FLOWSERVE®

Flow Solutions Division

BW Seals
Durametallic Seals
Pacific Wietz Seals
Pac-Seal

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Welcome

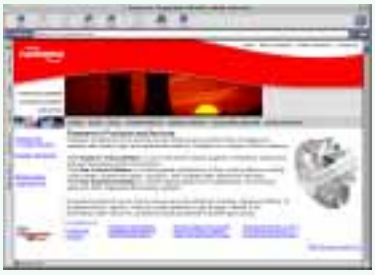
Welcome to the world of Flowserve Flow Solutions Division (Seal Group). This Products & Services brochure is designed to make you familiar with the latest Seal Group products and services.

Flowserve has focused on seal selection based on application and industry. We have limited the number of seal choices, which will help you optimize your seal selection.

Icons are shown with the seal descriptions so that even without looking at the application and industry sections you will have an immediate impression of the seal's main application target and operating window. Furthermore we have incorporated a basic explanation on seal operation and additional technical background information.

We hope this Flow Solutions Division Products & Services brochure will help you determine the best sealing solution for your applications.

If you have any questions please contact one of our locations or visit our website: www.flowserve.com



Flowserve FSD

Flowserve Flow Solutions Division's mission is to be the world's premier provider of sealing solutions, providing you with a well balanced range of high quality products and services to satisfy all your sealing requirements.

Serving customers for over 80 years, BW Seals, Durametallic, Pacific-Wietz and Pac-Seal have a long tradition of providing the Flow Solutions Division products trusted by the industry. Flowserve FSD represents not only a collection of trusted products, but also a single global source that can reduce your total cost of ownership.

Synergy

Flowserve can help you reduce the cost of plant ownership through enhanced sealing reliability and reduced maintenance, comprehensive technical services and lower transaction costs. As a pioneer in developing customer alliances to lower your total cost of ownership, Flowserve can offer various different commercial agreements.

Technology

Greater depth of experience and the blending of technological perspectives positions Flowserve to introduce superior technologies and quickly apply those technologies as practical sealing products.

Quality

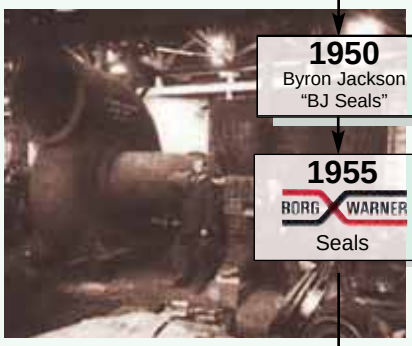
We mean what we say when we talk about quality. Designing and manufacturing seals and auxiliaries that exceed our customer's expectations is an important part of our dedication to 'Total Quality'. Our commitment to consistent quality is documented by the fact that Flowserve FSD facilities are ISO 9001 qualified.

Service

Around the clock and all over the world, Flowserve FSD staff is available to resolve customer problems. Our engineers have great experience and technical knowledge of mechanical seals, support systems and rotating equipment, which enables them to quickly pinpoint the root cause accurately.

1872
Byron Jackson founded

1923
1st centrifugal pipeline pump



1950
Byron Jackson "BJ Seals"

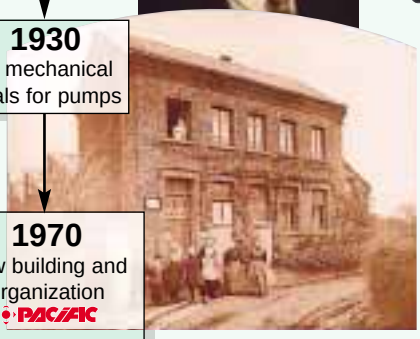
1955
BORG WARNER
Seals

1987
BW/IP International, Inc.
BW Seals

1994
acquisition of
PACIFIC

1919
Pacific-Wietz founded

1930
1st mechanical seals for pumps

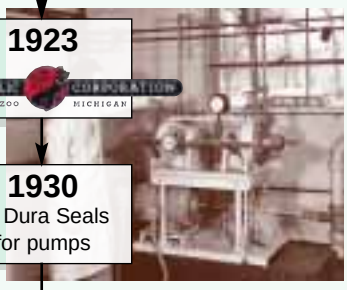


1970
new building and organization
PACIFIC

1986
1st Gaspac development

1901
New Era Manufacturing Co

1923
DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN



1930
1st Dura Seals for pumps

1995 Sept.
Pac-Seal acquired

1995 Oct.
Durco acquired
Durametallic

1997
FLOWSERVE

History
Flowserve was formed in July 1997 through the merger of two leading flow-management companies, BW/IP and Durco International. The heritage seal names are as follows:

BW Seals
The roots of BW/IP can be traced to the founding of the Byron Jackson Company in 1872. BJ built the first centrifugal pipeline pump in 1923. The Byron Jackson Co. became a division of Borg-Warner Corporation in 1955, including a Seal Division. In 1987, a leveraged buyout of Borg-Warner Industrial Products created BW/IP International. BW/IP became a publicly held corporation in 1991 and began trading on the New York Stock Exchange in 1996. In 1994 BW/IP acquired Pacific-Wietz.

Pacific Wietz
In 1919 the company was founded by Julius Huhn and Karl Wietz in Lütgendortmund, Germany, originally making piston rod packings. In 1930 the first mechanical seals were sold. New materials arriving in the 1960's allowed improved designs and growth, with further organizational changes in the early 1970's. The first Gaspac seals were sold in 1986.

Durametallic
Founded in 1901 by Henry P. White, the New Era Manufacturing company started with self-lubricated twisted metallic foil stuffing-box packing. In 1917 as the Endura Manufacturing Company, the company continued making Durametallic packing. The company was renamed 'Durametallic Corporation' in 1923. In 1930 the first Dura axial mechanical seal was developed. From 1950 onwards the product range was extended and international branches were opened. Durametallic bought PacSeal in September 1995. Durco acquired Durametallic in October 1995.

Responsiveness Worldwide

Globally, Flowserve Flow Solutions Division operates nine regionalized, state of the art manufacturing facilities to provide sealing solutions as a single resource for the improvement of End User Customer rotating equipment operations. In conjunction with its alliance customers, the Flow Solutions Division has improved operational efficiencies to world-class standards.

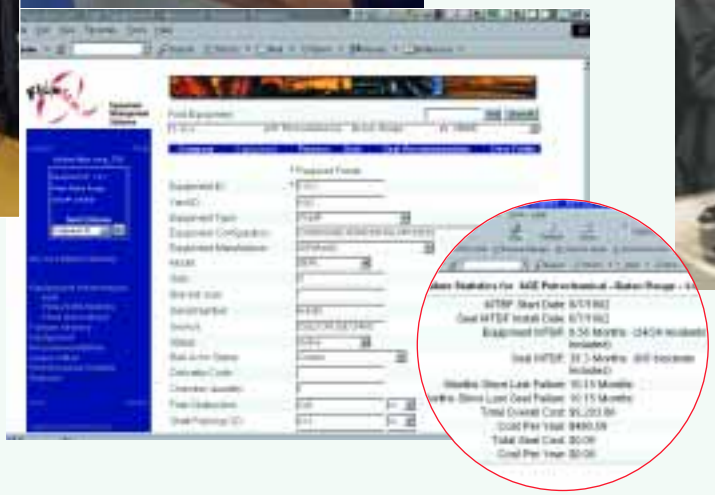
Alliances

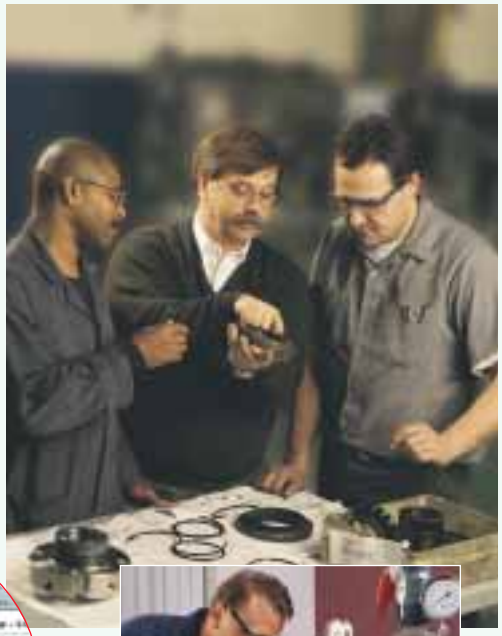
Flowserve FSD is the undisputed global leader in delivering Total Cost of Ownership (TCO) programs to the fluid handling marketplace. With over 225 current successful alliances, Flowserve stands by its documented results and customer references. No other mechanical seal company has the technological leadership, product breadth, service and support, financial stability and flexibility, or experience with reliability focused programs that Flowserve FSD has to offer. A potential alliance customer can select from a variety of FSD programs or create a unique arrangement that best suits their needs, including regional and global plans.

Flowserve alliance programs are focused on optimizing seal and rotating equipment performance, achieving dramatically improved MTBF, reducing inventory through standardization as well as driving down total costs associated with rotating equipment. The use of FlowStar.net, an internet based reliability software package developed through decades of Flowserve experience, delivers a complete survey of mechanically sealed equipment with performance, history and future recommendations to provide continuous improvement in the TCO program.

Quick Response Centers (QRC)

To meet the end user need for cost reduction, increased seal life and minimal down time the Flow Solutions Division has over thirty five Quick Response Centers (QRCs) located in strategic areas around the world. Typical facilities are equipped with modern manufacturing capabilities that include seal repair and reconditioning as well as the ability to design and produce complete seals. The QRCs are staffed with knowledgeable Customer Service Representatives to expedite the customer's needs and delivery requirements. Application Engineers are ready to assist in seal and system recommendations, on-site trouble shooting and failure analysis. The QRCs include complete CAD resources with the ability to quickly design and send to manufacturing the detailed drawing for parts or seals to maintain crucial rotating equipment. With this level of local customer focus, the Quick Response Centers are ready to respond to your needs quickly and completely.





Condition Data Point Monitoring

Optimizing equipment performance is a passion at Flowserve. The Condition Data Point Monitoring (CDPM) is one of the tools to help in this endeavor. Flowserve's CDPM program uses vibration, temperature and oil analysis to contribute to a plant's predictive preventive maintenance program and reduce overall maintenance costs.

- **Vibration collection and analysis** is used to detect the most common rotating equipment problems such as unbalance, bearing or gear defects, blade/impeller faults, cavitation/recirculation problems, structural resonance problems and equipment or seal distress.
- **Critical temperature trending** identifies and monitors critical temperatures at specified locations that could indicate premature equipment failure. Abnormal conditions are identified and can be corrected before the equipment is damaged.
- **Lube oil sampling** and analysis offers immediate results for conditions such as excessive particles, wear debris, viscosity and moisture that if left unchecked can result in catastrophic damage, extensive repair costs and lost production.
- **Trigger point monitoring** identifies and monitors specific conditions such as low NPSH available and low flow rates that ultimately lead to premature equipment failure.

As companies compete on an increasingly worldwide scale, advantage stands with the most efficient and cost-effective operations. CDPM helps improve operational excellence.

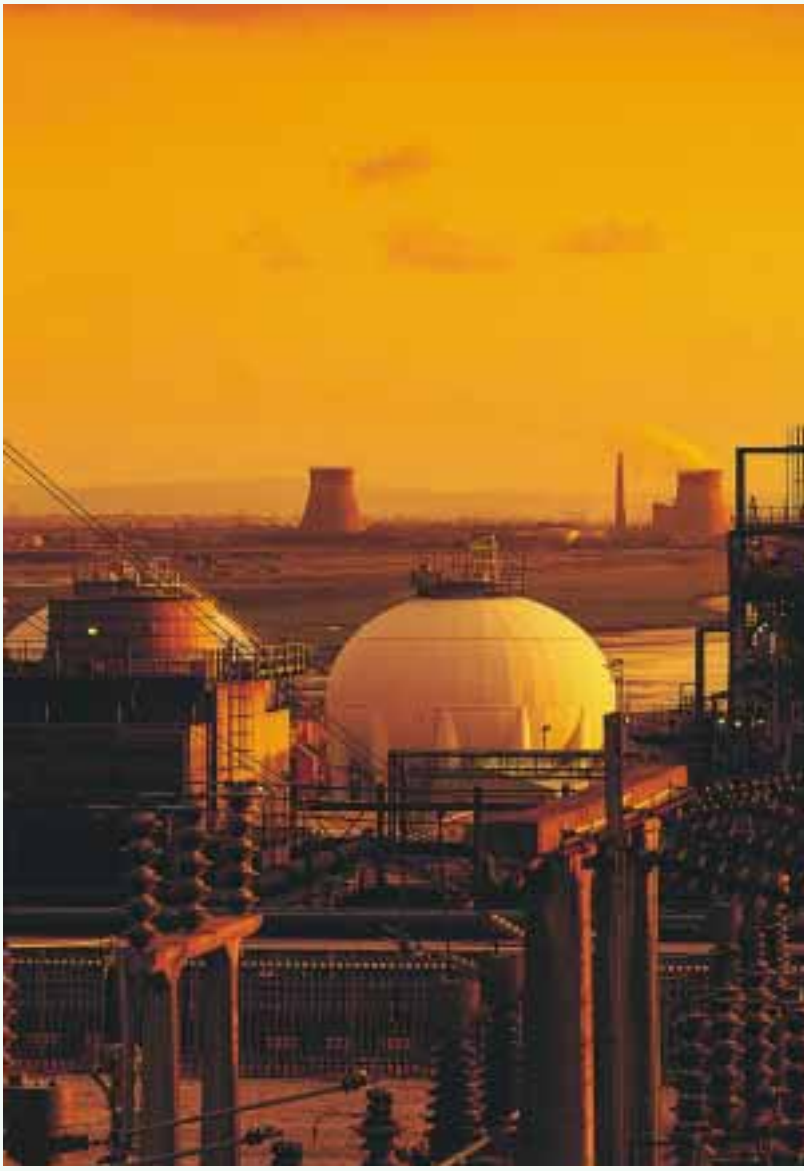
FlowStar.net

Reliability improvement programs are implemented to increase operational availability and save money, however, managing all the necessary information and deciphering meaningful results is a complex process that often hinders the effectiveness of such programs. FlowStar.net provides a total asset management solution that encompasses a plant's complete reliability situation from individual equipment details to multiple worldwide plant analysis. Starting from a thorough plant survey of rotating equipment including type, process, and operating conditions, FlowStar.net tracks performance data such as Mean Time Between Failure for the purpose of identifying specific equipment problems or general trends. Get real-time access to equipment databases with powerful filtering and sorting capabilities to create insight into conditions that affect plant performance.

Information collected with FlowStar.net is secure on a dedicated server and can be accessed over the Internet 24 hours a day. Existing equipment data can be uploaded or entered manually in FlowStar.net's intuitive screens. Reports, graphs, and data can be exported to spreadsheet format, printed, or emailed. View the big picture or drill down to the details to manage and run your plant better.

Training

Well trained operators and maintenance personnel are very important in achieving longer seal life and equipment reliability. Flowserve operates fully equipped training centers in Texas (Dallas-Fort Worth), Michigan (Kalamazoo), and Singapore (CPTC on Jurong Island). These facilities allow hands-on experimentation with live equipment backed up by technical classroom instruction.Training courses are offered in a variety of expertise categories including pumping systems, pumps, seals, valves, root cause failure analysis and vibration analysis. Training tailored to your needs can be developed and delivered on-site. Flowserve has the training you need from simple seal installation to in-depth failure analysis on a pumping system problem.

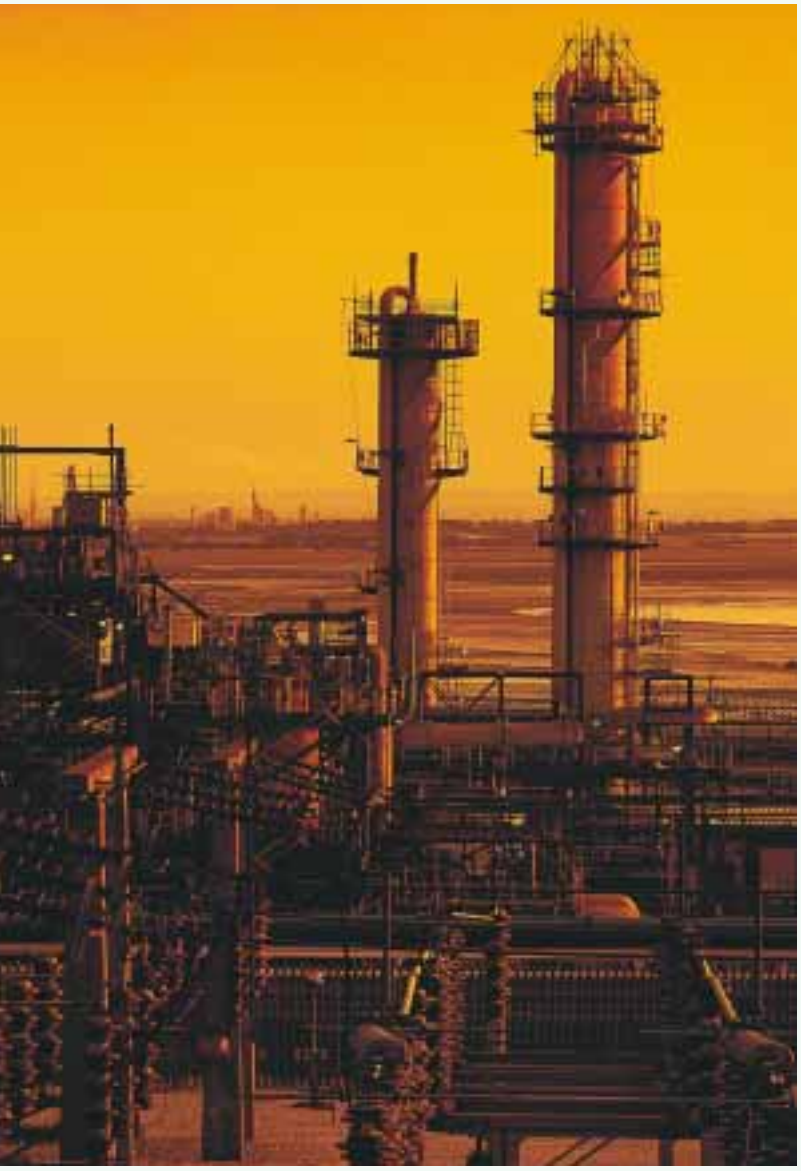


Refining & Petrochemical Industry
Today's hydrocarbon processing plants require shaft-sealing devices with an extraordinary range of capabilities. Safety, environment and reliability are of primary importance. Flowserve FSD has a range of specialized and proven solutions for:

- Low to zero emissions on light products
- Products ranging from viscous refinery bottoms to low specific gravity fluids to flammable gases
- Corrosive, caustic, acidic and abrasive products
- Recoverability from upsets
- A wide range of temperatures from sub zero up to 800°F / 427°C
- High speeds and high pressures

application	category	type	API 682
general purpose, (sour) water, non-flashing hydrocarbons, caustic, amines	pusher	QB	A 1, 2, 3
	pusher inner dia pressurized	QBB	A 3 inboard
	bellows general purpose	BX	B 1, 2, 3
	bellows inner dia pressurized	BXB	B 3 inboard
light hydrocarbons (LHC)	pusher LHC	QBQ	A 1, 2
high pressure, crude, acids	pusher single spring	UC	A 1
high temperature plan 23, Boiler Feed Water		D	A 1
high temp non-flashing hydrocarbons	bellows high temp	BXRH	C 1
		BXHH	C 1, 2, 3
	bellows inner dia pressurized	BXHHB	C 3 inboard
dry contacting gas back-up	gas seals	GSD	
lift-off back-up		GSL	
lift-off gas seal (double)		GF-200	
integrally geared equipment	OEM specialty equipment	GLS GSS GSG	

API 682 Flowserve FSD seals and support systems for the refinery industry satisfy all API 682 requirements.



Chemical Industry

Modern chemical plants produce a tremendous variety of products over a wide range of operating conditions. Next to safe handling of toxic products, good corrosion resistance, reliability and low cost are of great importance.

Critical needs are:

- Resistance to highly corrosive liquids
- A wide range of materials of construction
- Resistance to abrasive substances
- Ability to stand up under highly toxic, volatile and flammable fluid service
- Low leakage rates or zero leakage
- Low cost but durable designs for confined space requirements
- Maximum interchangeability of components to reduce inventories

application	category	ANSI	DIN
most low viscosity, mildly corrosive chemicals,	pusher	RO	Europac 600-610
water, process water, caustics, mild acids,	bellows	BX	BXLS
non-flashing low temperature hydrocarbons		CBR	
	standard cartridge	ISC	Allpac N
	cartridge pusher	80 Series	
	elastomer bellows	Pac-Seal	Pac-Seal
high temperature/heat transfer	bellows high temp	BXHH, BXRH	
high viscosity, slurry	pusher	SL-5000	Allpac
most clean low viscosity chemicals	gas seal (double)	GX-200	GX-200
		GF-200	
acids, corrosive chemicals	outside mounted	RA/RA-C	
		TBR	Chemiepac
integrally geared equipment	OEM specialty equip.	GLS/GSS/GSG	
mixers	mixers	M-series	M-series DIN
		VRA, MSS	256x-series

ANSI/ISO/DIN EN 12 756

Flowserve FSD has a wide range of products to cover both the ANSI pump designs as well as the DIN EN 12 756 standards, which are the most commonly used in the chemical industry. Engineered designs for pumps and mixers are also part of the product range.

