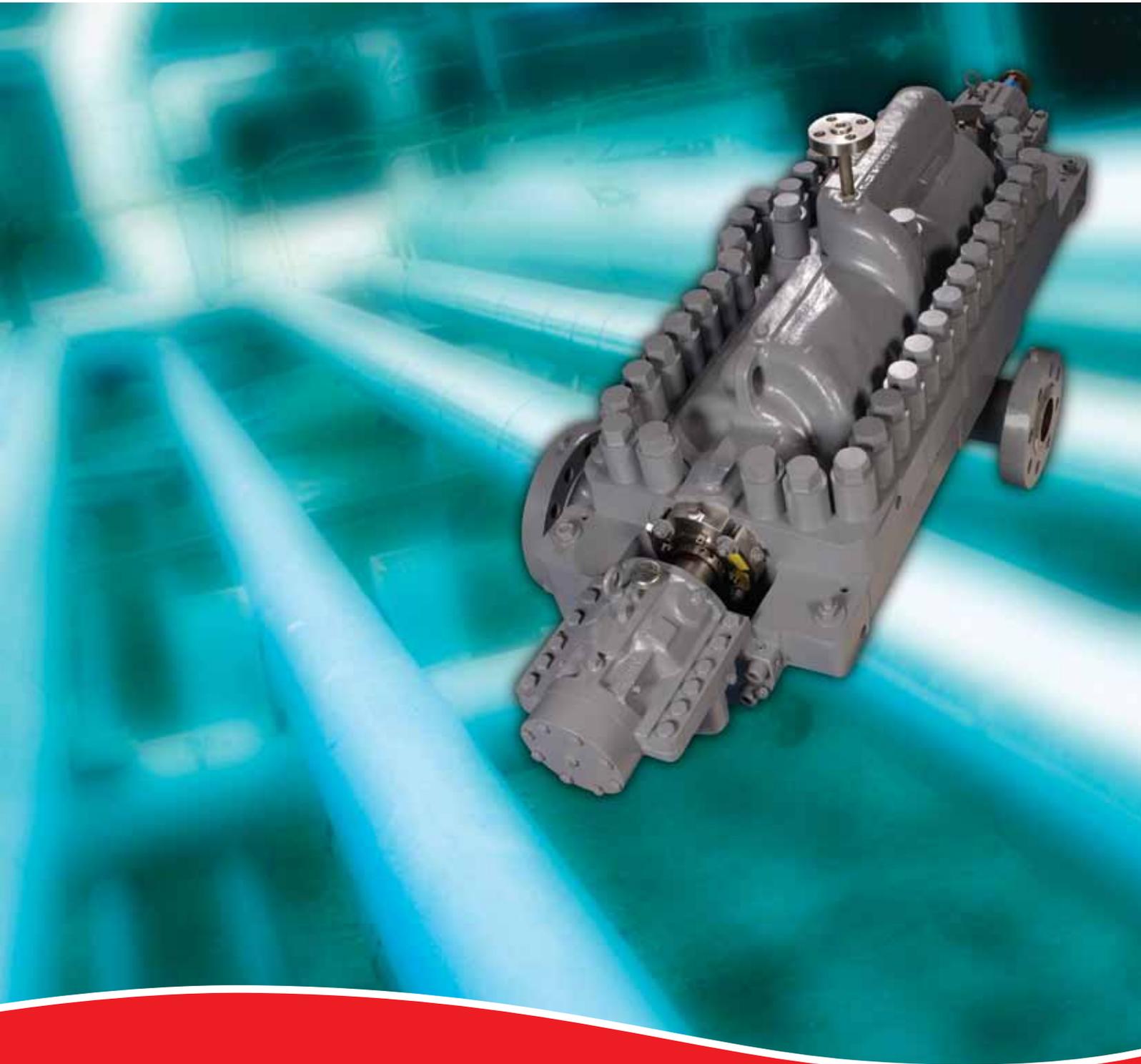




# ***CO<sub>2</sub> Transportation and Injection Pumps***

DMX • WIK/WIKO • DVSR



***Experience In Motion***



## **The Preferred Choice for CO<sub>2</sub> Pumps and Seals**

*Whether for pipeline or injection service, Flowserve boasts unrivaled expertise in developing and implementing pumping technologies and systems for carbon dioxide (CO<sub>2</sub>) transportation and storage. Flowserve design and applications engineers understand the challenges associated with pumping and sealing dense phase CO<sub>2</sub> and have pioneered many of the technologies the industry relies on today. The company's 30 years of leadership have been validated with proven field experience around the globe and continuous research, development and testing.*



### **A Foundation of Innovation and Leadership**

Since 1926 when it developed the first double case pump for hot oil, Flowserve has been in the vanguard of pump development for the oil and gas industry. This leadership position was reinforced in 1934 with the introduction of high-pressure water injection pumps and cemented in 1982 when it built what was then the world's largest water injection pump (17 900 kW [24 000 hp]). Two years later, Flowserve was the first to engineer pumps for high-pressure CO<sub>2</sub> pipeline and injection service.

