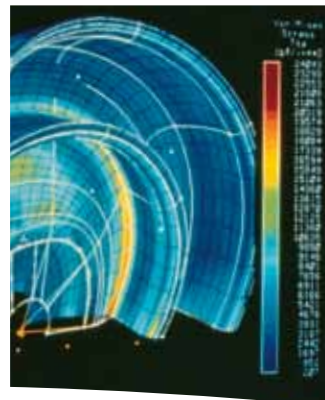




***CN***  
***Steam Generator and***  
***Reactor Feed Water Pump***



***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.*

### **Life Cycle Cost Solutions**

Flowserve is providing pumping solutions which permit customers to reduce total life cycle costs and improve productivity, profitability and pumping system reliability.

### **Market Focused Customer Support**

Product and industry specialists develop effective proposals and solutions directed toward market and customer preferences. They offer technical advice and assistance throughout each stage of the product life cycle, beginning with the inquiry.

### **Broad Product Lines**

Flowserve offers a wide range of complementary pump types, from pre-engineered process pumps, to highly engineered and special purpose pumps and systems. Pumps are built to recognized global standards and customer specifications.

Pump designs include:

- Single stage process
- Between bearing single stage
- Between bearing multistage
- Vertical
- Submersible motor
- Rotary
- Reciprocating
- Nuclear
- Specialty

### **Product Brands of Distinction**

*ACEC™ Centrifugal Pumps*

*Aldrich™ Pumps*

*Byron Jackson® Pumps*

*Calder™ Energy Recovery Devices*

*Cameron™ Pumps*

*Durco® Process Pumps*

*Flowserve® Pumps*

*IDP® Pumps*

*Lawrence Pumps®*

*Niigata Worthington™ Pumps*

*Pacific® Pumps*

*Pleuger® Pumps*

*Scienco™ Pumps*

*Sier-Bath® Rotary Pumps*

*TKL™ Pumps*

*United Centrifugal® Pumps*

*Western Land Roller™ Irrigation Pumps*

*Wilson-Snyder® Pumps*

*Worthington® Pumps*

*Worthington Simpson™ Pumps*

**CN  
Steam Generator  
and Reactor Feed  
Water Pump**



**Complementary Pumps**



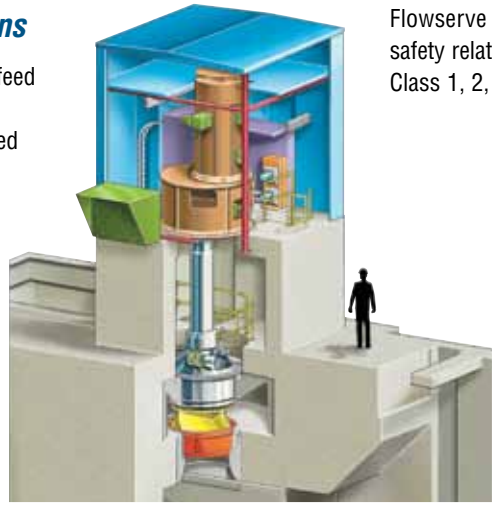
**The Preferred Supplier of Reactor  
and Steam Generator Feed Pumps**

*In the 1960s Flowserve pioneered the development of single-stage, high-speed feed pumps for commercial nuclear power plants (NPP). Today, 25 percent of the operating PWR<sup>1</sup> and BWR reactors in the world use Flowserve single-stage, high-speed feed pumps such as the CN.*

Designed to ASME Section IV Division 1 requirements as well as customer specifications, the CN features a centerline-mounted, radially split casing and a double-suction impeller. This design renders nearly balanced axial hydraulic thrust over the full operating range of the pumps.

