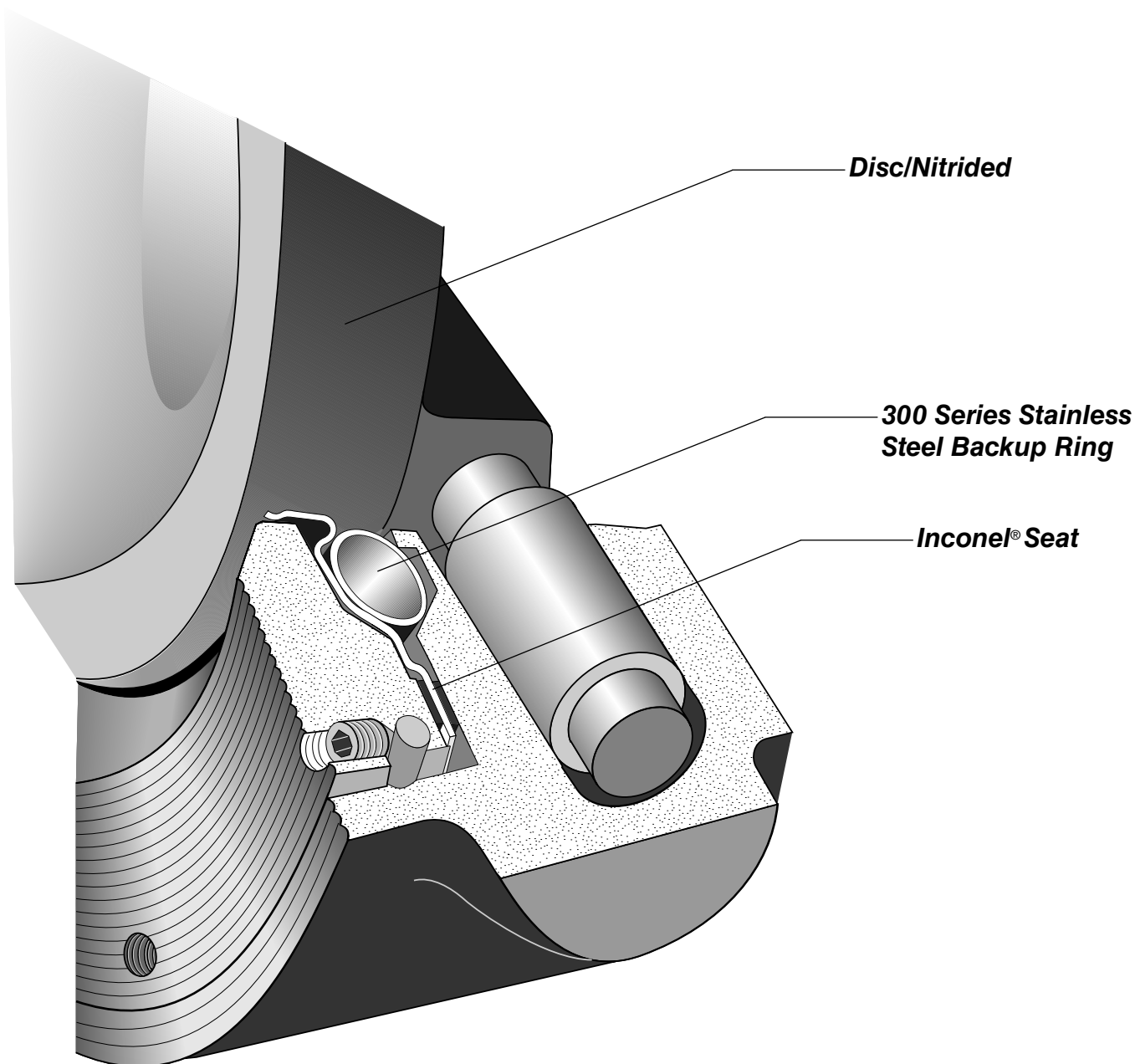
PACKING

GLAND

GLAND FLANGE

STUDS & NUTS

Flowseal® Unique Valve Seat Design **Metal Seat**



The Flowseal metal-to-metal seat high-performance butterfly valve incorporates an Inconel® seat for higher tensile strength, a 300 series stainless steel back-up ring in the seat cavity for axial seat support, and a disc that is case hardened by nitriding.

The Inconel® seat, by its dynamic and flexible design, applies enough force per linear inch against the disc

edge (Rockwell Hardness of C66 to C70) to obtain an optimum sealing characteristic while controlling the loads between the metal surfaces.

The Flowseal metal-to-metal seat valve is utilized for temperatures up to 900°F (482°C) in compliance with ASME B16.34 pressure/temperature specifications. Leakage is rated at Class IV per ASME FCI 70-2.

