FLOWSERVE

Pipeline Transportation Pumps

Crude Oil and Refined Products • Water • Slurry



Experience In Motion







The Trusted Partner in Global Pipeline Pumping

Flowserve offers innovative pumping solutions for every conceivable pipeline application, including oil, refined products, carbon dioxide (CO_2) liquid gases, water and slurry services. With more than 200 years of industrial pump experience and 100 years of pipeline pumping experience, Flowserve has earned a pre-eminent position in the industry through advanced design, engineered solutions, equipment re-rates and customer service excellence.

Customers all over the world turn to Flowserve for creative solutions that improve pipeline:

- Safety
- Life cycle cost
- Profitability
- Reliability

Experience … Innovation … Leadership

From the first pipelines, Flowserve leads the industry through the development of innovative products and creative solutions addressing the ever-increasing requirements of flow and operating pressures.

Case Study: Hydraulic Re-rate

Installation: DVS single-stage, double-suction horizontal split case pumps on a 645 km (400 mi) pipeline in northwest United States to transport gasoline, diesel and jet fuel. Pipeline diameters: 300 mm (12 in) through 500 mm (20 in).

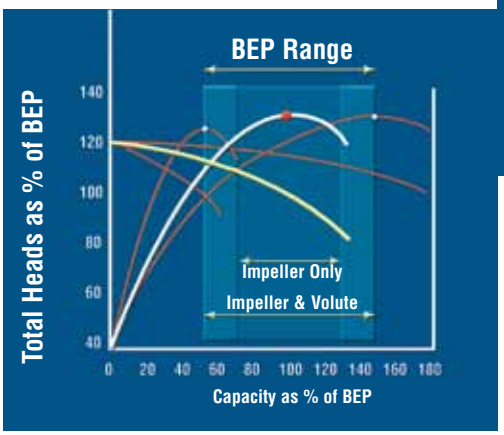
Problem: Over the years, pump flow rate had been significantly reduced, running at 46% BEP. In addition to lower efficiency, high vibration levels increased maintenance and operating costs.

Solution: Hydraulic re-rate to match lower current rated duty

- Replace impeller with lower flow design
- Reduce volute area to pull back BEP
- Increase volute cutwater diameter (“B” Gap)

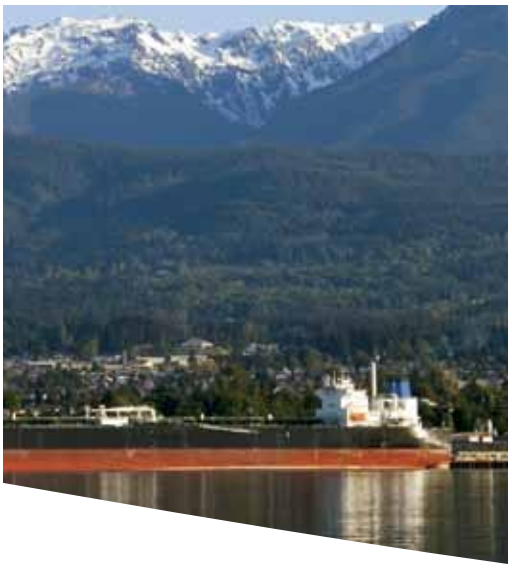
Benefit:

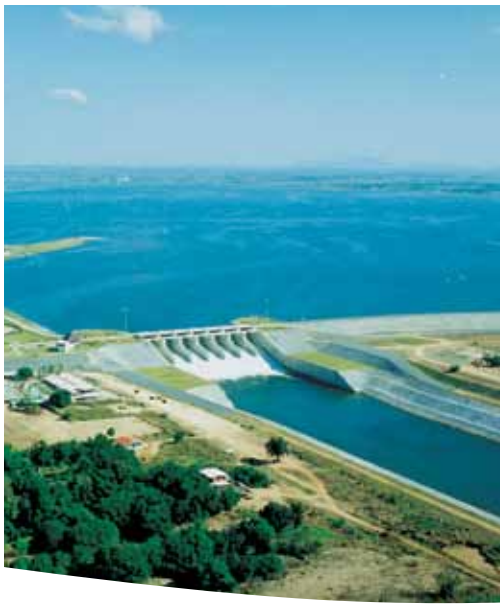
- Normal flow rate at 96% BEP
- Energy savings >135 kW (180 hp)
- Increased MTBR, resulting in maintenance savings





New volute lip extension tacked in place







A Complete Range of Pipeline Pumps

Crude Oil and Refined Product Pipeline Pumps

Mainline/Booster Pumps

- Single- and two-stage between bearings
- Multistage, horizontal split case
- Multistage, radially split double case
- Multistage vertical canned
- Twin screw multiphase

Auxiliary Pumps

- Single-stage overhung
- Vertical in-line
- Submersible motor
- Single-stage and multistage vertical wet pit
- Single-stage and multistage vertical canned
- Service-specific specialty designs

CO_2 Pipeline Pumps

- Single-stage, between bearings, radially split
- Multistage, horizontal split case
- Multistage, radially split double-case

Water Pipeline Pumps

- Single- and multistage overhung
- Axially split, single-stage between bearings
- Vertical turbine
- Submersible motor
- Horizontal, multistage ring section

Slurry Pipeline Pumps

- Single-stage overhung
  - – Hard metal
  - – Metallic and non-metallic lined
- Reciprocating positive displacement

All the Expertise You Need

Flowserve has the expertise to serve as the overall systems manager for pipeline operations. Working with architect and construction firms or in-house design teams, Flowserve provides turnkey services, pump-specific diagnostics, maintenance and repair, and a full spectrum of technical services to optimize the return on pipeline investment.

Whether new equipment or system upgrades, Flowserve aggressively advances pipeline pump technology. Further information about system and equipment upgrades may be found beginning on page 14.

Market-Focused Customer Support

Flowserve pipeline specialists provide customers the technical support necessary to develop effective solutions for tough pipeline challenges. These solutions can incorporate all manner of specific market and customer preferences. They offer technical advice and assistance throughout each stage of the product life cycle. From feasibility through pipeline design, inquiry through order fulfillment, installation through start-up and pipeline re-rates, Flowserve specialists work with customers to successfully achieve their operational goals.