Reflecting its leadership position, Flowserve continues to be involved in establishing the ISO 13709/ API 610 standard governing the construction of these and other pumps for the oil and gas industry.

### **Heritage Brands of Distinction**

Flowserve CO<sub>2</sub> pipeline booster and injection pumps and seals have evolved from the time-honored designs of these world-renowned heritage brands:

*Byron Jackson® Pumps*

*IDP® Pumps*

*Pacific® Pumps*

*United Centrifugal® Pumps*

*Worthington® Pumps*

*BW Seals®*

*Pacific Weitz™ Seals*



### ***Unsurpassed Application Knowledge***

FlowsERVE design and applications engineers have unequalled experience and success in dense phase CO<sub>2</sub> pump and seal technology. They understand the critical impact that product density, lubricity, and contaminants have on the selection and performance of CO<sub>2</sub> pump and seal systems. FlowsERVE engineers are eager and fully capable of specifying reliable and efficient dense phase CO<sub>2</sub> pumping solutions.

### ***Available Pump Designs***

FlowsERVE offers the industry's most complete and reliable range of dense phase CO<sub>2</sub> pumps. Pumps are built to customer specifications, often exceeding the requirements of ISO 13709/API 610. Models include:

- DMX – ISO 13709/API 610 (BB3) axially split multistage pump for pipeline booster service
- WIK/WIKO – ISO 13709/API 610 (BB5) diffuser-style double case pumps for pipeline booster or injection service
- DVSR – ISO 13709/API 610 (BB2) radially split, single-stage, double-suction pump for pipeline booster or injection service

### ***Committed to the Complete Pump System Life Cycle***

For more than two centuries, FlowsERVE has served industries requiring solutions that add value and reduce costs throughout the life cycle of a pumping system.

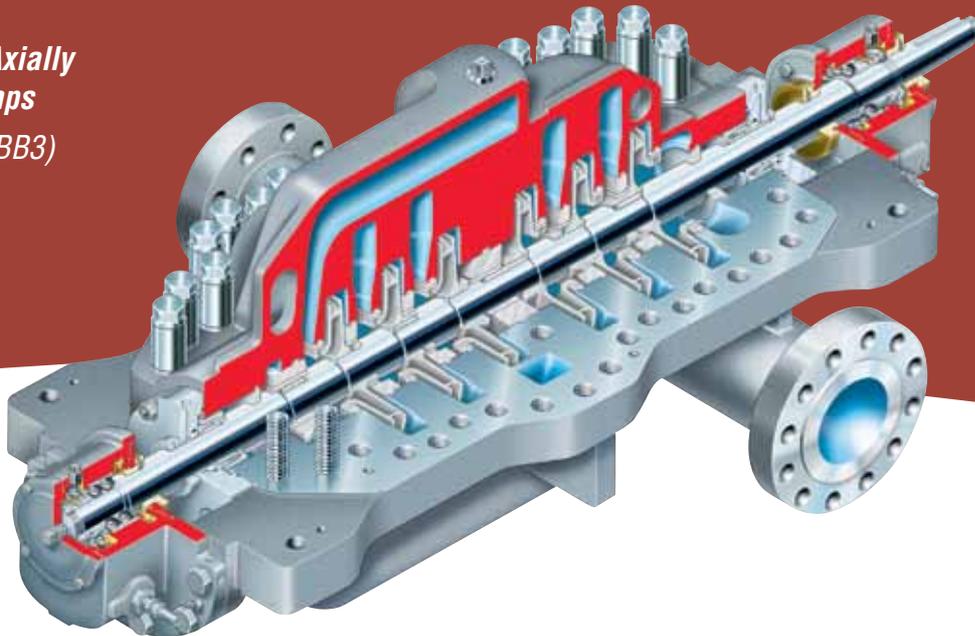
- Oil and gas
- Water
- Power generation
- Chemical
- General industry

FlowsERVE partners with customers to respond to the dynamic business

conditions that affect them. FlowsERVE works with customers to improve efficiency, maximize throughput and control process quality. Whether customer needs involve on-site technical assistance, equipment upgrades or broader project planning with full turnkey responsibility, FlowsERVE delivers professional, reliable results.