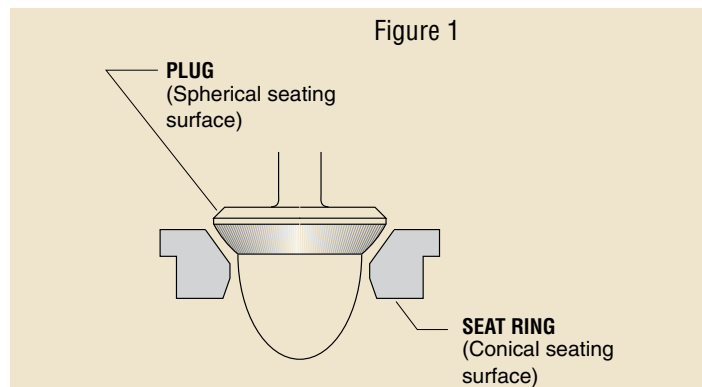
Inconel® is a registered trademark of Special Metals Corporation.

Flowseal® Principle of Seat Sealing Metal Seat

PRINCIPLE OF METAL SEATING

Metal-to-metal sealing is accomplished by the “line contact” between a spherical surface and conical surface. Figure 1 illustrates a typical globe control valve seat and plug. The plug seating surface is the segment of a sphere; when engaged against the seat ring, a line contact seal is achieved.

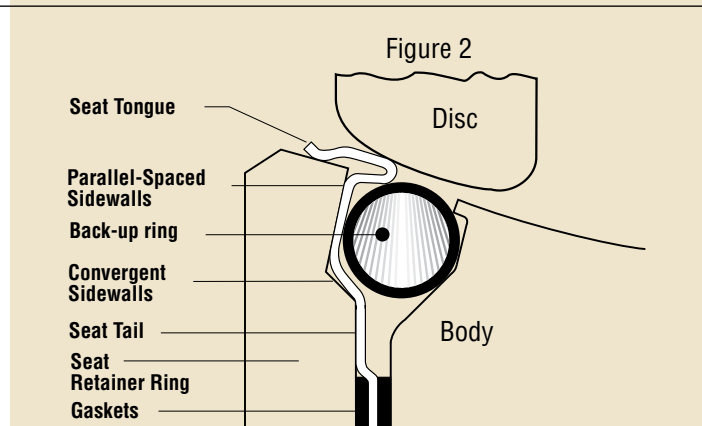
In a metal seat design, it is necessary to apply enough force per linear inch to maintain a tight metal-to-metal contact between the sealing members; however, high linear thrust can cause a collapse of the seating members (“bearing failure”).



DISC CLOSED, Self-energized Seal

In Figure 2, the Flowseal disc and seat are engaged, and the process fluid is under low pressure. The spherical edge of the disc, with a larger diameter than the conical seat tongue, imparts a thrust of approximately 600 pounds per linear inch against the seat. The mechanical properties and shape of the Inconel® seat allow it to both flex and maintain a constant thrust against the disc.

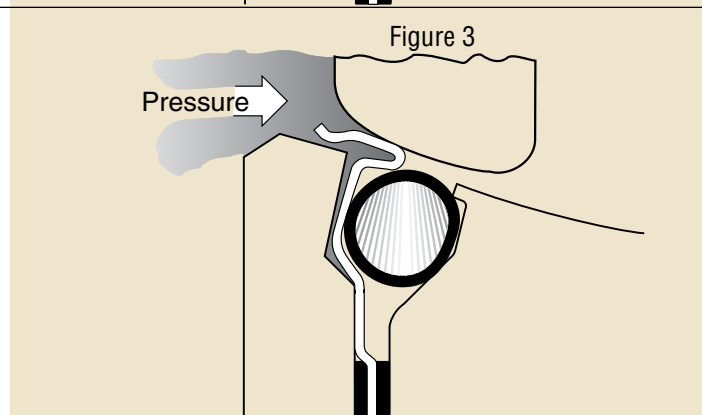
This controlled loading prevents the occurrence of bearing failure and reduces the leakage and wear between the components.



DISC CLOSED, Pressure-energized Seal (Seat Upstream)

As line pressure increases, the process fluid enters the sidewall area and applies a load against the parallel-spaced sidewall and convergent sidewall of the metal seat. The seat moves towards the downstream sidewall while being supported axially by the support ring, as shown in Figure 3. The cavity shape confines the seat movement and directs the movement radially inward towards the disc; the higher the line pressure, the tighter the line contact between the disc and seat. The Inconel® seat, shaped by a special hydroforming process, is able to flex under these loads and return to its original shape after removal of the loads.