FLOWSERVE

Heritage Names of Distinction

Byron Jackson®
IDP®
Pacific®
Pleuger®
United Centrifugal®
Worthington®





Crude Oil and Refined Product Pipeline Systems

Flowserve is the industry's preferred supplier of petroleum product pipeline pumps. Reliability makes Flowserve pumps the products of choice for unattended mainline operation in some of the world's most inhospitable environments. No other manufacturer offers a comparable breadth of products and services for transportation, transfer, storage and cargo stripping.

Flowserve has reliable and cost-effective solutions for the most demanding upstream and downstream pipeline applications.

Offshore Pipelines

Flowserve offers a complete line of single- and multi-stage pumps in either axial or radial split configurations. These pumps are perfectly suited for main oil line, transfer and tanker loading on offshore platforms. With a history of operating pumps at capacities up to 9500 m^3/h (41 825 gpm) and differential heads to 6000 m (19 685 ft), Flowserve has the proven products capable of moving crude oil directly from the platform to marine terminals or waiting tankers. And Flowserve is the only manufacturer offering the safety and reliability of shaft seals to ISO 21049/API 682.

Subsea

Flowserve is in the forefront of subsea technology with the application of integrated multiphase pumping and seabed processing systems.

CO_2 Pipelines

Flowserve has a significant amount of pioneering experience in the design and supply of pumping equipment for the transportation, injection and re-injection of CO_2. This capability is the result of: prior work on other near and supercritical fluids; and the development, design and supply of the pumping equipment for several CO_2 enhanced oil recovery projects. Pumps typically used in this application include horizontal axially split and radially split multistage pumps as well as specially designed high-pressure single-stage pumps. (See bulletin FPD-17 for more information.)

Experience:	**Refined Products Pipeline**
Installation:	More than 300 DVS single-stage, double-suction horizontal split case pumps (sizes 24 x 27, 24 x 29, 30 x 27 and 30 x 29) with driver sizes up to 3730 kW (5000 hp).
Application:	One of the world's largest products pipelines, 4665 km (2900 mi) from the Gulf Coast to mid-/northeastern United States. Pipeline diameters: 900 mm (36 in) through 1050 mm (42 in).









Diluent/Bitumen, Froth Transfer and Synthetic Crude Pipelines

Flowserve pumps are especially suited to the unique requirements of diluent/bitumen service for steam-assisted gravity drainage (SAGD). Through extensive knowledge of heat tracing and variable speed operation along with close working relationships with Flowserve seal experts and other mechanical seal suppliers, Flowserve pumps are custom-designed to suit each application. Typical models for this service include vertical canned and horizontal single- and multistage split case pumps.

In tar sands mining, Flowserve high-pressure, hard metal slurry pumps feed a mixture of air, water and bitumen down a pipeline from the sand extraction plant at the mine to the base plant for further extraction and refining. From here, axially split single- and multistage pumps transport the synthetic crude to the refinery.



Products Cavern and Well Storage Transfer Terminals

Flowserve leads the way in providing vertical wet-pit and submersible motor pump solutions for direct storage transfer pumping applications in salt dome and cavern services. Additionally, horizontal single- and multistage pumps offer excellent injection solutions for indirect storage transfer applications.

Crude Oil and Products Supply Pipeline and Terminals

Flowserve takes pride in its breadth of products designed for the transportation, transfer, storage and cargo stripping of crude oil and finished products for the pipeline market. With models ranging from pipeline sampling pumps to large radially split barrel mainline pumps, Flowserve can provide a cost-effective solution for all terminal and pipeline applications.

Ship, Tank Car and Truck Loading Terminals

With a full line of ISO 2858/5199, ANSI B73.1, ISO 13709/API 610, DIN and JIS compliant designs, Flowserve maintains the largest family of pumps to address any terminal application.

Low NPSH pumps in both horizontal and vertical configuration are also available for booster-station service.

FLOWSERVE

From the Producing Fields to the Market, Flowserve Has the Pipeline Pump Solution



1 DVSH/LPN/LPLD (BB1)
Axially Split, Single-Stage



2 UZDL (BB1)
Axially Split, Two-Stage
ALT. BFD (BB1)
Double-Suction



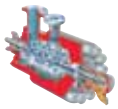
3 DVSR (BB2)
Radially Split, Double-Suction, Single-Stage