**DMX**  
**Between Bearings, Axially**  
**Split Multistage Pumps**  
 ISO 13709/API 610 (BB3)



*The DMX pump is fully compliant with ISO 13709/ API 610, latest edition. It is engineered and built for high-pressure, heavy-duty applications. Boasting a comprehensive range of hydraulic coverage, the DMX permits precise selection to ensure the best hydraulic fit, operating with efficiency and stability. This helps to minimize operating expenses and extend mean time between repair.*

### **Operating Parameters**

- Flows to 2950 m<sup>3</sup>/h (13 000 gpm)
- Heads to 2130 m (7000 ft)
- Pressures to 275 bar (4000 psi)
- Temperatures to 200°C (400°F)
- Speeds to 6000 rpm

### **Features and Benefits**

**Heavy-duty, Axially Split Casing** features double volutes positioned 180 degrees apart so hydraulically generated radial loads are balanced.

**Opposed Impeller Configuration** effectively balances axial thrust over a wide range of operating conditions.

**Robust Rotating Element** includes large diameter shafts and short bearing spans to minimize deflection. Dynamic balancing and TIR verifications ensure optimum mechanical performance.

**Available Bearing Designs** include ball radial/ball thrust, sleeve radial/ball thrust and sleeve radial/tilting pad thrust configurations to suit application needs.



**ISO 21049/API 682 Seal Chambers** accommodate wet and dry gas seals, cartridge type single, dual unpressurized and dual pressurized mechanical seals.

**Nozzles** are integral with the lower half casing, permitting disassembly without disturbing piping connections. Nozzles are designed to handle external forces and moments equal to or in excess of ISO/API values.

**Raised Face Flanges** meet ASME B16.5 dimensional criteria. Class 600 suction and discharge minimum. High-pressure casings and Class 900 and 1500 flanges are also available.

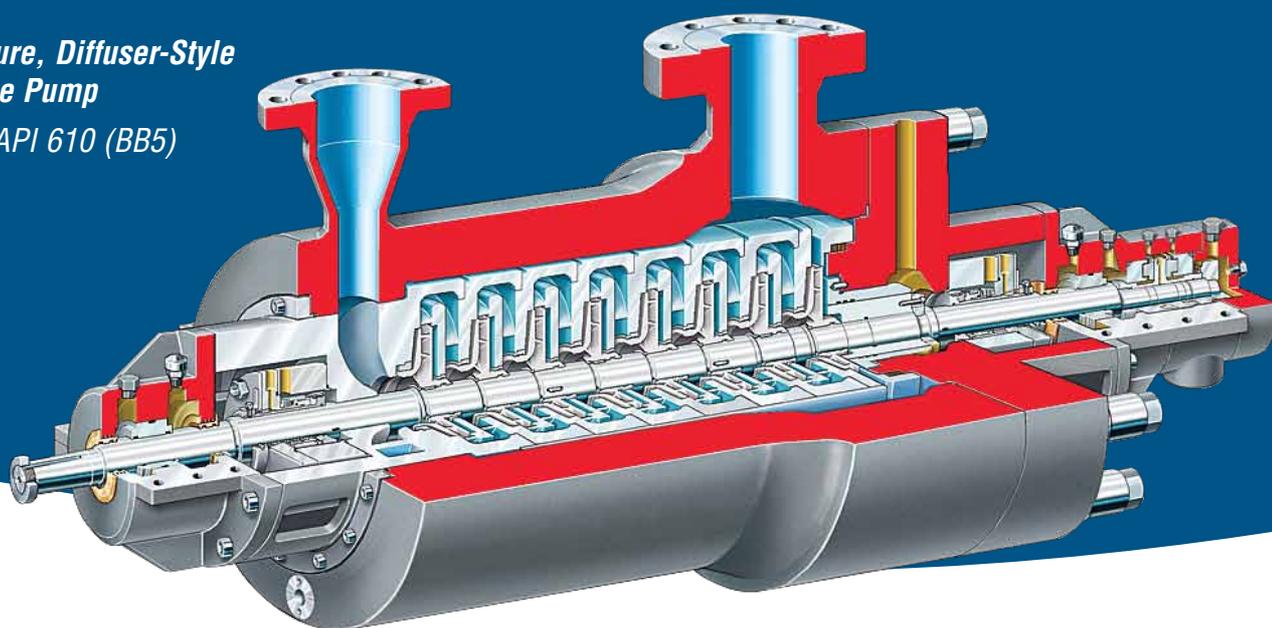
**Materials of Construction** are selected to meet service requirements. Options include carbon steels, chromium steels and a variety of stainless steels.