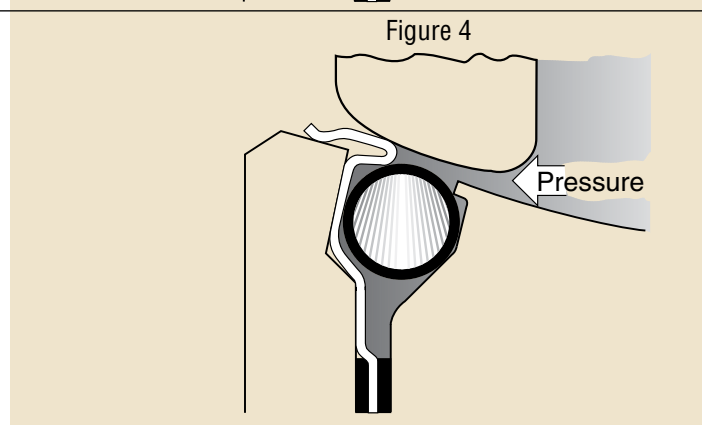
This dynamic seal, patented by Flowseal, is totally unique among high performance butterfly valves.



DISC CLOSED, Pressure-energized Seal (Seat Downstream)

The Flowseal valve is bi-directional (in some instances, modifications may be required to operate this arrangement for dead end service). The cavity and seat sidewalls are symmetrically designed to permit, confine, and direct movement of the seat to the disc to dynamically seal with line pressure in the seat downstream direction, as in Figure 4. Recommended installation direction is “SUS” (seat upstream), as in Figure 3.

The stainless steel back-up ring interacts dynamically with the metal seat for axial support in seat sealing. Additionally, this ring effectively restricts corrosion and particulate build-up in the cavity.



Flowseal® Valve Components Metal Seat

KEY

Square key valve-to-operator connection provides an externally controlled failure point upon over-torquing.

GLAND FLANGE

Applies load against packing gland to prevent external leakage. Fully adjustable.

PACKING

Common materials are TFE for up to 450°F (232°C) and Graphite for up to 900°F (482°C).

WEDGE RING

Stainless steel band wedged between valve body and retainer ring by set screws to lock seat and retainer ring in position on valve sizes 2" through 30". Socket head cap screws are used on valve sizes 36" and larger.

WEDGE PINS

Provide positive mechanical attachment of disc to shaft.

OVERTRAVEL STOP

Prevents disc from rotating into wrong quadrant.

SET SCREWS

Cone point screws force wedge ring outward to lock seat retainer in position on valve sizes 2" through 30". Socket head cap screws are used on valve sizes 36" and larger.

METAL SEAT

Patented metal seat with metal back-up ring.

SHAFT

Solid shaft provides alignment and rigid support for disc.

PACKING GLAND

Separate part from gland flange, preventing uneven load distribution against packing.

BEARINGS

Both above and below the disc, bearings maintain shaft alignment.

Common materials include:

- Glass-backed TFE for up to 450°F (232°C). (Not for steam service.)
- Lubricized Bronze for up to 750°F (398°C).
- 300 Series Stainless Steel Nitrided for up to 900°F (482°C).

DISC SPACERS

Disc is centered by use of thrust spacers around shaft in sizes 2" to 5". Disc position stops or thrust bolt arrangements are used for larger sizes.

BODY

ASME B16.34 design in either wafer or lug configuration.

DISC

360° uninterrupted spherical edge for sealing. Profile is designed for maximum flow and equal percentage control. Disc seating surface is Nitrided for enhanced temperature and abrasion resistance.

RETAINER RING

Retains seat in valve. Standard surface finish is 125 to 250 AARH and is compatible with both standard gaskets and spiral wound gasket designs. Outside diameter is recessed within gasket sealing surface to prevent external leakage.

End Seal Variation

The ASME 150 14" through 24" sizes feature a two-piece shaft design. The lower shaft utilizes an end seal in the body to prevent external leakage. The component parts include an end seal, an end cap and end cap bolts.

END SEAL

END CAP

BOLTS

Lower Packing Variation

The ASME 150 30" through 48"; ASME 300 14" through 30"; ASME 600 10" through 16" sizes feature a two-piece shaft design which utilizes a lower packing seal in the valve body to prevent external leakage. The component parts are of the same design used in the packing assembly in the top of the valve body neck.