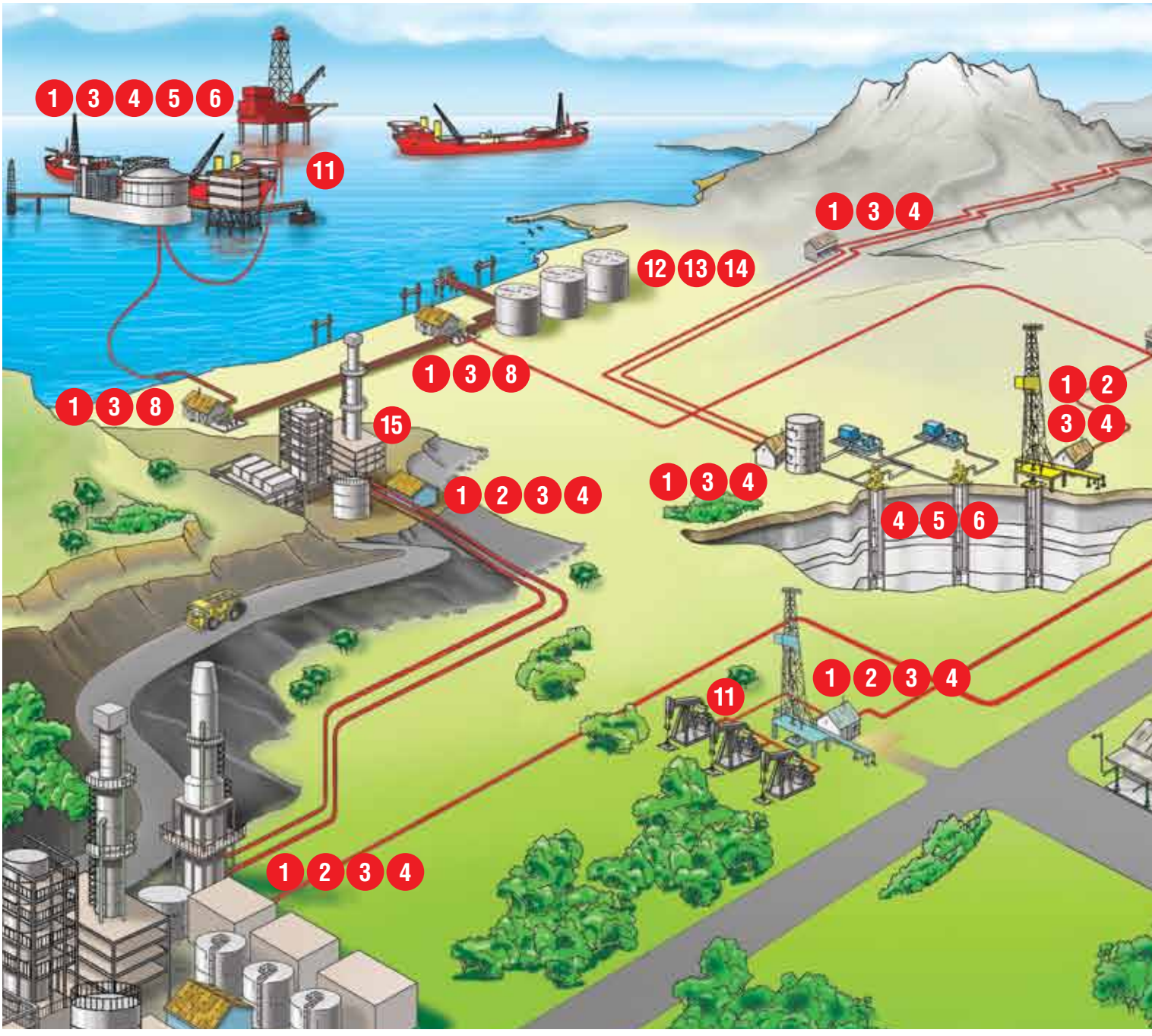
4 DMX (BB3)
Axially Split, Multistage



5 WCC/WIK (BB5)
Multistage, Diffuser Collector, Barrel Casing, Volute Collector



6 HDO/HSO (BB5)
Multistage, Volute Casing, Process Barrel





7 **WUJ/VTP (VS1)**
Wet-Pit

8 **VPC (VS6)**
Vertical Turbine, Double-Casing

ALT. WUC (VS6)
Double-Casing Multistage



9 **SUBM** – Deep-Well Submersible
(Pleuger water-filled) (Byron Jackson oil-filled)



10 **ESP3**
Vertical Immersion Sump



11 **MP1**
Multiphase



12 **HPX (OH2)**
Centerline Mounted



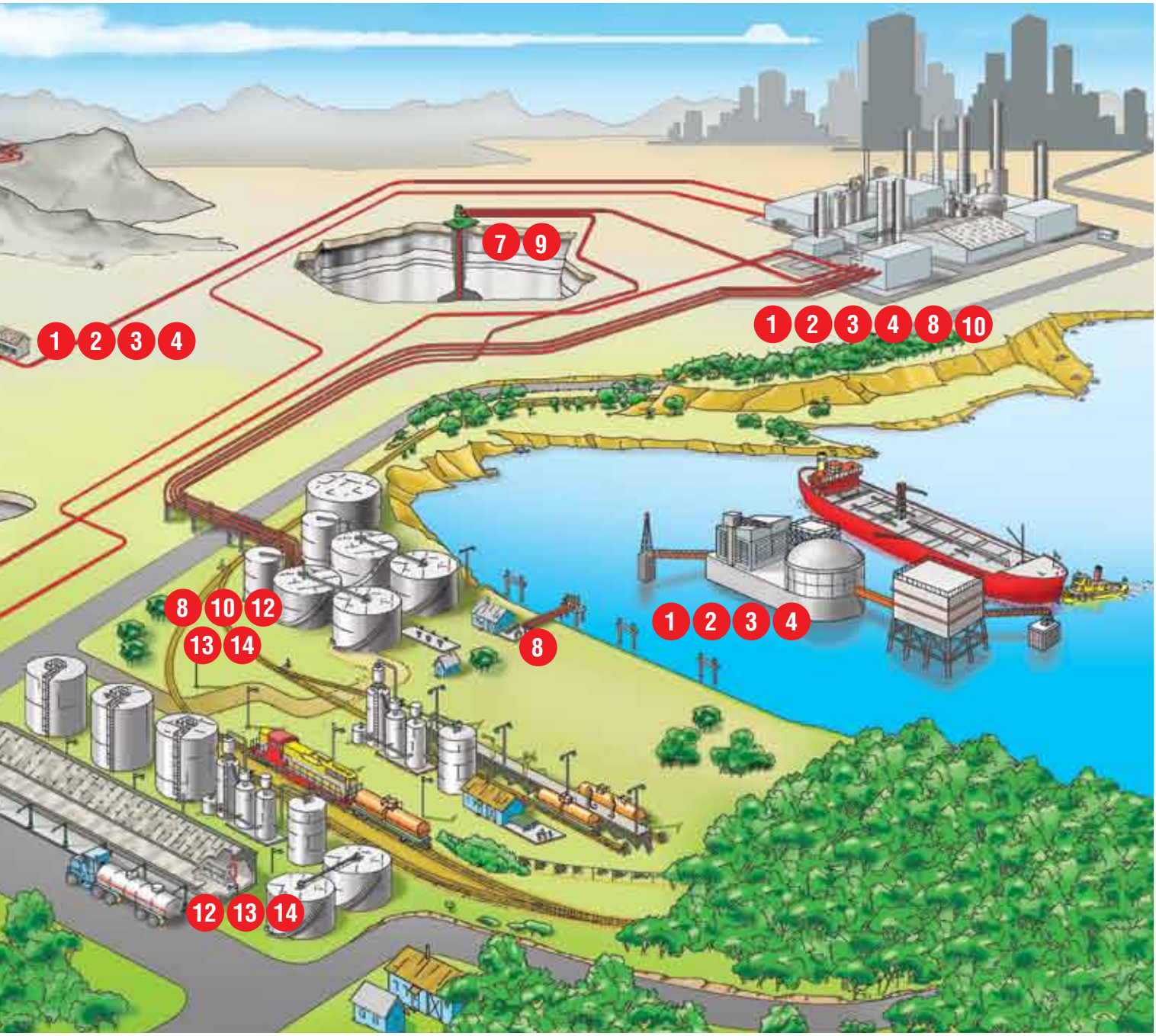
13 **PVXM (OH3)**
Vertical In-Line



14 **Mark 3™**
ASME and ISO Standards



15 **Type M**
Hard Metal



FLOWSERVE

The World's Most Complete Line of Crude, Petroleum and CO_2 Pipeline Pumps.