Power Industry
As power generation plants continue to increase in size, output and complexity, sealing devices with an ever-greater range of capabilities are required. When sealing hot water at higher pressures, difficult lubrication conditions between the seal faces exist, requiring the very best materials to achieve long mechanical seal life.

application	temperature	pressure	cooling	egory	type
water, condensate	low	low	none	see Municipal	
boiler feed water	medium	medium	no additional	pusher	QB-Lube
					Europac 615
	high	high	plan 23		D
		very high			DP
					DHTW
flue gas desulphurization	low	low			SLM-6000
					Allpac

At Flowserve FSD, ongoing development has optimized performance and seal life for these critical conditions:

- Reliable performance coupled with long seal life
- High face speeds on large shaft diameters
- High pressures and high temperatures on water
- Minimum reaction to temperature transients
- 'Hot standby' capability
- Ability to maintain seal integrity under low or lost suction conditions

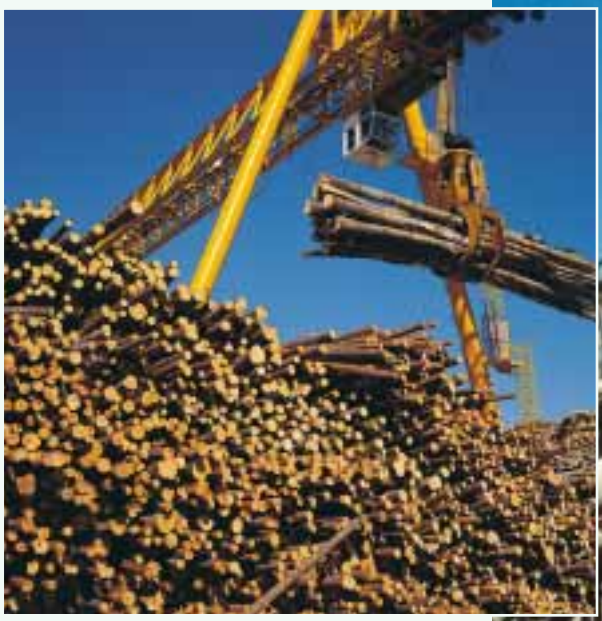
Pipeline Industry

Modern product pipeline operation requires batch type transport of various refined products ranging from fuel oils to Liquefied Natural Gas (LNG), often at varying pressures.
Crude oil transported from oil fields may contain sand, salt, water, scale and other erosive agents. Often high cost multistage pumps are used. These harsh conditions require engineering input to achieve best mechanical seal performance.

application	pressure	category	type
light hydrocarbons (LHC)	medium	pusher LHC	QBQ
hydrocarbons, crude oil		pusher	QB
		bellows	BX
	high	pusher single spring	UC, UOP
	very high	pusher	UHTW, DHTW
			HSC/HSH
dry contacting gas back-up	medium	gas back-up seal	GSD
dry lift-off gas back-up	medium	gas back-up seal	GSL
produced water		pusher	Allpac
			UC

At Flowserve FSD ongoing R&D programs have resulted in proven products that meet these special needs:

- Dependable performance in unattended main and booster station service, often at remote locations
- Operation under high pressures and very high face speeds
- Ability to handle a wide array of fluids of varying specific gravities - from light hydrocarbons to viscous sulfurous crude oils
- High resistance to dirt and abrasives
- Reliable sealing and low leakage despite radical fluctuations in temperature
- Performance in intermittent service, with many stops and high pressure start-ups



Pulp & Paper Industry

Paper stock, black liquor, chlorine, coating mixes, pumps, refiners, screens, agitators are common in the pulp and paper industry. Processing wood or waste paper and transforming it into paper or board requires cutting, grinding, cleaning, bleaching and de-watering operations. Reduction of energy and water usage is important to reduce operating cost. Flowserve FSD has developed advanced sealing systems that can help you reduce your plant's water, energy and maintenance costs:

- Resistance to highly corrosive liquids
- Resistance to abrasive substances
- A wide range of materials of construction
- Low leakage rates
- Low cost but durable designs for confined space requirements
- Maximum interchangeability of components to reduce inventories.

application	equipment	category	type
specialty equipment	refiners, conveyors	bellows	BX
	axial flow circulators	split pusher	PSS II
	pulpers	pusher	SL-5200
paper stock	pumps	bellows	BXLS
		pusher	Allpac, SL-5000
			80 Series
		standard cartridge	ISC
chemical pumps		see Chemical	
municipal pumps		see Municipal	
hot water/power		see Power	

Mineral and Ore Processing Industry
Alumina, cement, clay, coal, copper, gold, gypsum, mineral sands, nickel, phosphate, potash, silver, trona, taconite, titanium, zinc; whatever the mineral and ore process, can represent one of the toughest machinery and sealing environments around. Taking raw material from the earth, extracting, and refining finished mineral products requires rugged equipment capable of surviving abrasive and corrosive services, often at extreme pressures and temperatures.

application	slurry	category	type
slurry pumps	extreme	pusher	SLC
		pusher double seal	SLM-6200
	standard	pusher	SLM-6000, SLM-6100
	unique		Allpac
agitators/ autoclave		mixer seal	M-series or 256x
accessories			SLD, QCD, EPD
axial flow circulators		split pusher	PSS II
chemical pumps		see Chemical	
municipal pumps		see Municipal	
hot water/power		see Power	

Flowserve FSD's ongoing R&D programs have delivered advanced sealing systems to decrease maintenance expenditures, limit and in many cases eliminate water usage, maintain safety and reliability, and help reduce plant energy costs while ensuring equipment availability with increased mean time between planned maintenance allowing for higher production throughput by having:

- Resistance to highly abrasive liquids
- Resistance to highly corrosive substances
- A wide range of materials of construction for long seal life
- Maximum interchangeability of components to reduce inventories
- Ability to isolate highly toxic and corrosive fluids from the atmosphere
- Recoverability from low or lost suction upset conditions
- No product diluting flush requirements

Municipal / Water

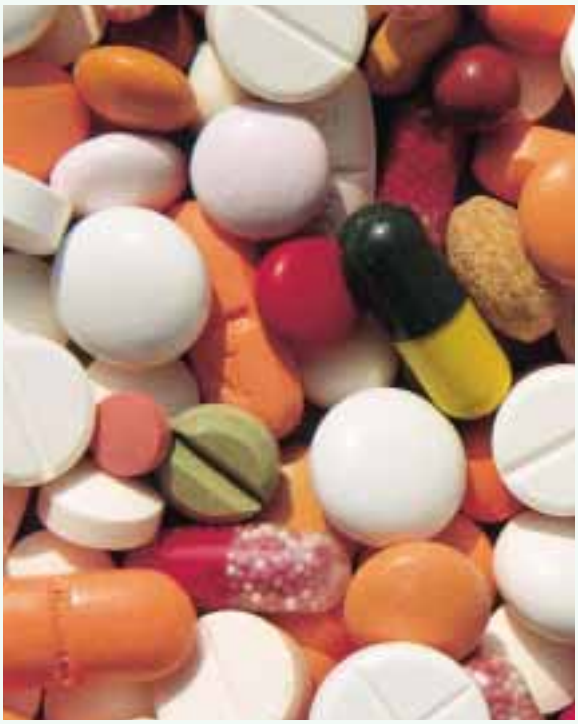
Water is the most common liquid on earth and a primary requirement for life. It is used for many purposes, such as drinking water, cooling water, heating water, irrigation, process water and sanitary water.

Wastewater treatment plants have two basic purposes: to speed up the purification process that takes place naturally in rivers, lakes and streams and to reduce toxic contaminants that can that can interfere with natural processes. Typical applications can involve chemicals, solids and slurrys.

application	category	type
water	standard cartridge	ISC
	pusher	80 Series
		RO
		Europac
	split seal	PSS II
	elastomer bellows	Pac-Seal
sludge	slurry seals	SL Series

As government regulations on water quality increase, the cost of water treatment could rise. Flowserve sealing systems can offer a significant savings in operating costs:

- Low leakage rates
- Reliability
- Resistance to contamination and abrasives
- Low cost but durable designs for confined space requirements
- Maximum interchangeability of components to reduce inventories.
- Reduce or eliminate environmental contamination



Pharmaceutical Industry

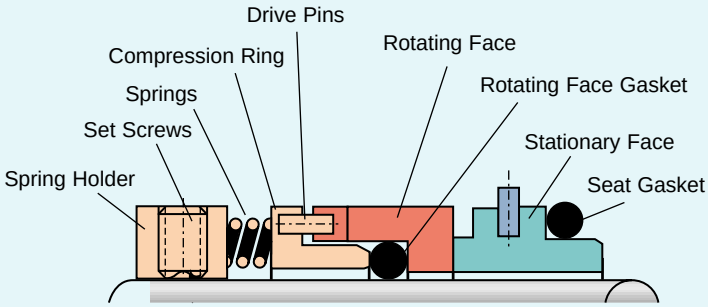
Since federal, state and regional environmental regulations on fugitive emissions were first introduced beginning in the early 1990s, manufacturers of pharmaceutical products have been refining their processes to improve the performance of their rotating equipment and remain within compliance with local and federal regulations. Lower emissions and improved purity of end products are the two main focuses with sealing rotating equipment, along with being a good community neighbor for the pharmaceutical industry.

Flowserve FSD has close relationships with many of the end users and specialty equipment manufacturers and knows the industry requirements:

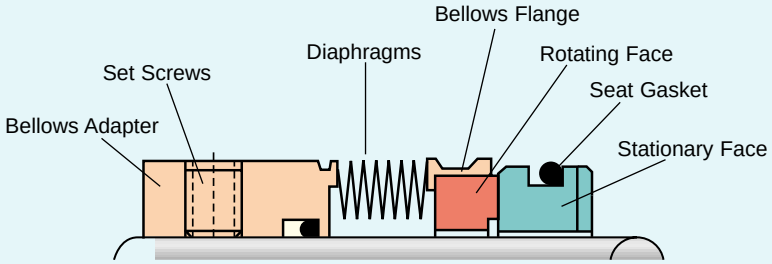
- No product contamination allowed
- Low or no emissions to atmosphere
- A wide range of materials of construction including 'food grade'

application	category	remark	type
mixers, agitators, blenders, dryers,	mixer seal	wet double (also DIN)	MW-200
autoclaves, centrifuges		wet double DIN	256x-series
		dry cont. double (also DIN)	MD-200
		dry contacting single	VRA single
		dry lift-off (also DIN)	ML-200
		CIP/SIP	2568/ 2570
		split seal	MSS
pumps	split pusher		PSS II
	standard cartridge		ISC

- Low leakage rates
- Electro-polish finishes available on critical metal surfaces for ease of cleaning and increased sanitary protection
- Sanitary glands and debris wells.
- Application experience sealing high alloy vessels as well as glass lined vessels
- A long history of experience sealing top entry, side entry and bottom entry mixer and agitator equipment with great success
- Application parameters have been met from very low speeds to very high speeds with gas seal designs and from cryogenic vacuums to very high pressure and high temperature autoclaves with dual seals
- Seals are designed for Clean In Place (CIP) and Steam In Place (SIP) applications as well as the ability to stand up to caustics and acid between batch flushes



Pusher nomenclature



Bellows nomenclature

Basic design

A typical 'pusher type' mechanical seal consists of a rotating face, a stationary face and secondary sealing elements with adaptive metal parts such as a flange and a sleeve.

The stationary face is seated in a flange which is bolted onto the pump cover. For most seals the rotating face can move in the axial direction and is kept in place by a spring holder and one or more springs. The rotating parts are installed on a shaft sleeve or directly on the shaft. The gasket that can move axially with the rotating face is called a 'dynamic' gasket. The secondary sealing elements are often elastomers, but by special design PTFE can also be used.

A bellows type mechanical seal is very similar, but uses a welded metal bellows to achieve flexibility in the design. A bellows seal avoids the use of a ‘dynamic’ gasket, which allows the use of grafoil for high temperature applications.

Operation

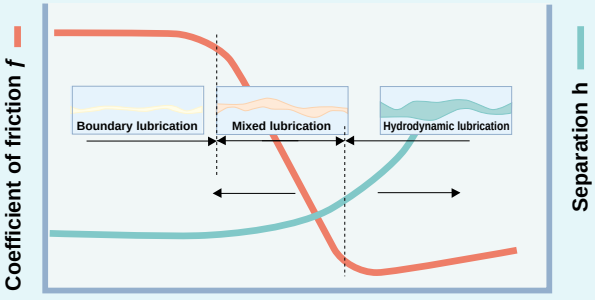
Key to low leakage and reliable operation of a mechanical seal is maintaining a minimal but sufficiently thick fluid film between the faces, with the gap typically below 40 µin/1 µm.

This film's thickness typically is in the order of the surface roughness, allowing a low friction coefficient and thus low heat generation. A very slight touching of roughness high spots occurs, and this operation is called 'mixed lubrication' in tribology. The face sliding surfaces are lapped to optimum roughness.

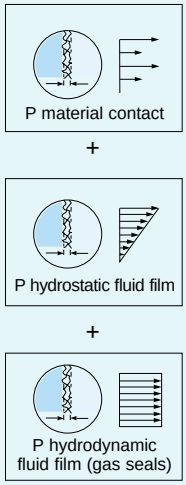
The dynamic or spring loaded face represented on the left (red face, bottom right pressure equilibrium diagram) can be seen as a piston, where a number of forces are in balance:

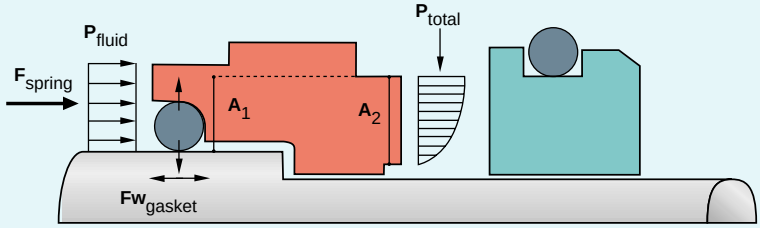
- Hydrostatic pressures (closing and opening forces)
- Mechanical contact between faces (minimal during normal operation)
- Hydrodynamic pressure (minimal for a liquid seal, essential for a gas seal)
- Spring force
- Gasket friction (O-ring drag)

Flowserve engineers have tuned all designs such that the axially moving face is in perfect equilibrium over the entire range of operating conditions. One method is changing the 'balance ratio' by changing the hydrostatic closing force, used for seals at higher pressures.



Lubrication regime





Equilibrium:

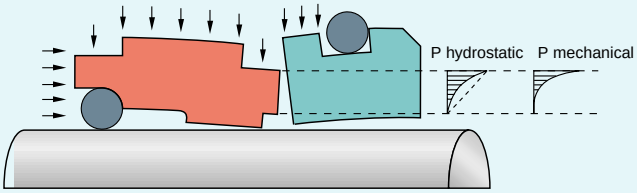
$F_{spring} + Fw_{gasket} + P_{fluid}\,A_1 = P_{total}\,A_2$

Balanced: $A_2 > A_1$

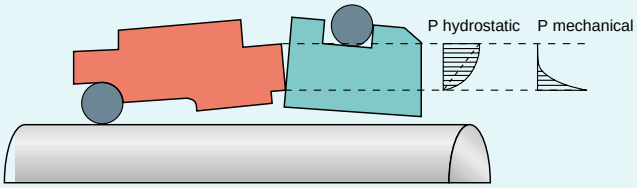
Unbalanced: $A_2 \leq A_1$

Operating window

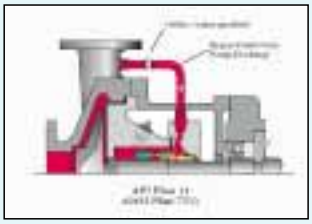
Hydraulic pressure on the faces causes a concave deformation. This closes off the liquid film in the gap, which changes the hydrostatic pressure distribution between the faces. Fortunately this is compensated for by the frictional heat generation in the gap, which by nature of the temperature distribution causes an opposite convex thermal deformation. Seal designs are carefully optimized by iterative solution of finite element equations and special fluid film models. Over a large range of pressures, speeds and liquids (operating window) the total of pressure and thermal deformation is kept to a minimum to maintain a constant film thickness and thus optimum reliability. Caution is required if all aspects are close to the seal limits simultaneously, this will require a careful engineering review.



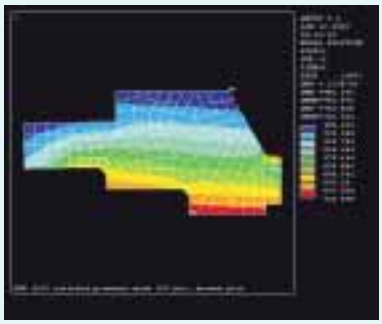
Pressure deflection - concave



Temperature deflection - convex



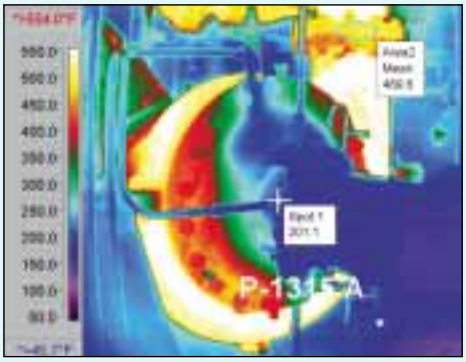
API Plan 11



Finite Element Analysis (FEA)

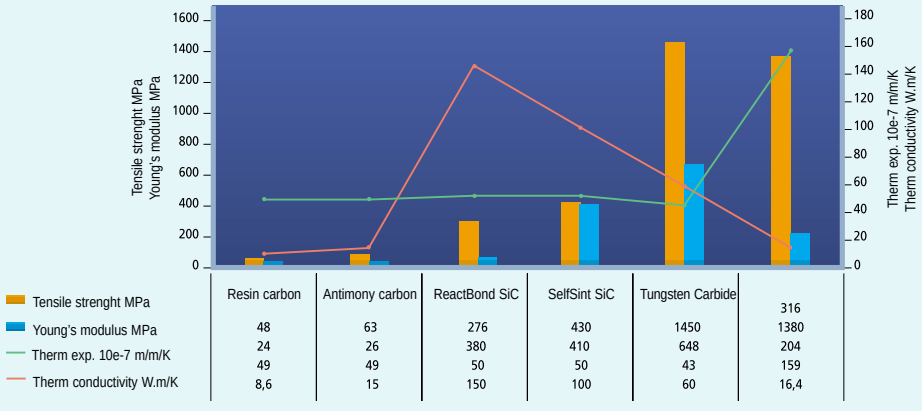
Seal environment

Just as important as the mechanical design of the seal is the seal environment. A clean and stable lubricating fluid film and free axial movement of the dynamic face is essential. The piping arrangement, typically indicated as 'API plan' (listed on page 55), helps to cool the seal and keep the face environment clean. Obviously there can also be other reasons for special seal arrangements and piping plans, such as safety or environmental restrictions (emissions). Besides the seal design and the piping plan the pump design (the shape and arrangement of the seal cavity) and operation are crucial for ensuring safety and reliability.



IR temperature measurement

Seal face materials



	Resin carbon	Antimony carbon	ReactBond SiC	SelfSint SiC	Tungsten Carbide	316
Tensile strenght MPa	48	63	276	430	1450	1380
Young's modulus MPa	24	26	380	410	648	204
Therm exp. 10e-7 m/m/K	49	49	50	50	43	159
Therm conductivity W.m/K	8,6	15	150	100	60	16,4

Materials

Over the years seal face materials have evolved from simple carbon mixes and steel faces to advanced antimony impregnated faces and silicon carbides. These last two materials have a proven reliability record even when operated in very marginal lubrication conditions, such as light hydrocarbon or hot water applications. A very important factor is the hardness, strength and heat conduction of the silicon carbide, compared in the graph on the left.

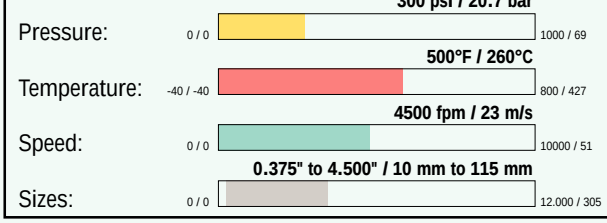
For corrosive liquids the corrosion resistance is important, for which reason the default metallurgy is stainless steel or a higher alloy. Resin impregnated carbons and sintered silicon carbide grades provide highest corrosion resistance. A wide range of gasket materials is available, from fluoroelastomers to chemically virtually inert PTFE to high temperature grafoil. Standard materials for each seal type are listed on page 55.