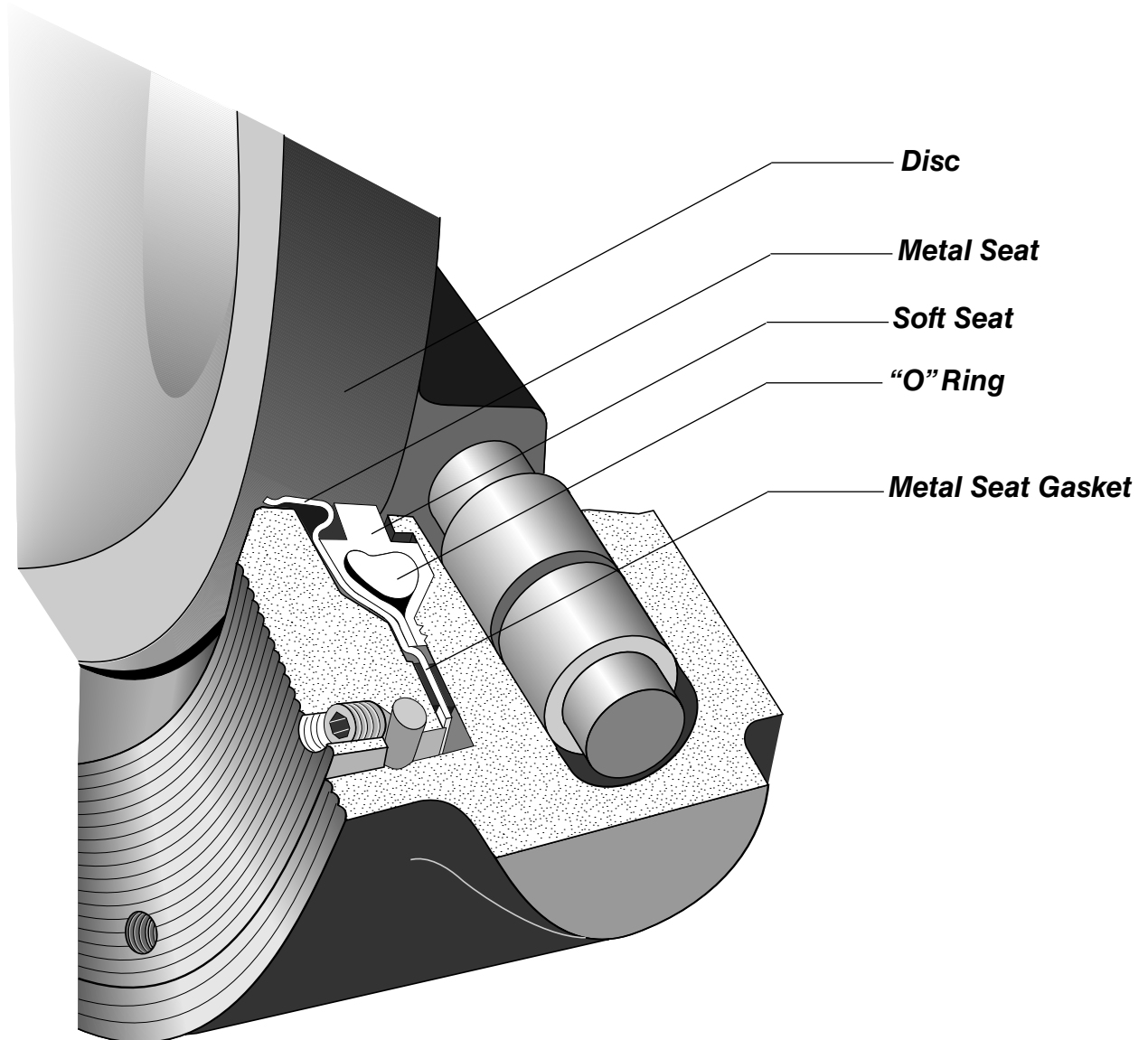
PACKING

GLAND

GLAND FLANGE

STUDS & NUTS

Flowseal[®] Unique Valve Seat Design **Fire Flow**



The Flowseal Fire-Flow™ high-performance butterfly valve (HPBV) is a fire-safe, soft seat quarter-turn valve. The Fire-Flow™ design incorporates two patented seats which function together to seal off pipeline flow. In normal operation, the soft seat provides a bi-directional “bubble tight” shutoff (zero leakage); the metal seat provides bi-directional shutoff in the event of a fire, in conformance to industry fire-safe requirements.

With little or no pressure, the Fire-Flow seat creates a self-energized seal against the disc. Higher line pressures act on

the geometry of both seats to dynamically load them against the disc, creating higher sealing forces in either direction.

The Fire-Flow™ metal seat is made of Inconel[®] material which is shaped by a proprietary hydroforming process into its unique, patented design. Stainless steel outer bearings are included for post-fire disc and shaft alignment. Fireproof packing is used to prevent external shaft leakage.

