



## ***Desalination***

Reverse Osmosis • Multistage Flash • Multi-Effect Distillation



***Experience In Motion***



## ***Pump Supplier to the World***

*Flowserve is the driving force in the global industrial pump marketplace. No other pump company in the world has the depth or breadth of expertise in the successful application of pre-engineered, engineered, and special purpose pumps and systems.*

### ***A Leader in Pumps for Desalination***

As worldwide demand for potable water continues to grow, municipalities and industries are turning increasingly to desalination. In the forefront of virtually every significant advancement in water-handling pump technology, Flowserve is the supplier of choice for thermal and membrane desalination. Flowserve offers a complete line of pumps, power recovery systems, and technical support for efficient and cost-effective desalination.



### ***Product Brands of Distinction***

*ACEC™*

*Aldrich™*

*Byron Jackson®*

*Calder™ Energy Recovery Devices*

*Cameron™*

*Durco®*

*Flowserve®*

*HALBERG™*

*IDP®*

*INNOMAG®*

*Lawrence Pumps®*

*Niigata Worthington™*

*Pacific®*

*Pleuger®*

*Scienco™*

*Sier-Bath®*

*SIHI®*

*TKL™*

*United Centrifugal®*

*Western Land Roller™*

*Wilson-Snyder®*

*Worthington®*

*Worthington Simpson™*



### ***Pump Designs***

Flowserve offers a wide range of complementary pump types, built to recognized global standards and customer specification. These include:

- Single-stage process
- Between bearings single-stage
- Between bearings multistage
- Vertical
- Submersible motor
- Positive displacement
- Specialty

### ***Available Configurations***

- Sealed and sealless
- Axially and radially split
- Volute and diffuser
- Close coupled and spacer-coupled
- Single and double casing



### ***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.

- Water
- Power generation
- Oil and gas
- 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.





## ***The Desalination-Flowserve Interface***

High corrosion resistance, energy efficiency and proven performance are paramount to the selection of pumps and systems for water desalination. Flowserve is unmatched in materials expertise and applications know-how. Having equipped water desalination plants for more than a half-century, Flowserve has the experience and expertise to meet these challenges.

### ***Application Know-how***

Flowserve engineers are highly regarded for their knowledge and skill in helping customers solve difficult process problems. These are materials, product and applications engineers who provide detailed technical assistance to help customers lower costs and increase availability. They also can assist customers with maintenance advice, spare parts recommendations and inventory analysis.



### **Materials Expertise**

FlowsERVE offers its customers a broad range of corrosion-resistant materials — both metallic and nonmetallic — along with materials application expertise to provide the safest, lowest total cost solutions for the difficult services found in desalination plants. Pitting, crevice corrosion and stress corrosion cracking are major challenges in processing seawater and brackish water. FlowsERVE effectively addresses these issues with its broad range of materials, including proprietary super austenitic stainless steels, duplex stainless steels, bronze alloys, nickel alloys, and Ni-Resist metals along with a complete range of engineered polymers. For assured quality, FlowsERVE maintains its own steel, nickel and light reactive alloy foundries.

### **Engineering Design**

Moving saline water from its source through desalination and distribution facilities requires dependable high-volume pumps. FlowsERVE water resource pumps are renowned for their reliability and minimal total life cycle cost. They are versatile and adaptable to any thermal and membrane desalination plant parameters.

### **Reliability and Availability**

Many plants today are constructed as build, own, operate and transfer (BOOT) projects. FlowsERVE offers maintenance contracts that guarantee the minimum efficiency of key equipment over a period and include monitoring and preventative maintenance to guarantee availability of the plant.

### **Dedicated Local Support**

#### **Quick Response Centers (QRC)**

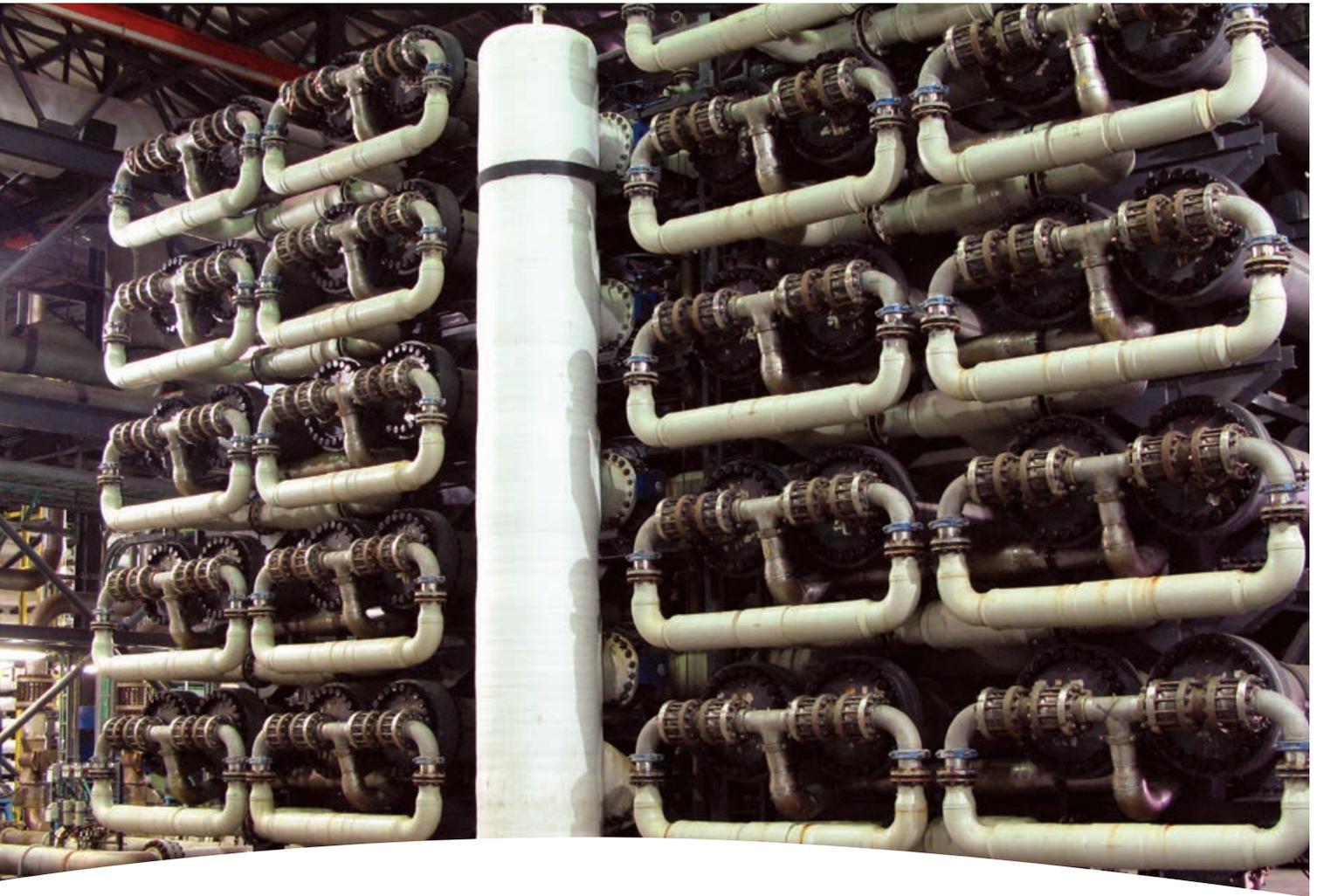
FlowsERVE has a network of QRCs that are designed to support customers with local parts, repairs, and service for FlowsERVE and other equipment. Capabilities include condition monitoring, pump diagnostics, removal and re-installation services as well as re-rate and upgrade of equipment. Some locations feature pump testing facilities.