	Type	Page	Arrangement	Seal Technology	Design Standard	High Temperature	High Pressure	High Speed	Remarks
Pusher	RO	18	Component	Liquid	ANSI				Unbalanced single pusher
	QB	19	Cart Sgl		API 682 type A				Balanced single pusher
	QBQ	19	Cart Sgl		API 682 type A				As QB, low emission, high balance for light hydrocarbons
	QBB	19	Cart Sgl		API 682 type A				As QB, arrangement 3
	QB-Lube	19	Cart Sgl			BFW			As QB, boiler feed water lube groove
	Europac 600	19	Component		DIN EN 12 756				Unbalanced single pusher
	Europac 610	19			DIN EN 12 756				As 600, balanced stepped shaft
	Europac 615	19			DIN EN 12 756	BFW			As 610, boiler feed water lube groove
	84/85	20	Cart Sgl		ANSI				General purpose single pusher cartridge
	86/87	20	Cart Dbl		ANSI				General purpose dual pusher cartridge
	CRO	20	Component		ANSI				Unbalanced single spring pusher
	UC/UCQ	20	Cart Sgl		API 682 type A				Single spring, UCQ low emission high balance
	UOP	20	Cart Sgl				HP		As UC, high pressure
	D	21	Cart Sgl		API 682 type A	BFW			Single spring, boiler feed water
	DP	21	Cart Sgl			BFW	HP		As D, high pressure boiler feed water
	Allpac 480/487	21	Cartridge						For viscous or dirty product, unique slurry
	SL-5000/5200	21	Cart Sgl Dbl						For viscous or dirty product, pulp & paper slurry
Bellows	BX/BXB	22	Component	Liquid	API 682 type B				Alloy C-276 bellow for API 682, BXB arrangement 3
	CBR	23							General purpose single bellows
	BXLS	23			DIN EN 12 756				As BX, DIN version
	BXR	23						HS	Stationary bellow
	BXRH	24			API 682 type C	HT		HS	Stationary Alloy 718 bellow
	BXHH/BXHHB	24			API 682 type C	HT			Rotating alloy 718 bellow, BXHHB arrangement 3
Standard Cartridge	ISC1PX	25	Cart Sgl	Liquid	ANSI/ISO/DIN				Single pusher, also for light abrasives
	ISC2PP	26	Cart Dbl		ANSI/ISO/DIN				Dual pusher, also for light abrasives
	ISC1BX	26	Cart Sgl		ANSI/ISO/DIN				Single bellows, also for light abrasives
	ISC2BB	26	Cart Dbl		ANSI/ISO/DIN				Dual bellows, also for light abrasives
	ISC1EX	27	Cart Sgl		ANSI/ISO/DIN				Single elastomer bellows, also for light abrasives
	Allpac N	27	Cart		DIN EN 12 756				Single/double/tandem
Slurry	SLC	28	Cart Sgl	Liquid					Extreme solids
	SLM-6000	29	Cart Sgl						Standard slurry
	SLM-6100	29	Cart Tdm						Standard slurry, tandem operation
	SLM-6200	29	Cart Dbl						Hazardous solids, double operation
Mixer Seals	ML-200	31	Cart Dbl	APGS lift-off					ML-platform non contacting
	MW-200	31	Cart Dbl	Liquid					MW-platform liquid seal
	MD-200	31	Cart Dbl	Dry contacting					MD-platform contacting dry running
	ML-200 DIN	31	Cart Dbl	APGS lift-off	DIN 28138				ML-platform DIN steel & glass-lined (with/without bearing)
	MW-200 DIN	31	Cart Dbl	Liquid	DIN 28138				MW-platform DIN steel & glass-lined (with/without bearing)
	MD-200 DIN	31	Cart Dbl	Dry contacting	DIN 28138				MD-platform DIN steel & glass-lined (with/without bearing)
	2561 - 2564	32	Cart Dbl	Liquid	DIN 28138				Standard DIN steel single/double (with/without bearing)
	2565 - 2566	32	Cart Dbl		DIN 28138				Standard DIN sterile double (with/without bearing)
	VRA	32	Component	Dry contacting					Single dry running
	MSS	33		Wet/Dry cont					Split seal
	Custom Engineered	33	Cartridge						For special equipment
Lift-off & dry running	GSD	34	Cartridge	Dry contacting	API 682 type A				Back-up contacting dry running
	GSL	35	Cartridge	Wavy lift-off					Back-up wavy face
	GF-200	35	Cart Dbl	APGS lift-off	ANSI Enlarged				Dual pusher lift-off
	GX-200	35	Cart Dbl	APGS lift-off	ANSI/ISO/DIN				Dual bellows lift-off

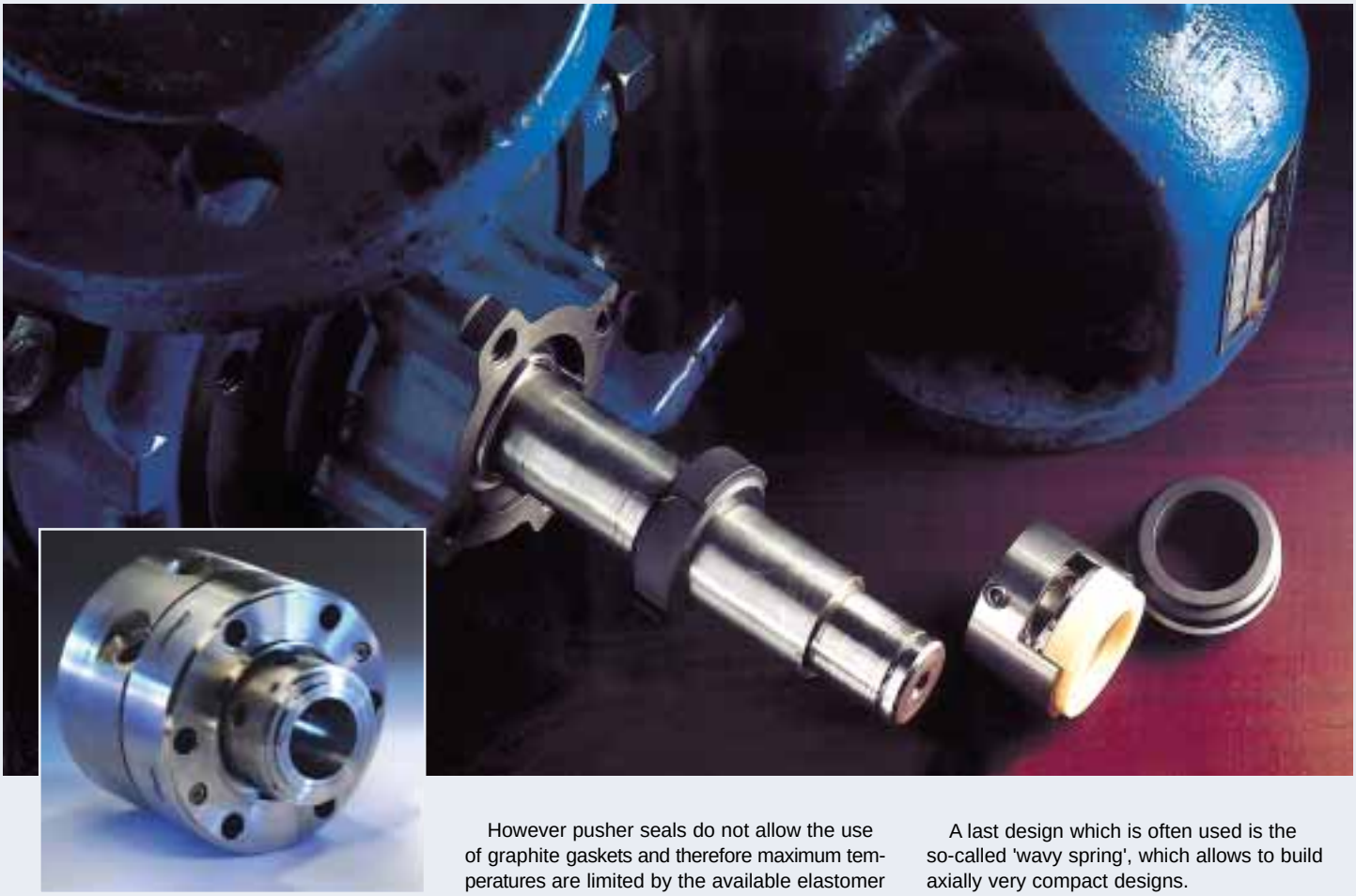
	Type	Page	Arrangement	Seal Technology	Design Standard	High Temperature	High Pressure	High Speed	Remarks
Outside mounted	RA/RA-C	36	Component	Liquid					For corrosive liquids
	TBR	36							PTFE bellow, for corrosive liquids
	Chemiepac 955/970	36							PTFE bellow, for corrosive liquids
Compressors	Gaspac T	37	Cart Tdm	T-Groove or APGS			HP	HS	Tandem
	Gaspac L	37	Cart Tdm	T-Groove or APGS			HP	HS	Tandem with interstage labyrinth
	Gaspac S	37	Cart Sgl	T-Groove or APGS			HP	HS	Single
	Gaspac SRD	37	Cart Sgl	T-Groove or APGS			HP	HS	Single, single rotor design (SRD)
	Gaspac D	38	Cart Dbl	T-Groove or APGS			HP	HS	Double
	Turbopac 375	38	Component	Liquid			HP	HS	Oil lubricated liquid seal
	Turbopac 368	38						HS	Oil lubricated seal for screw compressors
	Circpac CB	39	Cartridge					HS	Floating ring nitrogen barrier seal
	Circpac LO	39	Cartridge					HS	Floating ring nitrogen barrier seal
	Circpac HP	39	Cartridge	Dry contacting					High performance circumferential seal
Steam	GTS	40	Cart Sgl	Wavy lift-off		HT		HS	Single seal for steam
OEM & special duty	GSS	42	Component	Wavy lift-off			HP	HS	High duty pusher for integrally geared API pumps and compressors
	GLS	42		Liquid			HP	HS	High duty pusher for integrally geared API pumps and compressors
	GSG	42		HST			HP	HS	High duty pusher for integrally geared API pumps and compressors
	GW	41		Liquid				HS	Standard pusher for integrally geared API pumps and compressors
	BAW	41						HS	Standard bellows for integrally geared API pumps and compressors
	DHTW/UHTW	42	Cartridge			BFW	HP	HS	Boiler feed water
	LS-300	42	Cartridge	Lip					Triple lip-seal for positve displacement pumps
	CPM	43	Cartridge	Liquid					Cartridge, liquid single an dual pusher seals for light abrasives (steep)
	PSS II	43	Component						Split seal
	Circpac MD	43		Dry contacting					Segmented circumferential seal
	Elastomer diaphragm	44		Liquid					Cost effective seal range
	Elastomer bellows	44							Cost effective seal range
	Single spring	44							Cost effective seal range

Accessories	Bearing Gard II	Page	45
	Bearing Gard Magnetic (BGM)	Page	46
	Compressor panels	Page	46
	Barrier Gas Panels	Page	46
	Buffer fluid reservoirs (ANSI general duty, API and DIN)	Page	47
	Seal Gard	Page	48
	Closed Loop (Plan 53 B)	Page	48
	Piston transmitter	Page	48
	Seal coolers (standard, API 682 and air cooled)	Page	49
	Pressurizer	Page	50
	Magnetic Separator	Page	50
	Cyclone Separator	Page	50
	SLD (Synthetic Lubrication Device)	Page	51
	QCD (Quench Containment Device)	Page	51
	EPD (Erosion Protection Device)	Page	51

Maximum Operating Limits



OPERATING LIMITS:
This graphic representation allows a quick and easy comparison of operating limits. The scale is indicated by the small numbers and given in Imperial units/SI units. These scales cover the most common seals, special high pressure and high temperature seal scales are adjusted. Note that (low) temperature limits are typically dictated by gasket material limits. **Unless otherwise indicated the products are suited for non-volatile liquids with a specific gravity (s.g.) > 0.6.**



Pusher seals incorporate secondary seals, called the dynamic gasket, that are pushed by springs axially along the shaft or sleeve to compensate for seal face wear or wobble due to misalignment. Pusher seals - except for high duty versions- are generally less expensive than bellow designs and come in more sizes.

The pusher seal is often chosen for light hydrocarbons, high pressures and high speed applications because of the inherently greater strength of the design and the axial damping action of the dynamic gasket.

However pusher seals do not allow the use of graphite gaskets and therefore maximum temperatures are limited by the available elastomer or PTFE gasket materials. Chemical attack of the gasket material can also be a limiting factor. In addition build-up from weepage across the seal faces can keep the secondary seals from moving axially on the shaft, thus robbing the face of its ability to compensate for face wear (hang-up).

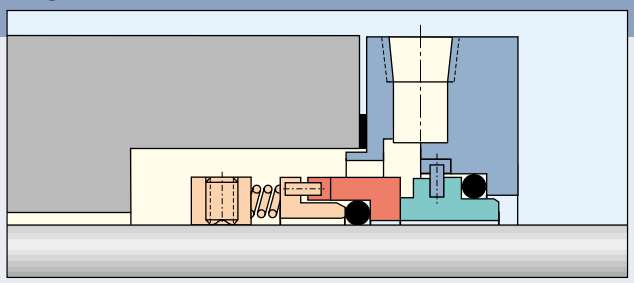
The most common spring arrangement is a number of small, highly corrosion resistant, springs. To protect the small springs from contamination some designs position the springs outside the product. Alternatively a large single spring is used, that is better suited to harsh duties and dirty product.

A last design which is often used is the so-called 'wavy spring', which allows to build axially very compact designs.

+ general purpose
+ can be lower cost
+ high pressure
+ high speed
+ axial damping of gasket: suitable for light hydrocarbons

- gasket material and temperature limitations
- can be more sensitive for hang-up depending on application

R O

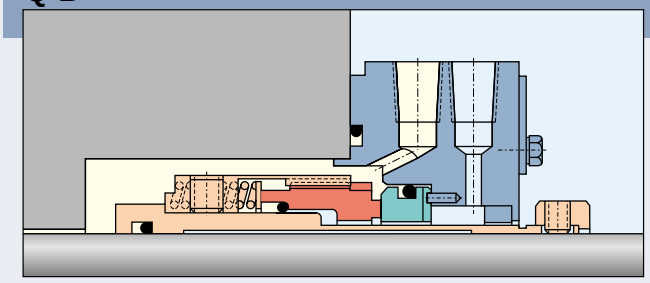


Standard Operating Limits

Pressure:	0 / 0	**300 psi / 20.7 bar**	1000 / 69
Temperature:	-40 / -40	**500°F / 260°C**	800 / 427
Speed:	0 / 0	**4500 fpm / 23 m/s**	10000 / 51
Sizes:	0 / 0	**0.375" to 4.500" / 10 mm to 115 mm**	12.000 / 305

Single, unbalanced, multi-spring seal used for general purpose mainly in the chemical industry. Individual parts are completely interchangeable and easy to replace. Can be used as an inside or outside seal in abrasive and corrosive services.

Q B



Single, balanced, multi-spring, pusher seal for general service, primarily applied in the petrochemical and chemical industry. The QB complies fully with all requirements of API 682 type A. Design variations include those mentioned below and customized QBW's.

QBQ High balanced low emission light hydrocarbon design, same operating limits as QB, specific gravities down to 0.45 with multi-port flush.

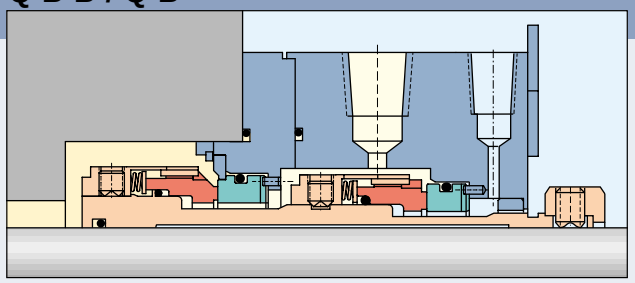
QB-lube Lube-groove design for hot water service without extra cooling. Pressure: To 255 psi / 17.5 bar, Temperature: To 340°F / 170°C.

REF. & PETROCHEM. PIPELINE POWER LHC API 682 TYPE A

Standard Operating Limits

Pressure:	0 / 0	750 psi / 51.7 bar — 1000 / 69
Temperature:	-40 / -40	400°F / 204°C — 800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s — 10000 / 51
Sizes:	0 / 0	0.411" to 5.911" / 10.4 mm to 150 mm — 12.000 / 305

Q B B / Q B



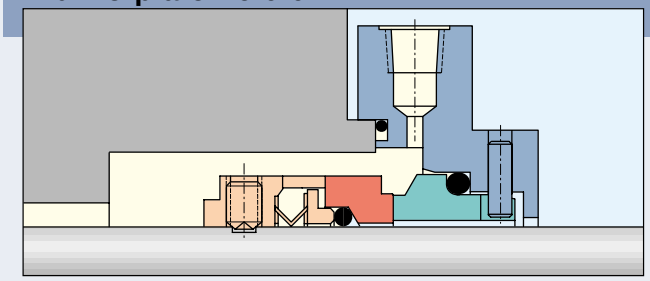
A QB version designed for reversed pressure operation. Fully compliant with all requirements of API 682 type A arrangement 3, but with an extended pressure range.

REF. & PETROCHEM. API 682 TYPE A3

Standard Operating Limits

Pressure:	0 / 0	750 psi / 51.7 bar — 1000 / 69
Temperature:	-40 / -40	400°F / 204°C — 800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s — 10000 / 51
Sizes:	0 / 0	1.750" to 4.250" / 45 mm to 108 mm — 12.000 / 305

Europac 600



Single, unbalanced, single wavy spring seal designed according the metric DIN EN 12 756 standard to L1k. This seal is applied on a wide range of duties, primarily in the chemical industry where DIN standard pumps are used.

Europac 610 As above, in balanced version needing stepped shaft. Pressure: To 360 psi / 25 bar

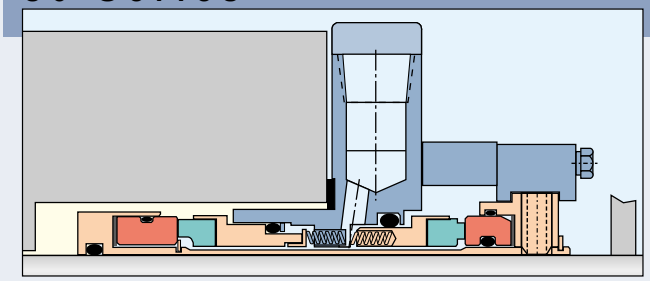
Europac 615 As 610 version above, but equipped with lube-groove design for hot water services without cooling. Pressure: To 255 psi / 17.5 bar, Temperature: To 340ºF / 170ºC

CHEMICAL MUNICIPAL POWER DIN EN 12 756

Standard Operating Limits

Pressure:	0 / 0	150 psi / 10.4 bar — 1000 / 69
Temperature:	-40 / -40	430°F / 220°C — 800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s — 10000 / 51
Sizes:	0	10 mm to 100 mm — 305

80 Series



Single and dual cartridge seals that are durable and proven seal designs for most general purpose applications. Springs are located outside the process fluid to reduce chemical stress corrosion and spring clogging by dirty fluids. Flexibly mounted mating rings reduce face distortion for adverse operating conditions. Rotary faces are protected and shock mounted for longer seal life. Gland designs are available to fit large bore seal chambers and standard stuffing boxes.

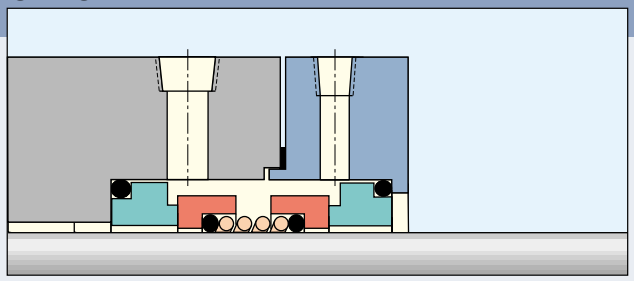
Standard Operating Limits

Pressure:	0 / 0	400 psi / 27 bar	1000 / 69
Temperature:	-40 / -40	400°F / 204°C	800 / 427
Speed:	0 / 0	6000 fpm / 30 m/s	10000 / 51
Sizes:	0 / 0	1.000" to 7.000" / 25.4 mm to 177.8 mm	12.000 / 305

86/87 As shown. Dual seal is double balanced to allow pressurized or non-pressurized operation.

84/85 Single seal with standard flush tap.

CRO

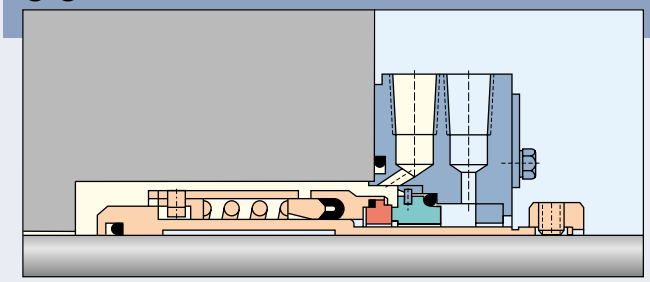


Double, friction drive, single spring, pusher seal that can be used in moderate pressure applications with water or similar viscosity product. Seal depends on friction between dynamic gasket and pump shaft for drive. Metal parts of the seal are isolated from pumped product to prevent possible chemical or abrasive attack. Very easy to install.

Standard Operating Limits

Pressure:	0 / 0	300 psi / 20.7 bar	1000 / 69
Temperature:	-40 / -40	500°F / 260°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	0.375" to 4.500" / 22 mm to 115 mm	12.000 / 305

UC



Single, balanced, rotating, single spring seal for heavy duty applications and general services. The UC seal has sufficient flexibility and clearance to compensate for minor misalignment of the shaft and bearings, while incorporating a state of the art encapsulated graphite gasketed silicon carbon rotating face. The UC seal's canned face provides optimum face flatness or low level emissions control.

Standard Operating Limits

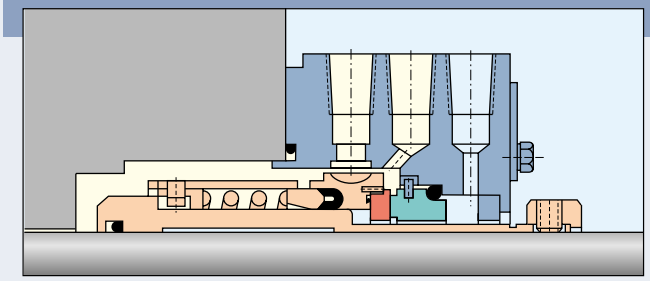
Pressure:	0 / 0	400 psi / 27.6 bar*	1000 / 69
Temperature:	-40 / -40	400°F / 204°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	0.566" to 5.838" / 14.1 mm to 148 mm	12.000 / 305

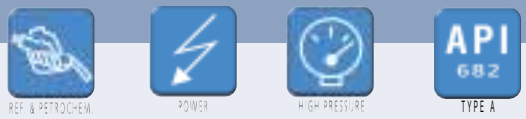
UCQ High balanced low emission light hydrocarbon design, same operating limits as UC, specific gravities down to 0.45 with multi-port flush

UOP As above, with 4-piece rotating face and high pressure stationary face, Pressure: To 1500 psi /103.4 bar.

* UO 4-piece design is used above 400 psi / 27.6 bar up to 1000 psi / 69 bar.

D



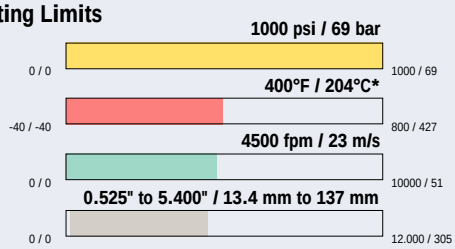


Single, balanced, rotating, single spring seal for the power industry or other high pressure applications. The design is similar to the U seal, except for the pump ring slots in the rotating face. Using an API plan 23 system to keep the seal cool, this seal is used in hot water and flashing hydrocarbon applications.

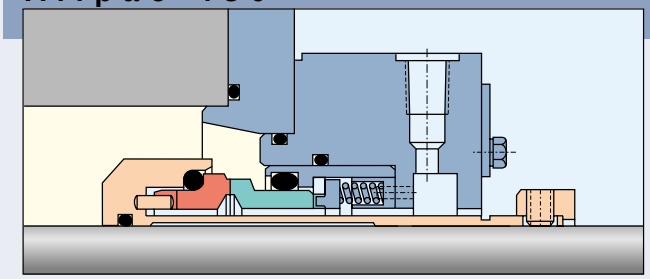
DP As above, with high pressure stationary face, Pressure: To 1500 psi /103.4 bar.

* max. temperature at seal faces with fluoroelastomer gaskets

Standard Operating Limits



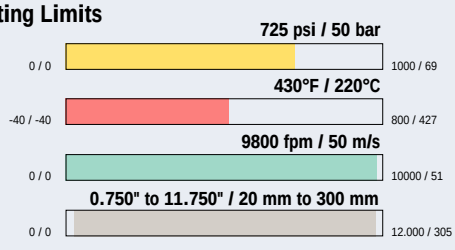
Allpac 480



Single, balanced, multi spring seal with springs outside the product to avoid clogging. Faces are made from silicon carbide. Clean component design and large clearances between seal and shaft sleeve, robust construction. Non slurry duties can use the extended operating window:

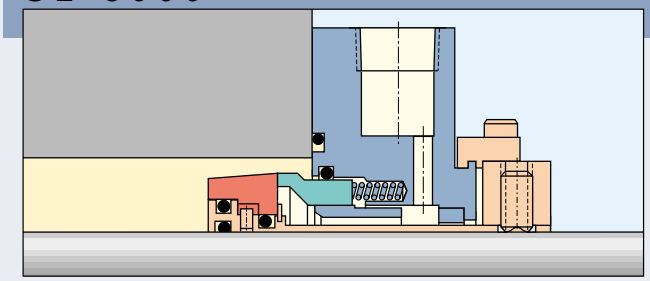
Allpac 481 As 480 version, but with single spring and available with tungsten carbide faces for use in pulp & paper and sugar industry applications.

