



Pipeline/Transportation Pumps

Crude Oil and Refined Products • Water • Slurry



Experience In Motion



The Trusted Partner in Global Pipeline Pumping

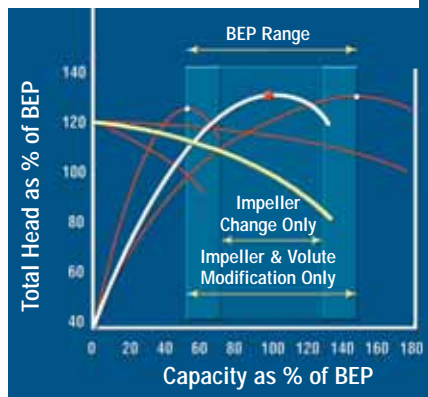
Flowserve offers innovative pumping solutions for every conceivable pipeline application, including oil, refined products, liquid gases, water and slurry services. With more than 200 years of industrial pump experience and 100 years of pipeline pumping experience, Flowserve has earned a pre-eminent position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

Customers all over the world continually turn to Flowserve for creative solutions as they strive to 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 north-west 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



Complete Range of Pipeline Pumps for Every Application

Crude Oil and Refined Product Pipeline Pumps

Mainline/Booster Pumps

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

Auxiliary Pumps

- Single stage overhung
- Vertical sump
- Vertical in-line
- Submersible motor
- Multistage vertical wet pit
- Single and multistage vertical canned tank farm booster
- Pipeline sampling
- Cargo stripping
- Service-specific specialty designs

Water Pipeline Pumps

- Single and multistage overhung
- Axially split single stage between bearing
- 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.

Heritage Names of Distinction

- Byron Jackson®*
- IDP®*
- Pacific®*
- 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 the cost-effective solution 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 m³/h (41 825 gpm) and differential heads to 6000 m (19 685 ft), Flowserve has the proven products capable of moving crude oil direct from the platform to marine terminals or waiting tankers. And Flowserve is the only manufacturer offering the safety and reliability of shaft seals to API-682.

Subsea

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

CO₂ Enhanced Recovery 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 carbon dioxide (CO₂) for enhanced oil recovery. 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 CO₂ 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.

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 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 Pipeline

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 applications, 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 and API 610 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.

From the Producing Fields to the Market Flowserve has the Pipeline Pump Solution



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



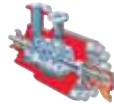
- 2** UZDL (BB1)
Axially Split, Two Stage
ALT. BFD (BB1)
Double Suction



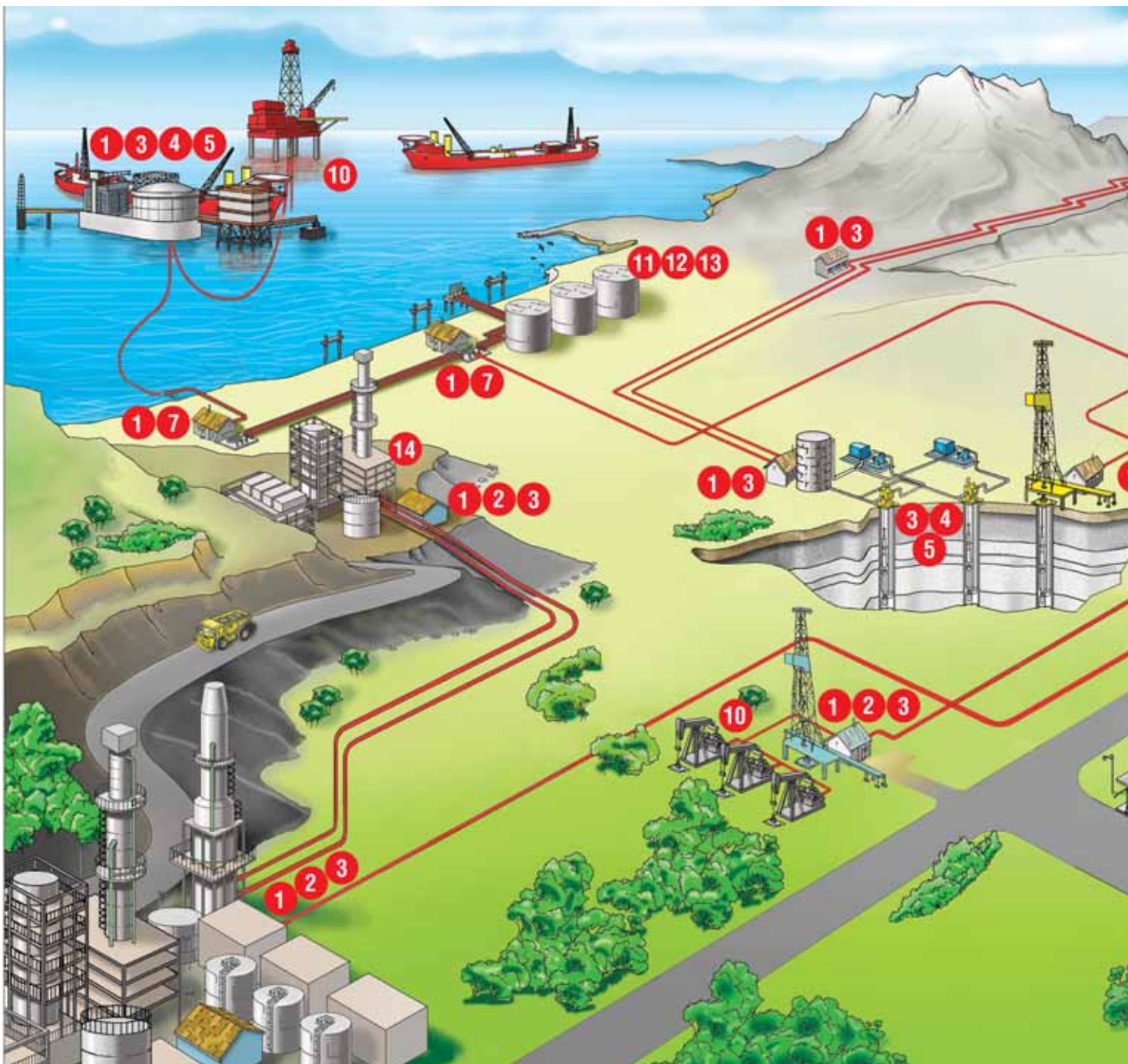
- 3** DMX (BB3)
Axially Split, Multistage