Mainline Pumps – Operating Parameters

DVSH/LPN/LPLD (BB1)
Axially Split, Single-Stage

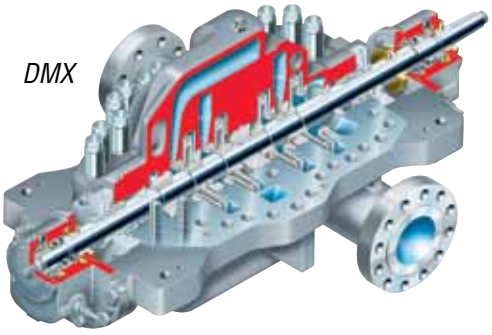
- Flows to 15 000 m^3/h (65 000 gpm)
- Heads to 565 m (1854 ft)
- Pressures to 150 bar (2175 psi)
- Speeds to 6000 rpm

UZDL (BB1)
Axially Split, Two-Stage

- Flows to 2950 m^3/h (13 000 gpm)
- Heads to 685 m (2250 ft)
- Pressures to 64 bar (910 psi)

DVSR (BB2)
Radially Split, Double-Suction Single-Stage

- Flows to 3635 m^3/h (16 000 gpm)
- Heads to 250 m (820 ft)
- Pressures to 260 bar (3750 psi)



DMX (BB3)
Axially Split, Multistage

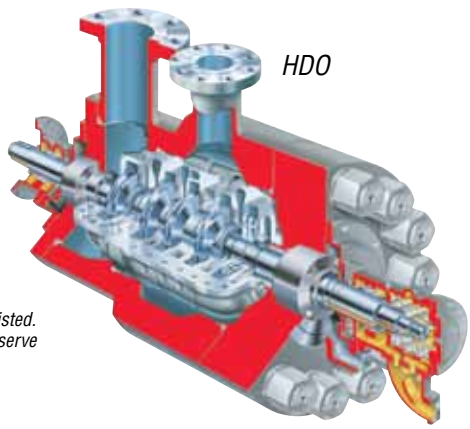
- Flows to 2950 m^3/h (13 000 gpm)
- Heads to 2130 m (7000 ft)
- Pressures to 275 bar (4000 psi)
- Speeds to 6000 rpm

WCC/WIK (BB5)
Multistage, Diffuser Collector, Barrel Casing

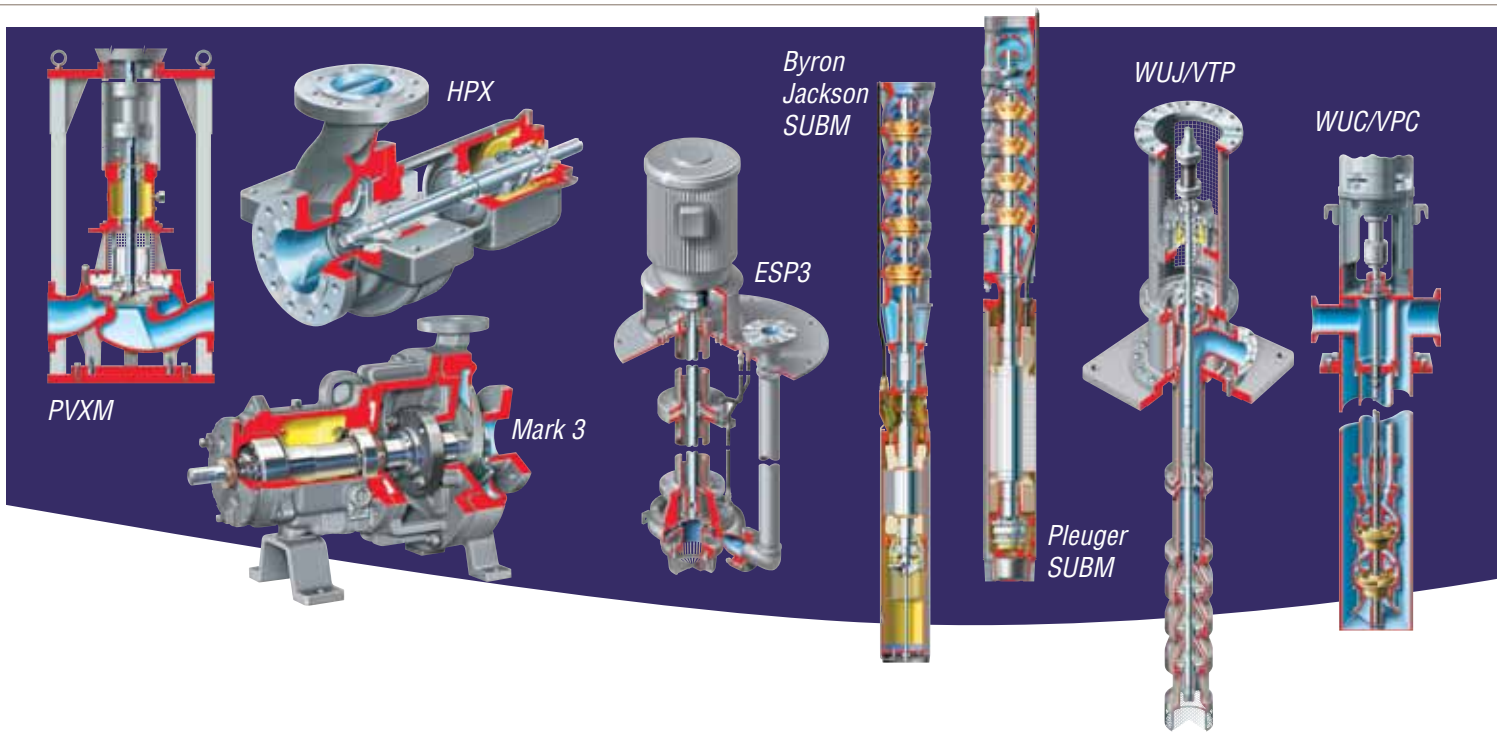
- Flows to 4000 m^3/h (17 610 gpm)
- Heads to 3050 m (10 000 ft)
- Discharge pressures to 650 bar (9425 psi)
- Speeds to 8600 rpm

HDO/HSO (BB5)
Multistage, Volute Collector, Barrel Casing

- Flows to 4000 m^3/h (17 610 gpm)
- Discharge pressures to 450 bar (6525 psi)
- Speeds to 9000 rpm



Note: The above values indicate the typical performance envelope for the models listed. Flowserve has significant experience beyond these limits. Consult your Flowserve representative with your specific performance requirements.