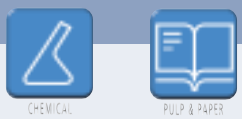
Standard Operating Limits



Allpac 487 As above, reverse balanced, Pressure: To 150 psi / 10.4 bar.

SL-5000

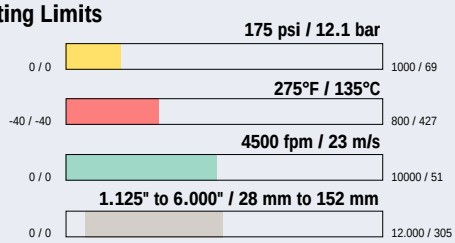




Single, balanced, multi spring, cartridge, pusher seal specifically designed for pulp & paper slurry services. Unique design exposes seal faces to pumped product for maximum heat dissipation - eliminates a common failure point. Special shroud protects compression springs in stationary portion of seal, and rotor drive pin, from weepage build-up. Pre-set cartridge design and centering tabs simplify installation.

SL-5200 As above, but in a double back to back arrangement with the outboard faces being the same as the inboard faces.

Standard Operating Limits



The bellows design overcomes many of the problems associated with pusher designs. The absence of a dynamic gasket eliminates the possibility of 'hang-up', caused by build-up of deposits or gasket swell. A rotating bellow has the benefit of 'self-cleaning action', disposing of particles or solids through centrifugal force. Some bellows seals can withstand higher temperatures than pusher designs, since their designs are not dependant on elastomers or PTFE. Instead grafoil can be used, which has an excellent temperature range and chemical resistance.

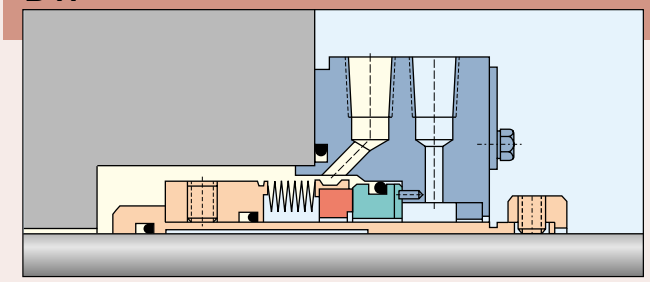
Bellows seals are generally easier to install because they have fewer parts.

However bellows are not suitable for high pressures since the bellows diaphragms are relatively thin. Since the bellows has less inherent damping action, boundary film lubrication with 'stick-slip' conditions such as with light hydrocarbons can generate axial vibration leading to fatigue failure. In view of the more complicated manufacturing process bellows are available in fewer sizes.

+ no dynamic gasket
+ wide temperature range
+ easier to install: fewer parts

- not for high pressure
- not for low specific gravity products

B X



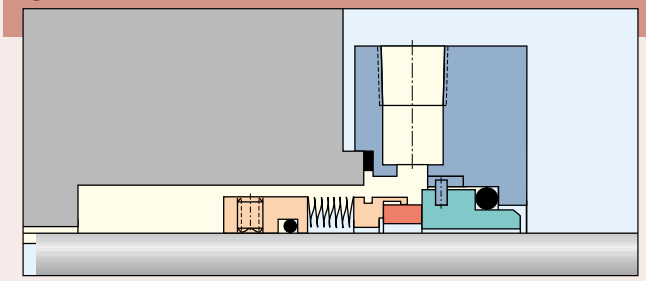
Single, balanced, welded rotating metal bellows seal for general service, primarily applied in the refining, petrochemical and chemical industry. The standard BX uses a 316 bellows core, but when equipped with an Alloy C-276 bellows core it complies fully with all requirements of API 682 type B. Because the bellows is rotating it provides a so-called 'self-cleaning' effect which prevents solids from entering the bellows convolutions.

Standard Operating Limits

Pressure:	0 / 0	**400 psi / 27.6 bar**	1000 / 69
Temperature:	-40 / -40	**400°F / 204°C**	800 / 427
Speed:	0 / 0	**4500 fpm / 23 m/s**	10000 / 51
Sizes:	0 / 0	**0.875" to 5.000" / 22 mm to 127 mm**	12.000 / 305

BXB Reverse balanced design, API 682 type B arrangement 3. Pressure reversed: To 150 psi / 10.4 bar, Temperature: To 300°F / 150°C.

C B R

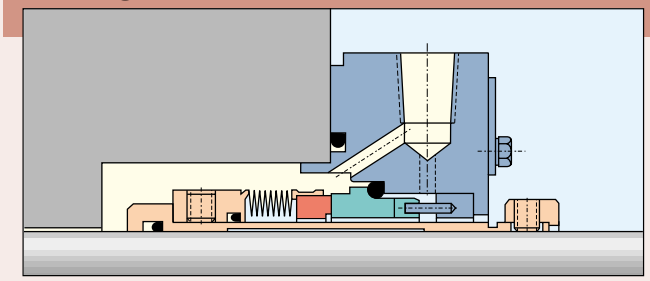


Single, rotating metal bellows design eliminates shaft packing hang-up fretting for general service in e.g. chemical industry. The seal ring is easily and economically replaced. Patented Centroid Loaded Face Attachment increases seal life by preventing seal face distortion caused by different thermal expansion rates of the face and hold materials. Cartridge design available. With standardized insert fits most ANSI pumps.

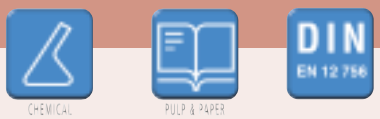
Standard Operating Limits

Pressure:	0 / 0	300 psi / 20.7 bar	1000 / 69
Temperature:	-40 / -40	400°F / 204°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	0.750" to 5.500" / 19 mm to 140 mm	12.000 / 305

B X L S



Single, balanced, welded rotating metal bellows seal according DIN EN 12 756 L1k. Intended for general purpose DIN pump applications for the process industry. The BXLS is based on the standard BX and uses a 316 bellows core. The seal can have high reverse pressure capability with retained stationary face. Because the bellows is rotating it provides a so-called 'self-cleaning' effect which prevents solids from entering the bellows convolutions.

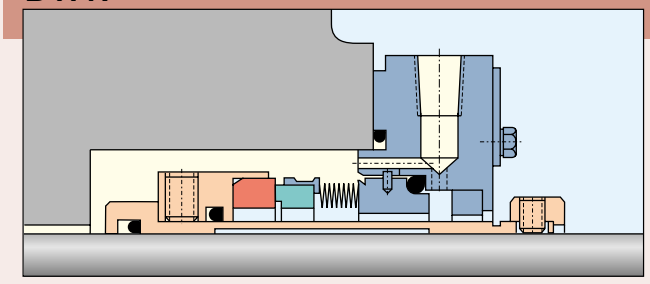


Standard Operating Limits

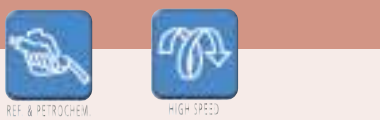
Pressure:	0 / 0	400 psi / 27.6 bar	1000 / 69
Temperature:	-40 / -40	450°F / 232°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0	18 mm to 100 mm	305

BXLSB Reverse balanced DIN design.
Pressure reversed: To 150 psi / 10.4 bar,
Temperature: To 300°F / 150°C.

B X R



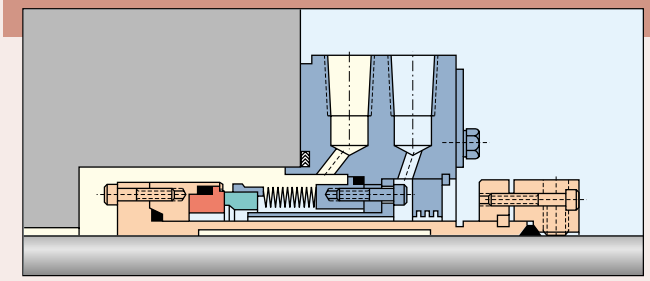
Single, balanced, welded stationary metal bellows seal for general service, primarily applied in the refining, petrochemical and chemical industry. Because of the stationary bellows the seal is less sensitive for misalignment and off-squareness, and can tolerate high speeds.



Standard Operating Limits

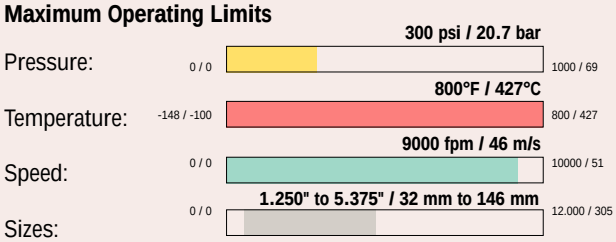
Pressure:	0 / 0	400 psi / 27.6 bar	1000 / 69
Temperature:	-40 / -40	550°F / 288°C	800 / 427
Speed:	0 / 0	9000 fpm / 46 m/s	10000 / 51
Sizes:	0 / 0	0.875" to 4.000" / 22 mm to 102 mm	12.000 / 305

B X R H

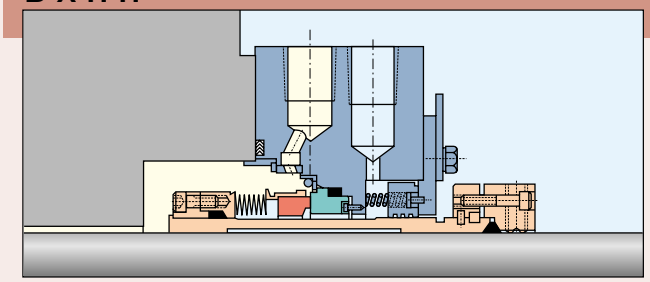


Single, balanced, stationary welded Alloy 718 bellows seal for high temperature petrochemical services. This seal complies fully with all requirements of API 682 type C. The use of Alloy 718 material and a low stress bellows design provides improved corrosion resistance. The special patented stationary face shrinkfit design minimizes face distortion and allows low leakage and low wear under a wide range of conditions. Because of the stationary bellows the seal is less sensitive to misalignment and can tolerate high speeds.

Maximum Operating Limits



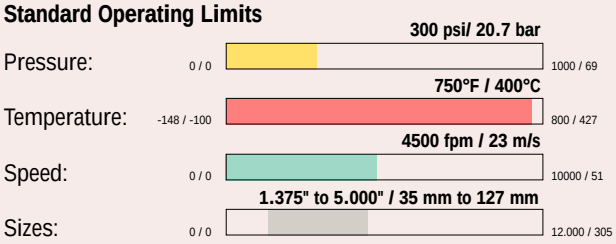
B X H H



Single or double, balanced, welded rotating Alloy 718 bellows seal for high temperature petrochemical services. This seal complies fully with all requirements of API 682 type C. The use of Alloy 718 material and a low stress bellows design provides improved corrosion resistance. The special rotating face shrinkfit design minimizes face distortion and allows low leakage and low wear under a wide range of conditions. The bellows is rotating so it provides a so-called 'self-cleaning' effect which reduces the possibility of solids entering the bellows convolutions.

BXHHB Reverse balanced design, API 682 type C arrangement 3. Pressure reversed: To 150 psi / 10.4 bar, Temperature: To 750°F / 400°C.

Standard Operating Limits



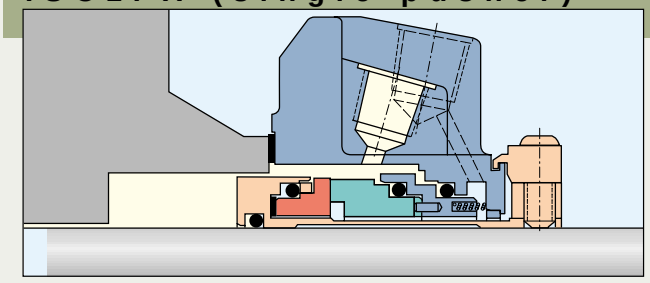
Standard cartridge seals such as the ISC seals are designed for general purpose applications on ANSI and DIN process pumps serving chemical processing, pulp and paper, oil and refining, food and beverage, water and wastewater, and other industries. Single, dual pressurized, or dual non-pressurized arrangements provide versatility to help meet a full range of general purpose application conditions, performance reliability, and environmental requirements. The standard cartridge requires no engineering, and can be manufactured in quantity which makes it very cost effective.

+ Factory assembled complete unit
+ Pre-tested for correct assembly
+ Less chance of pump installation errors
+ Easy to handle
+ Cost effective standard design

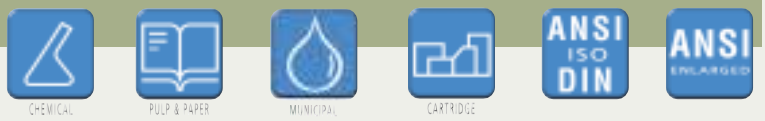
- Standard may not fit all pumps
- Not suited for light hydrocarbons

For sizes over 2.750", use the P-series and X-series.

ISC1PX (single pusher)



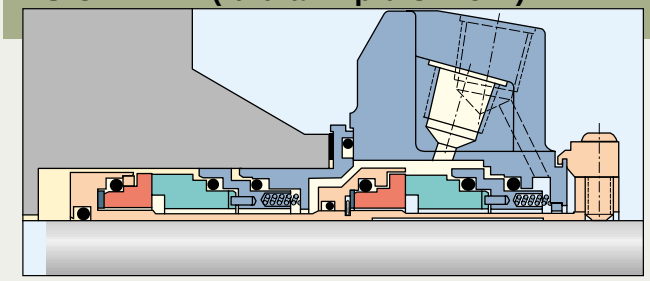
Single, stationary, spring, pusher seal in modular cartridge design, with parts interchangeable with other ISC versions. The springs are outside the product for reduced corrosion. The carbon and silicon carbide cross sections are optimized within the dimensional constraints for stable performance. Available in a wide range of materials. Suitable for most common ANSI standard bore, ANSI enlarged bore and DIN standard chemical pumps.



Standard Operating Limits

Pressure:	0 / 0	300 psi / 20.7 bar	1000 / 69
Temperature:	-40 / -40	0 to 400°F / -18 to 204°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.125" to 2.750" / 33 mm to 65 mm	12.000 / 305

ISC2PP (dual pusher)

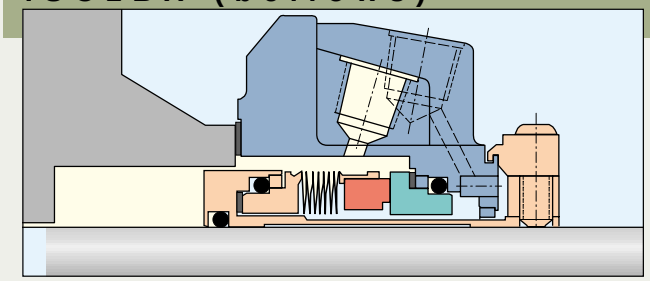


Dual, stationary spring, pusher seal in modular cartridge design, with parts interchangeable with other ISC versions. The seals are arranged in tandem configuration, but are double balanced to allow both pressurized and unpressurized operation. Unique high efficiency standard pumping feature allows cooler seal operation for increased reliability. Available in a wide range of materials. Suitable for most common ANSI standard bore, ANSI enlarged bore and DIN standard chemical pumps.

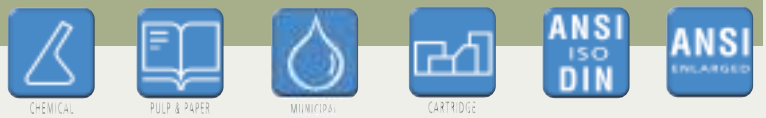
Standard Operating Limits

Pressure:	0 / 0	300 psi / 20.7 bar	1000 / 69
Temperature:	-40 / -40	0 to 400°F / -18 to 204°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.125" to 2.750" / 33 mm to 65 mm	12.000 / 305

ISC1BX (bellows)



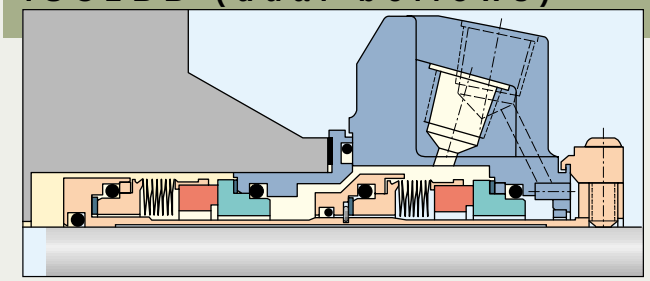
Single, bellows seal in modular cartridge design, with parts interchangeable with other ISC versions. The bellows module is made of Alloy C-276 for increased chemical compatibility. Both stationary and rotating bellows options are available. The bellows shrinkfit design uses centroid loading technology for optimum face flatness over a wide operating range. Suitable for most common ANSI standard bore, ANSI enlarged bore and DIN standard chemical pumps.



Standard Operating Limits

Pressure:	0 / 0	200 psi / 13.8 bar	1000 / 69
Temperature:	-40 / -40	0 to 400°F / -18 to 204°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.125" to 2.750" / 33 mm to 65 mm	12.000 / 305

ISC2BB (dual bellows)

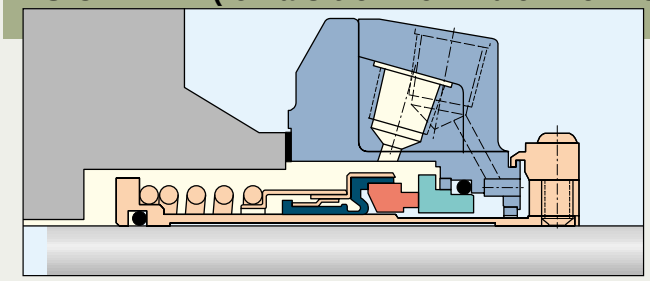


Dual, bellows seal in modular cartridge design, with parts interchangeable with other ISC versions. The seals are arranged in tandem configuration, but are double balanced to allow both pressurized and unpressurized operation. The bellows module is made of Alloy C-276 for increased chemical compatibility. Unique high efficiency standard pumping feature allows cooler seal operation for increased reliability. Available in a wide range of materials. Suitable for most common ANSI standard bore, ANSI enlarged bore and DIN standard chemical pumps.

Standard Operating Limits

Pressure:	0 / 0	200 psi / 13.8 bar	1000 / 69
Temperature:	-40 / -40	0 to 400°F / -18 to 204°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.125" to 2.750" / 33 mm to 65 mm	12.000 / 305

ISC1EX (elastomer bellows)



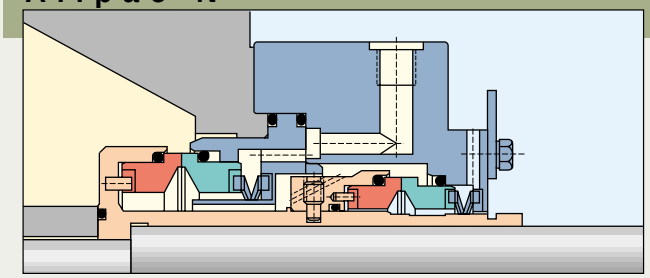
Single, elastomer bellows seal in modular cartridge design, with parts interchangeable with other ISC versions. The elastomer bellows module is based on proven Pac-Seal technology, and available in a wide range of materials. Suitable for most common ANSI standard bore, ANSI enlarged bore and DIN standard chemical pumps.

CHEMICAL · PULP & PAPER · MUNICIPAL · CARTRIDGE · ANSI ISO DIN · ANSI ENLARGED

Standard Operating Limits

Pressure:	0 / 0	150 psi/ 10.4 bar	1000 / 69
Temperature:	-40 / -40	0 to 400°F / -18 to 204°C	800 / 427
Speed:	0 / 0	6000 fpm / 30 m/s	10000 / 51
Sizes:	0 / 0	1.125" to 2.750" / 33 mm to 65 mm	12.000 / 305

Allpac N



Single, tandem or double, balanced, wavy spring seal, cartridge designed according the metric DIN EN 12 756 form C. Each seal face pair uses two 100% identical faces. When used as a double seal the inboard seal is reverse pressurized and very resistant to clogging. This seal is designed specifically for the so-called 'form C' part of the DIN standard, and is therefore available only in four sizes.

CHEMICAL · CARTRIDGE · DIN EN 12 756 FORM C

Standard Operating Limits

Pressure:	0 / 0	360 psi / 25 bar	1000 / 69
Temperature:	-40 / -40	430°F / 220°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	30, 40, 50, 60 mm	12.000 / 305

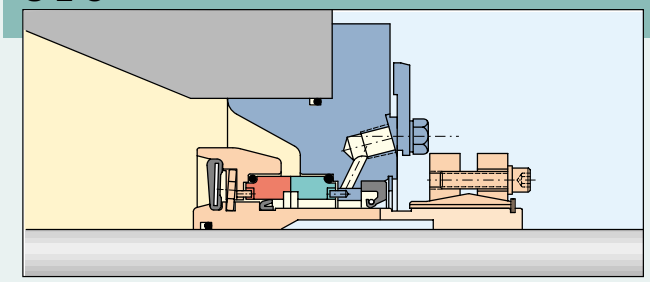
Flowserve has developed a complete range of sealing products for all types of slurries. They are engineered to perform and built to last.

Whether you have a slurry liquid that requires economic value, standard application or extreme service seals, Flowserve is uniquely positioned to provide the following solutions:

- The broadest performance window for flush-less applications
- No flush required up to MOH 9 slurry particle hardness
- Economical designs for low solids applications
- Modular components that promote field repair capability
- Engineered assemblies to fit common slurry pumps
- Knowledgeable and experienced slurry team to support installation, commissioning and unique job site applications
- Accessories (SLD), (QCD) & (EPD) to enhance seal operation that extends plant reliability

For flue gas desulphurization as well as unique slurry the Allpac 480 range (see page 21) can also be used.
For pulp & paper slurry the SL-5000 (see page 21) is also used.

SLC

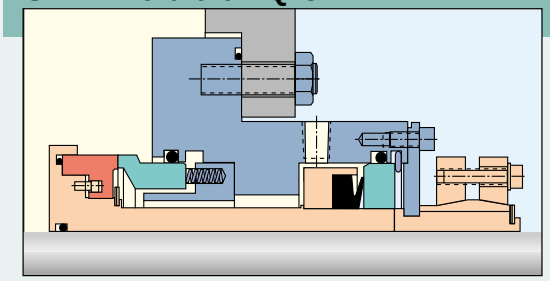


Single, balanced, rotating spring, cartridge seal specifically designed to operate without a flush in harsh slurry environments. No flush reduces operating costs, eliminates product dilution, increases plant throughput and maintains process efficiency. The seal incorporates a unique non-clogging elastomer encapsulated cone spring design that increases seal reliability in the most thick and viscous fluids up to and exceeding 60% solids.

