



# ***Pumps for Geothermal Power Generation***

Production Well • Heat Transfer Fluid  
Condensate Extraction • Circulating Water • Re-injection Well



***Experience In Motion***





## ***Harnessing the Earth's Power***

*Flowserve is the driving force in the global industrial pump marketplace. From the direct acting steam pump in 1840 to today's most advanced traditional and alternative power stations, Flowserve has pioneered virtually every significant advancement in pumping technology for the power generation industry.*

Today, Flowserve is extending that leadership to geothermal power generation. From advanced vertical downhole and submersible production well pumps to heavy-duty re-injection well designs and everything in between, Flowserve offers the industry's most comprehensive package of pumping systems, engineering services and application know-how to support all aspects of geothermal power generation.

## ***Supplier of Choice for Geothermal Power Generation***

Arguably the only reliable renewable option for base-load power generation, geothermal power is both sustainable and environmentally friendly.

Yet, geothermal power generation poses severe operating challenges. Pressures and temperatures vary widely from installation to installation, as does feed water quality. Superheated steam as well as chloride-rich and heavy metals-laden brines elevate corrosion risks. As a result, materials selection and hydraulic specification are critical factors in successful pump and system performance.

Flowserve is uniquely qualified to meet the punishing requirements of geothermal power generators. It has the materials expertise to minimize the impact of corrosion without driving up costs. And, Flowserve hydraulic engineering and applications know-how can solve stubborn NPSHa challenges along with cavitation and flashing phenomena to assure long-lived and efficient system operation.





## ***A Complete Package***

Flowserve can provide geothermal plant operators with a complete package of reliable, proven pumps and sealing systems along with the power industry's most accomplished team of technical support and field service experts.

- Vertical downhole and submersible motor production well pumps
- Axially split, between bearings and multistage, double-case re-injection and transfer pumps
- ISO, ASME and API overhung, process booster pumps
- Canned, multistage, vertical condensate extraction pumps
- Vertical and horizontal circulating water pumps
- ASME and ISO chemical process pumps
- Overhung, end-suction as well as between bearings auxiliary service pumps
- Complete lines of pusher and bellows type seals

## ***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.

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

Flowserve partners with customers to respond to the dynamic business conditions that affect them and 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.





*Flowserve provides the best combination of equipment, materials expertise and auxiliary systems for efficient and reliable pump.*



## ***Pumps for All Applications***

Converting geothermal fluids to electricity presents varied and unique pumping demands. No two sites are the same so pumping systems must be designed to site-specific operating parameters. Whether using superheated steam or chloride-rich hot water, Flowserve provides the best combination of equipment, materials expertise and auxiliary systems for efficient and reliable pump operation in geothermal power generation.

### ***Production Well***

Steam and geothermal brines present very difficult challenges for pumps and mechanical seals:

- Lineshafts can stretch under high temperatures, resulting in shaft misalignment and reducing critical pump clearances. Pump efficiency is compromised.
- Silica and calcite fouling obstruct critical pump clearances, dramatically impacting pump maintenance and reliability as well as motor sizing and efficiency.
- Chloride-rich brines can induce stress corrosion cracking.
- High-velocity, superheated steam is highly erosive.

Flowserve engineers have the requisite mechanical design and materials expertise to successfully address the high-temperature scaling corrosion and erosion issues related to production well pumping.

Flowserve offers several pump models that deliver reliable and extended operation in production well service. Flowserve is one of the few pump manufacturers to offer both vertical lineshaft and deep-well submersible pumps for downhole service.

### ***Heat Transfer Fluid***

In binary cycle plants there are many issues related to heat transfer fluid (HTF) pumping. Pump and seal reliability are at the top of the list in maximizing the thermodynamic efficiency of the brine/working fluid heat exchange system. But health, safety and environmental considerations are also of high importance. Working fluids – propane, butane, pentane, ammonia – are flammable, toxic, ozone-depleting and contributors to global warming.

Flowserve offers the broadest lines of pumps for HTF feed and booster/circulation services:

- ISO and ASME chemical process pumps
- API (OH2) overhung process
- API (BB2) between bearings radially split pumps
- API (VS6) vertical double-case pumps

### ***Condensate***

Flowserve has a long and proven record in condensate service. Its versatile line of condensate pumps offers unsurpassed hydraulic coverage and a broad range of options to address system requirements. Both single- and double-suction first-stage, vertical canned pump designs are available. Horizontal booster pumps are also offered to provide continuous, extended operation.