#### **Learning Centers**

FlowsERVE has regional facilities designed to offer customers classes in a wide variety of subjects. Topics include selecting new pumps, valves or seals as well as basic hydraulics and advanced diagnostics. The laboratory setting allows students to witness pump testing, cavitation and other operational situations.



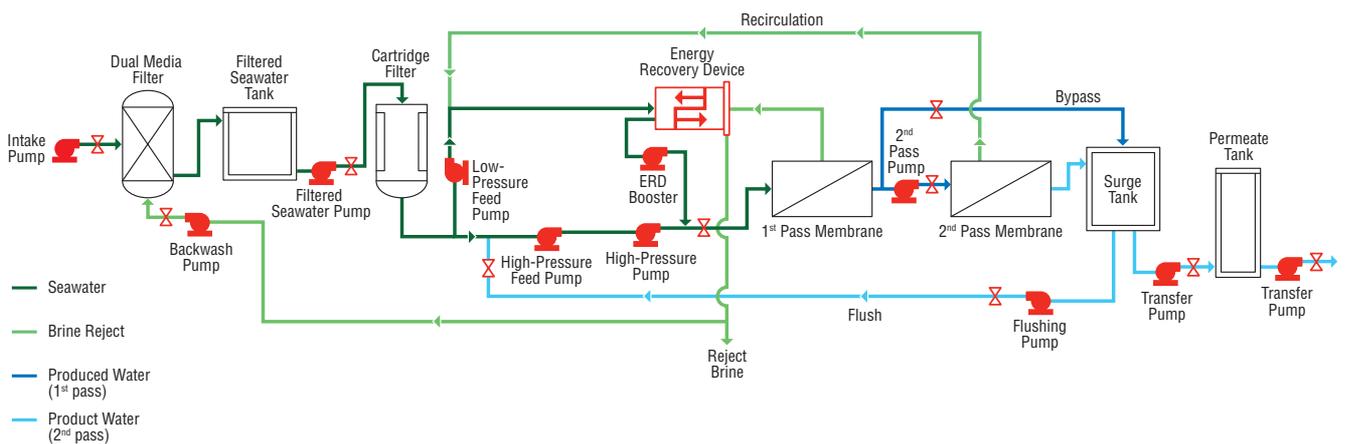
The LRC in Saudi Arabia – a 13 000 m<sup>2</sup> (140 000 ft<sup>2</sup>) facility

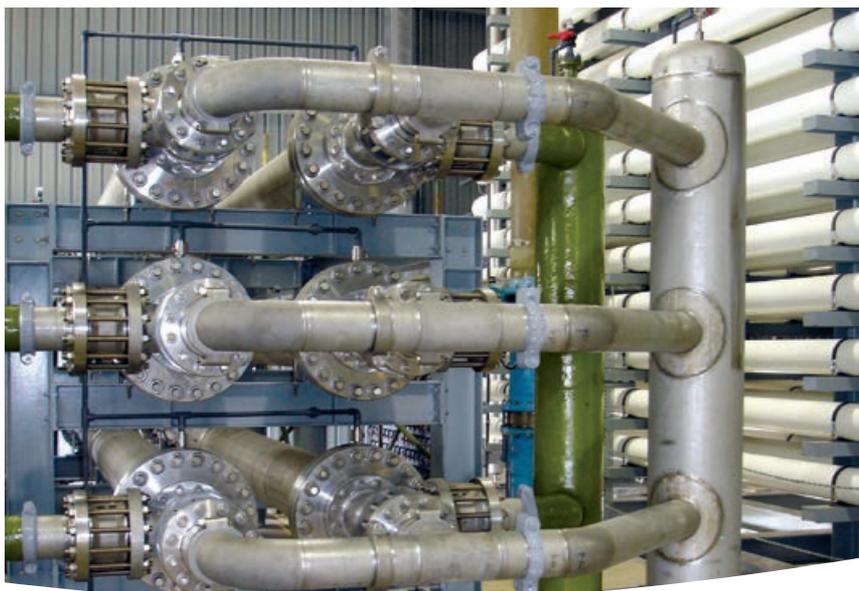


## Reverse Osmosis

With its inherently simple design and significantly lower energy consumption, the reverse osmosis (RO) process is often the choice for municipal and commercial water supply. The comprehensive line of Flowserve pump products featuring high

efficiency and advanced material technology can be a major factor in achieving success in potable water creation. Detailed systems knowledge along with a full menu of technical support and services are available wherever and whenever needed.





### ***High-Pressure Membrane Feed Pumps***

The heart of the RO system is the high-pressure membrane feed pump. Flowserve offers high-efficiency membrane feed pumps, designed using the latest technology (e.g., computational fluid dynamics), to provide best pump performance. These critical pumps are manufactured in corrosion-resistant materials to ensure long performance life without degradation. Whether the design is horizontal split case or ring section type, Flowserve has the pump for this service.

### ***Source Water Intake***

As one of the toughest applications in desalination, source water intake requires pumps to be highly corrosion resistant. They also must have the versatility to fit various intake methods. Flowserve vertical pumps include a conventional lineshaft or submersible motor, both offering wide capacity ranges to effectively maximize system efficiency while minimizing initial cost. Flowserve also offers horizontal pumps for dry pit installation or space-saving vertical configurations, which provide the same premium efficiency with a reduced footprint.

### ***Energy Recovery Devices***

Energy consumption is generally the biggest cost driver of desalination, thereby making energy recovery equipment critical to the RO process.