**Wear Parts** are made from Graphalloy® or non-metallic materials to compensate for the low lubricity of CO<sub>2</sub>.

**API Performance Testing** is conducted on each DMX pump prior to shipment.

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**WIK/WIKO**  
**High-Pressure, Diffuser-Style**  
**Double Case Pump**  
 ISO 13709/API 610 (BB5)



*The WIK is a diffuser-style multistage, double case barrel pump with a tandem (in-line) impeller rotor. The WIKO is the opposed impeller variation, capable of handling ultra high injection pressures. They are ideal for special purpose, unspared, high-power density and extremely arduous applications. Both are designed and built to meet or exceed ISO 13709/API 610 (BB5), latest edition, and custom-engineered to stringent customer requirements.*

**Operating Parameters**

- Flows to 4000 m<sup>3</sup>/h (17 610 gpm)
- Heads to 7000 m (23 000 ft)
- Pressures to 650 bar (9425 psi)
- Temperatures to 450°C (840°F)
- Speeds to 13 000 rpm

**Features and Benefits**

**High Stiffness Rotor** with low static deflection is the result of large diameter shaft and short bearing spans. This eliminates the need for Graphalloy or non-metallic stationary wear parts normally required for low lubricity fluids like CO<sub>2</sub>. It also improves the pump's tolerance to operational upsets.

**Back Pullout Cartridge Construction** allows quick replacement of the entire inner-case subassembly. Maintenance can then be performed in the shop, rather than in the field.

**Cast Multi-vane Radially Split Diffuser and Channel Rings** eliminate radial imbalance across the entire operating range.



**Precision Cast, Low Specific Speed Impellers**

are statically and dynamically balanced. Single- and double-suction, first-stage impellers are available.

**Heavy-duty, Journal-type Radial Bearings** are thick-walled and pressure-lubricated. Heavy-duty, tilting pad thrust bearings feature leading edge groove (LEG) lubrication and are self-equalizing.

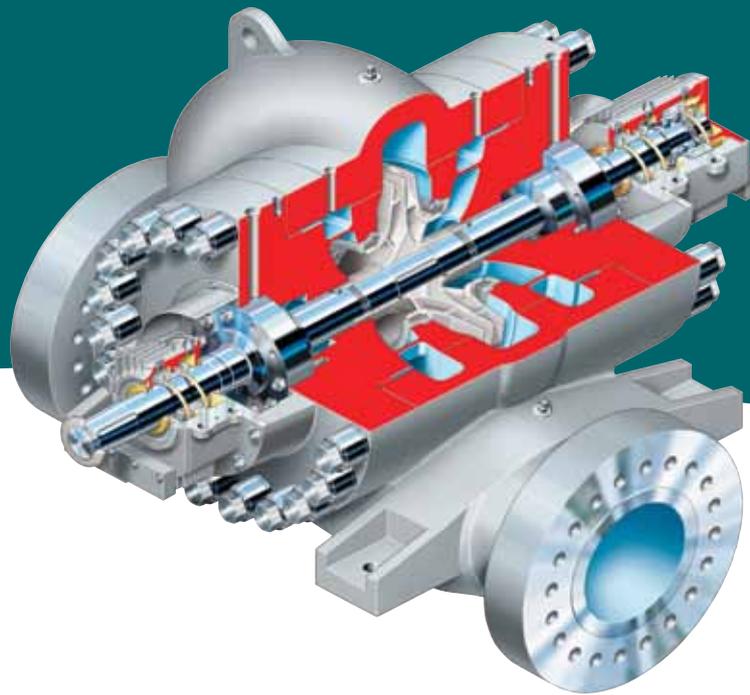
**ISO 21049/API 682 Seal Chambers** accommodate wet and dry gas seals, cartridge type single, dual unpressurized and dual pressurized mechanical seals.

**Single-diameter Balance Drum** compensates for residual axial thrust.

**Optional Grooved Impeller Running Fits** increase the pump's tolerance to foreign materials and desensitize it during start-up, stopping and system transients.

**API Performance Testing** ensures each unit meets the specified design conditions. Pumps may be tested at full flow, pressure and speed, up to 18 650 kW (25 000 hp).