### ***Circulating Water***

Flowserve offers both vertical and horizontal circulating pumps in a wide range of configurations, hydraulics and materials to meet any application requirement in these low-head, high-flow services. Vertical wet-pit pumps are specifically designed for extended operation in condenser cooling service and are available in pullout and non-pullout designs. For geothermal plants relying on seawater for condenser cooling service, Flowserve provides mixed flow pumps in materials to contend with crevice corrosion pitting and stress cracking caused by concentrated chlorides.

### ***Re-injection Well Service***

Silica sealing, the precipitation of silica from cooling brine, is a problem commonly associated with the injection well pumping. As with production wells, mineral scaling can cause equipment design and materials selection concerns, requiring careful attention.

Flowserve offers a variety of axially split, between bearings single-stage pumps for re-injection well service. These high-head, high-volume pump designs are compliant with ISO 13709/API 610 (BB1), latest edition, and may be fitted with variable speed motors. Flowserve also offers high-energy multistage process barrel pumps for the high-pressure re-injection applications found in many dry steam units.

### ***Auxiliaries***

Flowserve offers extensive lines of ISO, ASME, API, special-purpose and general service centrifugal pumps for balance-of-plant applications, including:

- Cooling water chemical treatment for pH control
- Brine treatment to remove or recover salts, silica, heavy metals, etc.
- Fire suppression
- Waste brine pond/lagoon transfer
- Treated sewage effluent transfer or injection
- District heating applications



Top left photograph courtesy of the National Renewable Energy Laboratory (NREL). The NREL is not affiliated with Flowserve.

*Flowserve pumps  
deliver reliable,  
extended operation  
in production  
well service.*



## ***Production Well Pumps***

Flowserve offers both deep set vertical lineshaft pumps and submersible motor pumps that deliver reliable and extended operation in production well service.

### ***Vertical Downhole Pumps***

Enclosed lineshaft with threaded column; high temperature construction. Increased lateral clearance to accommodate shaft stretch.

#### **Operating Parameters**

- Flows to 500 m<sup>3</sup>/h (2200 gpm)
- Heads to 700 m (2300 ft)
- Pressures to 70 bar (1000 psi)
- Temperatures to 200°C (400°F)
- Motor sizes to 750 kW (1000 hp)
- Settings to 350 m (1150 ft)

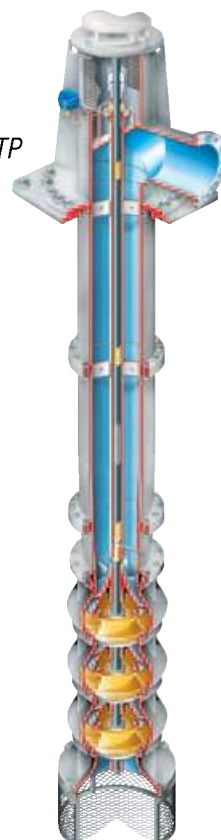
### ***Deep-Well Submersible Motor Pumps***

Vertical, oil-filled model with an internal cooling system and advanced heat transfer design; high-volume compensator module; integrated downhole monitoring system; modular motor design accommodates changing duty conditions.

#### **Operating Parameters**

- Flows to 900 m<sup>3</sup>/h (3960 gpm)
- Heads to 750 m (2461 ft)
- Temperatures to 160°C (320°F)
- Motor sizes to 1500 kW (2000 hp)
- Settings to 1000 m (3281 ft)

VTP



Byron  
Jackson  
SUBM







## Heat Transfer Fluid Pumps

Flowserve offers numerous horizontal and vertical process pumps to cost effectively address virtually all heat transfer fluid (HTF) service parameters in binary cycle units.

### **Multistage, Double-Case Vertical Pumps**

ISO 13709/API 610 (VS6), latest edition, compliant pumps for primary HTF service.