Auxiliary Services Pumps – Operating Parameters

HPX (OH2) Centerline Mounted

- Flows to 2000 m^3/h (8800 gpm)
- Heads to 350 m (1100 ft)
- Pressures to 80 bar (1160 psi)

PVXM (OH3) Vertical In-Line

- Flows to 500 m^3/h (2200 gpm)
- Heads to 275 m (900 ft)
- Pressures to 40 bar (600 psi)

Mark 3 ANSI and ISO

- Flows to 4540 m^3/h (20 000 gpm)
- Heads to 220 m (720 ft)
- Pressures to 27 bar (400 psi)

ESP3 Vertical Immersion Sump

- Flows to 1300 m^3/h (5700 gpm)
- Heads to 90 m (300 ft)
- Pressures to 12 bar (175 psi)

WUJ/VTP (VS1) Wet-Pit

- Flows to 13 600 m^3/h (60 000 gpm)
- Heads to 2000 m (6560 ft)
- Pressures to 200 bar (2900 psi)

WUC/VPC (VS6) Vertical Turbine, Double Casing

- Flows to 13 600 m^3/h (60 000 gpm)
- Heads to 2000 m (6560 ft)
- Pressures to 200 bar (2900 psi)

Pleuger SUBM Deep-Well Submersible (Water-Filled Design)

- Flows to 6000 m^3/h (26 415 gpm)
- Heads to 800 m (2625 ft)
- Motor sizes to 5000 kW (6700 hp)
- Speeds from 200 to 3600 rpm

Byron Jackson SUBM Deep-Well Submersible (Oil-Filled Design)

- Flows to 6000 m^3/h (26 415 gpm)
- Heads to 800 m (2625 ft)
- Motor sizes to 1650 kW (2200 hp)
- Speeds from 1000 to 3600 rpm

Specialty Designs

- In-line, double-suction
- Multistage, axially split, double-suction
- Abrasive slurry pump
- Positive displacement two-screw

FLOWSERVE

Heritage Names of Distinction

Byron Jackson®
IDP®
Pleuger®
United Centrifugal®
Worthington®
Worthington Simpson™



Water Pipeline Systems

Flowserve traces its history to the late 1790s when its Simpson heritage brand began applying steam pumping engines to municipal waterworks in the United Kingdom. Today, Flowserve pumps are used extensively in:

- Source water and transmission
- Treated water distribution
- Irrigation

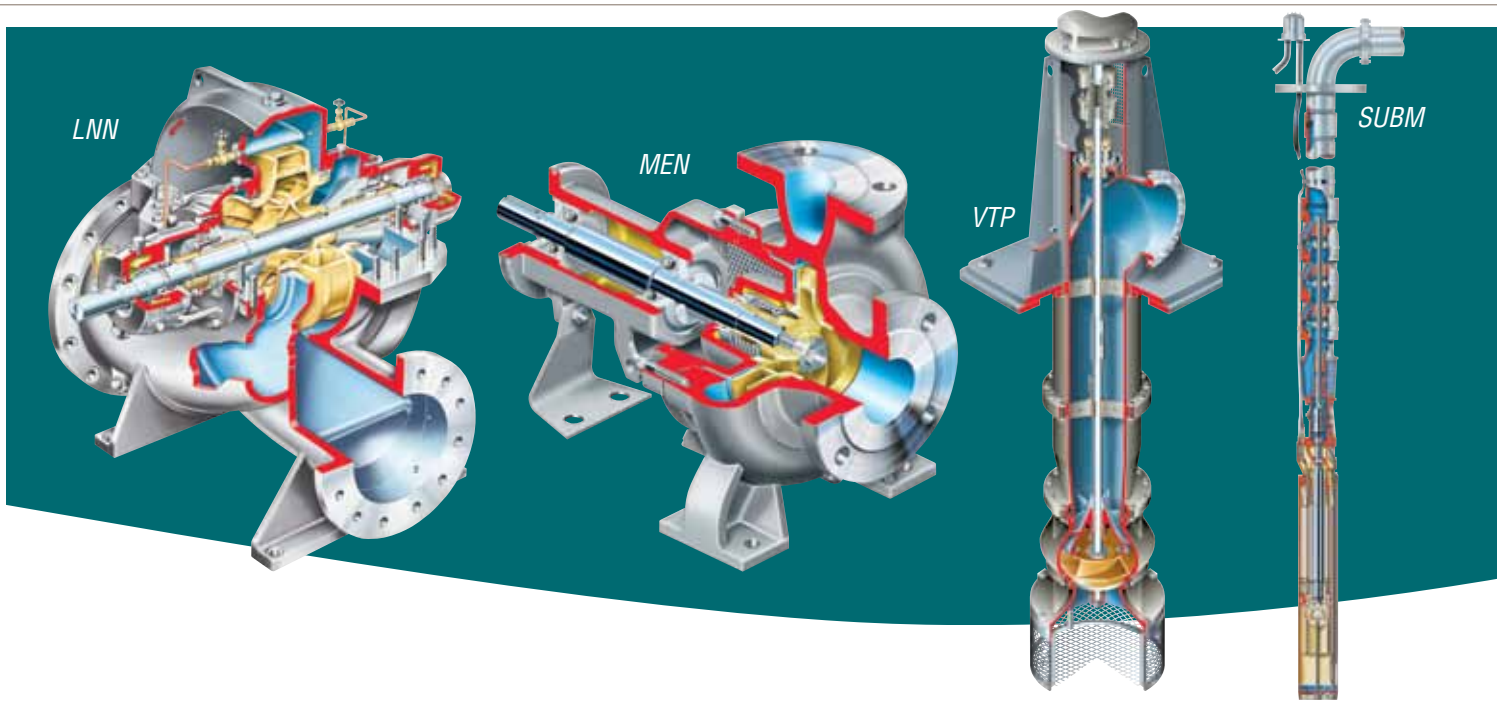
Where surface water or groundwater is not readily available, pipelines are required to transport water from alternate sources to its destination.