Flowserve acquired the Swiss company Calder in 2009 to complement its portfolio of pumps for the reverse osmosis process. Calder specializes in the design, engineering and supply of energy recovery equipment and related propriety technologies for reverse osmosis desalination. The Calder dual work exchanger energy recovery (DWEER) technology and energy recovery turbines (ERT), combined with the company's valves and seals, enable Flowserve to deliver a complete and integrated desalination flow control solution.

### ***Auxiliary Services***

- Booster pumps
- Filter feed
- Filter backwash
- Chemical dosing
- Brine disposal
- Brine transfer
- Product transfer



## Multistage Flash Distillation

Flowserve has a comprehensive product range to fit every service in the multistage flash (MSF) plant. Critical to success in this process is the selection of equipment and materials which can survive saline brine at elevated temperatures.

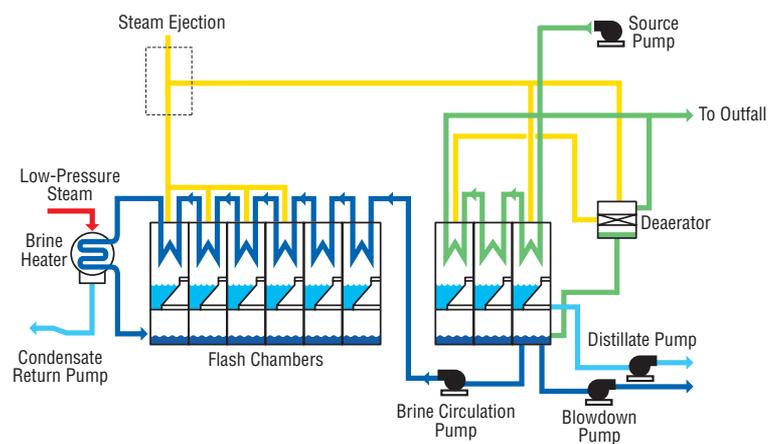


Photo courtesy of Doosan Heavy Industries and Construction



### ***Source Water Intake***

FlowsERVE offers a complete line of corrosion-resistant pumps with the flexibility to meet any intake requirement. Pump models include vertical configurations in a wide capacity range to maximize system efficiency.

### ***Brine Recirculation***

Brine recirculation is the most arduous service in the MSF plant because of the low NPSHA. The service is made all the more aggressive by the combination of elevated brine temperature and salinity, which creates a highly corrosive environment. FlowsERVE supplies pumps capable of withstanding the most corrosive forces in a variety of designs to achieve the exact hydraulic requirements. Each is available in standard commercial or proprietary high alloy materials to fit service conditions.



### ***Distillate Extraction***

Distillate extraction requires a pump that is highly efficient and dependable. FlowsERVE offers several proven pump models in both vertical and horizontal configurations for this service.

### ***Cooling Seawater Recirculation***

FlowsERVE horizontal single-stage pumps are ideal for cooling water recirculation. Available in a variety of corrosion-resistant materials and a wide range of hydraulics, these pumps provide the efficiency and flexibility required for this service. Many are offered in an optional vertical configuration, saving valuable floor space without compromising performance.

### ***Potable Water Transfer***

When the final product is ready for transport, FlowsERVE has the right pump to suit application needs. Whether the service calls for a horizontal overhung, between bearings or vertical design, FlowsERVE makes this a worry-free service, devoid of contamination or the reintroduction of outside pollutants.

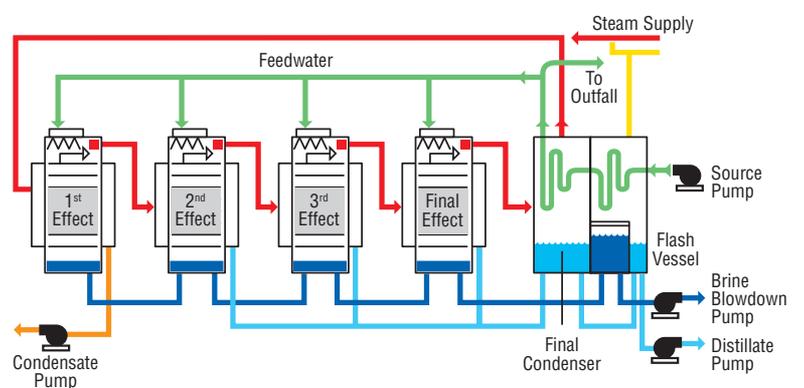


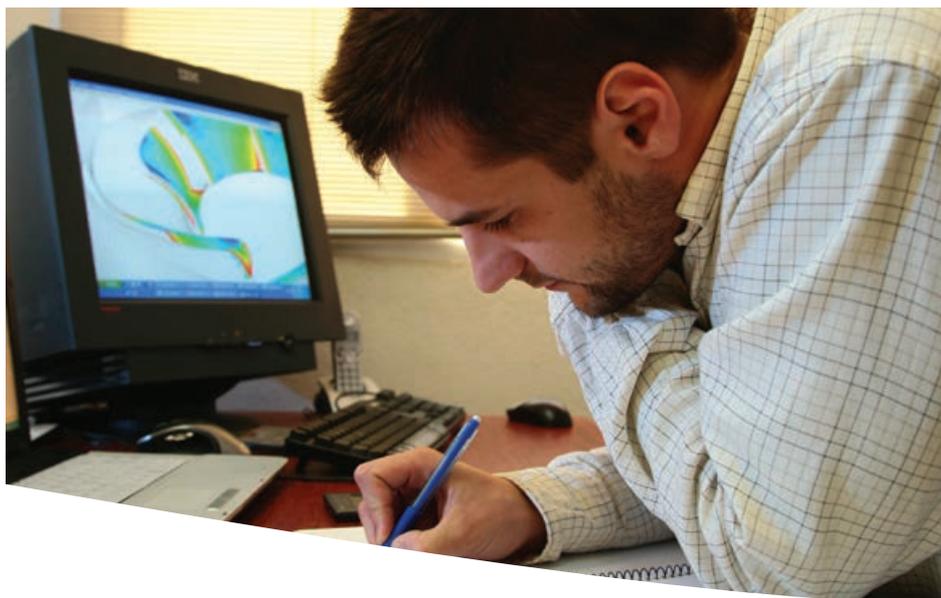
## Multi-Effect Distillation

With the promise of low primary energy consumption, low heat transfer area and high gain ratio, multi-effect distillation (MED) is experiencing renewed interest and growth.