#### **Operating Parameters**

- Flows to 3000 m<sup>3</sup>/h (13 200 gpm)
- Heads to 2000 m (6560 ft)
- Pressures to 200 bar (2900 psi)
- Temperatures to 350°C (660°F)

### **API Overhung Process Pumps**

Centerline mounted, horizontal pumps for primary HTF service. Compliant with ISO 13709/API 610 (OH2), latest edition.

#### **Operating Parameters**

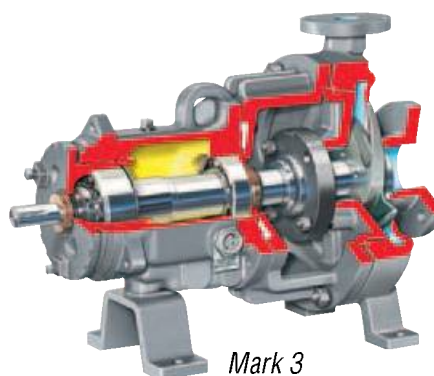
- Flows to 2000 m<sup>3</sup>/h (9000 gpm)
- Heads to 350 m (1100 ft)
- Pressures to 80 bar (1160 psi)
- Temperatures to 455°C (850°F)

### **ASME Pumps for Auxiliary Service**

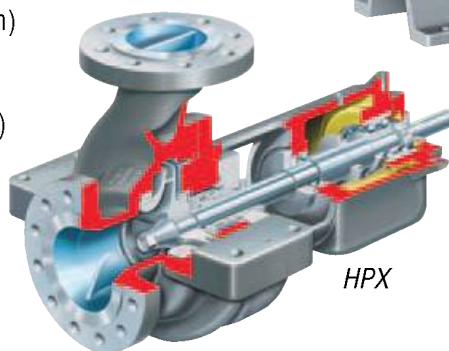
Single-stage, overhung pumps for auxiliary HTF services such as secondary recirculation, overflow, makeup and storage.

#### **Operating Parameters**

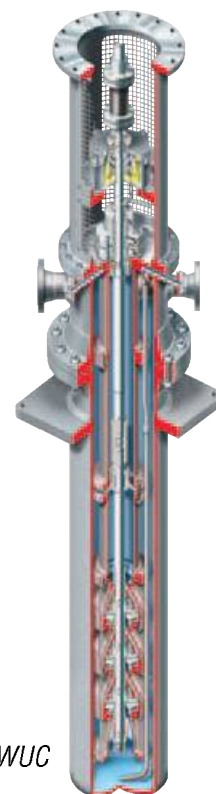
- Flows to 1680 m<sup>3</sup>/h (7400 gpm)
- Heads to 215 m (700 ft)
- Pressures to 27 bar (400 psi)
- Temperatures to 370°C (700°F)



Mark 3



HPX



WUC

*No other pump company has the systems knowledge, hydraulic expertise or application know-how Flowserve possesses.*



## ***Condensate Extraction Pumps***

Flowserve has a long and proven performance record in condensate extraction. Its versatile line of vertical condensate pumps has unsurpassed hydraulic coverage and are available with a broad range of options to address system requirements.

### ***Vertical, Multistage Canned Pumps***

Multistage, mixed flow designs with single- or double-suction first-stage impeller to fit NPSH requirements; mechanically sealed; optional spacer coupling.

#### **Operating Parameters**

- Flows to 4600 m<sup>3</sup>/h (20 200 gpm)
- Heads to 500 m (1640 ft)
- Pressures to 50 bar (725 psi)
- Temperatures to 95°C (200°F)

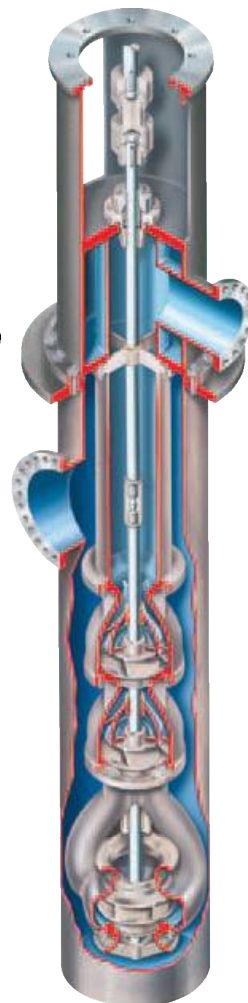
### ***Vertical Turbine Canned Pumps***

Multistage, diffuser casing designs with large eye first-stage impeller for enhanced suction characteristics; mechanically sealed; optional spacer coupling.