Standard Operating Limits

Pressure:	0 / 0	**300 psi / 20.7 bar**	1000 / 69
Temperature:	-40 / -40	**300°F / 149°C**	800 / 427
Speed:	0 / 0	**3000 fpm / 15 m/s**	10000 / 51
Sizes:	0 / 0	**1.250" to 7.125" / 32 mm to 181 mm**	12.000 / 305

SLM-6000 QCD



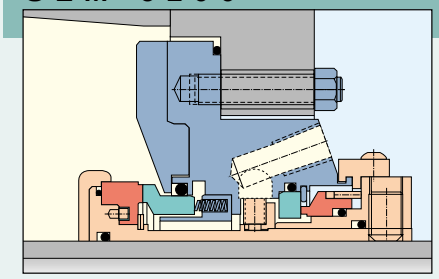
Single, balanced, multi-spring, pusher, cartridge seal specifically designed to operate without a flush in common slurry services. The seal incorporates a centroid loaded monoblock rotor to compensate for various temperatures and pressures, a flexible stator to address shaft deflection and run out, with springs located outside of the product to avoid clogging for services up to 40% solids. Quench Containment Device (QCD) feature allows the addition of low-pressure water or synthetic lubricant to atmospheric side of seal to enhance operation.

Standard Operating Limits

Pressure:	0 / 0	250 psi / 17.2 bar	1000 / 69
Temperature:	-40 / -40	275°F / 135°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.250" to 9.250" / 32 mm to 235 mm	12.000 / 305

SLM 6000 As above without QCD
SLM 6000 SLD As above with QCD and addition of Synthetic Lubrication Device.

SLM-6100

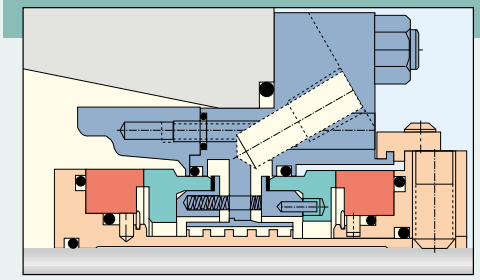


As the SLM 6000 but in a tandem arrangement having a carbon vs. silicon carbide secondary seal. Secondary seal fitted with circulating device allows operation of low pressure closed loop barrier system.

Standard Operating Limits

Pressure:	0 / 0	250 psi / 17.2 bar	1000 / 69
Temperature:	-40 / -40	275°F / 135°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.250" to 9.250" / 32 mm to 235 mm	12.000 / 305

SLM-6200



Double, balanced, multi-spring pusher, cartridge seal, specifically designed to operate in slurries where corrosive, toxic or volatile liquids are being handled and a single seal is not acceptable. Flexible stators address shaft deflection and run out with pressurized barrier fluid preventing process fluid from reaching atmosphere. No external or process bypass flush is required when installed into an open taper bore stuffing box. Optional Erosion Protection Device (EPD) shown can prevent abrasive wear to expensive pump and seal components.

Standard Operating Limits

Pressure:	0 / 0	300 psi / 20.7 bar	1000 / 69
Temperature:	-40 / -40	300°F / 149°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	1.250" to 9.250" / 32 mm to 235 mm	12.000 / 305

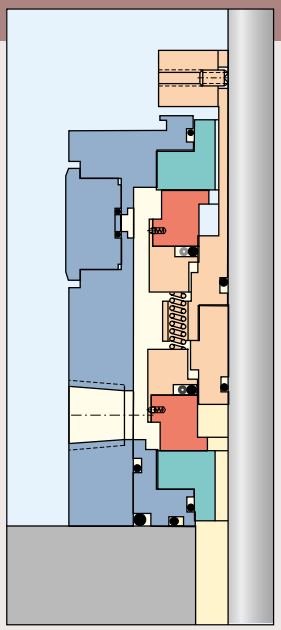
APGS (Advanced Pattern Groove System)

In chemical, pharmaceutical, food and oil refinery process plants diverse systems are employed for agitating, blending and mixing products. The units require low maintenance operation and safety, both to protect the environment and the workplace. The mechanical seal design must provide excellent performance in the application, allowing for axial and radial shaft movements.

Flowserve FSD is focused specifically to provide the best mixer sealing solutions:

- Liquid lubricated, dry contacting or non-contacting face technology
- Modular designs allowing easy part replacement
- Cartridge designs with and without a bearing
- Top and side mounted
- Accommodation for sanitary gland/debris catcher for applications requiring steam cleaning
- Reverse pressure capability and emergency sealing solutions
- Cooling flange option
- Designs engineered to fit major OEM's products
- Designs engineered according to DIN
- Ability to handle significant radial and axial run-outs
- Materials selected for corrosion resistance and long seal life
- Split mixer seal designs to allow easy installation
- Sterilizable designs available
- Auxiliary systems to enhance reliability
- Knowledgeable and experienced mixer seal team support
- Ability to design to customer specification

ML-200



Flowserve FSD M-series are specifically engineered for mixer applications and can be configured to operate wet, dry or with the latest non-contacting gas barrier technology by changing out the faces. The type ML-200 uses the non-contacting technology to provide zero emissions performance.

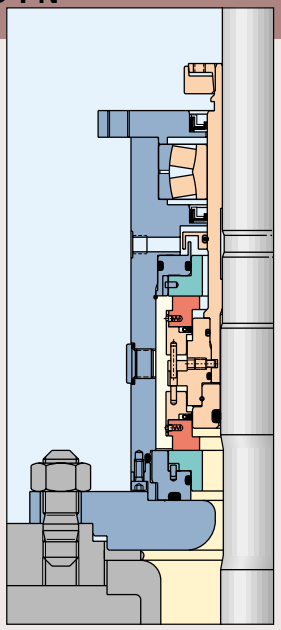
MW-200 As above, but liquid lubricated, option for internal cooling coil, Pressure: To 500 psi / 35.4 bar, Temperature: To 500°F / 260°C, Speed: To 250 rpm

MD-200 As above, but contacting gas barrier, self-lubricating faces providing an alternative to liquid seals and packing, Pressure: To 125 psi / 8.5 bar (speed dependant), Speed: To 250 rpm.

Standard Operating Limits (ML)

Pressure:	0 / 0	150 psi / 10.4 bar	1000 / 69
Temperature:	-40 / -40	300°F / 150°C	800 / 427
Speed:	0	500 rpm	1000
Sizes:	0 / 0	1.500" to 6.500" / 38 mm to 165 mm	12.000 / 305

ML-200 DIN



The modular ML DIN series is based on the DIN standard, and uses the M-series basic seals to be configured to operate wet, dry or with the latest non-contacting gas barrier technology by changing out the faces. The ML-200 DIN EB uses the non-contacting gas barrier faces, incorporates a bearing (B) and is designed for glass-lined vessels (E). The ML-200 DIN SB is designed for steel vessels (S), and incorporates a bearing (B), where the ML-200 DIN S is without bearing.

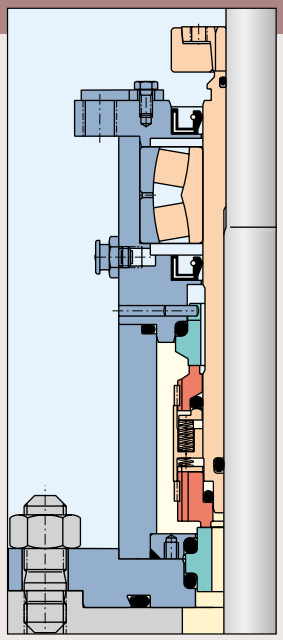
MW-200 DIN As above, liquid lubricated, Pressure: To 230 psi / 16 bar, Temperature: To 500°F / 260°C.

MD-200 DIN As above, contacting gas barrier, self-lubricating faces providing an alternative to liquid seals and packing, Pressure in vessel: To 90 psi / 6 bar (speed dependant), Speed: To 250 rpm.

Standard Operating Limits (ML DIN)

Pressure:	0 / 0	150 psi/ 10.4 bar	1000 / 69
Temperature:	-40 / -40	300°F / 150°C	800 / 427
Speed:	0	500 rpm	1000
Sizes:	0	40 to 220 mm	305

2564



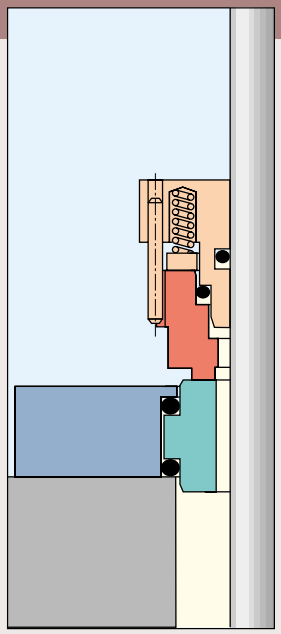
The modular 2560 series is based on the DIN standard, and uses the standard liquid seal components. The 2564 contains a double liquid seal, incorporates a bearing and is designed for steel vessels.

2561-2566 As above, single/double executions, with/without bearing and easy to clean design (double seal). Single and cleanable seals have reduced pressure, speed and temperature limits.

Standard Operating Limits

Pressure:	0 / 0	**230 psi / 16 bar**	1000 / 69
Temperature:	-40 / -40	**392°F / 200°C**	800 / 427
Speed:	0 / 0	**782 fpm / 4 m/s**	10000 / 51
Sizes:	0	**40 to 220 mm**	305

VRA



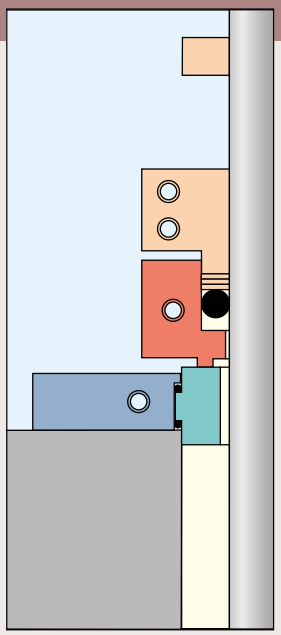
Single, outside, dry-running pusher seal designed specifically for use in top-entry agitator/mixer services. This seal's heavy-duty construction accommodates a combined out-of-concentricity and eccentricity of 0.150" TIR (3.8 mm). The contacting dry-running design eliminates need for buffer fluid system. Milled slots and mating pins in the drive collar evenly distribute torque to the faces to eliminate stress areas.

VRA-C As above, no wetted metal parts, with a sanitary gland for steam cleaning.

Standard Operating Limits

Pressure:	0 / 0	**200 psi / 13.8 bar**	1000 / 69
Temperature:	-40 / -40	**250°F / 121°C**	800 / 427
Speed:	0 / 0	**300 fpm / 1.5 m/s**	10000 / 51
Sizes:	0 / 0	**1.000" to 7.000" / 25 mm to 178 mm**	12.000 / 305

MSS

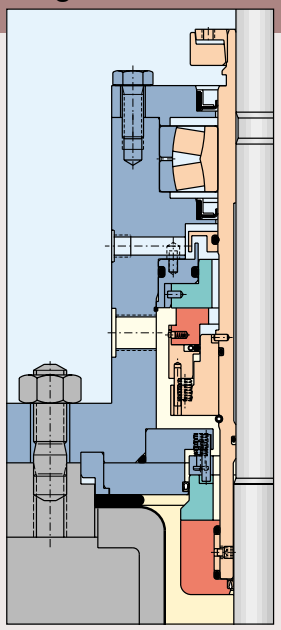


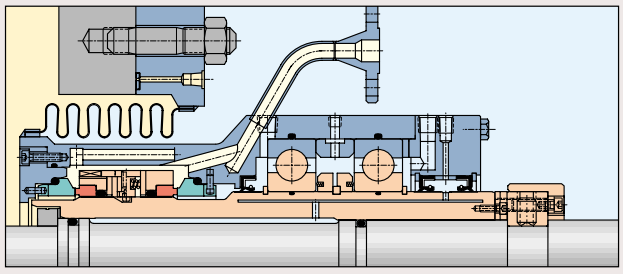
Split, single outside seal designed for use on large, heavy or inaccessible equipment where seal changeout is costly or prohibitive. Split design facilitates installation without dismantling the equipment. Self-lubricating faces dissipate heat and can be run dry. Also, withstands pressure reversals common to agitator services. Very easy to install & maintain. Runouts to 0.150" TIR (3.8 mm). Non-metallic wetted parts.

Standard Operating Limits

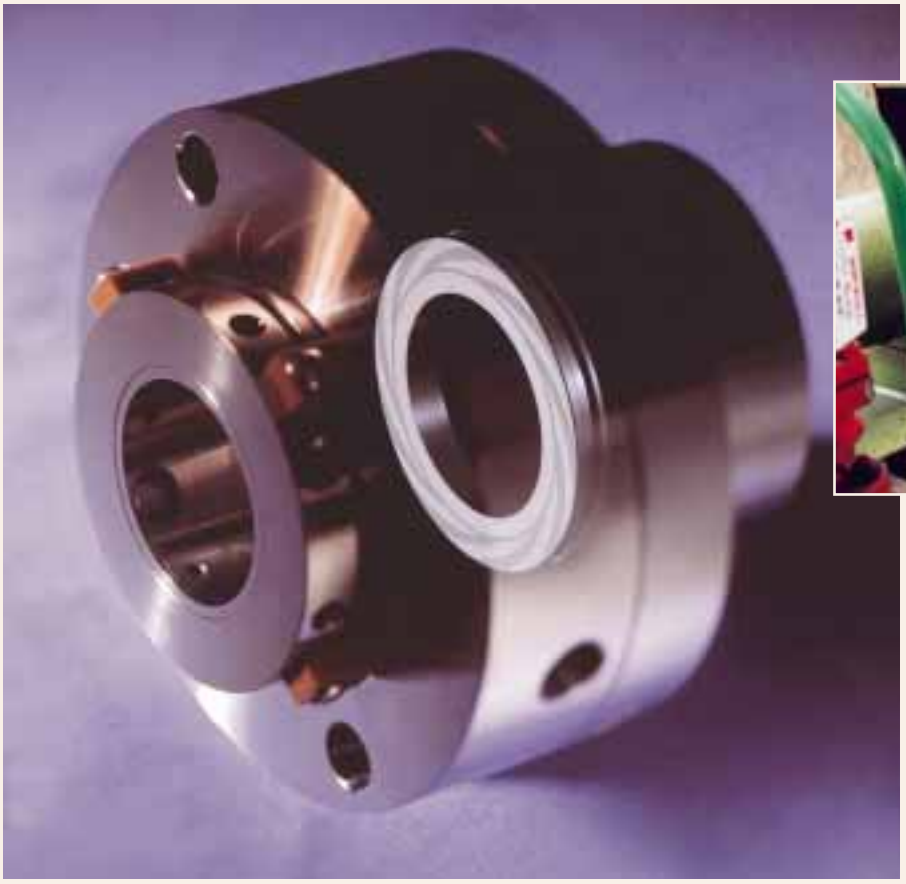
Pressure:	0 / 0	wet 100 psi / 6.9 bar - dry 75 psi / 5.2 bar	1000 / 69
Temperature:	-40 / -40	250°F / 121°C	800 / 427
Speed:	0 / 0	2200 fpm / 11 m/s	10000 / 51
Sizes:	0 / 0	1.000" to 12.000" / 25 mm to 305 mm	12.000 / 305

Custom Engineered

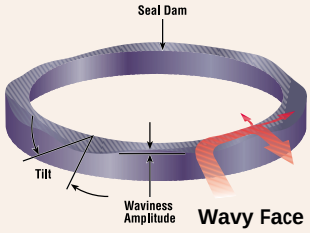




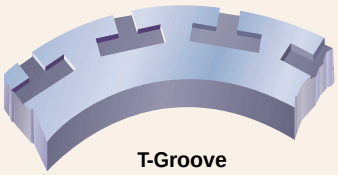
In many cases the equipment to be sealed is custom engineered, which requires special sealing solutions. Flowserve FSD has a dedicated team of mixer seal engineers who are able to design a mixer seal to handle special requirements, such as large axial and radial movements, large sizes, high pressures, high temperatures. Use of existing basic seal parts is made as much as possible, but if necessary new designs can be made.



APGS (Advanced Pattern Groove System)



Wavy Face



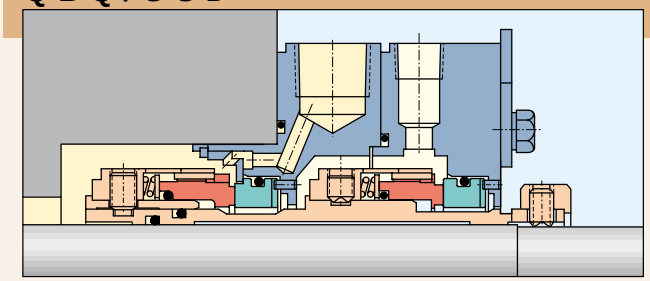
T-Groove

Gas seal technology and gas seal operation depends on aerostatic and aerodynamic forces. Careful design keeps the two faces separated by a gas film of 40-80 µin (1-2 µm). Aerodynamic forces are created by the presence of a 'pattern' on one of the faces. Flowserve uses:

- APGS technology for compressor, pump and mixer seals, unidirectional
- wavy face technology for pump back-up, steam turbine and special OEM seals, bi-directional
- T-Groove for compressors, bi-directional

Each pattern has its specific advantages and is carefully matched to the seal and its application. The force equilibrium is more delicate than with a liquid seal. It is essential to control face pressure deformation, as well as reducing dynamic gasket axial friction.

Q B Q / G S D



Dry running contacting, balanced, multi spring back-up seal for reliable, long life containment performance in hydrocarbon services. Offers longer life than conventional dry running plain face continuous contact technology. No barrier fluid required, simplifies operation in tandem configurations. Shares many parts with the QB seal.

REF. & PETROCHEM

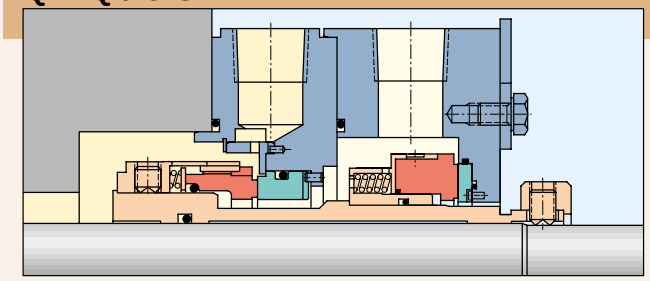
Dry contacting

LHC

Standard Operating Limits

	dry to normal flare pressure - wet 300 psi / 20.7 bar	
Pressure:	0 / 0	1000 / 69
	400°F / 204°C	
Temperature:	-40 / -40	800 / 427
	4500 fpm / 23 m/s	
Speed:	0 / 0	10000 / 51
	1.000" to 3.500" / 25 mm to 89 mm	
Sizes:	0 / 0	12.000 / 305

QBQ/GSL

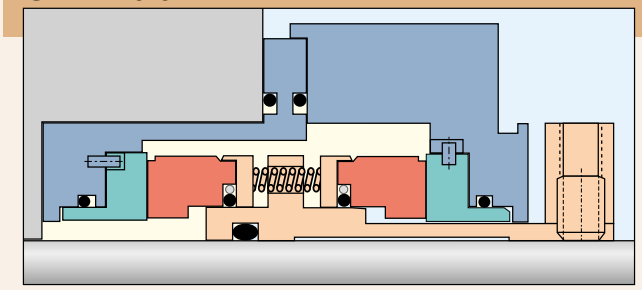


Non-contacting bi-directional, balanced, multi spring seal provides full back-up containment with no wear for light hydrocarbons, crude oil and other applications. Features patented Wavy Face seal technology as part of the stationary face which provides lift-off in gaseous environments and extremely low torque under liquid conditions.

Standard Operating Limits

Pressure:	0 / 0	600 psi / 41.4 bar	1000 / 69
Temperature:	-40 / -40	400°F / 204°C	800 / 427
Speed:	0 / 0	300 to 6000 fpm / 1.5 to 30.5 m/s	10000 / 51
Sizes:	0 / 0	1.000" to 6.000" / 25 mm to 152 mm	12.000 / 305

GF-200

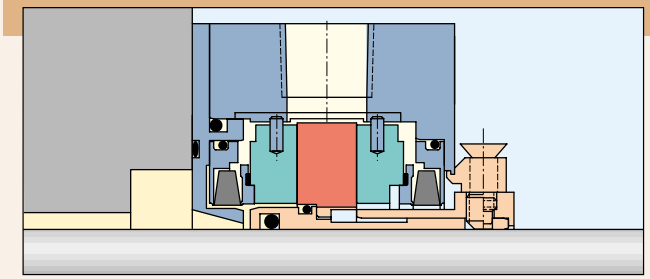


Double, non-contacting design used in applications where no emissions of hazardous pumped product can be tolerated. Seal uses inert gas barrier, such as nitrogen for lift-off, which eliminates contamination of pumped product by a buffer fluid. Provides total containment, even if outer seal fails. Uses Advanced Pattern Groove System faces, which insures low speed lift-off, low gas leakage and no face contact. Standard designs for ANSI enlarged bore pumps.

Standard Operating Limits

Pressure:	0 / 0	500 psi / 34.5 bar	1000 / 69
Temperature:	-40 / -40	500°F / 260°C	800 / 427
Speed:	0 / 0	250 to 5000 fpm / 1.3 to 25 m/s	10000 / 51
Sizes:	0 / 0	1.000" to 6.000" / 25 mm to 152 mm	12.000 / 305

GX-200



Double, non-contacting externally mounted bellows seal, cartridge for standard bore ANSI and DIN pumps. Designed to upgrade any standard bore ANSI or DIN pump to reliable gas barrier performance. Provides total containment, even if outer seal fails. Uses Advanced Pattern Groove System faces, which insures low speed lift-off, low gas leakage and no face contact.