**DVSR**  
*Between Bearings,  
 Radially Split,  
 Single-Stage,  
 Double-Suction Pump*  
 ISO 13709/API 610 (BB3)



*The DVSR is the preferred choice for very high-pressure or low-specific gravity applications, such as liquefied gases and dense phase CO<sub>2</sub> pipelines. Consisting of a double-suction impeller operating in a heavy-duty, radially split casing, the DVSR's design inherently results in optimal axial and radial thrust balance over the pump's full operating range. Comprehensive hydraulic coverage permits precise sizing, very high efficiency and low total cost of ownership.*

**Operating Parameters**

- Flows to 3635 m<sup>3</sup>/h (16 000 gpm)
- Heads to 250 m (820 ft)
- Discharge pressures to 260 bar (3750 psi)
- Speeds to 4000 rpm

**Features and Benefits**

**Double-suction Impeller** provides axial hydraulic thrust balance and is designed for maximum hydraulic efficiency.

**Double Volute Design** minimizes hydraulic radial loads, even at minimal flow. The result is prolonged service life for bearings, seals and wear rings.

**ISO 21049/API 682 Seal Chambers** accommodate wet and dry gas seals, cartridge type single, dual unpressurized and dual pressurized mechanical seals.

**Radially Split Casing** provides containment of dense phase fluids. Integral nozzles are designed to handle external forces and moments equal to or in excess of ISO/API specified figures.

**Raised Face Flanges** meet ASME B16.5 dimensional criteria and are available in Classes 600, 900 and 1500.

**Stiff Shaft Design** ensures trouble-free performance by operating under the first critical speed.

**Multiple Bearing Designs** are available to suit application needs. Designs include sleeve radial/ball thrust, sleeve radial/tilting pad thrust and tilting pad radial/tilting pad thrust configurations.

**Materials of Construction** are selected to meet service requirements. Options include carbon steels, chromium steels and a variety of stainless steels.

**Wear Parts** are made from Graphalloy® or non-metallic materials to compensate for the low lubricity of CO<sub>2</sub>.

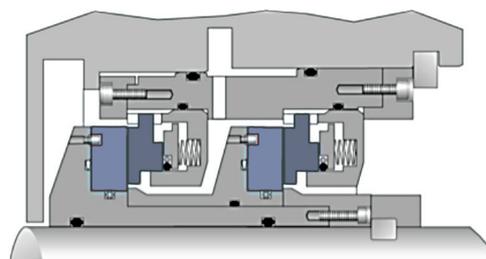
**API Performance Testing** is conducted on each pump prior to shipment.



**Seals for CO<sub>2</sub> Transportation and Injection**



Just as with pumps, the density, lubricity, and impurities of dense phase CO<sub>2</sub> dramatically affect mechanical seal selection and performance. Gas-like viscosity makes it difficult to maintain fluid film thickness with traditional liquid seals. Liquid-like density can create high leakage rates and the potential for atmospheric-side icing with gas seals. These challenges can only be addressed with advanced technology and innovative engineering solutions. Flowserve offers two proven sealing solutions for dense phase CO<sub>2</sub> service.



**GASPAC T Non-Contacting Inner Seal With a Containment Seal**

**Suction Pressures** to 201 bar (3000 psi).

**Compressor Seal Design** utilizes gas-like properties of dense phase CO<sub>2</sub> to seal it as if it were a gas.

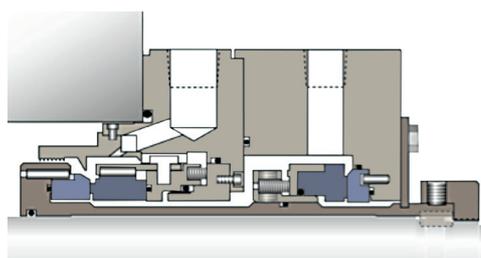
**High-pressure Seal** carefully controls CO<sub>2</sub> temperature and pressure drop across the faces to prevent icing and maintain a supportive fluid film.

**Symmetrical T-groove Technology** enables face liftoff for zero wear. Seal face topography establishes reliable non-contacting performance for long, uninterrupted life.

**Piping Plans Maximize Reliability**

A Plan 11 flush and available filtration system at the inboard seal provides a low flow of CO<sub>2</sub> to stabilize temperatures and prevent debris accumulation.

A Plan 76 vent monitors for high leakage and captures vapor for recovery in a safe location. Pressure or flow alarms can detect leakage.



**UHTW/GSLW Contacting Inner Seal With a Containment Seal**

**Suction Pressures** to 138 bar (2000 psi).

**Unique Precision Seal Face Topography** provides hybrid gas and liquid performance without significant auxiliary support.

**UHTW Hydrodynamic Face Features** provide load support and lower heat generation. Optimized seal face geometry minimizes atmospheric emissions and icing.

**GSLW Containment Seal** provides additional protection against CO<sub>2</sub> leakage. It operates unpressurized normally but can handle full process pressure when needed.



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