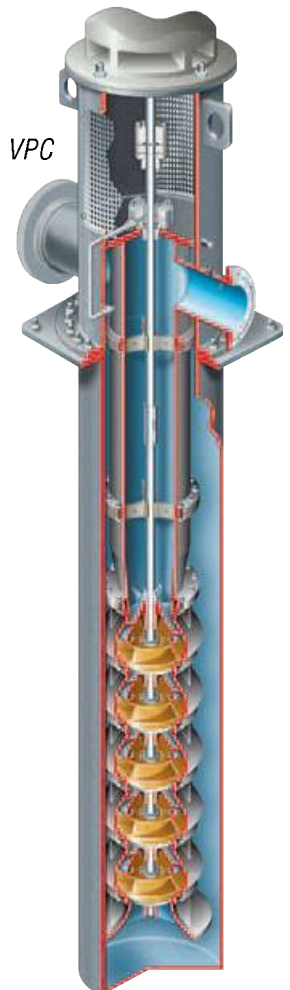
#### **Operating Parameters**

- Flows to 13 600 m<sup>3</sup>/h (60 000 gpm)
- Heads to 1070 m (3500 ft)
- Pressures to 100 bar (1450 psi)
- Temperatures to 230°C (450°F)

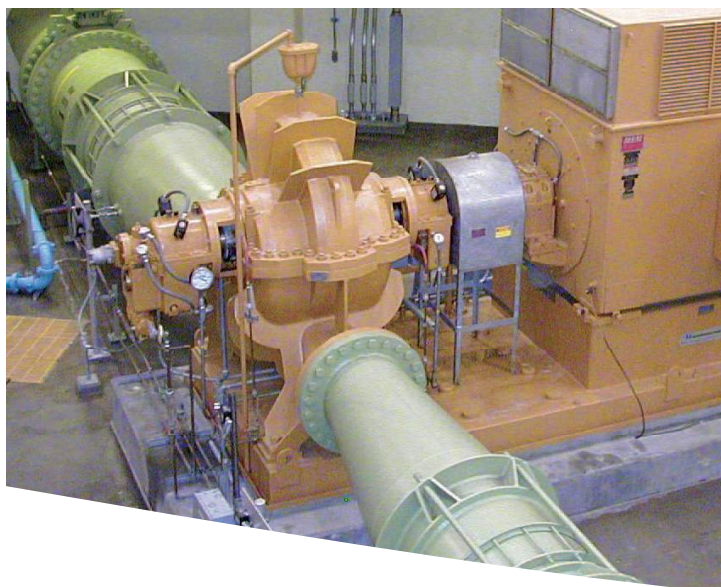
APKD



VPC







## Circulating Water Pumps

Flowserve offers several vertical and horizontal pump models for reliable and extended operation in circulating water service. Pumps are available in a wide range of configurations, hydraulics and materials to maximize efficiency while meeting site requirements.

### Vertical, Wet-Pit Pumps

Mixed flow; pullout and non-pullout designs.