**Typical Applications**

- PWR steam generator feed
- BWR reactor feed
- Startup and standby feed



**Complementary Pump Designs**

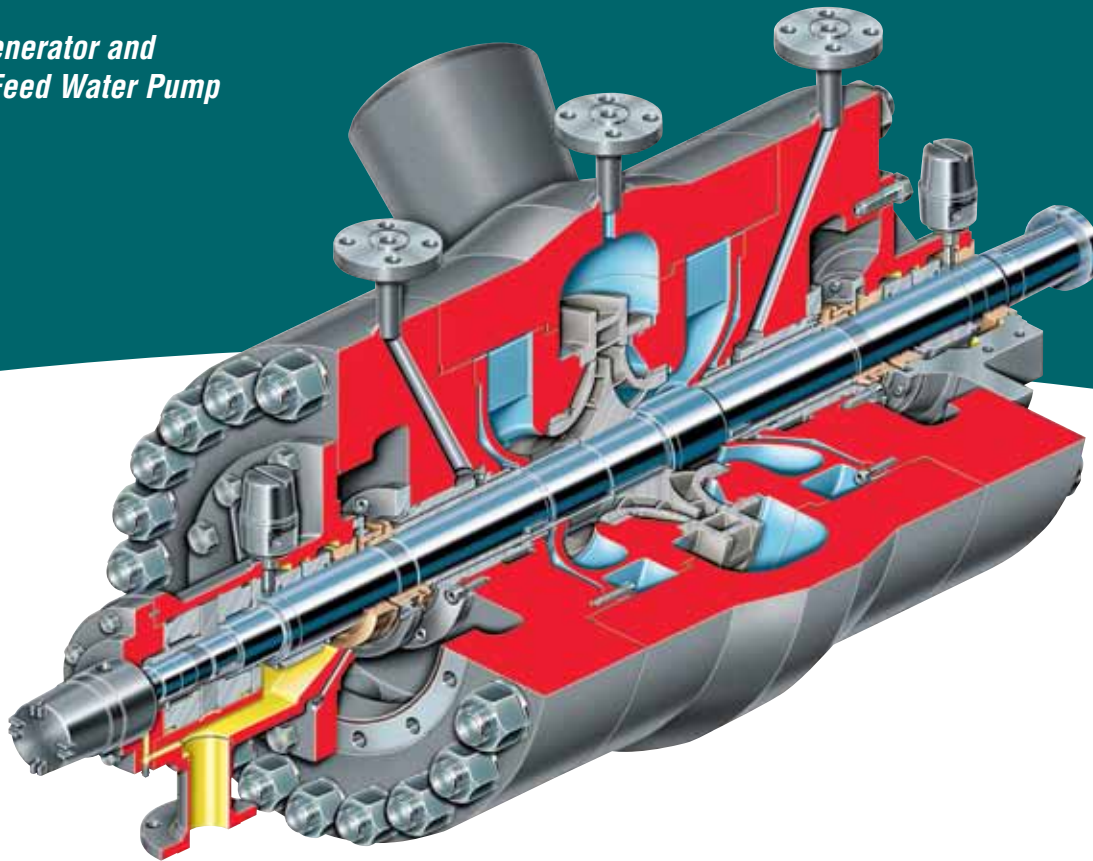
Flowserve manufactures a complete range of pumps for turbine island services in nuclear power plants:

- Double-suction, radially split case pumps for main feedwater booster
- Multistage barrel pumps for start-up and standby feedwater service
- Canned vertical multistage pumps for condensate extraction and heater drain service
- Vertical turbine pumps for service water applications
- Vertical wet pit and concrete volute pumps for condenser cooling water

Flowserve also manufactures a complete range of safety related nuclear island pumps to ASME Section III Class 1, 2, and 3 as well as RCC-M specifications.

<sup>1</sup> Russian VVER reactors are excluded.