Standard Operating Limits

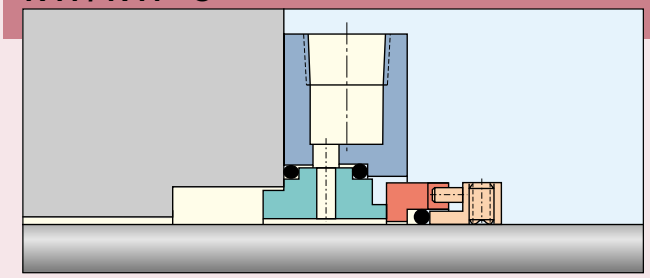
Pressure:	0 / 0	200 psi / 13.8 bar	1000 / 69
Temperature:	-40 / -40	500°F / 260°C	800 / 427
Speed:	0 / 0	500 to 7000 fpm / 2.5 to 35 m/s	10000 / 51
Sizes:	0 / 0	1.000" to 3.000" / 25 mm to 75 mm	12.000 / 305

Outside mounted seals

Outside mounted seals are used in strongly corrosive applications. This arrangement allows seal designs that have no metal parts in contact with the process liquid. Both pusher designs and PTFE bellows designs exist.

The PTFE bellows seals can not handle high pressures, temperatures and speeds.

R A / R A - C



Single, outside mounted, pusher seal used in applications where pressures above 15 psi / 1 bar eliminate the usage of the RO seal. The RA version features a two piece rotary collar and seal ring unit.

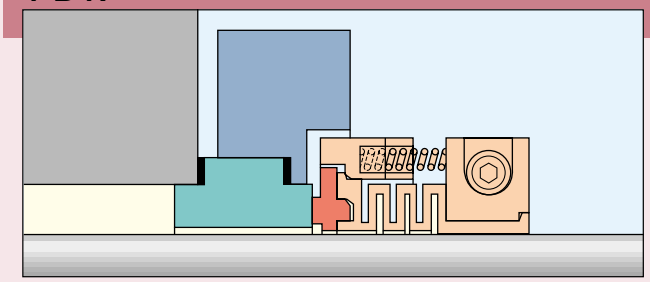
RA-C As above, designed for use with chemical products in plastic, glass and other non-metallic pumps.

CHEMICAL

Standard Operating Limits

Pressure:	0 / 0	400 psi / 27.6 bar	1000 / 69
Temperature:	-40 / -40	350°F / 177°C	800 / 427
Speed:	0 / 0	4500 fpm / 23 m/s	10000 / 51
Sizes:	0 / 0	0.500" to 5.000" / 13 mm to 127 mm	12.000 / 305

T B R



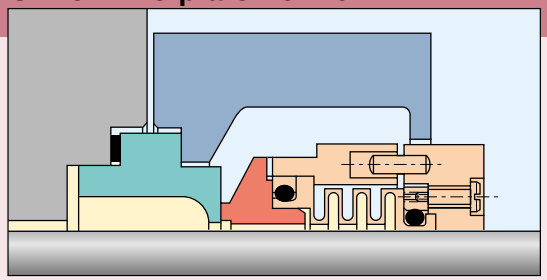
PTFE bellows seal, which provides nearly universal chemical resistance for a wide range of services, especially in highly corrosive applications. Eliminates dynamic gasket problems including shaft fretting and hang-up. Drive lugs are engineered to minimize face distortion. Easy to install and maintain.

CHEMICAL

Standard Operating Limits

Pressure:	0 / 0	75 psi / 5 bar	1000 / 69
Temperature:	-40 / -40	160°F / 71°C	800 / 427
Speed:	0 / 0	3600 fpm / 18.4 m/s	10000 / 51
Sizes:	0 / 0	1.000" to 3.000" / 25 mm to 76 mm	12.000 / 305

C h e m i e p a c 9 7 0



Features non-metallic construction and single PTFE, bellows design to meet highly corrosive applications where an externally mounted seal is desired. Multiple face combinations allow selection of application specific material. Cartridge design with setting clips simplify seal setting.

CHEMICAL

Standard Operating Limits

Pressure:	0 / 0	196 psi / 13.5 bar	1000 / 69
Temperature:	-40 / -40	260°F / 125°C	800 / 427
Speed:	0 / 0	1560 fpm / 8 m/s	10000 / 51
Sizes:	0	18 mm to 100 mm	305

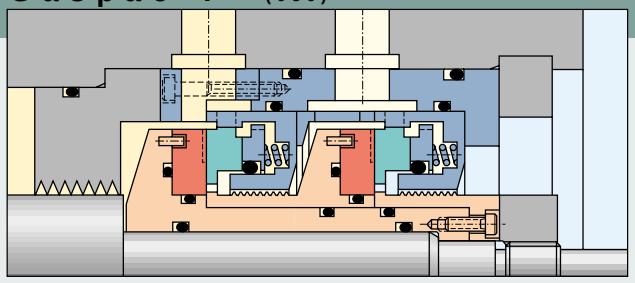
Centrifugal compressors and other turbomachinery are critical to the operation of a process plant. Selecting a manufacturer with well proven state-of-the-art low friction dry gas seals who can offer full field maintenance support is very important. The Gaspac® seal is a proven design using either patented bi-directional SMT groove technology or the Advanced Pattern Groove System. Flowserve FSD Gaspac® seals have millions of hours with more than 4000 units furnished around the world.

Gaspac® design features:

- Bi-directional patented SMT-grooves or uni-directional APGS
- Very high pressure capability (tested to 6300 psi / 435 bar)
- Very high speed capability (300 m/s)
- Lightweight rotating face for less rotor dynamic influence
- Low leakage rates
- Multiple material combinations available
- Standardized components and established proven design

- Every seal is performance tested before delivery for optimum quality
- Narrow face design option for screw compressors

Gaspac T (986)



Tandem cartridge, compressor seal used on many applications. The primary seal handles the full product pressure. The secondary seal is a back-up seal that normally runs at low pressure but can handle the full pressure in the event of a primary seal failure.

Standard Operating Limits

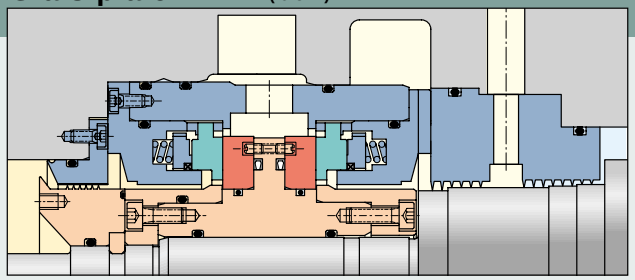
Pressure:	0 / 0	3300 psi / 230 bar	3300 / 230
Temperature:	-148 / -100	-148°F to 446°F / -100°C to 230°C	800 / 427
Speed:	0	180 to 39000 fpm / 1 to 200 m/s	39000 / 200
Sizes:	0 / 0	1.500" to 12.000" / 40 mm to 305 mm	12.000 / 305

Gaspac L (984) As above, with a labyrinth seal between inner and outer seal. This allows the introduction of an inert gas which directs product leakage to an appropriate disposal point.

Gaspac S (985) As above, single seal for use on non-toxic non-flammable gases.

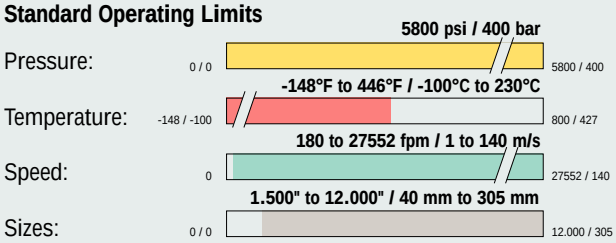
Gaspac SRD As above, single seal with one piece ductile rotor design.

Gaspac D (987)

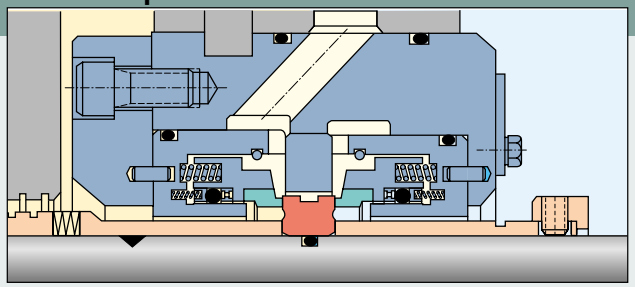


Double, cartridge, compressor seal used on toxic and/or flammable gases, or when the process is contaminated with particles. The seal supply gas is maintained at a pressure higher than the pressure of the gas being sealed, which isolates the process gas from the atmosphere. The Gaspac D is also used for very low pressure applications where a tandem can not be used.

Standard Operating Limits



Turbopac



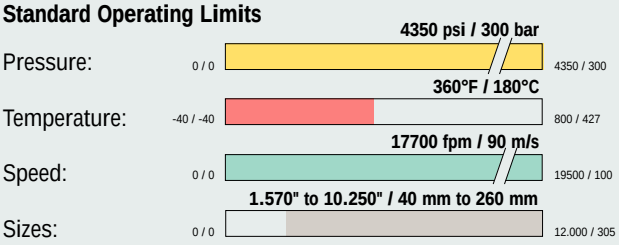
Single or double oil, lubricated seal for turbomachinery, suited for very high pressures and speeds. Uses special materials to allow very high pressures and speeds. Finite element analyzed for low face deformation to achieve a wide operating window with highest reliability and low leakage.

Turbopac 368 Compact design for screw compressors in single and double configurations
Pressure: To 360 psi / 25 bar,
Speed: To 11,868 fpm / 60 m/s.
Standard sizes to 7.00" / 180 mm

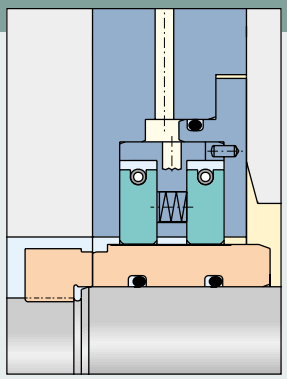
Turbopac 375 Standard centrifugal compressor design, single and double (as shown above)
Pressure: To 360 psi / 25 bar,
Speed: To 17,800 fpm / 90 m/s.
Standard sizes to 10.25" / 260 mm

Turbopac 2100 High pressure double seal
Pressure: To 4300 psi / 300 bar,
Speed: To 17,800 fpm / 90 m/s.
Standard sizes 6.30" / 160 mm

Standard Operating Limits



Circpac CB (977)

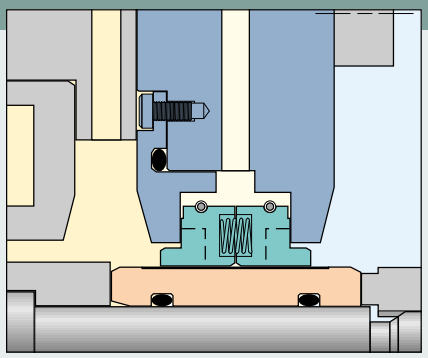


Dual spring loaded segmented floating ring bushing for use with Gaspac® seals. With a flow of clean nitrogen prohibits contamination of the gas seal by bearing oil mist. Can also be used on the product side to keep abrasives or liquid away from the gas seal faces. Has limited back-up sealing capability. Can also be applied on blowers or similar equipment.

Standard Operating Limits

Pressure:	0 / 0	70 psi / 4.9 bar	1000 / 69
Temperature:	-40 / -40	180°F / 80°C	800 / 427
Speed:	0 / 0	39000 fpm / 200 m/s	39000 / 200
Sizes:	0 / 0	2.000" to 12.000" / 50 mm to 305 mm	12.000 / 305

Circpac LO

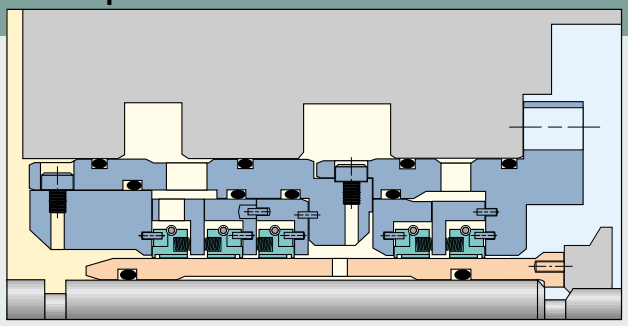


Bi-directional springloaded multi segmented carbon rings for use with Gaspac® seals. The Circpac LO creates a balanced, stable gas film to provide consistent low consumption over the complete operating cycle and tolerance to upset conditions. A nitrogen or air purge prohibits contamination of the gas seal by bearing oil mist. Can also be used on the product side to keep abrasives or liquid away from the gas seal faces. Has limited back-up seal capability

Standard Operating Limits

Pressure:	0 / 0	14.5 psi / 1 bar	1000 / 69
Temperature:	-40 / -40	284°F / 140°C	800 / 427
Speed:	0 / 0	27600 fpm / 140 m/s	39000 / 200
Sizes:	0 / 0	3.125" to 11.000" / 80 mm to 280 mm	12.000 / 305

Circpac HP

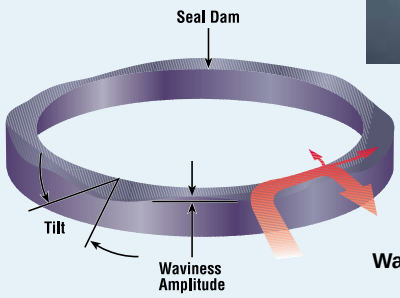


An engineered segmented circumferential gas seal for gas compressors with higher pressure capability than typical circumferential seals. Pressure balanced ring designs and hydrodynamic surface features provide low gas consumption and long life in a variety of ring configurations.

Standard Operating Limits

Pressure:	0 / 0	150 psi / 10 bar	1000 / 69
Temperature:	-40 / -40	350°F / 177°C	800 / 427
Speed:	0 / 0	18000 fpm / 91 m/s	18525 / 95
Sizes:	0 / 0	1.000" to 11.000" / 25 mm to 280 mm	12.000 / 305

Steam clouds with conventional carbon bushing



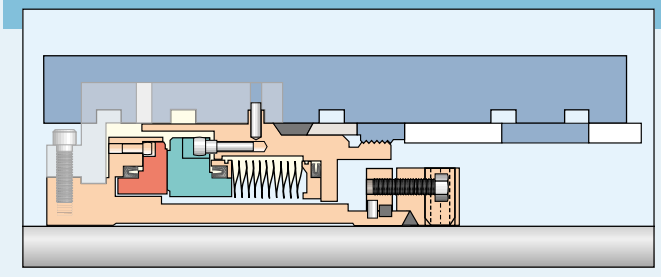
Wavy Face

Many plants have small steam turbines to drive (standby) pumps or other equipment. The most current sealing arrangement used is based on floating carbon bushings. Though the investment cost of this arrangement is low, the cost of steam energy losses are significant. Not only is operational cost high, but bushing ring life is short and bearing oil is contaminated by water, resulting in high maintenance cost. Even safety is an issue, when the turbine is in operation often large clouds of steam obstruct vision in the turbine area.

New gas lubricated wavy face technology is applied by Flowserve FSD to provide the GTS mechanical seal that is especially designed for steam turbine applications, providing the real benefits of a mechanical seal:

- Significant energy savings
- Virtually no bearing oil contamination resulting in enhanced MTBF of the turbine
- Elimination of hazardous ‘steam clouds’ which improves plant safety

GTS integral



Single, wavy face, steam seal for steam turbines, able to handle hot condensate. Available as integral design or as detachable design for various different turbines.

The GTS seal uses patented thin film wavy face technology for non-contacting operation on steam as well as on water or water-steam mixtures. The wavy face smooth surface is non-clogging and able to recover from upset conditions. To reduce installation errors and improve interchangeability the wavy face is bi-directional.

The FEA analyzed design of the sleeve reduces distortion which helps maintain face integrity. The GTS uses an Alloy 718 bellows along with a lapped joint, which eliminates dynamic gasket problems traditionally experienced in lightly loaded pusher seal designs.

Standard Operating Limits

Pressure:	0 / 0	300 psi / 20.7 bar	1000 / 69
Temperature:	-40 / -40	600°F / 315°C	800 / 427
Speed:	0	9000 fpm / 46 m/s	10000 / 51
Sizes:	0 / 0	2.125" to 4.125" / 54 mm to 105 mm	12.000 / 305

Original Equipment Manufacturers (OEM's) are very important for Flowserve FSD. Therefore Flowserve is committed to develop and supply designs for special equipment and for special duty requirements.

Flowserve FSD has developed special mechanical seals to handle the high speed and high pressure conditions for integrally geared API pumps and compressors with excellent performance and reliability.

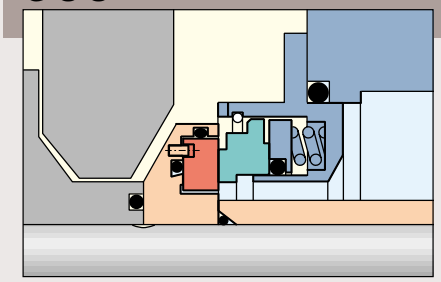
Flowserve also offers the GSG gearbox seal with a proven track record for increasing reliability on this type of equipment.

For additional high pressure, high speed applications, the UHTW and the DHTW are used. These seal designs are typically fine-tuned for optimum performance.

The LS-300 is another OEM design suited for low speed high viscosity positive displacement pumps. The PSS II is used when assembly on the equipment is difficult and a split seal offers significant benefits.

In addition, the PacSeal range of single spring seals is available in a wide range of designs in accordance with common industry standards or according to OEM standards. Complete new custom designs can be made available.

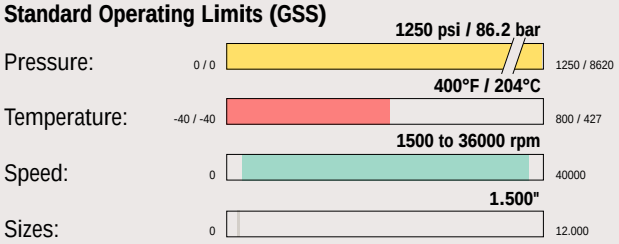
G S S



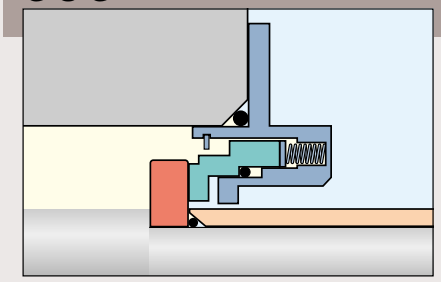
Gas lubricated wavy face non-contacting pusher seal with contained silicon carbide face. Finite element analyzed for lowest face deformation to achieve a wide operating window with highest reliability and low leakage. Also available with springloaded PTFE dynamic gaskets.

GLS As above, for liquid operation.

Standard Operating Limits (GSS)



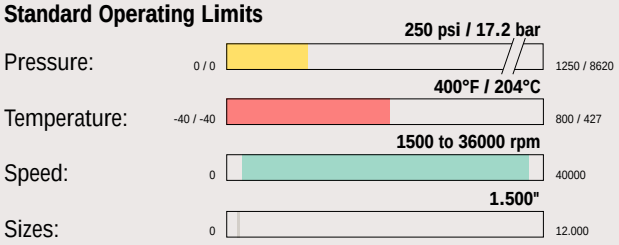
G S G



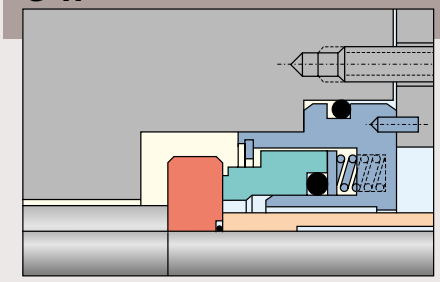
Liquid lubricated, non-contacting pusher seal with the innovative HST (Hydrodynamic Surface Tension) technology* utilizing non-contacting Wavy Face and surface tension effects to create a near-zero leakage seal. No equipment modifications required to replace any other design.

*Patent Pending

Standard Operating Limits



G W



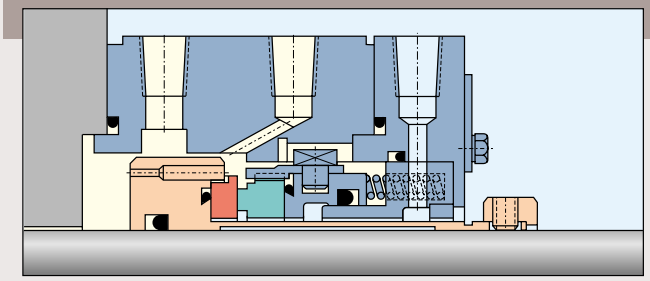
Single, pusher seal for integrally geared pumps.

BAW As above, single, bellows seal,
Pressure: To 400 psi / 27.6 bar,
Speed: To 9000 fpm / 46 m/s,
Standard sizes: 1.250”, 1.500”.

Standard Operating Limits

Pressure:	0 / 0	675 psi / 46.5 bar — 1000 / 69
Temperature:	-40 / -40	500°F / 260°C — 800 / 427
Speed:	0 / 0	15000 fpm / 76 m/s — 15000 / 76
Sizes:	0	1.250", 1.500" — 12.000

D H T W



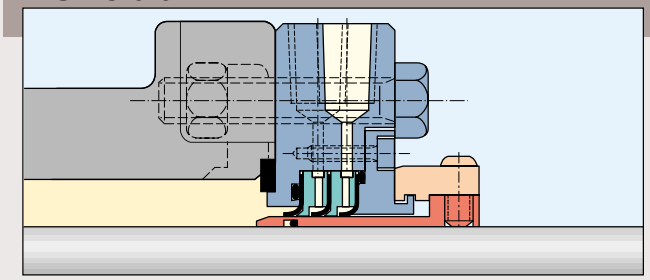
Balanced, stationary, multi-spring seal, designed for power industry or other high pressure / high speed applications. Using an API plan 23 system, this seal is used in hot water applications. This seal is always carefully analyzed and tuned for balance and low face deformation for critical applications.

UHTW As DHTW, without pumping device.

Standard Operating Limits

Pressure:	0 / 0	2500 psi / 172 bar — 2500 / 17200
Temperature:	-40 / -40	400°F / 204°C — 800 / 427
Speed:	0 / 0	15000 fpm / 75 m/s — 15000 / 75
Sizes:	0 / 0	1.625" to 12.000" / 41 mm to 305 mm — 12.000 / 305

L S - 3 0 0



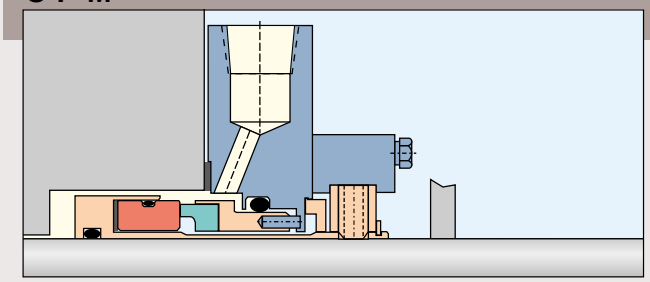
A cartridge multiple dynamic lip seal design for highly viscous applications in positive displacement style pumps. Designed to run dry without the need for an external flush or lubricating barrier fluid which can contaminate or dilute the process media. Preset cartridge design speeds installation, eliminating chance for installation error. Easily field repairable with optional repair kit. Designed for the likes of Viking H, HL, K, LL, LS, M, N, Q standard and Universal bracket pumps, Tuthill 120A and more.