#### Operating Parameters

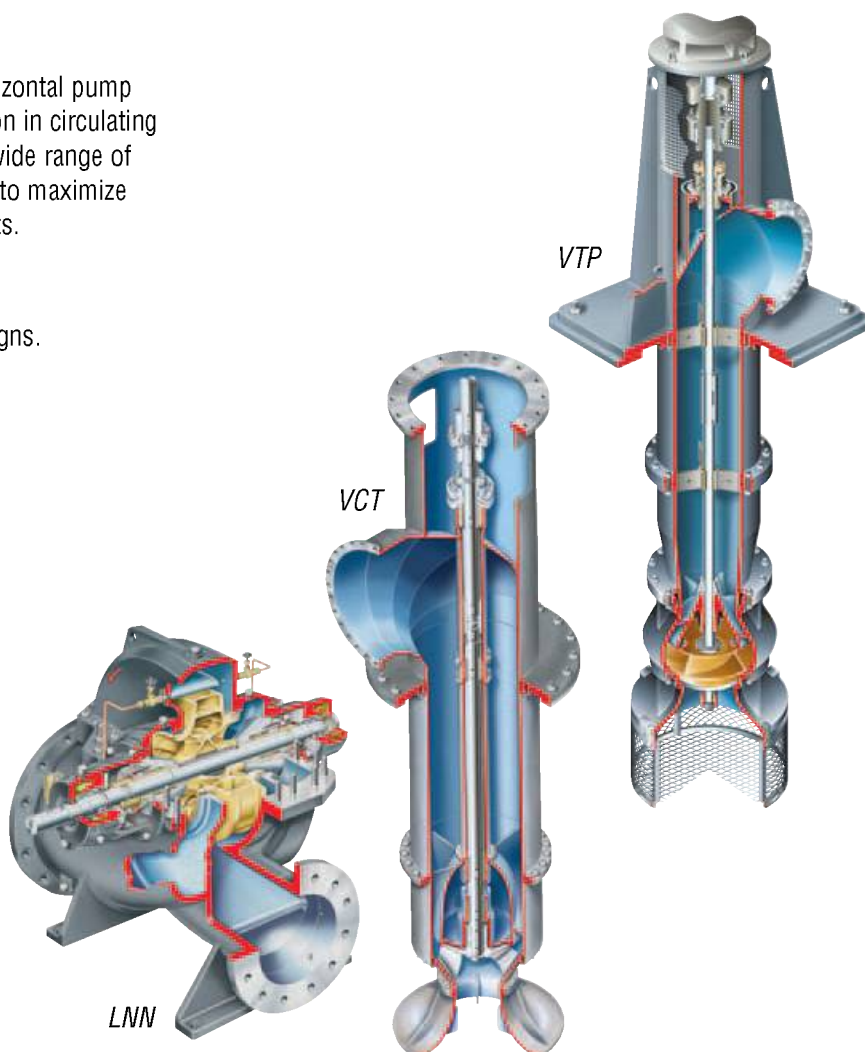
- Flows to 170 000 m<sup>3</sup>/h (750 000 gpm)
- Heads to 110 m (350 ft)
- Pressures to 10 bar (150 psi)
- Temperatures to 95°C (200°F)

### Horizontal, Between Bearings, Single-Stage Pumps

Heavy-duty, axially split, double-volute, double-suction.

#### 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)



*Flowserve offers several proven pump designs for re-injection well service.*



## ***Re-injection Well Pumps***

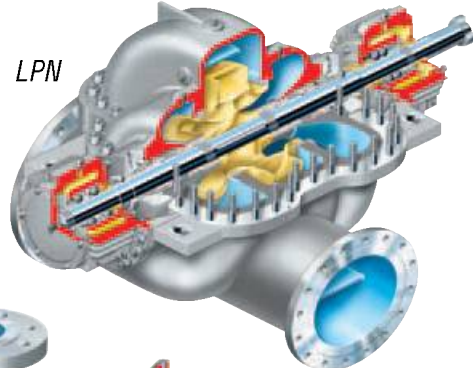
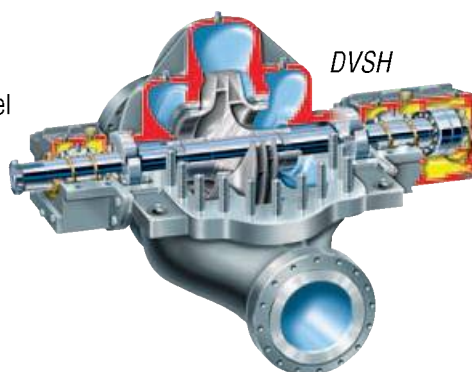
Flowserve offers several proven pump designs for re-injection well service, including high-pressure barrel pumps for hot dry rock installations. These pumps offer a wide range of discharge pressures to ensure optimum performance and suit site conditions.

### ***Axially Split, Between Bearings, Single-Stage Pumps***

Heavy-duty, double-volute, double-suction pumps compliant with ISO 13709/API 610 (BB1), latest edition.