- 4** WCC (BB5)
Multistage, Diffuser Collector, Barrel Casing,
Volute Collector

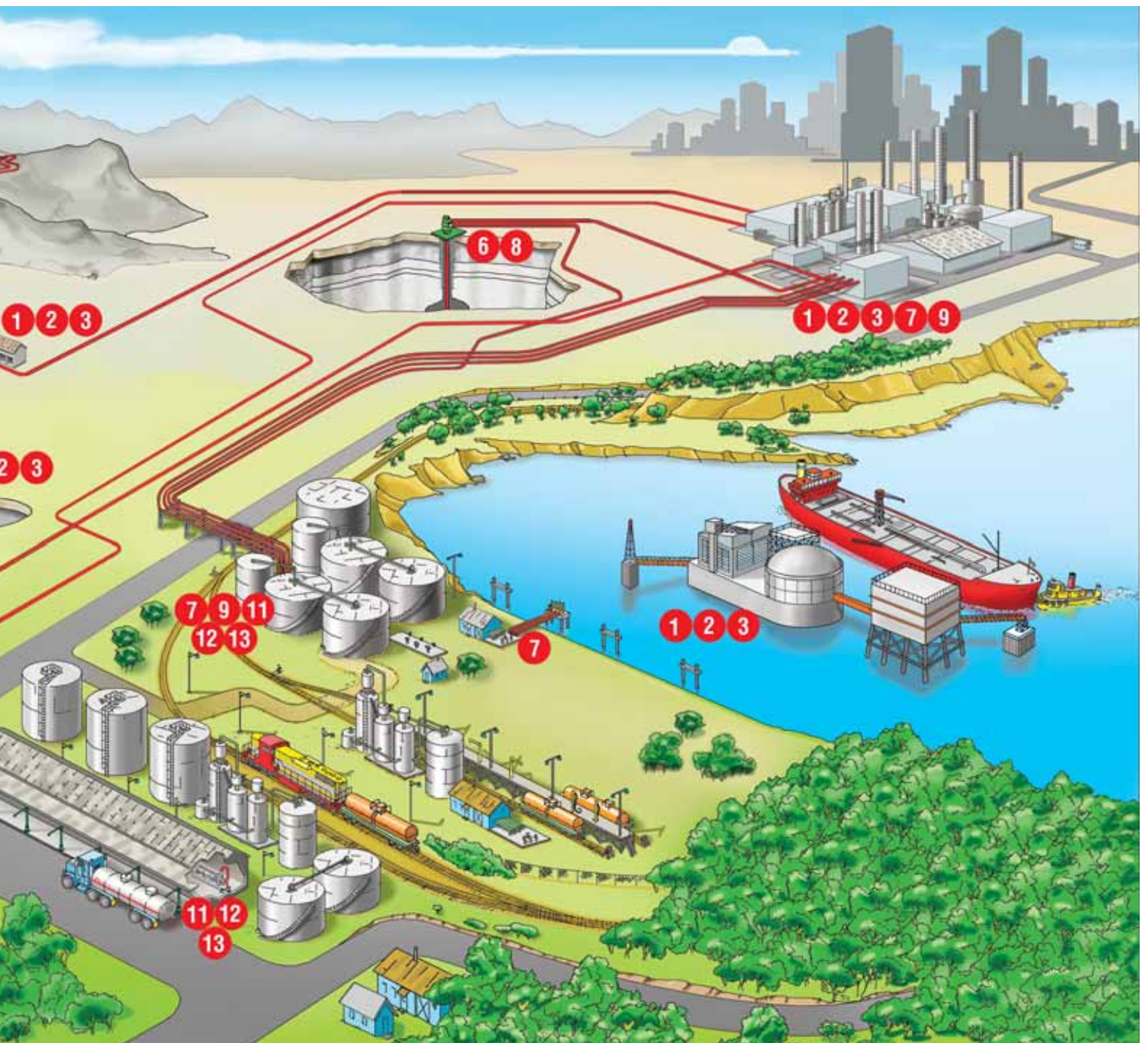


- 5** HDO/HSO (BB5)
Multistage, Volute Casing, Process Barrel

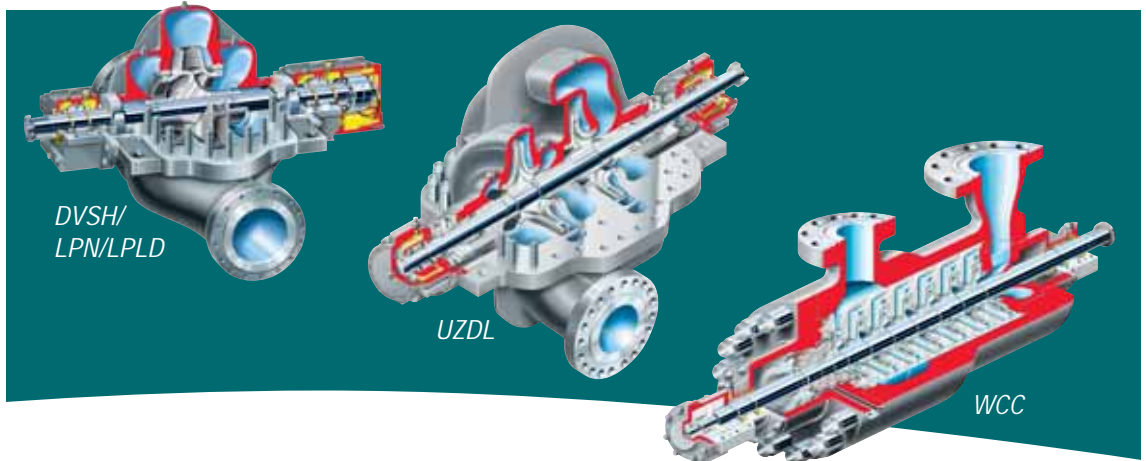


-  **6** WUJ (VS1)
Wet-Pit
-  **7** VPC (VS6)
Vertical Turbine, Double Casing
ALT. WUC (VS6)
Double Casing Multistage
-  **8** SUBM – Deep-Well Submersible
(Pleuger water-filled) (Byron Jackson oil-filled)
-  **9** ESP2
Vertical Immersion Sump

-  **10** MP1
Multiphase
-  **11** HPX (OH2)
Centerline Mounted
-  **12** HWX (OH3)
Vertical In-Line
-  **13** Mark 3 ANSI
Standard
-  **14** Type M
Hard Metal



*The World's
Most Complete
Line of Crude and
Petroleum
Pipeline
Pumps*



Mainline Pumps

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

Typical Operating Parameters

- Flows to 22 700 m³/h (100 000 gpm)
- Heads to 620 m (2030 ft)
- Pressures to 150 bar (2175 psi)
- Speeds to 8000 rpm

UZDL (BB1) **Axially Split, Two Stage**

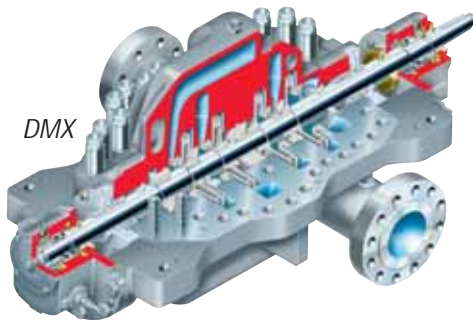
Typical Operating Parameters

- Flows to 2950 m³/h (13 000 gpm)
- Heads to 685 m (2250 ft)
- Pressures to 64 bar (910 psi)