Flowseal® Principle of Seat Sealing Fire Flow

DISC OPEN, Normal Operation

In Figure 1, the disc and seat assembly are not engaged. In this position, the metal seat acts to keep the soft seat inside the seat cavity while the soft seat shoulders seal the cavity from exposure to the process fluid. (The o-ring is under tension and imparts a load against the soft seat.)

The soft seat is protected from abrasion and wear because it is recessed inside the seat cavity area. The o-ring is isolated from exposure to the fluid because it is completely encapsulated by the seat tails which act as a (soft) gasket in the anchoring groove area. The metal seat gaskets add further high temperature protection past the anchoring grooves.

DISC CLOSED, Normal Operation

In Figure 2, the disc and seat assembly are engaged; both the metal seat and the soft seat are in contact with the disc. Under little to no pressure conditions, both seats are self-energized. The disc edge, with a larger diameter than the seat tongues, moves the seats radially outward; the metal seat shape, with a mechanical and dynamic flexibility, is designed to be hoop-loaded and impart a spring force against the disc, while the soft seat o-ring is stretched and flattened (without deformation of the material) and imparts a mechanical pre-load against the disc.

With increased line pressure, the process fluid enters the cavity sidewall area and applies loads against the seat sidewalls. The cavity design allows the seats to move toward the downstream sidewalls, but confines and directs the movement radially inward towards the disc; the higher the pressure the tighter the seal. The symmetrical shape and angle of the cavity permit the seal to be bi-directional.

DISC CLOSED, After Fire (Seat Upstream)

After a fire, with partial or complete destruction of the soft seat, the metal seat maintains metal-to-metal contact with the disc and restricts leakage of the process fluid in conformance to industry fire-safe requirements.

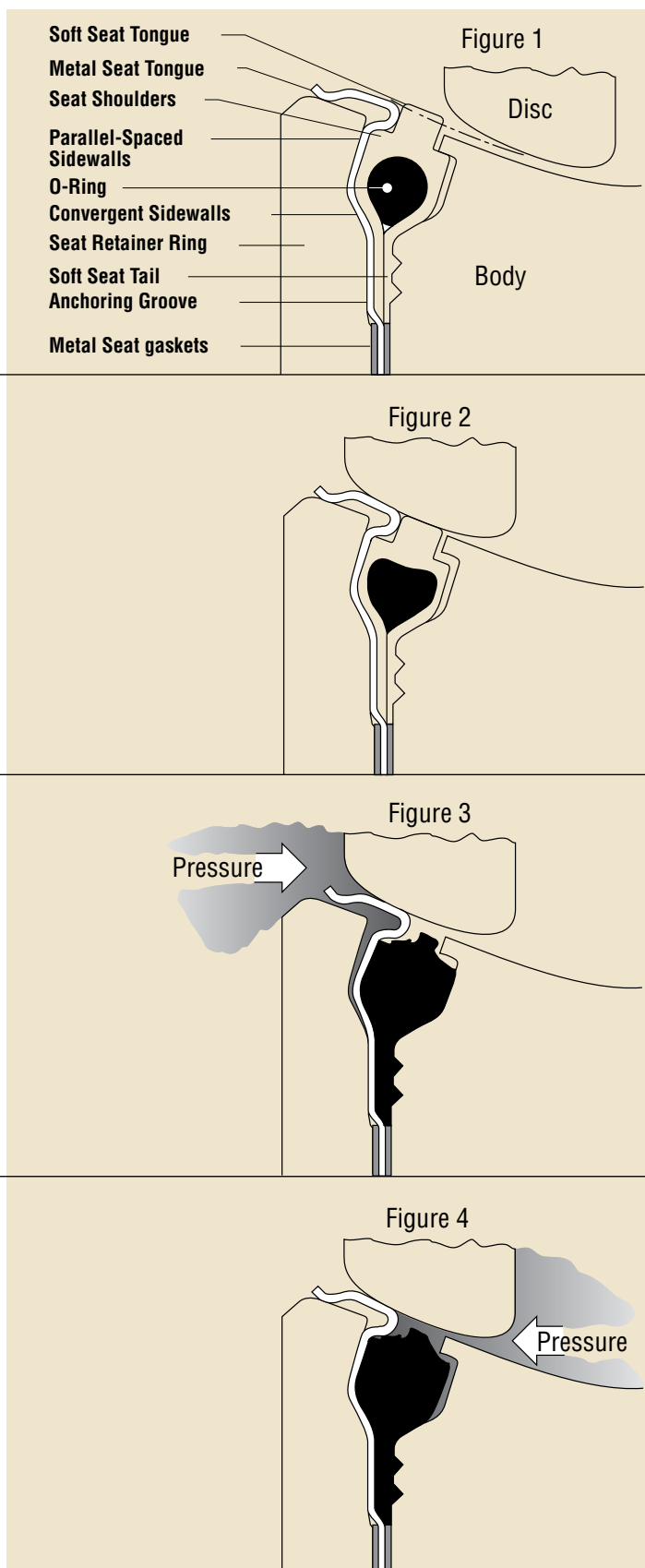
With little or no line pressure, the spring force and hoop load of the metal seat maintain a "line contact" seal against the disc edge. Under higher pressures, the process fluid enters the cavity sidewall areas and applies loads against the seat sidewalls (Figure 3). The geometry of the metal seat permits the seat to move axially, but directs the movement radially inward toward the disc. The higher the pressure, the tighter the line contact seal.