#### **Operating Parameters**

- Flows to 15 000 m<sup>3</sup>/h (65 000 gpm)
- Heads to 565 m (1854 ft)
- Pressures to 150 bar (2175 psi)
- Temperatures to 200°C (400°F)

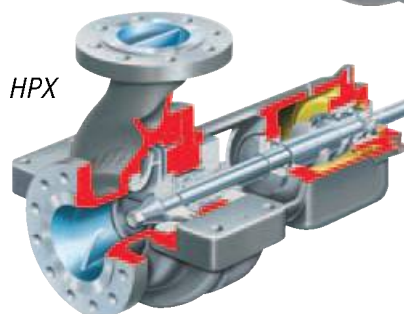


### ***API Process Booster Pumps***

Centerline mounted, single-stage, overhung pump compliant with ISO 13709/API 610 (OH2), latest edition.

#### **Operating Parameters**

- Flows to 2000 m<sup>3</sup>/h (9000 gpm)
- Heads to 350 m (1100 ft)
- Pressures to 80 bar (1160 psi)
- Temperatures to 455°C (850°F)

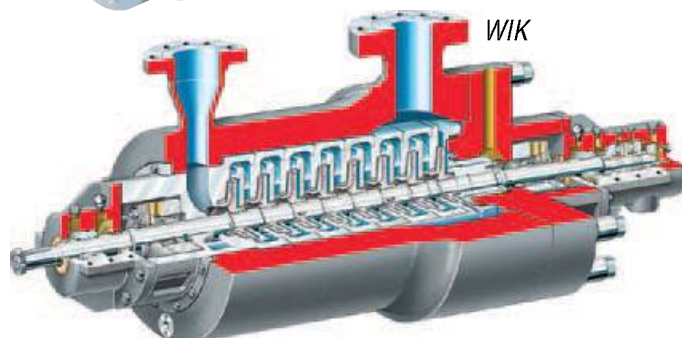


### ***High-Pressure, Multistage Barrel Re-injection Pumps***

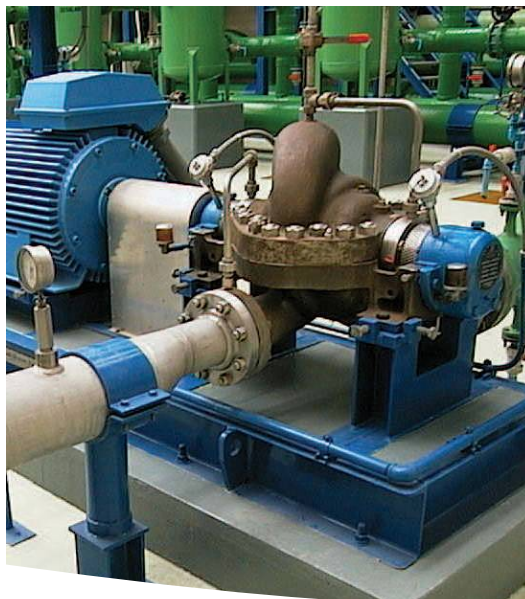
ISO 13709/API 610 (BB5), latest edition; multi-vane diffuser and channel ring design, tandem impellers, double-case barrel design.

#### **Operating Parameters**

- Flows to 4000 m<sup>3</sup>/h (17 600 gpm)
- Pressures to 650 bar (9425 psi)
- Temperatures to 450°C (840°F)







## Auxiliary Services Pumps

Flowserve pumps come in a wide variety materials and configurations to satisfy virtually all plant-wide needs.

### ASME, ISO and DIN Process Pumps

Many designs available: low-flow/high-head, self-priming, dynamic sealing, recessed impeller and in-line.

#### Operating Parameters

- Flows to 4540 m<sup>3</sup>/h (20 000 gpm)
- Heads to 300 m (1000 ft)
- Pressures to 30 bar (450 psi)
- Temperatures to 370°C (700°F)

### Axially Split, Single-Stage Pumps

Heavy-duty, high-efficiency design; broad hydraulic range. Well suited for district heating.

#### Operating Parameters

- Flows to 2000 m<sup>3</sup>/h (8800 gpm)
- Heads to 170 m (560 ft)
- Pressures to 21 bar (300 psi)
- Temperatures to 150°C (300°F)

### Segmental Ring Section Pumps

Multistage, radially split.

#### Operating Parameters

- Flows to 850 m<sup>3</sup>/h (3740 gpm)
- Heads to 700 m (2300 ft)
- Pressures to 60 bar (870 psi)
- Temperatures to 140°C (285°F)