DMX (BB3) **Axially Split, Multistage**

Typical Operating Parameters

- Flows to 2950 m³/h (13 000 gpm)
- Heads to 2130 m (7000 ft)
- Pressures to 275 bar (4000 psi)
- Speeds to 8000 rpm



DMX

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

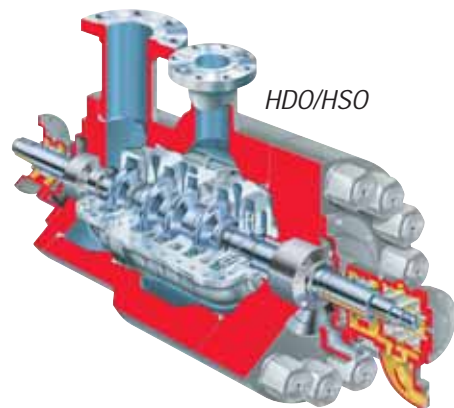
Typical Operating Parameters

- Flows to 4000 m³/h (17 610 gpm)
- Heads to 3050 m (10 000 ft)
- Discharge pressures to 650 bar (9425 psi)
- Speeds to 9000 rpm

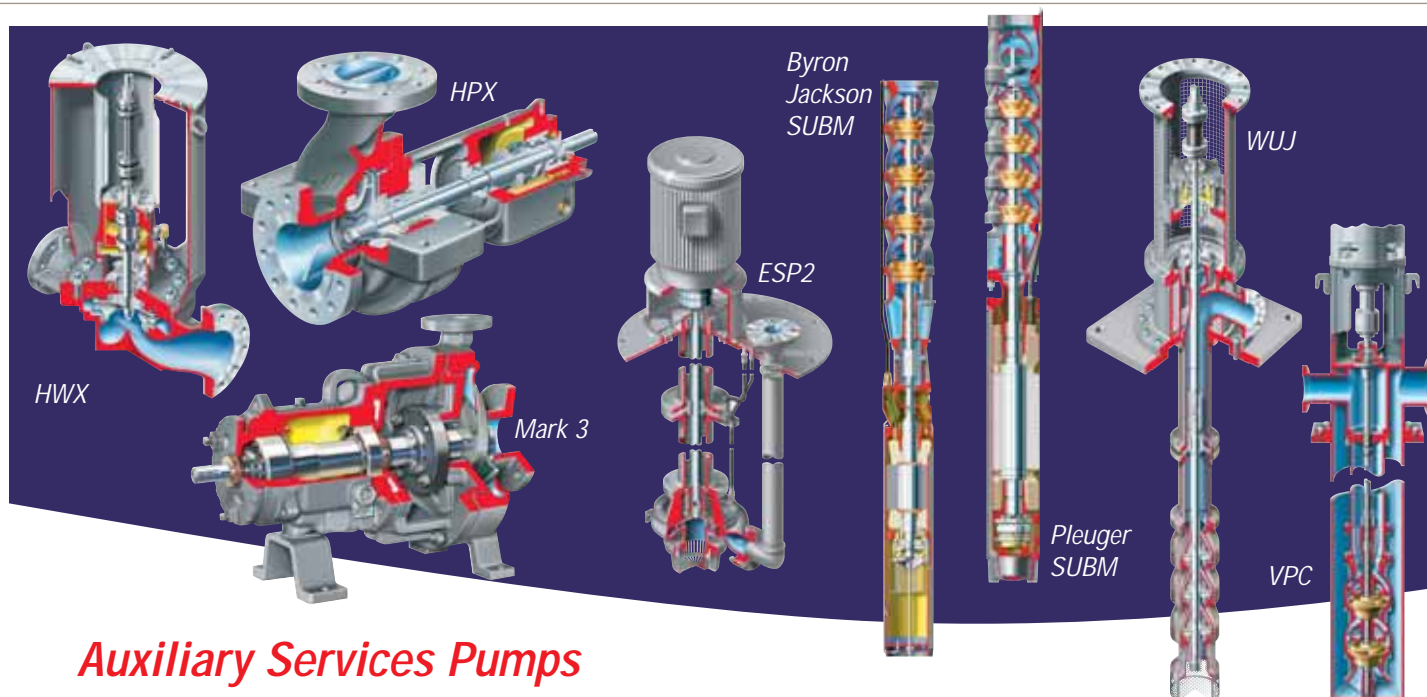
HDO/HSO (BB5) **Multistage, Volute Collector, Barrel Casing**

Typical Operating Parameters

- Flows to 4000 m³/h (17 600 gpm)
- Discharge pressures to 400 bar (5800 psi)
- Speeds to 9000 rpm