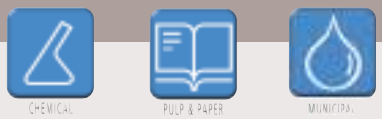
Standard Operating Limits

Pressure:	0 / 0	150 psi/ 10.3 bar — 1000 / 69
Temperature:	-65 / -53	-65°F to 300°F / -53°C to 149°C — 800 / 427
Speed:	0	700 fpm / 3.5 m/s — 10000 / 51
Sizes:	0 / 0	0.750" to 3.000" / 19 mm to 76 mm — 12.000 / 305

Viscosity Range: 400 to 60,000 SSU / 80 cP – 12000 cP
(for higher viscosities contact factory).

CPM





This is a cartridge seal of optimum pusher design in both single and dual configurations. It is specifically designed to meet the application demands of the Corn Wet Milling Industry's difficult operating conditions. The seal has optional face combinations of Graphitized Sintered Silicon Carbide to Direct Sintered Silicon Carbide that allows for hard on hard face limited time operation in marginal lubrication operating conditions. Design features such as tangential porting, cutwaters and volute designs enhance barrier flow conditions as well as the ease of barrier port accessability for dual seals. An optional steam bushing is available for purging the atmospheric side of the seal when required. This seal has been derived from historical design features that have been successful in Pulp and Paper as well as municipal water applications for many years.

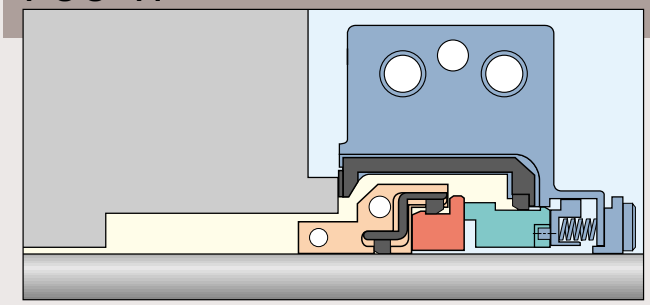
Standard Operating Limits

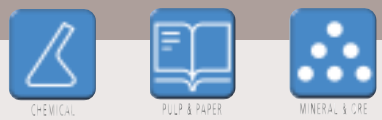
Pressure:	0 / 0	400 psi / 27 bar — 1000 / 69
Temperature:	-40 / -40	400°F / 204°C — 800 / 427
Speed:	0 / 0	6000 fpm / 30 m/s — 10000 / 51
Sizes:	0 / 0	1.375" to 4.750" / 35 mm to 120.6 mm — 12.000 / 305

Single CPM Shown above. Flush tap is standard.

Dual CPM Dual seal is double balanced to allow pressurized or non-pressurized operation for increased reliability.

PSS II



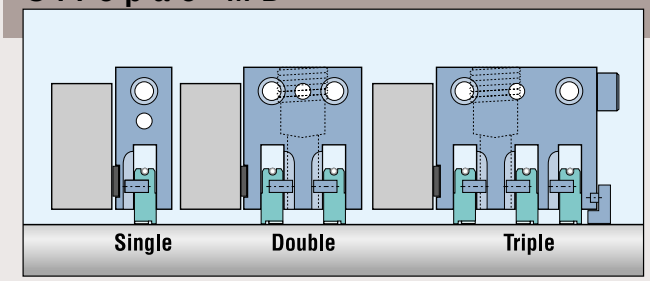


Split, single, inside seal for pumps. Pre-assembled, unitized construction makes installation and repair easy. Excellent for many non-hazardous services in chemical processing, pulp & paper, power generation and waste water treatment. Standard high runout design also appropriate for mixers, agitators, and other equipment where teardown is a problem.

Standard Operating Limits

Pressure:	0 / 0	150 psi / 10.3 bar — 1000 / 69
Temperature:	-40 / -40	250°F / 121°C — 800 / 427
Speed:	0 / 0	3200 fpm / 16 m/s — 10000 / 51
Sizes:	0 / 0	1.500" to 6.000" — 12.000 / 305

Circpac MD

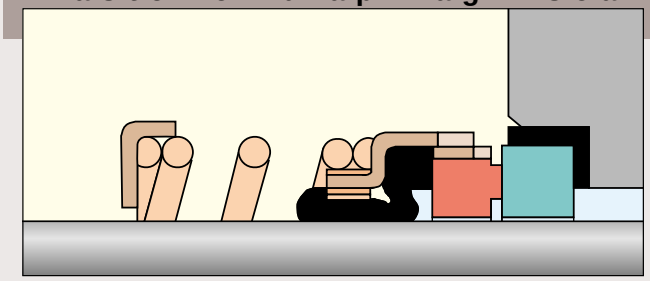


A segmented circumferential seal designed for fans, blowers, dryers, turbines, centrifuges and other rotating equipment comes packaged in a convenient split housing for easy installation. Standard designs consistently outperform packing, bushings, labyrinths, and felt seals with lower gas consumption over a wider range of operating conditions.

Standard Operating Limits

Pressure:	0 / 0	100 psi/ 6.9 bar — 1000 / 69
Temperature:	-40 / -40	1100°F / 593°C — 1500 / 812
Speed:	0	9000 fpm / 45.7 m/s — 10000 / 51
Sizes:	0 / 0	1.375" to 18.000" / 35 mm to 457 mm — 20.000 / 508

Elastomer diaphragm seals



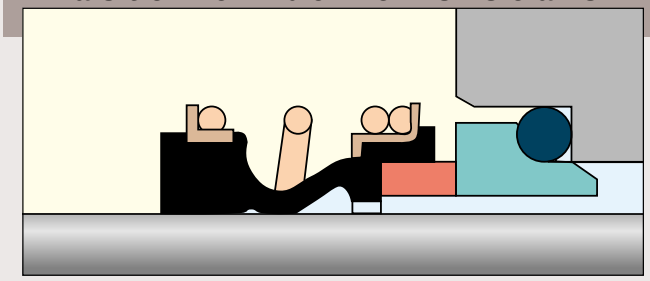
Typical Operating Limits

Pressure:	0 / 0	200 psi / 13.8 bar	1000 / 69
Temperature:	-40 / -40	392°F / 200°C	800 / 427
Speed:	0 / 0	3000 fpm / 15 m/s	10000 / 51

Pac-Seal is a separate brand within Flowserve FSD, specifically focused on design and high volume manufacturing of elastomer bellows seals, also to OEM standards. The Pac-Seal product range is described in detail in the separate Pac-Seal product catalog.

The elastomer diaphragm type will grip the shaft giving a strong static seal and positive drive via the drive ring to the seal face. As there is no relative movement between the shaft and the elastomer diaphragm, shaft fretting, wear and hang-up hysteresis are eliminated and the seal can immediately accommodate some shaft run-out and misalignment. Shaft axial movement and the movement required during the working life of the seal is handled by the elastomer flexing at its junction point.

Elastomer bellows seals

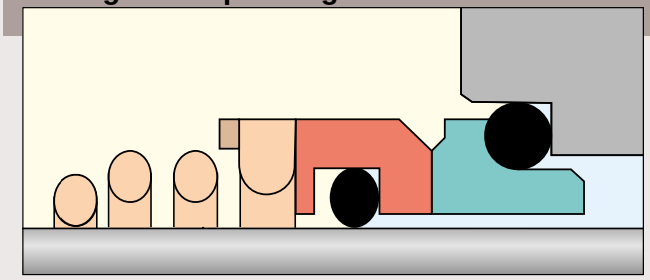


Typical Operating Limits

Pressure:	0 / 0	200 psi / 13.8 bar	1000 / 69
Temperature:	-40 / -40	392°F / 200°C	800 / 427
Speed:	0 / 0	2350 fpm / 12 m/s	10000 / 51

Flowserve elastomeric bellows seals are of compact design with a sealing action that provides many benefits. The bellow's high strength and flexibility is the key to the very reliable performance of this type of seal as it readily accommodates misalignment, end-float and seal face wear. The convoluted bellows profile makes these seals ideal for media prone to clogging or for hygienic applications. Designed for confined spaces and limited gland depths, Flowserve elastomer bellows seals are bi-directional in operation and provide secure bellows sealing for longer life in a wide range of applications.

Single spring seals



Typical Operating Limits

Pressure:	0 / 0	140 psi / 10 bar	1000 / 69
Temperature:	-40 / -40	392°F / 200°C	800 / 427
Speed:	0 / 0	3920 fpm / 20 m/s	10000 / 51

These conical spring, '0' Ring mounted, mechanical seals have been designed by Flowserve to have a small cross-section and a complete recessed '0' ring housing. A narrow seal head width allows the seals to easily fit confined DIN EN 12 756 housings, while also providing the benefits of reduced face surface running speed with increased circulation around the seal faces.

For optimum performance of mechanical seals, control over the sealing environment is very important. If the seal is kept clean and well lubricated by the product or barrier it will deliver years of reliable service. Auxiliaries are used to help create that favorable environment.

Seal cooling is required to remove seal face heat generation and avoid product vaporization between the seal faces.

On pressurized and un-pressurized dual seals, a barrier at the correct pressure, flow and level is essential for proper functioning of the seals. This requires reservoirs, closed loops, piston transmitters and pressurizers. A similar task for the gas lubricated seals is performed by the gas seal supply panels.

A clean mechanical seal environment reduces face wear and the potential for high dynamic gasket axial friction (hang-up). Cyclone separators and magnetic separators help remove unwanted particles from the product in the seal cavity.

Flowserve FSD has years of experience in designing and selecting the correct auxiliaries for every sealing solution. And if a customer has a special need for seal support systems designed to specification, Flowserve FSD has a team of specialized engineers to assist you in making the best and most cost-effective choice.

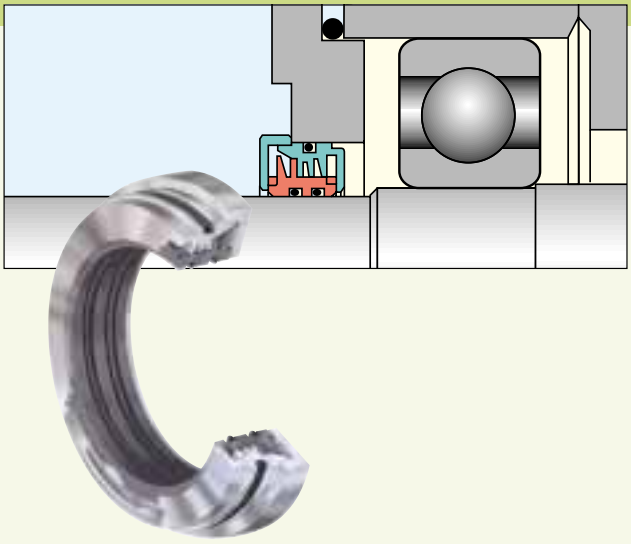
Kalrez® is a very high quality perfluoroelastomer compound used in secondary seals. It is sold by Flowserve FSD, and used for the most demanding applications with regard to elastomer chemical compatibility and temperature range.

Duraclear is a synthetic lubricant, with optimum properties to be used as a seal barrier liquid. It increases seal face life, eliminates blistering, aids in cooling, reduces energy consumption compared to thicker oils and reduces pollution.

Flowserve FSD also offers an array of compression packing materials, including metal foil packing, carbon, TFE and Kevlar® fibers, plus a variety of valve packings, gasketing materials, hooks and tools.

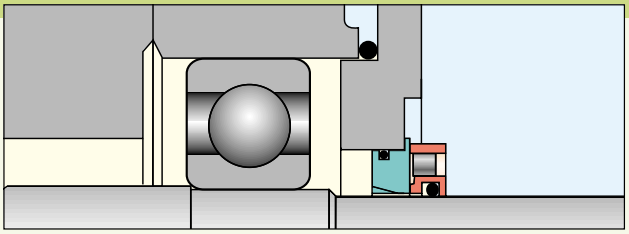
Kalrez and Kevlar are registered trademarks of Dupont.

Bearing Gard II



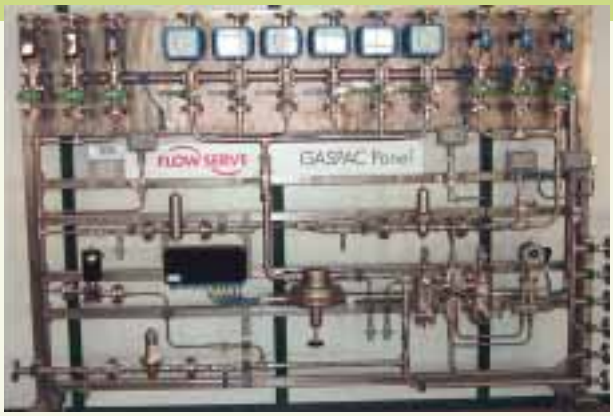
Bearing Gard II bearing isolators eliminate bearing failures due to lubricant contamination. Close tolerance labyrinth design locks out moisture, grit and dust. Allows bearing frame pressure vents (a common point of contamination) to be plugged. Lasts for the life of the motor and fits existing lip seal cavities.

Bearing Gard Magnetic (BGM)



A magnetic bearing isolator such as the BGM keeps contaminants from ruining bearings. Utilizes rare earth magnets to seal off the bearing housing completely. Often used in outdoor or other applications where absolutely no humidity, dirt or dust can be tolerated. Patented co-axial face design ensures long life. Easy to install, lasts up to 25 times longer than lip seals.

Compressor Gaspac Panels



The gas supply panel provides pressure regulation and measurement, filtering and flow measurement. A range of Gaspac buffer gas panels can be supplied, of which most are designed to customer specifications. Switches or transmitters can be installed for alarm purposes.

Barrier Gas Panels

Gas lubricated pump and mixer seals employ a gas barrier that requires that the seals be pressurized with a source of clean gas at a pressure higher than the seal chamber pressure. The barrier gas prevents leakage of the pumped product to atmosphere with a small amount of barrier gas leakage into the pumped product and to atmosphere. A simple static barrier gas system from a clean gas (nitrogen) source may be used with only enough flow to make up for the barrier gas consumption. Flowserve offers a number of different designs to suit each market and application.

Buffer Fluid Reservoirs (ANSI general duty)

A range of different plan 52 or plan 53 supply tank systems are available to suit local market and application requirements. Primarily for the US market, the ANSI Lite and CPM designs are used as economical light duty 150 psi ASME code tanks for general service applications. The ANSI Lite is available in carbon steel and 304 stainless with a 3 gallon capacity. The CPM has a 2 gallon capacity and comes in 316 stainless steel.

For the European market a similar ASME code design exists with 10 bar design pressure at 16 liter total volume. Connections are 0.500" or 0.750" NPT. A cooling coil is optional. The instrumentation on each reservoir is according to local standards and can be adapted to suit application and customer requirements. Other design codes are available on request.

Buffer Fluid Reservoirs (API)

API 682 requires a full size 5 gallon (20 liter) reservoir designed to 600 psi / 41.5 bar according to ASME, with an optional cleanable cooling coil. A range of switch options and instrumentation can be selected. The reservoirs are built in 316L stainless and use 0.750" NPT connections.

A variety of other API reservoir designs are available, as standard designs, but also fully in line with customer specifications. Flowserve FSD has a specialized design team to handle any customer specification. Other design codes are available on request.

Buffer Fluid Reservoirs (DIN)

To suit the specific design requirements of the German market a number of plan 52 or plan 53 reservoirs are available that satisfy the TRD design code requirements. Three standard versions are available: a 3 liter 32 bar compact version, a 6 liter 32 bar reservoir and a 10 liter 20 bar reservoir. Connections are G 0.500", and a cooling coil is included. The instrumentation on each reservoir is to German standards and can be adapted to suit application and customer requirements.

Seal Gard

The Seal Gard is an all in one unitized seal water flush regulator, with a control valve, flow tube, metering float, pressure gauge, check valve and pipe connections combined with an optional alarm into a compact package to provide total control of the sealing environment. Being able to reduce the flush water flow represents a significant saving in water cost. A special triangular shaped port is built into the valve to control flow with a plug resistant orifice.

Materials: acrylic/316
Connections: 0.250" NPTF
Flow range: 0-20 gph / 0-1.3 l/m or 0-40 gph / 0-2.6 l/m
Pressure: up to 300 psi / 20.7 bar at 150°F / 65°C, 125 psi / 8.6 bar at 300°F / 149°C

Closed Loop (plan 53B modified)

A closed loop such as a plan 53 modified (pictured) allows stand-alone operation of a double liquid seal, and contains either finned pipe air cooling, a forced draft air cooler or a water cooler to dissipate seal or pump heat. The seal provides the pumping action required for circulation in the loop. The advantage of such system is that each seal can be individually monitored for leakage. A range of standard designs with accumulator sizes from 20 liter up to 50 liter, various coolers and for overhung or between-bearing pumps.

Piston Transmitters

A piston transmitter is a ‘pressure multiplier’ which generates barrier pressure for double liquid seals from product pressure. It is used where the pressure in the pump fluctuates, or the inboard seal pressure differential must be limited. Best used for higher pressures above 50 psi / 3.5 bar. Can be executed with cooling coil, instrumentation, refill pump, standard according TüV but can be made according to ASME, total volume: 0.8 and 1.6 gallon / 3 and 6 liter. Multiplier options include 1:1.1 and 1:1.3.

Seal Coolers (standard)

Light weight high pressure heat exchangers for mechanical seal cooling.

Cooling area: 1.75 to 5.80 sq. ft / 0.16 to 0.54 m^2
Tube sizes: 0.500", 0.625" and 0.750"
Pressure: To 2650 psi / 183 bar at 200°F / 95°C, depending on material, size and temperature, case up to 150 psi / 10.4 bar
Standard sizes: NX-0500-FW (0.500" NPT), NX-0625-FW (0.500" NPT), NX-0750-FW (0.750" NPT)

Seal Coolers (API 682)

High pressure heat exchanger designed in full compliance with API 682. Can vent and drain both product and coolant side. Easy disassembly for cleaning without damaging coils. Standard materials are 300 series coil and casing.

Tube size: 0.750"
Pressure: To 4000 psi / 275 bar at 700°F /370°C, depending on material, size and temperature, case up to 200 psi / 13.8 bar at 200°F / 95°C.

Seal Coolers (air cooled)

Air cooled heat exchangers reduce temperatures surrounding the mechanical seal without using cooling water. This offers substantial savings in flush water purchase and treatment, and they are less susceptible for fouling and require less piping.

Standard: 625 NC - natural convection
625 FC - forced air using an 1/3 hp electric motor
Cooling area: To 26.8 sq ft / 2.5 m^2
Tube sizes: 0.500" NPTF
Pressure: To 2050 psi / 141 bar at 200°F / 95°C, depending on material, size and temperature
Motor: explosion proof Class 1, Gr D, Div 1, 1/3 hp (0.25 kW), 50/60 Hz, 230-460/190-380 V 3 phase

Circulators & pressurizers

Closed loop dual seals are often pressurized by static pressurizer systems, which are typically based on a relatively small barrier reservoir with one or more electric motor driven pumps.

The circulating pressurizer is similar in design, but has a much higher capacity pump that provides both circulation and pressure to a double seal. Such systems are typically used for mixer applications or large amounts of double seals which are close together.

Standard sizes

Capacity: 1 and 4 gpm (3.8 and 15 l/m)
Pressure: 400 psi (27.6 bar)
Reservoir: 25 gallon (95 liters)

Custom designs and instrumentation available.

Magnetic separators

The magnetic separator is designed for mechanical seal injection flow (plan 23) as well as installation in control lines and other locations. Creates a magnetic field that separates and holds iron oxide particles from the process liquid to prevent them from causing abrasion or hang-up.

Capacity: To 4 gpm / 15 l/m
Pressure: To 1500 psi / 103.4 bar at max 400°F / 204°C, depending on temperature
Standard: MS-0750-DJ, 0.750” NPT connections

Cyclone separators

Offered in six different models these separators are designed to efficiently remove sand, pipe scale and other abrasive particles from injection flow to mechanical seals. Separation is accomplished by centrifugal force generated by differential pressure across the cyclone.

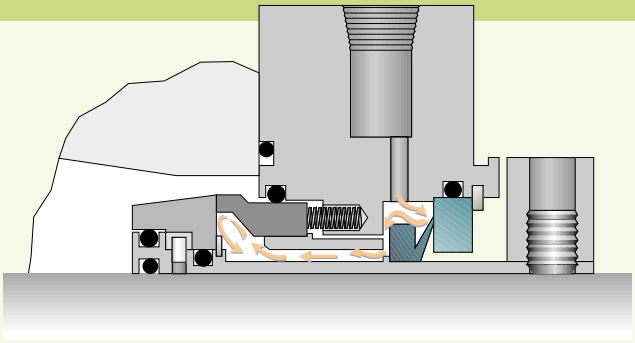
Capacity: clean flow from 0.9-7.5 gpm / 3.5-28 l/m
Pressure: To 2000 psi / 138 bar
Temperature: To 850°F / 455°C
Standard sizes: 0.500” and 0.750”, NPT or socket weld

SLD

The Synthetic Lubrication Device is a system that dispenses synthetic lubrication to the atmospheric quench side of mechanical seal faces. Developed for mechanical seals subjected to periods of dry running or cavitation when product liquid (pumpage) is not present to provide adequate fluid film between the seal faces. Ideally suited for single liquid mechanical end face seals incorporating two hard carbide faces and a QCD (Quench Containment Device). Proven to greatly extend single flushless mechanical seal life during marginal operation periods in harsh slurry conditions.