**CN**  
**Steam Generator and**  
**Reactor Feed Water Pump**



*Born out of the company's extensive feed pump experience in nuclear and fossil power plants, the Flowserve CN single-stage, high-speed pump features a rugged, diffuser-style barrel design to ensure nuclear industry quality standards are met.*

**Operating Parameters**

- Flows to 5100 m<sup>3</sup>/h (22 500 US gpm)
- Heads to 750 m (2460 ft)
- Temperatures to 206°C (402°F)
- Pressures to 120 barg (1740 psig)
- Speeds to 6000 rpm
- Power to 11 000 kW (14 757 hp)



**Features and Benefits**

**416 Stainless Steel Shaft** is ground in steps to minimize stresses and stress relieved in the vertical position to prevent warping. Chrome plating under the bearing journals minimizes wear

**Precision Cast Chrome Steel Impellers** ensure hydraulic efficiency and performance repeatability. Impellers are secured to the shaft with keys and a shrink fit against a shaft shoulder. Staggered impeller vanes reduce pressure pulsations and vibration. Biased wedge vanes improve cavitation resistance and enhance NPSH performance over a wide operating range

**Serrated Impeller Running Fits** reduce the effects of rotor contact during system upsets or turning gear operation

**Replaceable Casing Wear Rings** facilitate maintenance and enable running clearances to be renewed easily. For maximum reliability at the running fits, no impeller rings are used

**Suction and Discharge Nozzles** can be provided in five standard configurations to accommodate plant piping layouts. Customized configurations are also available



**High Quality Construction**

The CN pump is manufactured from the highest quality materials to ensure excellent performance and reliability:

- The barrel and end-covers of the CN are forged from 1¼% chrome steel, which is extremely hard and wear resistant. This eliminates the need for specialty overlays at metal-to-metal fits and high-velocity areas.
- The centerline-mounted casing uses pin and key blocks at the bottom of the barrel to maintain alignment while accommodating high nozzle loads.
- The bolted suction covers feature only one high-pressure fully confined circular compression gasketed sealing joint.
- Nozzles and attachments are welded to the casing in accordance with ASME Section IX and 100% of pressure containing welds are subjected to radiographic inspection.

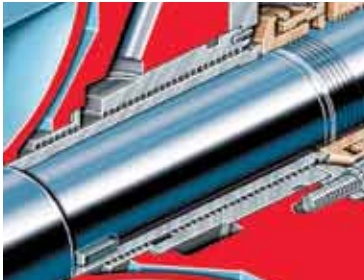
**Robust Bearing System**

The standard bearing system on the CN pump uses split sleeve tri-land hydrodynamic radial bearings to support radial loads. Axial loads are carried by pivot shoe thrust bearings. Proper cooling and lubrication are provided by an external lube oil system or from the gearbox or fluid coupling.

Full 360-degree bearing housings are used on the CN pump for added rigidity.

**Advanced Sealing System**

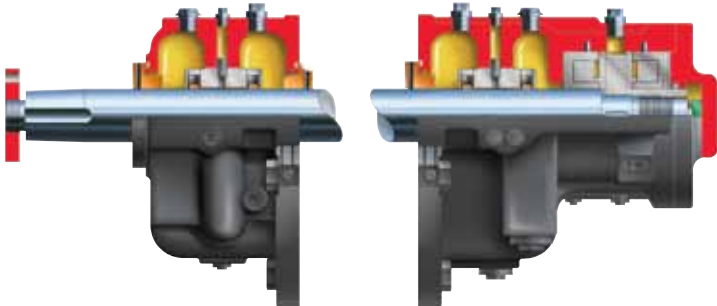
The standard sealing system used on the CN pump is a controlled leakage design which employs a fixed serrated bushing over a straight shaft sleeve at each end of the pump. Seal water injection is controlled by measuring seal drain temperature against a set point. This system has proved to be more reliable than differential pressure systems.



**Serrated sealing bushings**

**Tested to Ensure Performance**

Each CN pump is performance tested to ensure it meets the specified design conditions. Pumps can be tested at full speed and temperature.



*Options and  
Technical Data*



**Optional Seal Configuration**

The CN pump is available with an alternative mechanical sealing system which incorporates a seal flush system. Proven highly reliable in numerous installations, this sealing system eliminates the need for cold condensate injection and the resultant heat loss. This system also may be retrofitted on nuclear feed pumps of other OEMs.