Flowserve offers the industry's most complete and diverse line of water transmission and distribution pumps, including:

- Horizontal, axially split, single-stage
- Horizontal, radially split, end suction single-stage
- Horizontal, axially split multistage
- Between bearing, ring section multistage
- Overhung product lubricated, ring section multistage
- Submersible motor
- Short-coupled, vertical turbine

Case Study:	**Middle East Pipeline**
Installation:	22 DMX axially split, two-stage pumps (24 x 28) with driver sizes to 16 780 kW (22 500 hp) delivering 1.6 million bbl/d at heads to 625 m (2050 ft). Casing weights total equal 13 610 kg (30 000 lb).
Application:	1200 km (750 mi) pipeline across rugged terrain in the Middle East. Pipeline diameter of 1400 mm (56 in)
Challenge:	Maintain problem-free operation across all flow range requirements
Solution:	Employ computational fluid dynamics to analyze and optimize impeller blade geometry
Result:	New impeller design demonstrated no cavitation, far exceeding previous industry acceptance criteria for high-energy impellers.



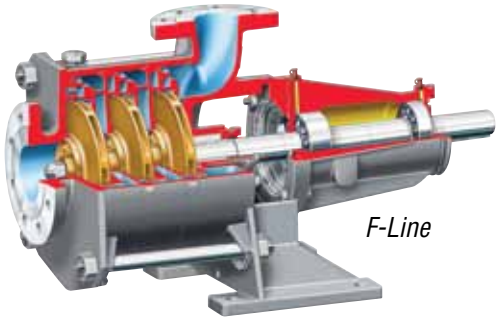


Water Pipeline Pump Solutions – Operating Parameters

LNN Axially Split, Single-Stage
- Flows to 30 000 m³/h (132 000 gpm)
- Heads to 300 m (980 ft)
- Pressures to 40 bar (580 psi)

MEN End Suction
- Flows to 340 m³/h (1500 gpm)
- Heads to 120 m (395 ft)
- Pressures to 15 bar (220 psi)

F-Line End Suction, Multistage
- Flows to 500 m³/h (2200 gpm)
- Heads to 250 m (820 ft)
- Discharge pressures to 25 bar (365 psi)

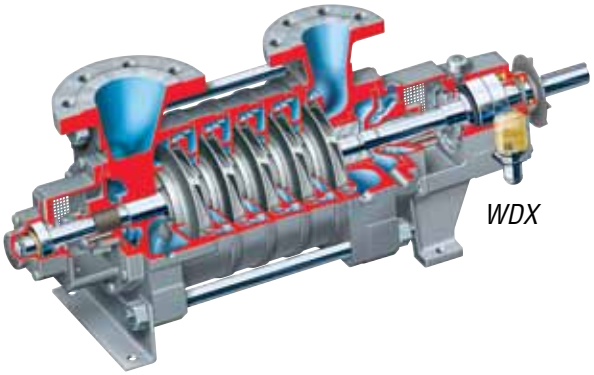


F-Line

VTP Vertical Turbine
- Flows to 13 600 m³/h (60 000 gpm)
- Heads to 700 m (2300 ft)
- Sizes from 150 mm (6 in) to 1375 mm (54 in)

Pleuger and Byron Jackson SUBM Deep-Well Submersible Motors (Water-Filled or Oil-Filled)
- Flows to 6000 m³/h (26 415 gpm)
- Heads to 800 m (2625 ft)
- Motor sizes to 5000 kW (6700 hp)
- Speeds from 200 to 3600 rpm

WDX/NM Radially Split, Multistage Ring Section
- Flows to 3000 m³/h (13 210 gpm)
- Heads to 700 m (2300 ft)
- Pressures to 75 bar (1090 psi)



WDX

Note: The above values indicate the typical performance envelope for the models listed. Flowserve has significant experience beyond these limits. Consult your Flowserve representative with your specific performance requirements.

FLOWSERVE

Heritage Names of Distinction

IDP®
TKL™
Wilson-Snyder®
Worthington®



Slurry Pipeline

Highly abrasive and often corrosive slurry creates an extraordinarily difficult pumping environment. Typical slurry pipeline applications include tailings (waste rock) disposal, extraction plant to concentrator and concentrator or washery to loading terminal. Coal slurry, metal ore slurry and diluent/bitumen froth all present severe corrosive and erosive challenges to high-pressure pumping.

Flowserve is unequaled in its materials expertise, offering an extensive selection of metallic and non-metallic solutions. These include hard metal and specialized hardening techniques, rubber and elastomeric linings and even ceramic linings for the most demanding services.

Slurry pipelines commonly employ multiple single-stage pumps in series to develop the pressure required to overcome pipe friction resistance. Series pumps require high-pressure casings (i.e., higher tensile strength material, more robust casing bolting, etc.) to cope with the high internal pressures. Flowserve has the necessary experience and engineering expertise to meet these challenges.