Flowserve offers pumps for all aspects of the MED process:

- Source water intake
- Process water pretreatment
- Filter backwash
- Feed
- Brine transfer and disposal
- Product and chemical transfer
- Power generation and co-generation





## ***Equipment and Services That Drive Success***

In designing modern desalination plants, low-cost water production and system availability are major considerations. Regardless of the desalination process, Flowserve is there to support customers with equipment and services that advance these goals:

- Broad hydraulic range to meet any process condition
- Hydraulic and materials engineering expertise to overcome tough operating conditions
- The highest efficiency pumps and energy recovery devices
- Local support of parts, repairs and service through QRCs
- Condition monitoring and maintenance contracts that guarantee the availability and efficiency of the equipment
- Educational services that train customer personnel in the selection, operation and maintenance of pumps, energy recovery devices, seals and valves

Flowserve is uniquely capable in providing this combination of technical expertise, products and services to support the desalination industry.





## Source Water Intake Pumps

Whether wet-pit, dry-pit or beach well, Flowserve offers a broad range of vertical and horizontal pumps designed for extended operation in source water intake.

### Vertical, Wet-Pit Pumps

Single or multistage vertical turbine diffuser type designs; submersible pumps with oil or water filled motor designs; pullout and non-pullout mixed flow models

#### Vertical Turbine Pump Operating Parameters

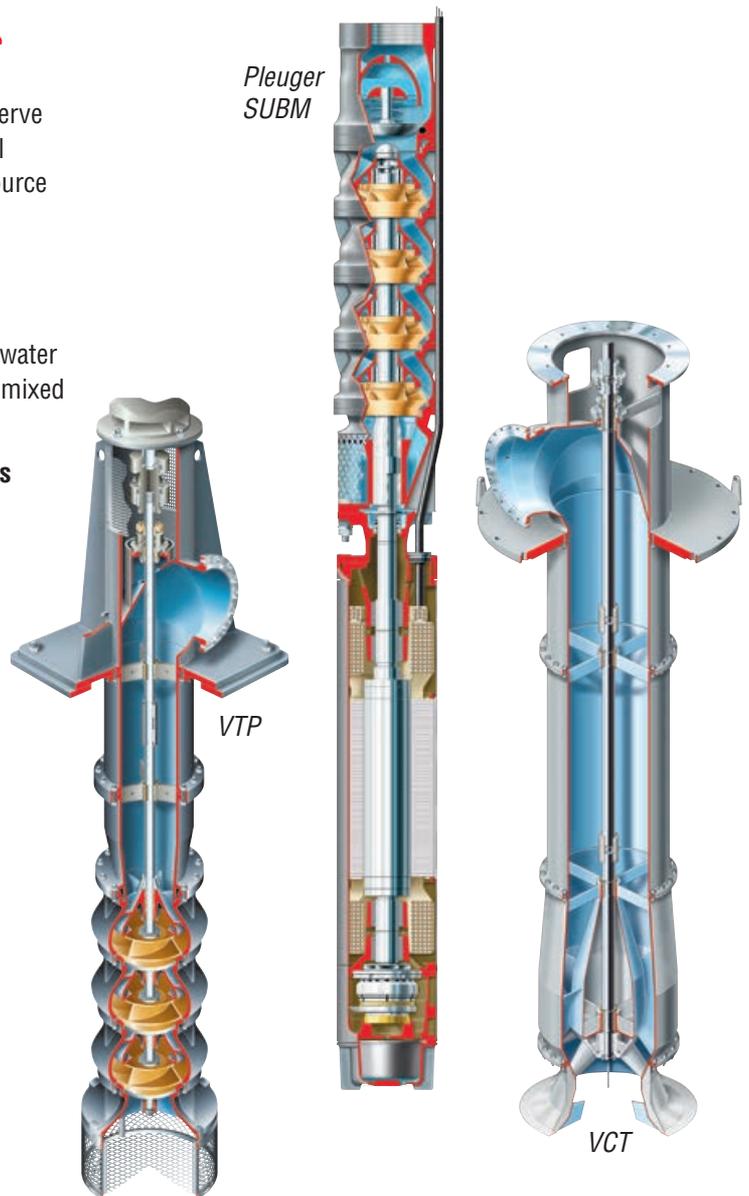
- Flows to 13 600 m<sup>3</sup>/h (60 000 gpm)
- Heads to 1070 m (3500 ft)
- Pressures to 105 bar (1500 psi)
- Temperatures to 65°C (150°F)

#### Submersible Pump Operating Parameters

- Flows to 1500 m<sup>3</sup>/h (6600 gpm)
- Heads to 100 m (330 ft)
- Pressures to 35 bar (500 psi)
- Temperatures to 120°C (250°F)

#### Mixed Flow Pump Operating Parameters

- Flows to 115 000 m<sup>3</sup>/h (500 000 gpm)
- Heads to 55 m (180 ft)
- Pressures to 5 bar (75 psi)
- Temperatures to 65°C (150°F)



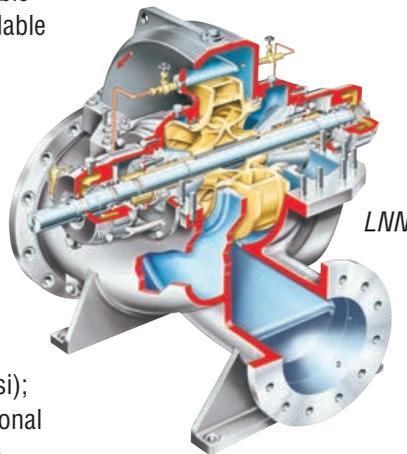


### **Horizontal, Dry-Pit Pumps**

Between bearings, axially split, double volute, double-suction pumps; vertical in-line configurations available for limited space requirements (LNN and LNNV)

#### **Operating Parameters**

- Flows to 51 000 m<sup>3</sup>/h (225 000 gpm)
- Heads to 300 m (985 ft)
- Pressures to 30 bar (435 psi)
- Temperatures to 150°C (300°F)