HDO/HSO



Auxiliary Services Pumps

HPX (OH2) **Centerline Mounted**

Typical Operating Parameters

- Flows to 2000 m³/h (9000 gpm)
- Heads to 350 m (1100 ft)
- Pressures to 80 bar (1160 psi)

HWX (OH3) **Vertical In-Line**

Typical Operating Parameters

- Flows to 1500 m³/h (6600 gpm)
- Heads to 300 m (1000 ft)
- Pressures to 80 bar (1160 psi)

Mark 3 ANSI Standard

Typical Operating Parameters

- Flows to 1680 m³/h (7400 gpm)
- Heads to 215 m (700 ft)
- Pressures to 27 bar (400 psi)

ESP2 Vertical Immersion Sump

Typical Operating Parameters

- Flows to 800 m³/h (3500 gpm)
- Heads to 90 m (300 ft)
- Pressures to 12 bar (175 psi)

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

Typical Operating Parameters

- Flows to 3000 m³/h (13 000 gpm)
- Heads to 2000 m (6500 ft)
- Pressures to 200 bar (3000 psi)

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

Typical Operating Parameters

- Flows to 13 600 m³/h (60 000 gpm)
- Heads to 1070 m (3500 ft)
- Pressures to 150 bar (2175 psi)

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

Typical Operating Parameters

- Flows to 4500 m³/h (19 800 gpm)
- Heads to 800 m (2600 ft)
- Motor sizes to 5000 kW (6700 hp)
- Speeds from 200 to 3600 rpm

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

Typical Operating Parameters

- Flows to 4500 m³/h (19 800 gpm)
- Heads to 800 m (2600 ft)
- Motor sizes to 1500 kW (2000 hp)
- Speeds from 1000 to 3600 rpm

Specialty Applications

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

Heritage Names of Distinction

- Byron Jackson®*
- IDP®*
- Pleuger®*
- United®*
- 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 Crude 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).

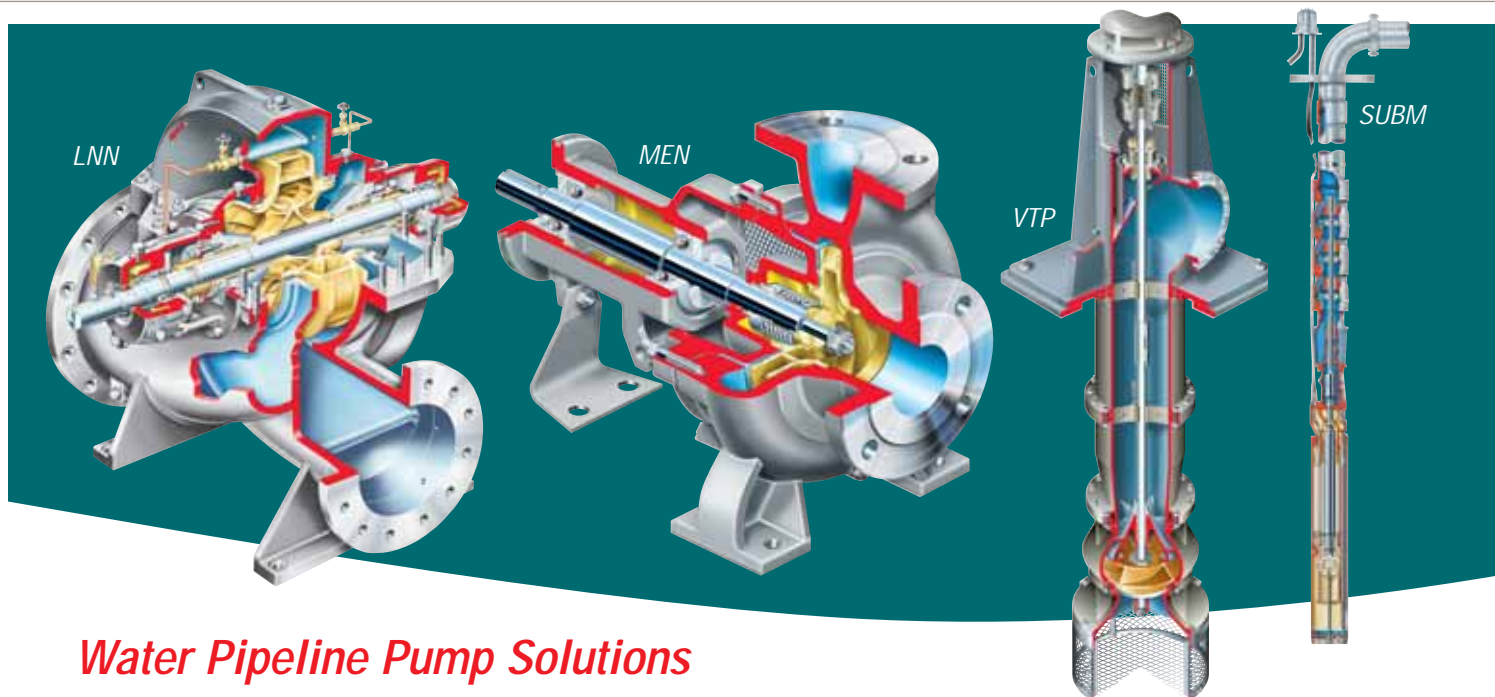
Application: 1200 km (750 mi) pipeline across rugged terrain in the Middle East. Pipeline diameter of 1400 mm (56 in)