**Available Up-rates and Retrofits**

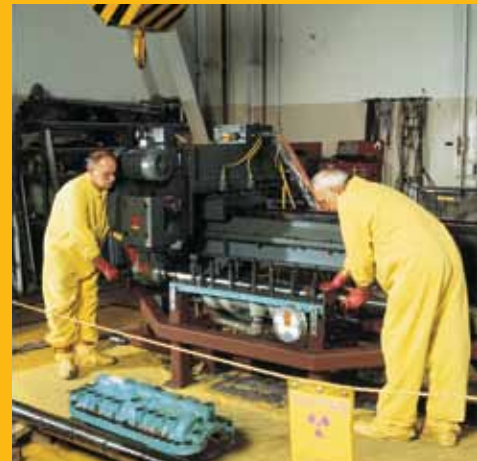
Flowserve has extensive experience in up-rating feed pumps to increase the electrical output of nuclear power plants. And, the economic benefit of doing so can be significant as the margins built into Generation II nuclear power plants were often substantial. As a result, power up-rates up to 30% have been proven feasible. Large power up-rates invariably involve modifications to the feedwater systems and feed pumps need to be either replaced or re-rated.

Flowserve takes a comprehensive approach to up-rate projects. Depending on the size and complexity of the up-rate this may include:

- A comprehensive benchmarking of the current pump installation including the feedwater system to verify the existing and new operating conditions and to identify any reliability issues
- Hydraulic design and optimization including modeling, flow visualization and CFD analysis as needed
- Lateral and torsional analyses
- Evaluation and upgrading or replacement of drive couplings, motors, lubrication systems, fluid couplings and gearboxes
- Shop performance tests
- Complete update of all documentation
- Turnkey installation and startup services

**Hot Shop Capabilities**

Flowserve offers full Hot Shop repair and upgrade capabilities for safety related and contaminated equipment. This is done in a controlled environment in accordance with 10CFR50 Appendix B and/or 50-C-Q-quality programs.



**Flowserve Hot Shop capabilities include:**

- Disassembly and inspection
- Re-machining of parts
- Balancing of rotating elements
- Assembly of contaminated components with newly manufactured parts and assemblies
- Complete QA documentation including as-built dimensional reports

The Hot Shop has been involved in reactor feed pump up-rates, condensate and heater drain re-bowls, reactor coolant pump re-manufacturing and nuclear seal rebuilds.

**Global Service and Technical Support**



## 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

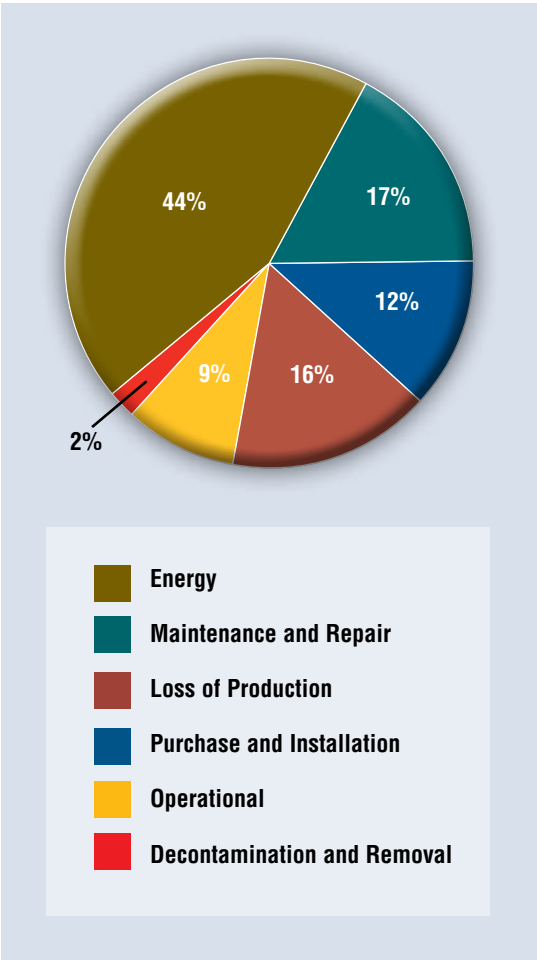
**Operating Expenses**

- Energy consumption
- Maintenance
- Production losses
- Environmental
- Inventory
- Operating
- Removal