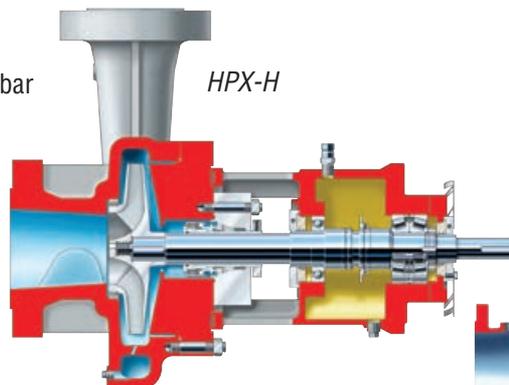
LNN

### **High-Pressure Booster Pumps**

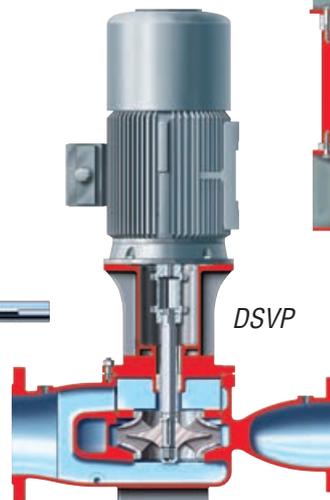
Efficiently operate under SWRO system pressure, where suction pressure can exceed 60 bar (870 psi); horizontal and vertical in-line designs with exceptional high-thrust capability available (HPX-H and DSVP)

#### **Operating Parameters**

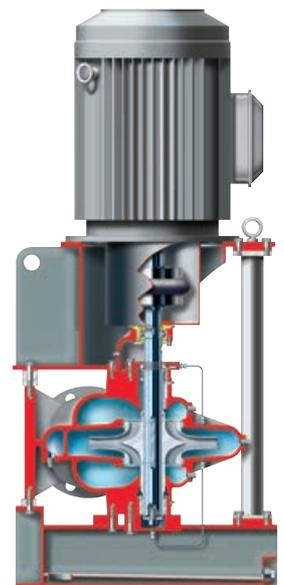
- Rated flows to 2000 m<sup>3</sup>/h (9000 gpm)
- Heads to 380 m (1250 ft)
- Pressures to 150 bar (2175 psi)



HPX-H



DSVP



LNNV



## ***Distillate Extraction, Brine Blowdown, and Brine Recirculation Pumps***

Flowserve vertical pumps incorporate proven hydraulics and metallurgies. They are particularly well suited for services with limited NPSHA or high temperatures.

### ***Vertical, Double Casing Pumps***

Single and multistage configurations; above or below ground suction

#### **Operating Parameters**

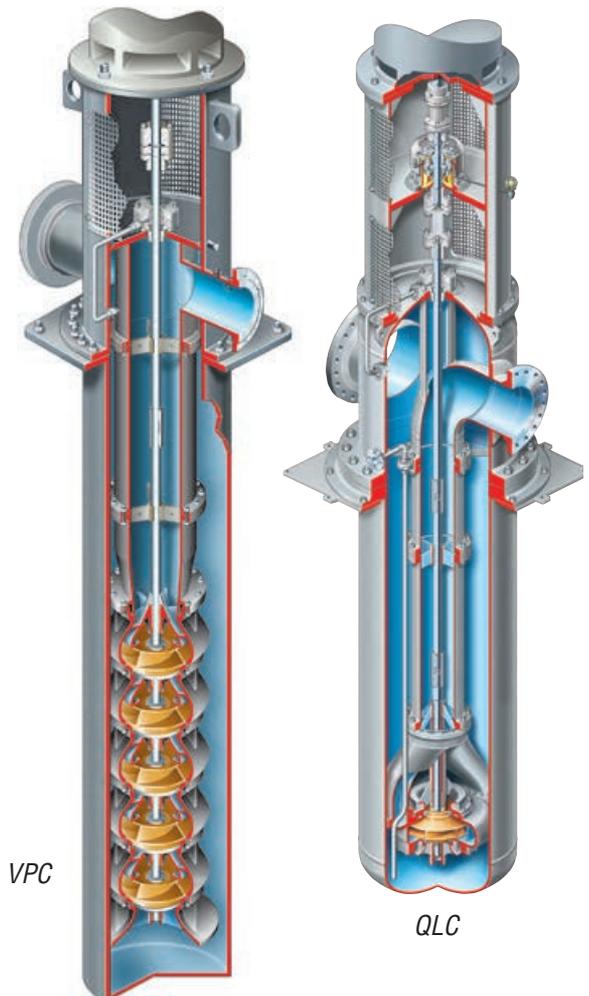
- Flows to 13 600 m<sup>3</sup>/h (60 000 gpm)
- Heads to 1070 m (3500 ft)
- Pressures to 100 bar (1450 psi)

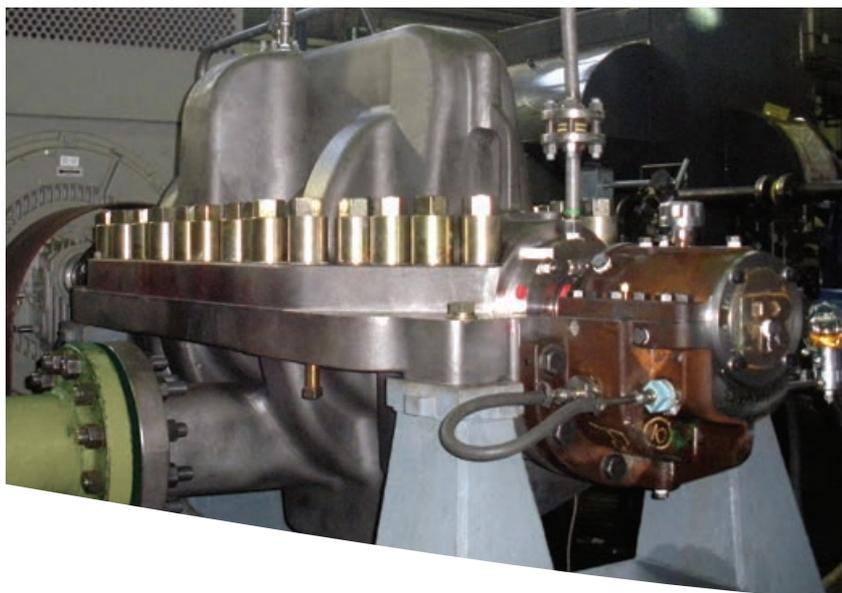
### ***Vertical, Double Casing, Double-Suction, Double Volute Pumps***

Innovative double-suction impeller produces more flow and higher head at lower NPSHA.

#### **Operating Parameters**

- Flows to 18 000 m<sup>3</sup>/h (79 200 gpm)
- Heads to 100 m (330 ft)
- Pressures to 15 bar (220 psi)





## Feed Pumps

The Flowserve product line includes axially and radially split multistage pumps for high-pressure feed service. These pumps are available in a variety of metallurgies specifically designed to withstand the corrosive nature of the fluids pumped.