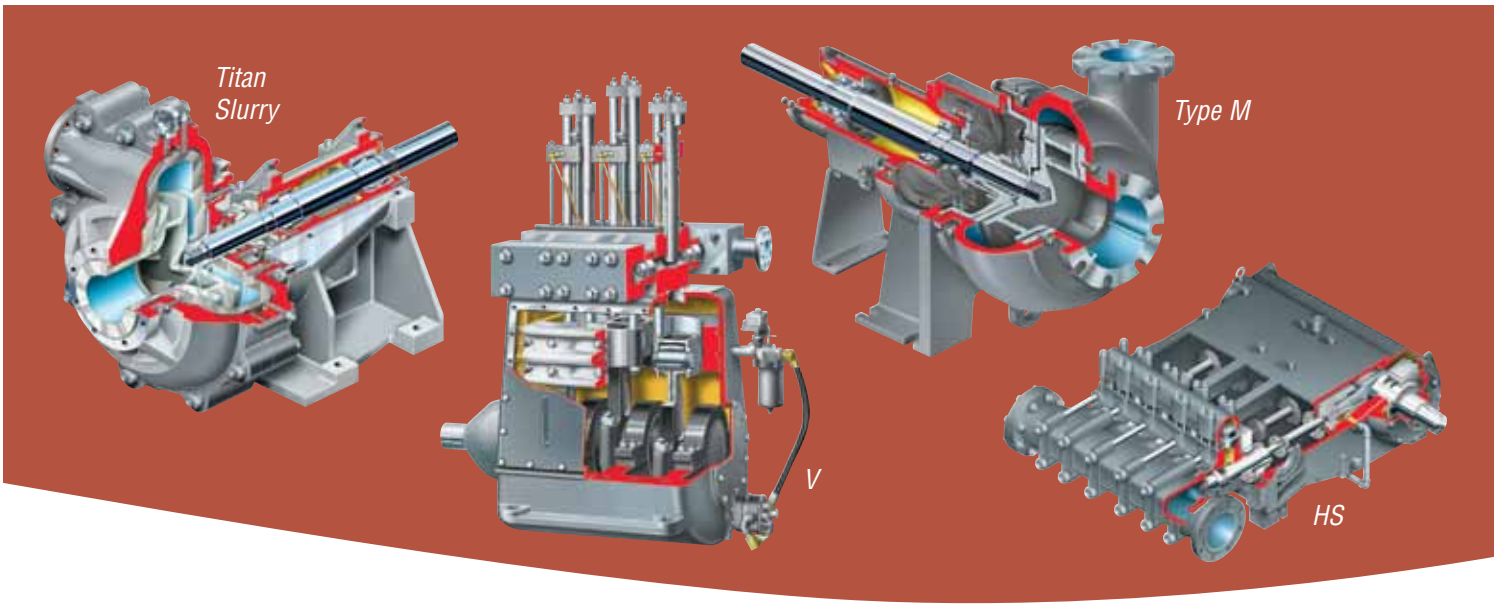
Flowserve offers a proven, application-tested line of slurry pipeline pumps, including:

- Titan Slurry™ pumps with a choice of hard metal, rubber, elastomeric or ceramic liners within metal armor
- Type M hard metal abrasive slurry pumps
- Type R rubber lined abrasive slurry pumps
- HS and V reciprocating plunger pumps

Experience:	**Slurry Pipeline**
Installation:	Ten horizontal triplex (three-cylinder) plunger pumps with stainless steel fluid ends. Rated for 220 m^3/h (970 gpm) at 84 bar (1220 psi) discharge pressure.
Application:	Fly ash removal from the scrubbers of a coal-fired power plant in China. Slurry of 35% fly ash by weight in sea water transported in a 22 km (13.7 mi) disposal pipeline.







Slurry Pipeline Pumps – Operating Parameters

Titan Slurry Heavy-Duty, Rubber Lined or Metal Lined

- Flows to 3600 m³/h (16 000 gpm)
- Heads to 90 m (300 ft)
- Pressures to 40 bar (580 psi)
- Packed gland, expeller or mechanical shaft seal
- Multiple liner materials available
  - Natural rubber and polyurethane for fine solids and mildly corrosive slurries
  - High chrome iron for applications containing coarse solids, as well as those at higher pressures or high temperatures
  - Ceramic materials (exhibiting outstanding abrasion and corrosion resistance) for hot, corrosive slurries

Type M Hard Metal

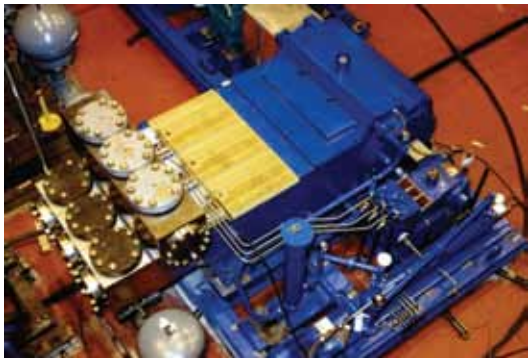
- Flows to 10 000 m³/h (44 000 gpm)
- Heads to 90 m (300 ft)
- Pressures to 50 bar (725 psi)
- Packed gland, expeller or mechanical shaft seal

V Vertical Reciprocating

- Flows to 1140 m3/h (5000 gpm)
- Standard pressures to 619 bar (8975 psi); custom pressures to 2070 bar (30 000 psi)
- Power to 3450 kW (4625 hp)
- Speeds to 360 rpm

HS Multiplunger, Horizontal Reciprocating

- Flows to 775 m3/h (3400 gpm)
- Standard pressures to 555 bar (8030 psi); custom pressures to 2070 bar (30 000 psi)
- Power to 2560 kW (3430 hp)
- Speeds to 530 rpm



Note: The above values indicate the typical performance envelope for the models listed. Flowserve has significant experience beyond these limits. Consult your Flowserve representative with your specific performance requirements.

Hydraulic Re-rates for Optimal Performance and Reduced Operating Costs





Services and Solutions

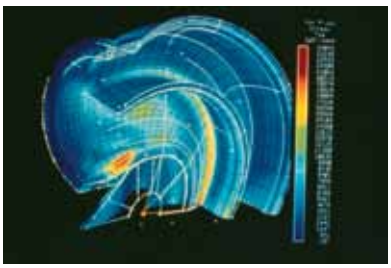
Providing Unequaled Pump and System Support

Flowserve can provide customers with everything from simple consultation and equipment selection assistance to complete turnkey and management services. Customers can choose the level of support which best meets their needs, including:

Complete Pipeline Systems Management
- Shared responsibility for improved operational performance, lower equipment ownership costs and increased revenues
- Combined world-class expertise in pumps, valves and mechanical seals

Global Service and Technical Support
- Worldwide network of service, repair and quick response centers staffed by highly skilled engineers

Product and System Support
- On-site repair
- Site-specific training
- Spare parts inventory and management programs
- Auxiliary equipment
- Training
- LifeCycle Advantage™ agreements[1]



Technical Services
- Hydraulic re-rates and upgrades
- Mechanical upgrades and retrofits
- Materials upgrades
- Analytical diagnostic services
- On-site pump system analysis and engineering
- Computer-aided analysis to support reliability and performance-based improvement projects
- Reliability and energy improvement