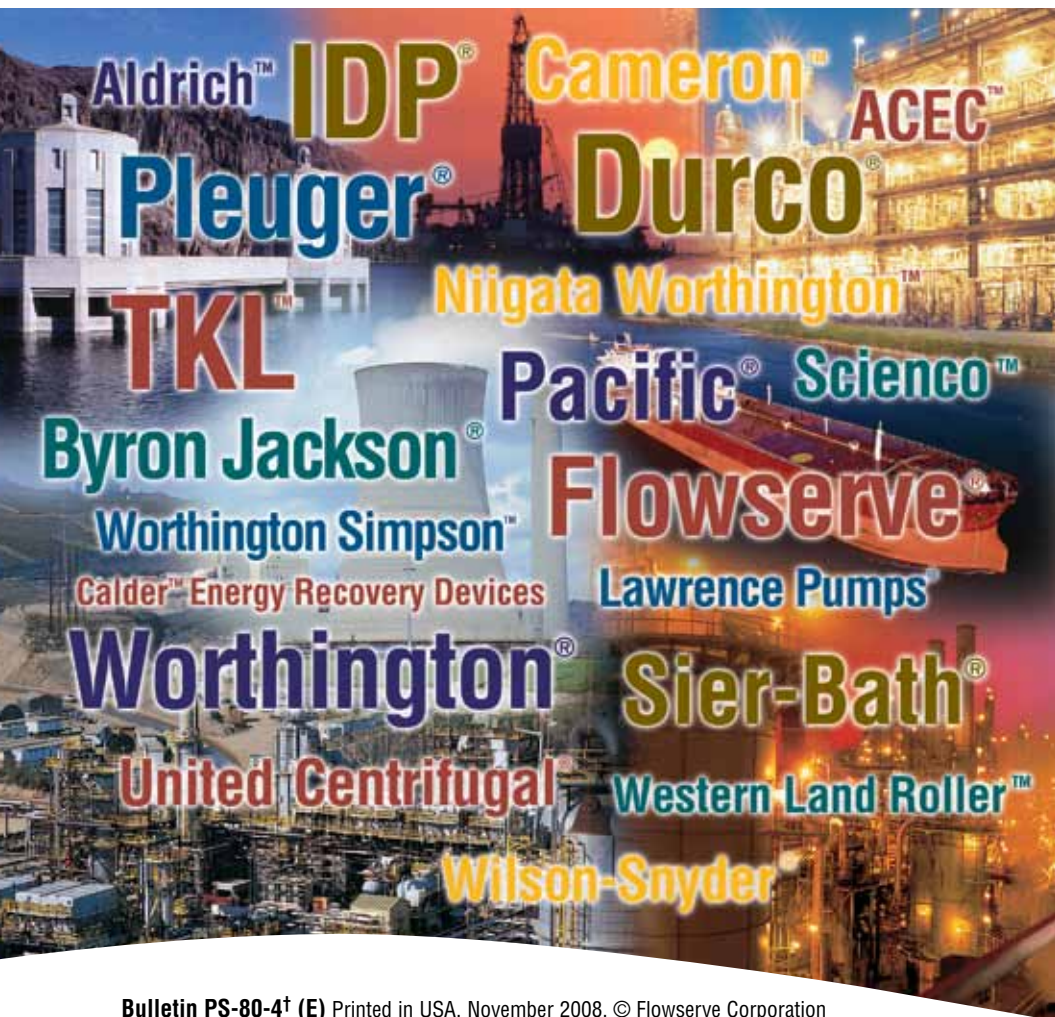
**Innovative Life Cycle Cost Solutions**

- New Pump Selection
- Turnkey Engineering and Field Service
- Energy Management
- Pump Availability
- Proactive Maintenance
- Inventory Management

### 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.



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