### **Multistage, Axially Split, Volute Pumps**

Between bearings, axially split, double volute case, side suction, side discharge

#### **Operating Parameters**

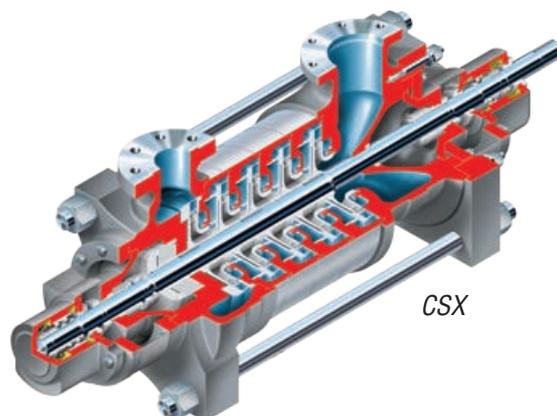
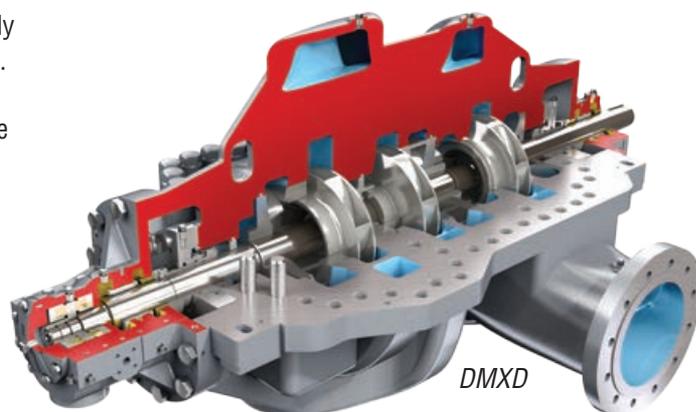
- Flows to 5000 m<sup>3</sup>/h (22 000 gpm)
- Heads to 2100 m (7000 ft)
- Pressures to 275 bar (4000 psi)

### **Multistage, Segmental Ring Diffuser Pumps**

Radially split, segmental ring, single-suction designs

#### **Operating Parameters**

- Flows to 600 m<sup>3</sup>/h (2650 gpm)
- Heads to 900 m (2950 ft)
- Pressures to 100 bar (1450 psi)





## Flowserve Calder™ Energy Recovery Devices

Flowserve manufactures a variety of equipment to recover energy from reverse osmosis desalination processes, thereby improving their cost effectiveness.

### Dual Work Exchange Energy Recovery (DWEER)

The Calder DWEER is the most efficient energy recovery device ever developed. It can recover up to 98% of the energy in the brine waste stream, which is then used to pressurize raw water.

#### Operating Parameters

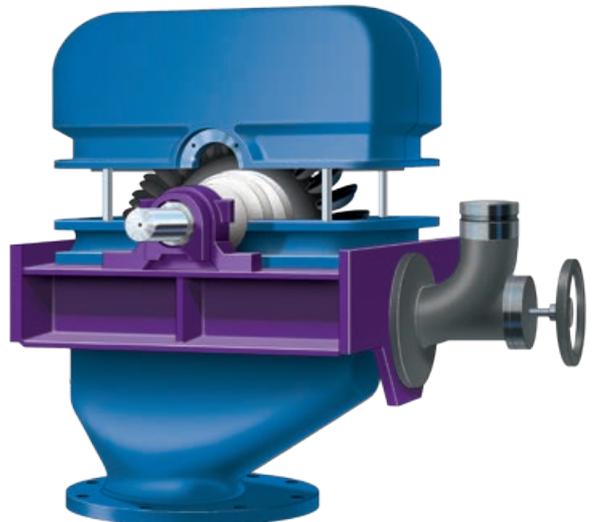
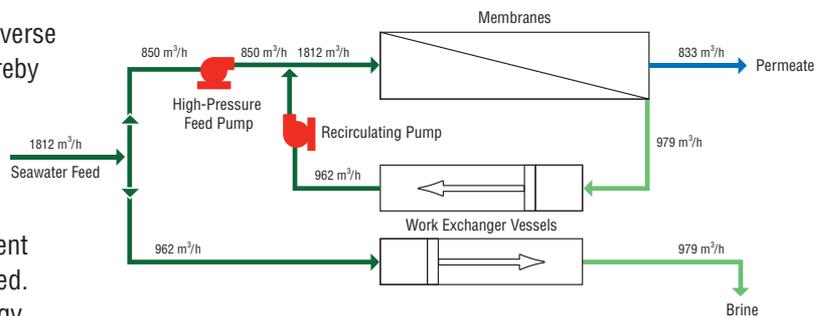
- Brine flow up to 350 m<sup>3</sup>/h (1.4 MGD) per unit
- Greater flows are achieved by placing multiple DWEER units in parallel.

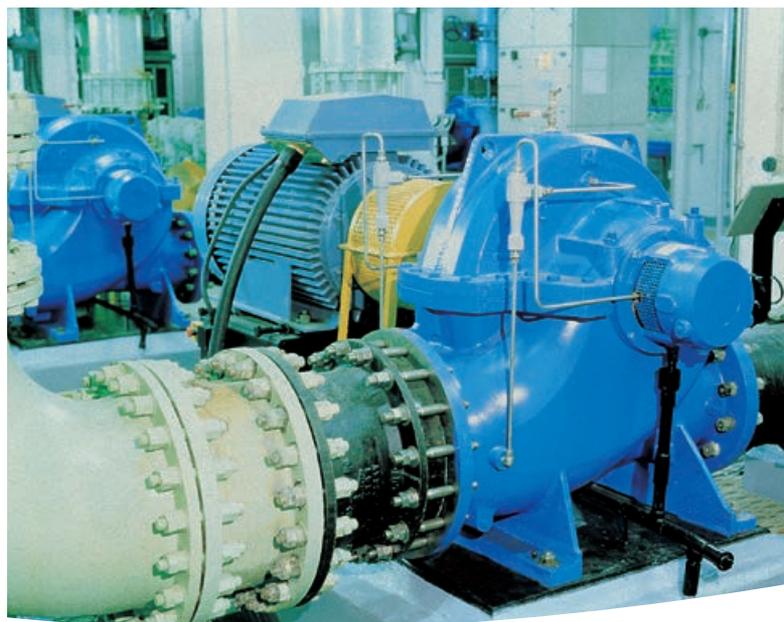
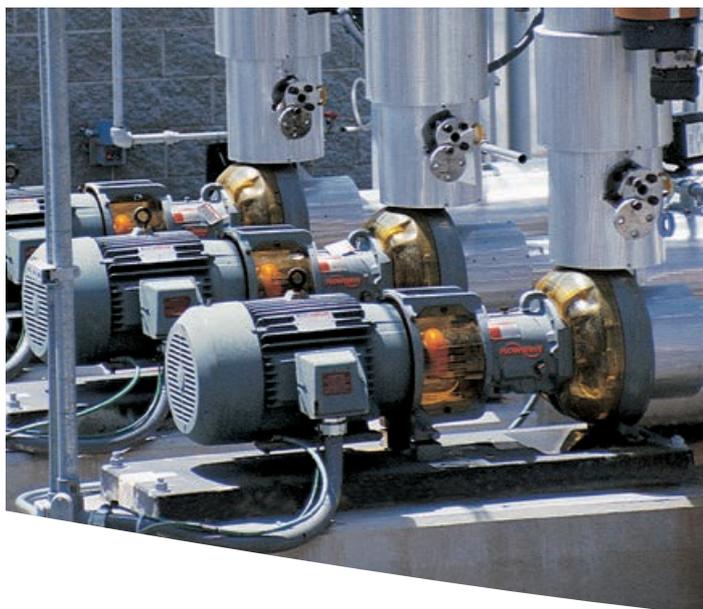
### Energy Recovery Turbines (ERT)