Graphite gaskets, on both sides of the metal seat tail, seal the anchoring groove and prevent leakage of the process fluid.

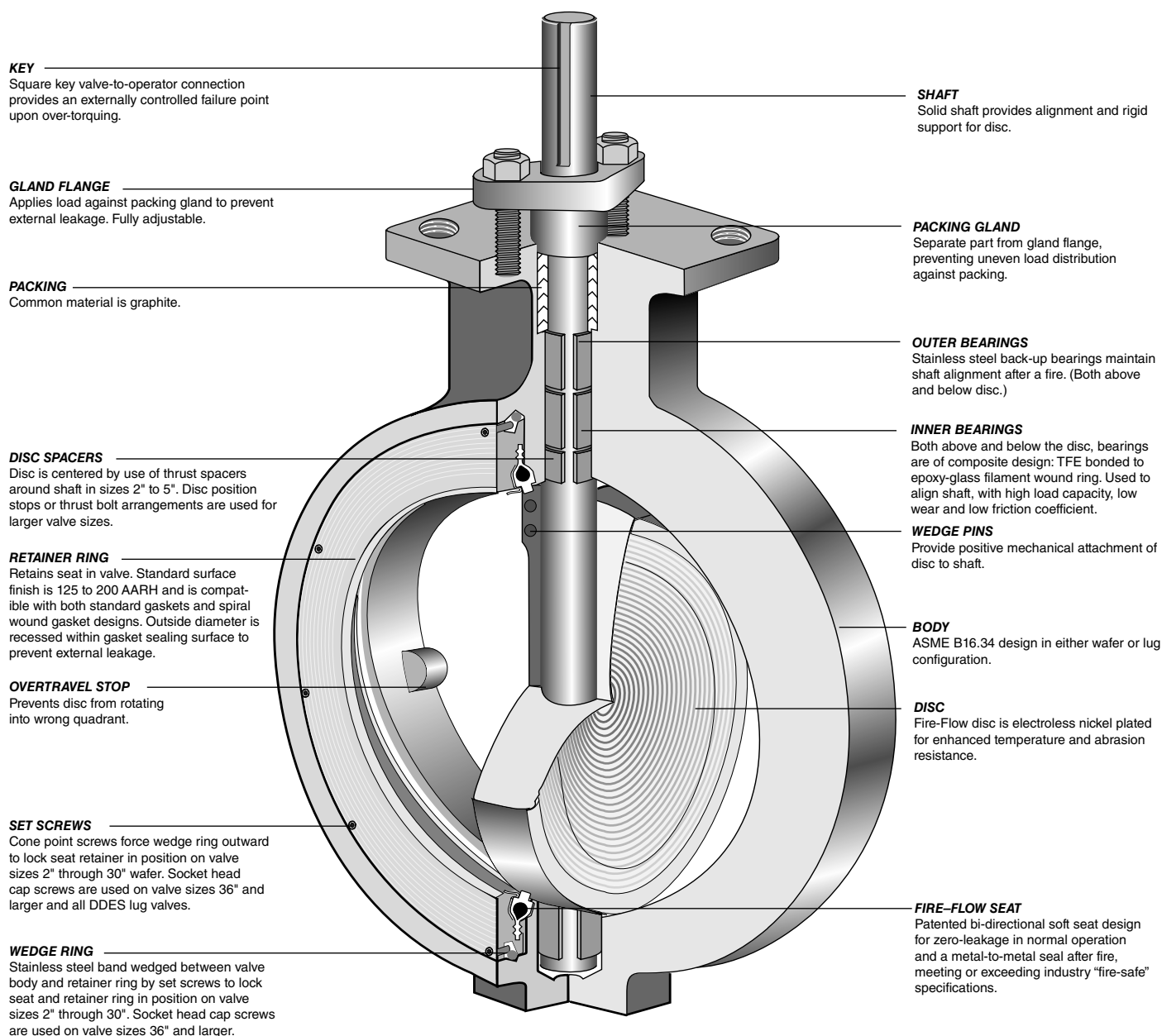
DISC CLOSED, After Fire (Seat Downstream)

The Flowseal Fire-Flow™ valve is bi-directional; however, modifications are required to operate for bi-directional dead end service. The angle and shape of the cavity and metal seat maintains metal-to-metal contact in the event of partial or complete soft seat destruction with line pressure in the reverse direction (Figure 4).