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

LNN

Axially Split, Single Stage

Typical Operating Parameters

- Flows to 51 000 m³/h (225 000 gpm)
- Heads to 300 m (1000 ft)
- Pressures to 30 bar (435 psi)

MEN End Suction

Typical Operating Parameters

- Flows to 700 m³/h (3080 gpm)
- Heads to 100 m (330 ft)
- Pressures to 16 bar (230 psi)

F-Line End Suction, Multistage

Typical Operating Parameters

- Flows to 500 m³/h (2200 gpm)
- Heads to 250 m (820 ft)
- Discharge pressures to 25 bar (365 psi)

VTP Vertical Turbine

Typical Operating Parameters

- Flows to 13 600 m³/h (60 000 gpm)
- Heads to 700 m (2300 ft)
- Sizes from 150 mm (6 in) to 1375 mm (55 in)

SUBM Submersible Motor (water-filled or oil-filled)

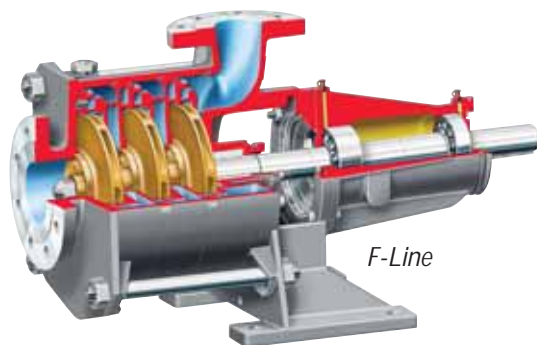
Typical Operating Parameters

- Flows to 4500 m³/h (19 800 gpm)
- Heads to 800 m (2600 ft)
- Motor sizes to 1500 kW (2000 hp)
- Speeds from 1000 to 3600 rpm

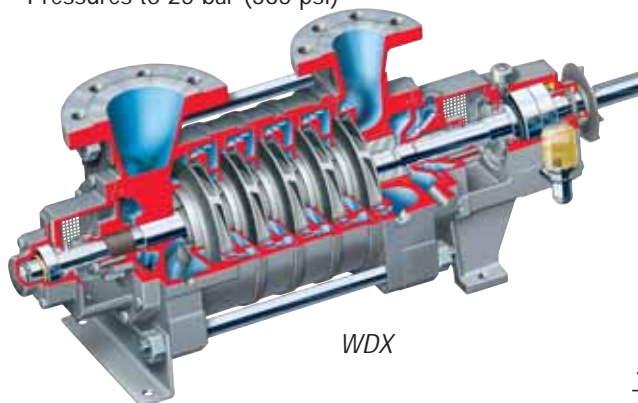
WDX/NM Radially Split, Multistage Ring Section

Typical Operating Parameters

- Flows to 850 m³/h (3740 gpm)
- Heads to 250 m (820 ft)
- Pressures to 25 bar (365 psi)



F-Line



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.

*Heritage Names
of Distinction*

IDP®

Jeumont-Schneider™

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 unequalled 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:

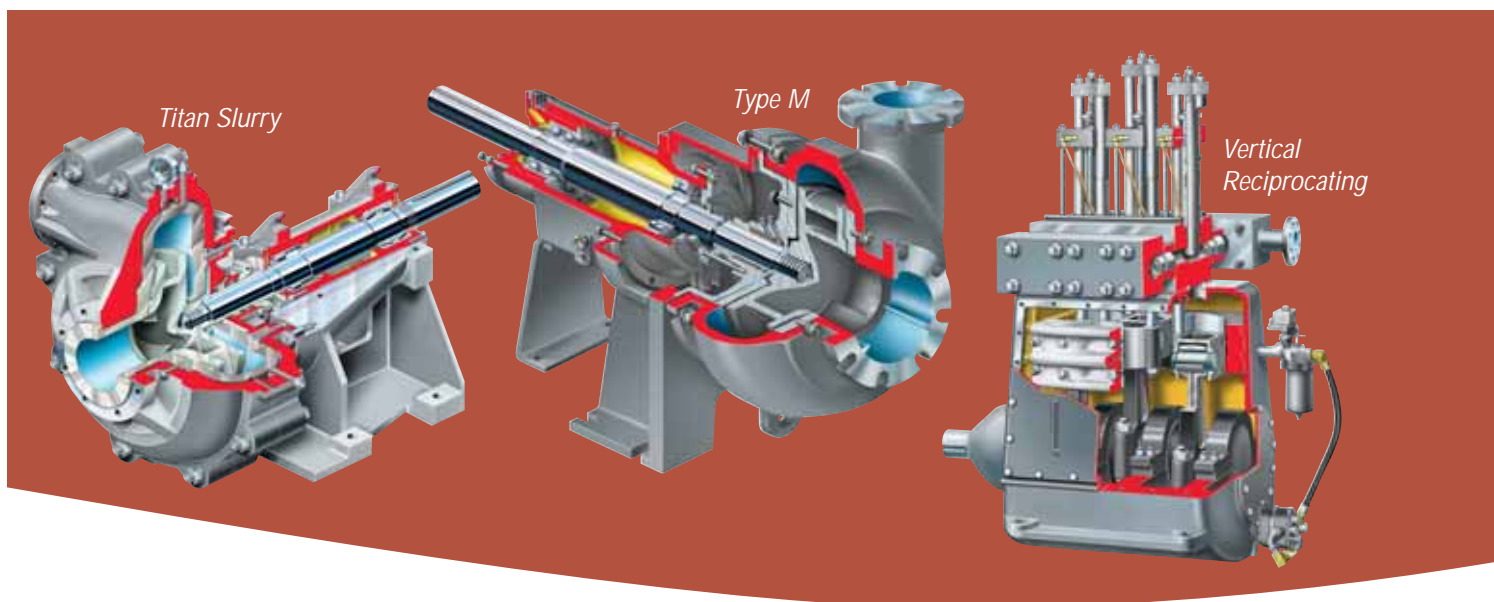
- Titan Slurry™ pumps with a choice of hard metal, rubber, elastomeric or ceramic liners within metal armor
- Type M hard metal abrasive slurry pumps
- Type R rubber lined abrasive slurry pumps
- HS and V reciprocating plunger pumps

Experience: Slurry Pipeline

Installation: Ten horizontal triplex (3-cylinder) plunger pumps with stainless steel fluid ends. Rated for 220 m³/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

Titan Slurry Heavy-Duty, Rubber Lined or Metal Lined

Typical Operating Parameters

- Flows to 4000 m³/h (17 500 gpm)
- Heads to 100 m (330 ft)
- Pressures to 40 bar (600 psi)
- Packed gland, expeller or mechanical shaft seal
- Multiple liner component materials
 - 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 and temperatures
 - Ceramic materials (exhibiting outstanding abrasion and corrosion resistance) for hot, corrosive slurries

Type M Hard Metal

Typical Operating Parameters

- Flows to 10 000 m³/h (44 000 gpm)
- Heads to 90 m (300 ft)
- Pressures to 50 bar (750 psi)
- Packed gland, expeller or mechanical shaft seal

V Vertical Reciprocating

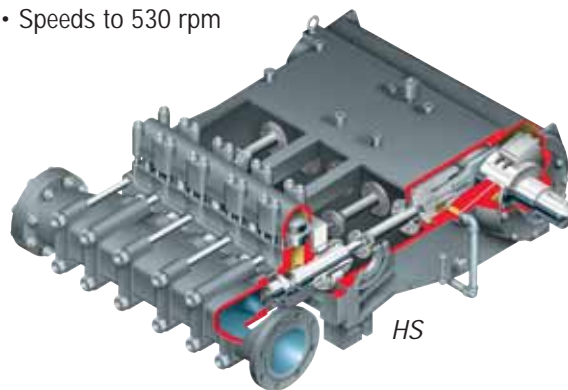
Typical Operating Parameters

- Flows to 1140 m³/h (5000 gpm)
- Standard pressures to 620 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

Typical Operating Parameters

- 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 Rerates
for Optimal
Performance and
Reduced
Operating Costs*



Engineered Services

Providing Unequaled Pump and System Support

Through its Engineered Services¹, 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

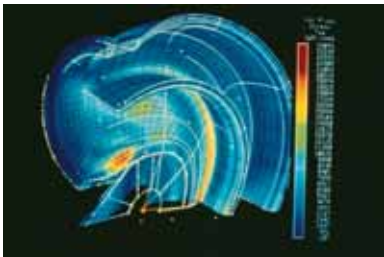
- Shared responsibility for improved operational performance, lower equipment ownership costs and increased revenues
- Combined world-class expertise in pumps, valves and mechanical seals