Calder ERTs are designed to convert the hydraulic energy of the brine waste stream into rotary power, used to drive the high-pressure feed pump train or a generator.

#### Operating Parameters

- Brine flow to 1200 m<sup>3</sup>/h (5280 gpm) standard; special designs available on request
- Efficiency up to 90%
- Power to 1500 kW (2025 hp)





## Auxiliary Service Pumps

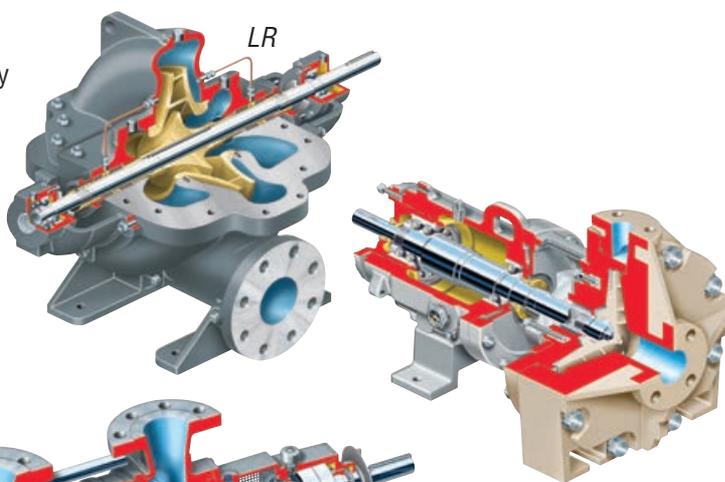
Flowserve can provide pumping solutions for virtually all desalination plant support services.

### Product Water and Transfer Pumps

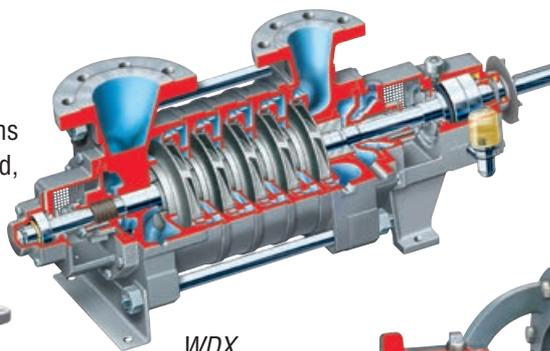
- Horizontal overhung, foot or centerline mounted
- Vertical in-line, single- or double-suction
- Between bearings, axially split, double-suction
- Vertical turbine, single or double case
- Radially split, multistage ring section

### Chemical Cleaning and Filter Backwash Pumps

- ASME, ISO and DIN models
- Metallic and non-metallic constructions
- Standard, low flow, dynamically sealed, self-priming, recessed impeller, in-line and magnetically sealed configurations available



PolyChem™ GRP



WDX



Durco Mark 3™



PolyChem S-Series



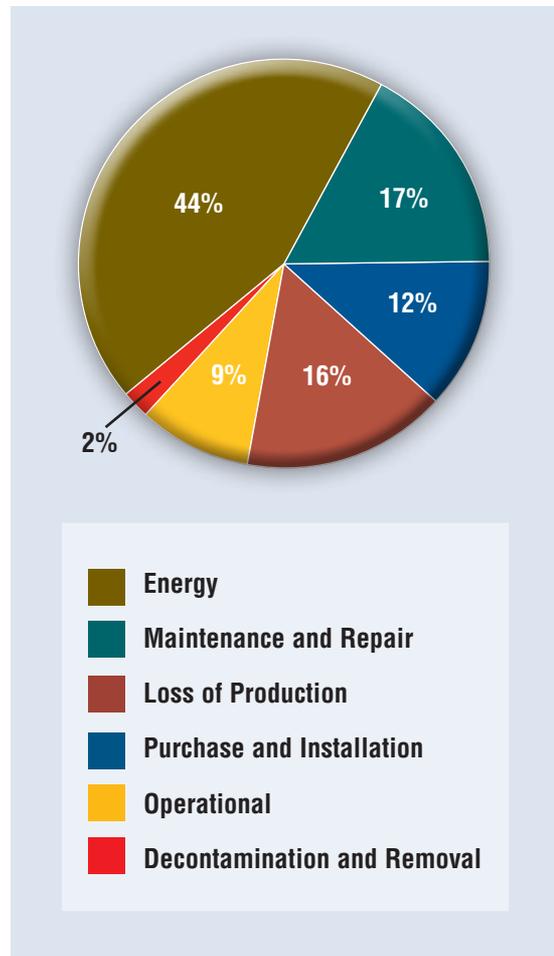
## Life Cycle Cost Solutions

Typically, 90% of the total life cycle cost (LCC) of a pumping system is accumulated after the equipment is purchased and installed. Flowserve has developed a comprehensive suite of solutions aimed at providing customers with unprecedented value and cost savings throughout the life span of the pumping system. These solutions account for every facet of life cycle cost, including:

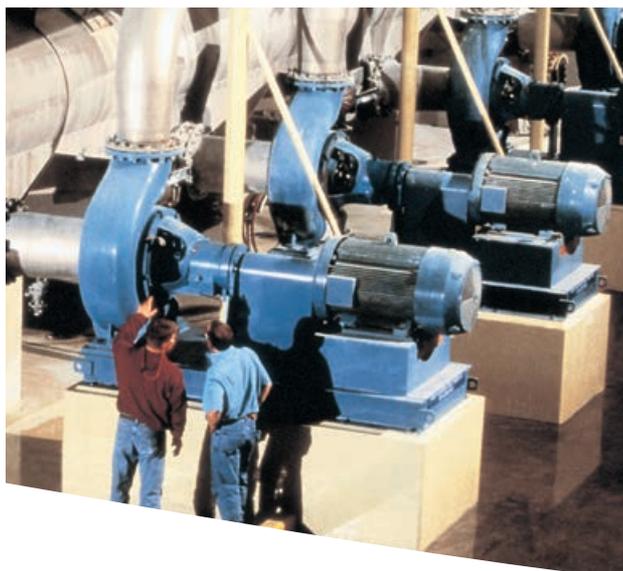
- Capital Expenses
  - Initial purchase
  - Installation
- Operating Expenses
  - Energy consumption
  - Maintenance
  - Production losses
  - Environmental
  - Inventory
  - Operating
  - Removal



### Typical Pump Life Cycle Costs<sup>1</sup>



<sup>1</sup> While exact values may differ, these percentages are consistent with those published by leading pump manufacturers and end users, as well as industry associations and government agencies worldwide.



## ***Innovative Life Cycle Cost Programs***

### **New Pump Selection**

FlowsERVE provides front-end consulting services that balance initial procurement cost with longer-term operational concerns, including equipment reliability and energy consumption. Proper upfront selection of a high-efficiency, high-energy pump can literally save millions of dollars in operating costs over the life of the system.

### **Turnkey Engineering and Field Service**

FlowsERVE offers turnkey engineering capabilities to streamline capital expenses related to piping design, foundation engineering, electrical systems and instrumentation. FlowsERVE technicians can offer installation and commissioning solutions that significantly reduce installation time such as advanced laser alignment and ungrouted foundation solutions.

### **Energy Management**

Pumping systems can comprise between 20% and 50% of energy usage in typical industrial plants and as much as 95% in pipeline systems. On behalf of its customers, FlowsERVE actively pursues hydraulic re-rates, pump upgrades and system enhancements that offer energy savings between 30% and 50% of existing levels. A typical improvement program may involve field assessments, analytical modeling and investment recommendations.

### **Pump Availability**

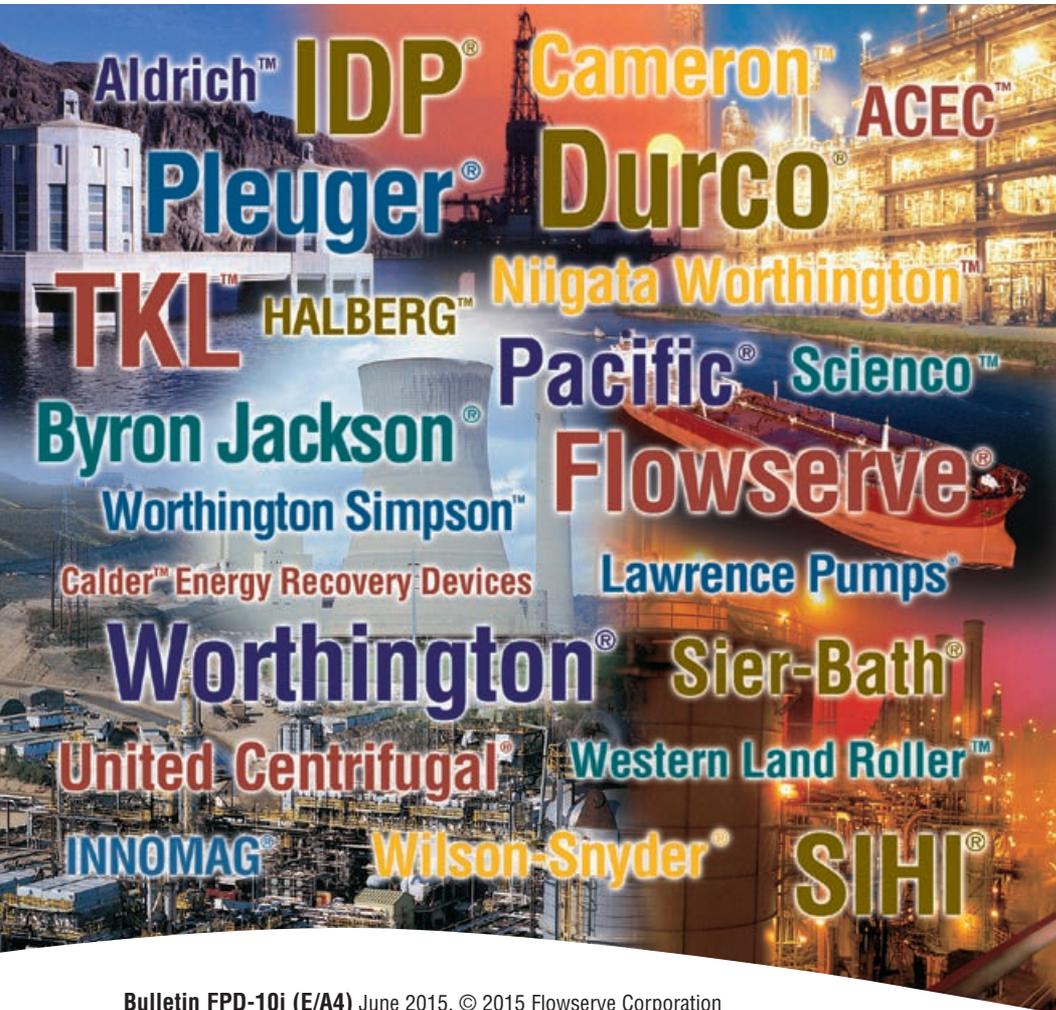
FlowsERVE engineers and technicians have been specially trained to help customers analyze, diagnose and solve those issues that cause problematic pump breakdowns and unscheduled outages. Engineers are equipped to collect real-time data, review performance problems, analyze data and make recommendations that result in improved pump system availability and higher profits.

### **Proactive Maintenance**

FlowsERVE technicians are trained to provide services that go beyond simple reactive maintenance and repair. By analyzing failure modes, FlowsERVE can offer upgrades ranging from materials and coatings upgrades to hydraulic re-rates — all aimed at increasing pump reliability.

### **Inventory Management**

Programs that help standardize materials, maximize interchangeability and increase part and assembly availability can have a significant impact on costs associated with spare parts inventory. Asset management experts from FlowsERVE can offer customized programs that reduce inventory levels while ensuring availability of critical parts.



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***To find your local Flowserve representative:***

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