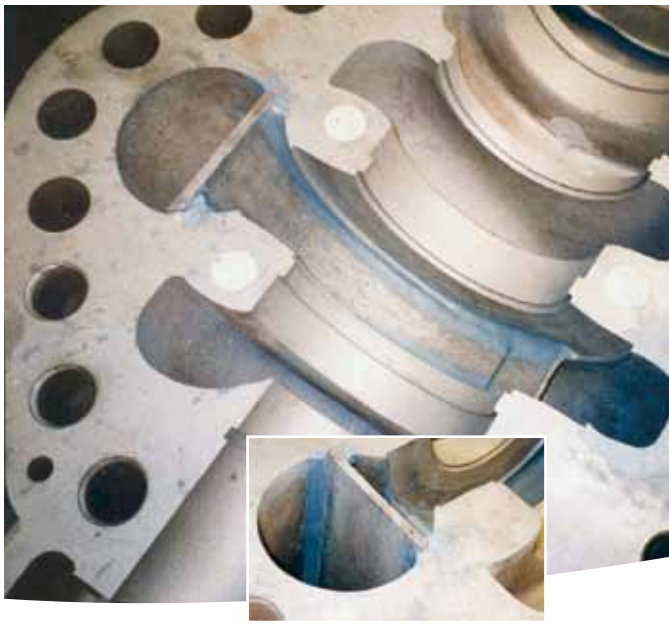
Maintenance, Repair and Inspection Services
- More than 140 service and manufacturing facilities worldwide
- Extensive on-site service and repair fleets

Technical Assessments

Flowserve is fully committed to maximizing pipeline profitability. Flowserve engineers can perform comprehensive equipment and system audits to identify operational issues that may be constraining output, increasing energy consumption or otherwise elevating operating costs. Proposed solutions are backed by life cycle cost calculations. The following types of assessments are available:

- System
- Energy
- Bad actor
- Safety, health and environmental





Intelligent Process Solutions (IPS)[2]

Through the application of advanced technologies, Flowserve Intelligent Process Solutions (IPS) family of products helps customers proactively manage their plant assets to increase plant uptime and reduce equipment life cycle costs. Flowserve offers advanced monitoring solutions — wired and wireless — for permanent and portable data collection and analysis of vital plant assets.



Flowserve Educational Services

FES provides companies around the world with innovative programs to teach best practices for maximum equipment reliability and minimal total life cycle cost. Training is conducted at Flowserve Learning Resource Centers and on-site at the customer's facility.

1 See bulletin FSG-104 for more information.
2 See bulletin PS-90-11 for more information.

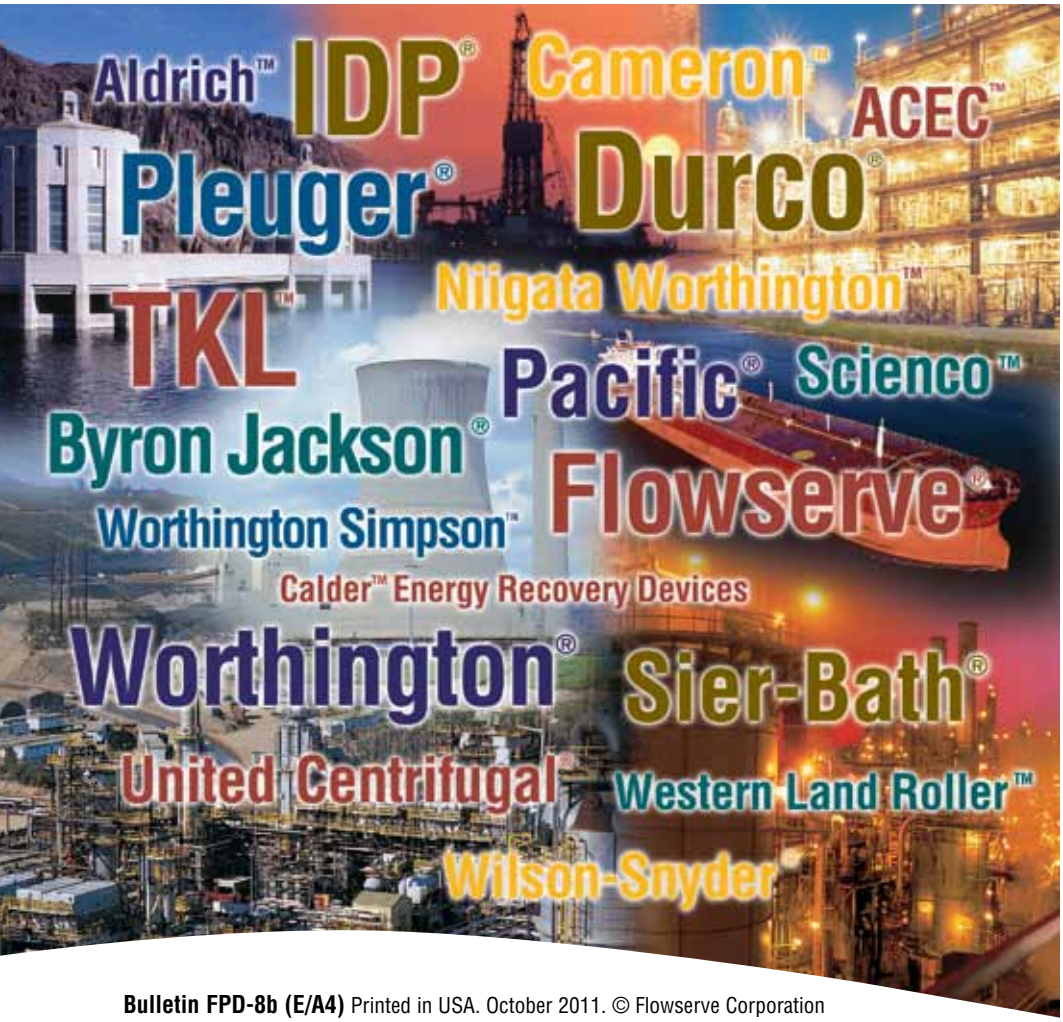
Case Study: **Hydraulic Re-rate**

Installation: 11 pumping stations each with two or three axially split, two-stage pipeline pumps with integral crossovers. Each pump is single volute with two different rotor layouts for two head duties. Viscous crude is being transported from the Adriatic Sea to eastern Austria through a 450 km (280 mi), 400 mm (16 in) diameter pipeline.

Problem: Pumps were performing below expectations, <78% efficiency, and at higher operating cost.

Solution:
- Convert from single to double volute casings
- Create six different head duties (instead of original two) with two different rotor layouts
- Fit different impellers for different head duties
- Reduce friction losses with coatings and polishing
- Change to open-end pipeline and central control room operation of all pump stations

Benefit:
- Efficiency increased to >85% BEP
- Energy savings >113 kW (150 hp) per pump
- Increased MTBR, resulting in maintenance savings



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