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™² agreements



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 70 service and manufacturing facilities worldwide
- Extensive on-site service and repair fleets

Pump Improvement Engineering (PIE)

Engineering assistance and technological solutions for pumping problems through PIE experts. Services include:

- Field performance testing
- Vibration analysis
- Design analysis and root-cause problem solving
- Material improvements
- Pump and system audit
- Advanced technology solutions
- Training



Intelligent Pump Solutions (IPS)³

IPS provides pre-engineered pump system optimization, control and protection through:

- Process control
- Process variable monitoring
- Pump condition monitoring and control
- Pump power monitoring



Flowserve Educational Services (FES)

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 Engineered Services Group, Bulletin: FPD-12
 2 LifeCycle Advantage, Bulletin: PS-100-5
 3 IPS Tempo, Bulletin: PS-90-5

Case Study: Hydraulic Re-Rate

Installation: 11 pump stations consisting of two-three pumps each with axially split, two stage pipeline pumps and cast on 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.

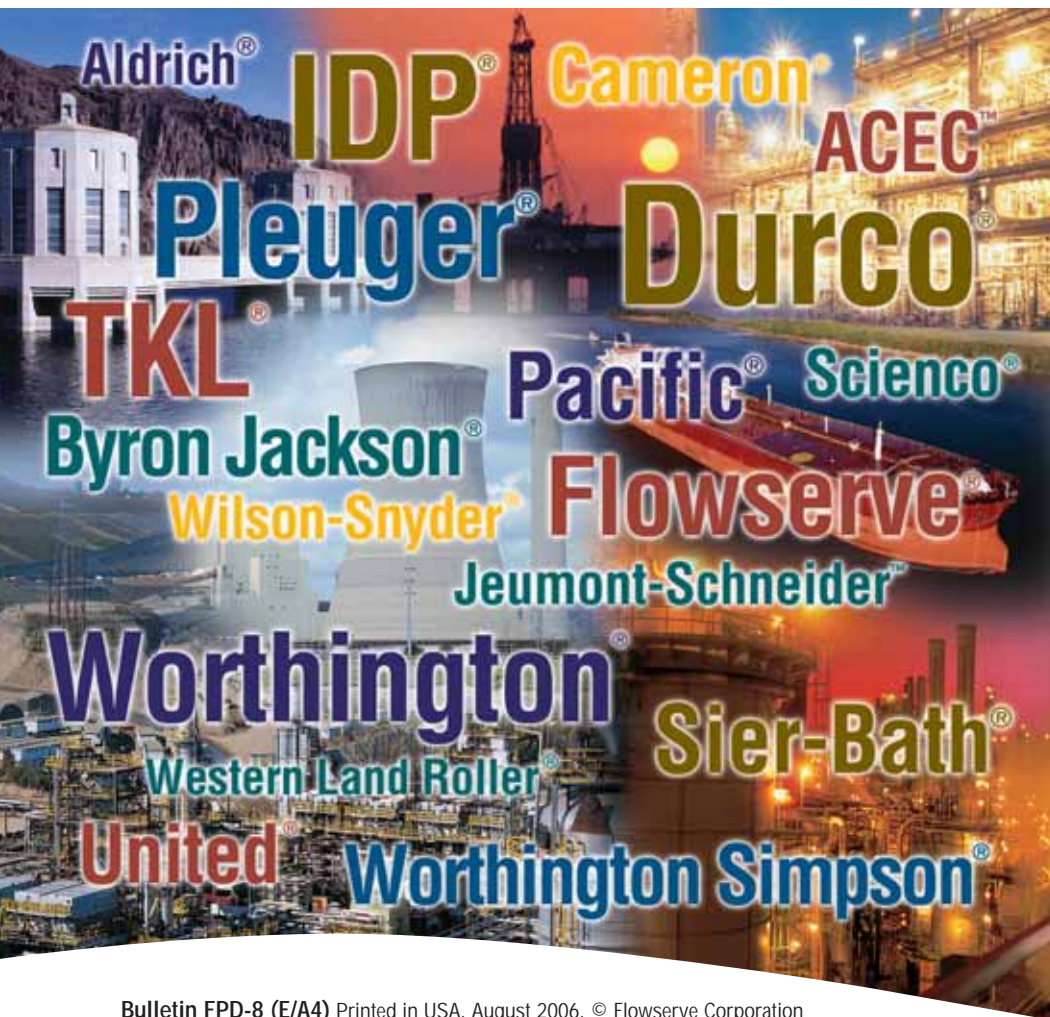
Problem: Pumps were performing below expectations, <78% efficiency, and at higher operating cost.

Solution:

- Convert from single to double volute casings
- Create six different head duties (instead of original two) with two different rotor layouts
- Fitting 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, i.e., maintenance savings



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