While the preferred flow direction is "seat upstream" (SUS), the bi-directional seat design is both self-energized and pressure-energized if the flow direction is "seat downstream" (SDS).

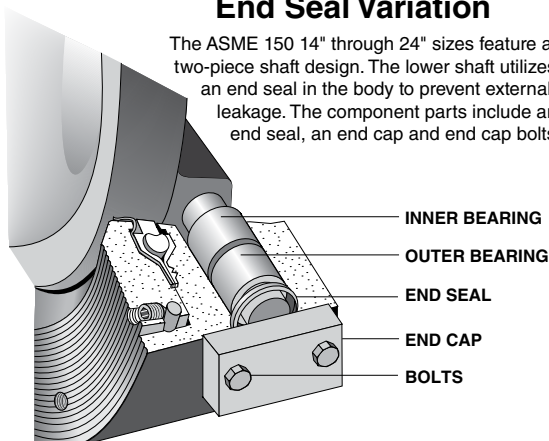


Flowseal® Valve Components Fire Flow



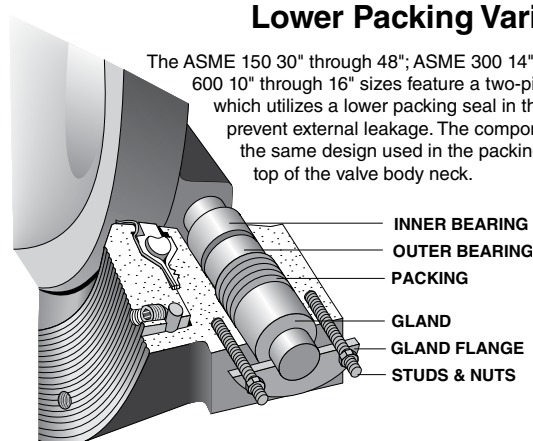
End Seal Variation

The ASME 150 14" through 24" sizes feature a two-piece shaft design. The lower shaft utilizes an end seal in the body to prevent external leakage. The component parts include an end seal, an end cap and end cap bolts.



Lower Packing Variation

The ASME 150 30" through 48"; ASME 300 14" through 30"; ASME 600 10" through 16" sizes feature a two-piece shaft design which utilizes a lower packing seal in the valve body to prevent external leakage. The component parts are of the same design used in the packing assembly in the top of the valve body neck.





CRANE ChemPharma and Energy, Xomox & Matryx® Actuators.

Tufline Valves are available as part of a complete valve package.

Actuators are available in multiple models:

- Double-acting vane
- Rack & pinion spring return
- Electric
- Others upon request



Tufline automated valve packages assure you of single-source responsibility for flow control equipment.

With Tufline valves, Matryx and Xomox actuators, Xomox control accessories and Tufline problem solving expertise, you are assured of valve packages that will provide optimum performance in your application.



Solid performance data means processors can size actuators with more of a confidence factor and less of a "fudge-factor". Initial cost, repair costs, replacement costs and costly downtime can all be reduced.

Rack and pinion actuators are available in both double-acting and spring-return models with both 90° and 180° rotation.

Flowseal® Ordering Information

VALVE SIZE			VALVE TYPE			MATERIALS OF CONSTRUCTION						FEATURES					
1	1	1	—	2	3	4	—	5	6	7	8	9	10	—	11	12	13*

Example: 12 - 1WA - 171MTG - 3: 12" Wafer Style Class 150 Carbon body, Straight 17-4 Ph SS Stem, 316 SS Nitrided Disc, Inconel® Seat, TFE Pkg, Garfil Bearings, Gear Operated