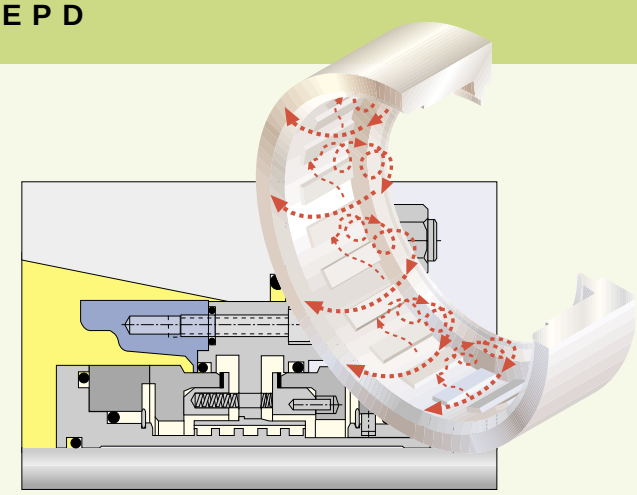
Max. Process Fluid Temperature: 175ºF / 80ºC
Atmospheric Temperature Range: -4ºF / -20ºC to 130ºF / 55ºC

QCD



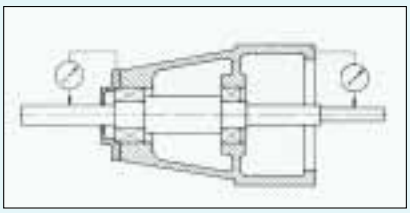
Used in conjunction with a Flowserve Seal, the Quench Containment Device (QCD) helps quench fluid protect seal faces in Dry Running slurry applications to improve equipment's Mean Time Between Planned Maintenance (MTBPM). Equipment cavitation, air ingestion, or improper venting can cause a mechanical seal to run dry and damage the seal faces, resulting in leakage and potential seal failure. The use of a liquid (water) or synthetic lubricant quench on the atmospheric side of a seal in rugged slurry services can greatly minimize seal face damage from dry running. Containment of the quench fluid directs necessary lubrication to the seal faces, prevents dry running, and provides important housekeeping benefits as well. The QCD is commonly supplied in either a V-ring or Lip-seal configuration.

EPD

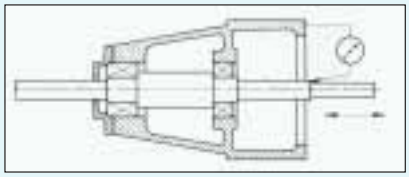


Used in conjunction with a Flowserve Mechanical Seal, the Erosion Protection Device (EPD) interrupts and modifies the fluid flow pattern generated in the cavity behind the impeller. In extremely aggressive slurry services, centrifugal force causes dense and heavy particles to be thrown to the outside creating a high velocity vortex that creates wear. The radial protrusions progressing axially inward along the outer portion of an enlarged-bore chamber of the EPD greatly decrease a particles' velocity when they are struck to significantly reduce direct erosion contact by process fluids containing solids. The EPD is a renewable surface allowing for an economical solution to prevent abrasive wear to expensive pump and seal components.

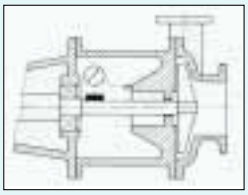
Equipment check (standard pumps)



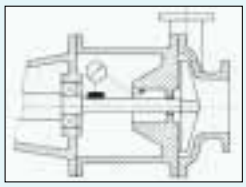
- **Shaft runout** max. 0.002" / 0.05 mm TIR (Total Indicator Reading) at any point along the shaft, for roller or ball type bearings. For sleeve type bearings refer to manufacturers instructions.



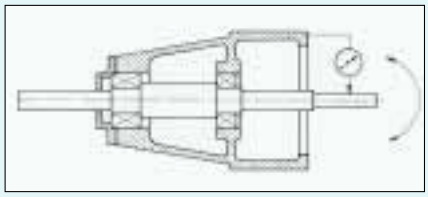
- **Shaft end play** max. 0.004" / 0.10 mm TIR on ball type thrust bearings. For pad type thrust bearings between 0.010" – 0.026" / 0.25 and 0.65 mm TIR can be used.



- Seal chamber face **square** to shaft centerline within 0.001" per 1.000" shaft diameter / 0.025 mm per 25 mm shaft diameter to a maximum of 0.005" / 0.125 mm TIR.



- Shaft **concentric** to seal chamber bore within 0.001" per 1.000" shaft diameter / 0.025 mm per 25 mm shaft diameter to a maximum of 0.005" / 0.125 mm TIR.



- **Radial Deflection** max. 0.002" / 0.05 mm TIR (Total Indicator Reading) at any point along the shaft, for roller or ball type bearings. For sleeve type bearings refer to manufacturers instructions.

Seal selection

Very important issues to consider when selecting a seal are: Safety, Environment and Total Cost of Ownership. There are many factors that we need to know that determine the selection:

- the properties of the product that needs to be sealed;
- all the conditions in the sealing cavity;
- equipment design and condition;
- operational requirements;
- maintenance requirements;
- standardization or customer preference.

Flowserve FSD knows the products and the industries. Project, sales and engineering teams are ready to assist you in selecting a mechanical seal. Upon your request we will discuss and analyze your application, and recommend the best possible solution for you. Please make use of our sealing expertise and ask us for our help.

Operating window

Each seal has certain operating limits, determined by its construction and materials. In this brochure an abbreviated operating window with maximum pressure, maximum temperature, maximum speed and a standard size range is given. More detail can be found in the specific product documentation.

Some additional words of caution:

- maximum and minimum operating limits are determined by materials, size, application, and may be lower than the values given herein;
- operation of a seal close to its pressure or temperature limits may demand our engineering support team to review the application and tune the design to optimize performance;
- only maximum pressure limits are given, but also minimum limits apply (like a single seal can not run reliably with vacuum in the seal cavity);
- the maximum pressure given is dynamic (running), static pressure limits are generally higher for pusher seals;
- maximum and minimum temperatures in seals using elastomers and PTFE gaskets are limited by these materials and may cause deviation from the values given herein;
- for most seals a minimum specific gravity of 0.6 is recommended, only specifically designed pusher seals are suited for lighter product.

Material description	min	Temperature limits	max
Fluoroelastomer	0°F / -18°C		400°F / 204°C
Ethylene Propylene (EPDM)	-40°F / -40°C		300°F / 149°C
Neoprene	-40°F / -40°C		300°F / 149°C
Nitrile Butadiene (Buna N)	-40°F / -40°C		300°F / 149°C
Kalrez® 4079	20°F / -7°C		600°F / 316°C
Kalrez® 1050LF	20°F / -7°C		550°F / 288°C
PTFE	-100°F / -73°C		450°F / 232°C
Flexible graphite	-320°F / -196°C		800°F / 427°C
Chemraz® 505	-20°F / -29°C		450°F / 232°C
Alternate materials			
Fluorosilicone	-75°F / -60°C		350°F / 177°C
Aflas®	15°F / -10°C		400°F / 204°C

Kalrez is a registered trademark of Dupont, Chemraz is a registered trademark of Green-Tweed, Aflas is a registered trademark of Asahi Glass Co.

Seal nomenclature

Due to the company history and the different markets served by Flowserve FSD several seal nomenclature and material coding systems are used. These are identified in each seal picture. Sizes are either given in inches x 1000 or in millimeters.

		MODEL	SIZE	MATERIAL CODE	
A	BW Seals	QB	2000	5U4X	(4 positions)
B	*Durametallic*	RO	1875	EU5EF/VVV	(7 positions, combinations given as "F/V")
C	PACIFIC	Europac 600	053	BSTGG	(5 positions single seal, + 3 positions atmospheric seal)

Quench
A liquid quench is used to remove product deposits on the atmospheric side, and in some cases to aid in seal cooling and lubrication.
A steam or nitrogen quench is used to keep oxygen away from the seal faces and eliminate coking. Typically a bushing is installed to contain the quench medium. Normally the quench amount can be very small. A steam quench should be dry and not contain water.

Dual Seal Environment
Barrier liquid
The following barrier liquid properties are important:

property	recommendation
viscosity	best at 1-5 cSt at operating conditions, good lubricant
specific heat	as high as possible to improve heat removal
specific gravity	normal range 0.8 - 1
boiling point	at least 77-86ºF / 25-30ºC above temperature to which it will be exposed
flash point	higher than service temperature if oxygen present
additives	no or little amount of additives to present plating
materials compatibility	no chemical attack on selected materials
process compatibility	compatible with process liquid and conditions
availability	easy to obtain
safety / environment	non toxic, not classified as hazardous waste

Barrier pressure
Dual pressurized seals: barrier pressure is at least 30 psi / 2 bar over the seal chamber pressure or 1.1 x seal chamber pressure. For plan 53 reservoirs: at higher pressures (API 682 limit: <150 psi / 10 bar) more gas will dissolve in the barrier liquid, which may cause gas bubbles and foaming between the faces. Oil dissolves more gas than water.

Barrier temperature
The total of the heat input into the seal cavity must be removed by the barrier liquid. The temperature increase of the barrier liquid over the seal cavity should not be excessive, with a target of 25°F / 14°C. For light hydrocarbon applications it is critical to keep the barrier temperature as low as possible, other applications are less critical and could allow a higher barrier temperature rise. For safety reasons at most applications the maximum barrier outlet temperature should stay below 180°F / 82°C, however depending on design higher temperatures can be allowed.

Heat generation and cooling
Most liquid seal applications need some form of cooling to dissipate frictional heat, viscous heat or heat soak. The steps taken in determining total heat dissipation are:
- Face frictional heat is determined by springload, hydraulic balance, pressure, friction coefficient, pressure distribution and speed.
- Viscous frictional heat is proportional to density, speed^3, radius^4, length and a friction factor. At higher speeds and viscosities viscous heat can be substantial.
- The amount of heat soak is an estimated value depending on pump and seal construction, temperature differential, type of liquids, and can exceed face frictional heat significantly.

For a self pumping secondary liquid seal a cooling loop is required. Alternatives are water cooling, forced draft air cooling and natural draft air cooling. Natural draft air cooling has the advantage of not requiring expensive external hook-ups, but dissipation is limited.

Piping
Pipe size should be in relation to the seal size and cooling requirements, but minimum 0.500", 0.750" for larger API or high duty seals. Pipe runs should be sloped for proper venting and draining, make sure the loop (including seal flanges) does not include vapor traps (high spots). Especially vertical pumps require special attention to achieve proper venting.

Piping should be as short as possible to avoid high pipe friction losses (especially with higher viscosity barrier liquids, such as oils). Likewise sharp radius bends and gate valves in the loop must be avoided. The top of the seal flange should contain the flow outlet, while the inlet should be at the bottom or lower than the outlet.

barrier	viscosity @ 104ºF/40ºC cSt	T min ºF / ºC	T max ºF / ºC	comment
Kerosene	2	0 / -18	275 / 135	good lubricity, low viscosity
Diesel #2	2	10 / -12	300 / 150	good lubricity, low viscosity
Ethylene-glycol/water 50%	1-2	-40 / -40	175 / 80	high heat capacity, ethylene-glycol considered hazardous waste, do not use anti-freeze because of additives
Propylene-glycol/water 50%	1-2	-13 / -25	175 / 80	high heat capacity, do not use anti-freeze because of additives
Water	1	32 / 0	175 / 80	high heat capacity, low viscosity, low boiling point, marginal lubricant
Synthetic oils	5-15	68 / 20	300 / 150	low viscosity, good running properties, some oils have excellent high temp. stability and oxidation resistance
Methanol Propanol	< 1	-130 to -58 -90 to -50	125 / 50	marginal lubricant, do not use hard faces, low boiling point, only for low temp.

Conversion tables

Length

1 inch (in)	25.4 mm
	0.0254 m
1 foot (ft)	12 in
	304.8 mm
1 yard	3 ft
	0.9144 m
1 He lightband	11.6e-6 inch
	2.95e-7 m
	0.3 micro m

Area

1 sq in	0.00694 sq ft
	6.4516 e-4 m^2
	6.452 cm^2
1 sq ft	144 sq in
	0.093 m^2
	929 cm^2

Volume

1 US gal	231 cu in (in^3)
	3.785 liter
1 UK gal	4.546 liter
1 cu in	16.39 cm^2
1 cu ft	7.4805 US gal
	28.32 liter
1 barrel	159 liter

Flow

1 m^3/s	1000 l/s
1 m^3/h	4.40 gpm
1 l/s	3.6 m^3/h
1 l/min	60 l/h
1 gpm	0.063 l/s
	0.227 m^3/h

Mass/Force/Torque

1 ounce	28.3495 g
1 lb	0.4536 kg
1 lbf	4.444 N
1 ft lbf	1.354 Nm
1 in lbf	0.113 Nm

Pressure

1 psi	0.06895 bar
	0.0703 kg/cm^2
	2.31 ft head water
	0.704 m head water
1 bar	100 kPa
	0.1 Mpa
	750 torr (mmHg)
	0.9896 atm
	14.5 psi
1 m liq	1.422 x sg psi
	0.1 x sg atm

Temperature

°C	(°F - 32) / 1.8
°F	(°C x 1.8) + 32

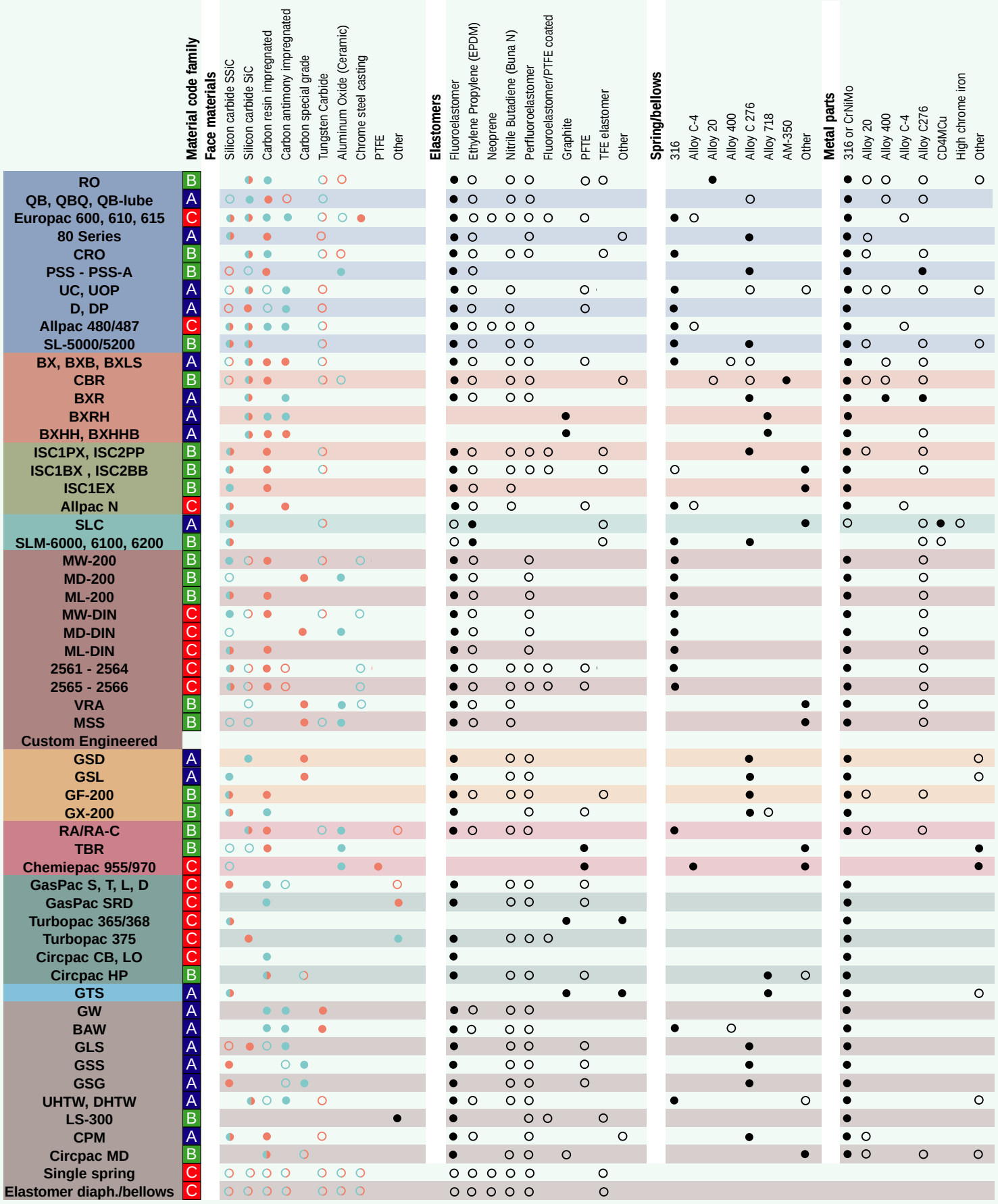
note: temperature differences do not add/ subtract '32'

Power

1 HP	0.746 kW
1 kW	3412 BTU/hr
1 kJ	0.95 BTU

Viscosity

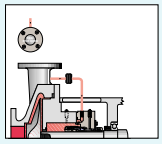
cSt	kinematic visc.
cP	dynamic or absolute visc.
SSU	Saybolt Universal visc.
1 cP	1 cSt x sg
	1 Pa s
1 lb/ft s	1.4882 Pa s
60 SSU	10 cSt
100 SSU	20 cSt
200 SSU	45 cSt
1000 SSU	220 cSt



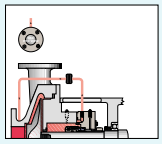
- Standard stationary / rotating face
- Optional stationary / rotating face
- Standard rotating face
- Optional rotating face
- Standard stationary face
- Optional stationary face
- Standard gaskets/metal parts
- Optional gaskets/metal parts

Above table provides an overview of available materials. On request alternate materials are available to best suit the application requirements, however this may impact delivery.

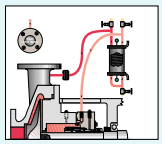
	A BW Seals	B Durametallic	C PACIFIC
Face materials			
Silicon carbide SSiC	Z (YO)	2 (Silcar 2)	Q1 (Q69)
Silicon carbide SiC	X (SL)	4 (Silcar 1)	Q2 (Q57)
		Z (Silcar A2)	
		G (Silcar A)	
		J (Silcar M)	
		L (Silcar 3)	
Carbon resin impregnated	A (GE)	R (#5 carbon)	B (B04)
	P (KI) rot	5 (5# carbon)	
	Q (NA) rot		
	Q (KI) stat		
	R (NA) stat		
	V (OH)		
	H (LM)		
Carbon antimony impregnated	U (RY)	6 (#6 carbon)	A (A01)
Carbon special grade	D (AE)		
Tungsten Carbide Nickel	N (LV)	A (Tungcar A)	U2 (U49)
Tungsten Carbide Cobalt	W (RI) rot	8 (Tungcar 62-1)	U1 (U20)
	M (RI) stat		
Tungsten Carbide		M (Tungcar M)	
		B (Tungcar M1)	
		U (Tungcar 62-6)	
Aluminum Oxide (Ceramic)	C (JT)	7 (Peramic)	V (V21)
Chrome steel casting		D (Duramate)	S (S17)
PTFE, glass fibre reinforced	L (HD)	F (GF Duraflon)	Y1 (Y23)
PTFE, carbon reinforced		T (Duraflon)	Y2 (Y60)
316/sapphire overlay	J (LT)		
Kalamate		Y (Kalamate)	
Stellite overlay		S	
Durchrome facing		P (Durchrome)	
Bronze			
		O	
Elastomers			
Fluoroelastomer (e.g. Viton)	4 (GU)	V	V (V86)
Ethylene Propylene (EPDM)	5 (MG)	U (EPT)	E (E84)
Neoprene	2 (GY)	N	N (N82)
Nitrile Butadiene (Buna N)	1 (GS, GW, QM)	O	P (P81)
Perfluoroelastomer (e.g. Kalrez)	D (TW) Kalrez 4079	P	K (X01)
	3 (ZV) Kalrez 1050LF		
Fluoroelastomer/PTFE encapsulated		H (Duraflon)	M (M87)
Duraflon V-ring & Duraflex ring		T	
GF Duraflon V-ring & Duraflex ring		F	
Duraflon Cove ring w fluoroelastomer		C	
Silicone		D	
Butyl		B	
EPR		E	
TFE elastomer (e.g. Aflas)	A (AF)	L-AQ	
Other elastomers			X
Graphite	C (QF)	G (Durafite)	G (G64)
PFTE	7 (GT)		T (T88)
PTFE glassfilled	8 (HD)		
Other non-elastomers			Y
Spring/bellows			
CrNi-steel 1.4310			F (F26)
CrNi-steel 1.4310			G (G55)
CrNiMo-steel			G (G30)
Alloy C-4			M (M13)
Alloy 400	7 (HU)	M	
Alloy C 276	9 (NL)	I	
316/Alloy C 276/ Ni-Fe Alloy 42	A (AK)		
316/Alloy 718/ Graphite	C (FI)		
316/Alloy C/ Duplex 2205	K (CX)		
304 or AM-350			
XM-19		B	
Metal parts			
316	5 (DB)	E	
18-8	4 (CK)		
CrNi steel			F (F26)
CrNiMo steel			G (G30)
304 or AM-350		C	
Duplex	F (DX)	A	
Duplex CD4MCuN	D (ZB)	B	
Alloy 20	6 (DY)	K	
Alloy 400	7 (HU)	M	
Alloy B	8 (ED)	H	
Alloy C-4			M (M13)
Alloy C 276	9 (NL)	I	
Alloy 718	J (NH)	J	
Bronze	2 (FJ)	O	
410		Q	
416	3 (CB)		
17-4 PH		D	
Steel parkerized	1 (EU)		
High chrome iron	E (DN)		
Titanium		S	
Cast Iron		P	
Nickel		Z	
Special	Y	V	T



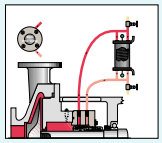
Plan 11
Circulation from discharge through orifice



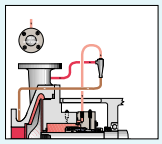
Plan 13
Circulation from seal cavity through orifice to suction



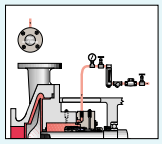
Plan 21
Circulation from discharge through orifice and cooler



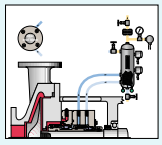
Plan 23
Forced circulation through cooler, back to seal, by pumping ring



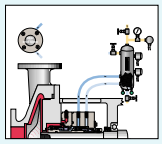
Plan 31
Circulation from discharge through cyclone separator



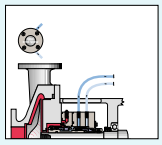
Plan 32
Flush from external source



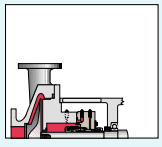
Plan 52
External pressureless vessel, either thermosyphon or forced circulation by pumping ring



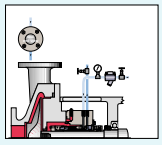
Plan 53
External pressurized vessel, either thermosyphon or forced circulation by pumping ring



Plan 54
Forced barrier circulation from external system



Plan 61
Plugged quench and drain ports



Plan 62
External quench (steam, gas, water, etc.)

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Flow Solutions Division

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Durametallic Seals
Pacific Wietz Seals
Pac-Seal

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