1. Size		Code
2"		02
2 ½"		025
3"		03
3 ½"		035
4"		04
to 48"		48
2. Body Class		Code
150 PSI Max. Diff. Pressure		0
ASME 150		1
ASME 300		3
ASME 600		6
3. Body Type		Code
Wafer		W
Lugged		L
Lugged DDES ²		D
4. Shaft Design		Code
Straight		A
Class ASME 150 2" - 12"		
Class ASME 150 36" - 48"		
Class ASME 300 2" - 12" & 30"		
Class ASME 600 2" - 8"		
Balanced		C
Class 150 14" - 30"		
Derated 36" - 48" (150 psig max.)		
Class 300 14" - 24"		
Class 600 10" - 16"		
5. Body Material		Code
Carbon Steel		1
316 SS		2
Aluminum Bronze MIL-B-24480		5
Aluminum Bronze B148 ASTM C958		8
Duplex ASTM A995 Gr 4A		B
Duplex ASTM A995 Gr 1B		D
FLOWSEAL ACTUATOR OPTIONS:		
Lever:	<ul style="list-style-type: none">• Not recommended for Metal Seat• High Performance Butterfly Valve	
Worm Gear Operators:	Five types available: <ul style="list-style-type: none">• High temperature service• Buried service	
6. Disc Material		Code
Alum Bronze/ENP B148 C958		0
316 SS		2
Monel®		3
Alum Bronze MIL-B-24480		5
316 SS Nitrided		7
Alum Bronze B148 ASTM C958		8
316 SS/ENP		9
Duplex ASTM A995 Gr 4A		B
Duplex ASTM A995 Gr 1B/ENP		D
Monel®/ENP		M
7. Shaft Material		Code
17-4PH SS ¹ w/DHT		D
17-4PH SS ¹		1
316 SS		2
Monel® ¹		3
Inconel® 718/750		6
Ferrallium A479		7
Nitronic 50		0
ASTM B472 AL-6XN		A
8. Seat Material / O-Ring		Code
TFE / Viton® ⁴		T
RTFE / Silicone ⁵		R
RTFE / Viton® ⁴		P
Polyethylene (UHMWPE) / Viton® ⁴		L
Fire-Flow (TFE & Metal) / Viton® ⁴		F
Fire-Flow (RTFE & Metal)/ Viton® ⁴		A
Fire-Flow (RTFE & Metal) / Silicone		B
Inconel®		M
Fire-Flow (TFE & Metal) / Silicone		J
9. Packing Material		Code
TFE		T
Graphite		G
Fire-Flow		F
Live-Load Packing/TFE		A
Live-Load Packing/Graphite		B
Live-Load Packing/Fire-Flow		C
EF Seal (Viton® O-Rings)/TFE		D
10. Bearing Material		Code
Garfil (Glass Backed TFE)		G
316 SS Backed TFE		H
Fire-Flow (Garfil & 316 SS)		F
Stainless Steel Nitrided		S
Bronze		B
Monel®		K
11. Actuator Type		Code
Bare Shaft		B
Worm Gear w/2" Square Nut & Hndwl		D
Ratchet Handle		H
Ratchet Handle w/Lock		L
Throttle		T
Worm Gear		3
Worm Gear (4-way keyed)		9
Pneumatic Double Acting		4
Pneumatic SR Fail Close		5
Pneumatic SR Fail Open		6
Hydraulic		7
Electric		8
12. Special Feature		Code
None		O
Bi-directional		B
Chlorine Service		C
Dead-end Service (DDES) ²		D
CE Marked (impact tested) ³		PI
CE Marked (non-impact tested) ³		PN
CE Marked (impact tested w/ vacuum service) ³		VI
CE Marked (non-impact tested w/ vacuum service) ³		VN
EF Seal (low emissions)		E
EF Seal Vacuum Service (low emissions)		EV
Silicone Free		G
Epoxy Coated Body		H
Chainwheel		J
Stem Extension		K
Lockable Gear		L
Limit Switch w/Stainless Steel Bolting L1		L1
Limit Switch w/Monel® Bolting		L2
Gear with Memory Stop		MS
NACE Construction ⁵		N
NACE Construction (w/CE marked impact tested) ^{3,5}		NI
NACE Construction (w/CE marked NON-impact tested) ^{3,5}		NN
Buried Service		R
Drill Through Lugs		T
Drill Through Lugs and NACE Constr.		TN
Vacuum Service		V
Only select ONE special feature code per part number.		
13. Series		Code
*Factory Assigned		J

Note¹ Shaft materials other than 17-4 PH or Monel® will affect working pressure ratings. Please consult factory.
Note² DDES = Double Dead End Service.
Note³ For CE marked valves, see Body Rating chart on page 18, as temp ranges can vary per material.
Note⁴ Viton® O-Ring is recommended for use in Hydrocarbon and NACE service.
Note⁵ RTFE/Silicone combination is not to be used with "NACE" valves.

Viton® is a registered trademark of DuPont Performance Elastomers L.L.C.
Hastelloy C® is a registered trademark of Haynes International, Inc.
Monel® and Inconel® is a registered trademark of Special Metals Corporation

Notes

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Notes

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