EXPERIENCE IN MOTION

Volume 1 • June 2008

Has Product Development Kept Pace?

Browns Ferry
Reduces Costs, Improves Performance

Global Growth and the Regulatory Environment
Preparing for the Next Phase of Commercial Nuclear Power Generation

SUPPLY CHAIN
Does Manufacturing Have the Capacity to Meet Projected Demand?

FLOWSERVE

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The 80% statistic is based on exclusion of select facilities where due to historic regulatory limitations we were unable to bid the work.

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Experience in Motion is a publication created by Flowserve, our customers and partners, to bring you important information on issues in key industries. This issue focuses on trends in the nuclear power industry and how companies around the world are working to address challenges and capitalize on opportunities. Your story ideas and topics for future issues are always welcomed.

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HAS PRODUCT DEVELOPMENT KEPT PACE?

The past several years have seen almost unimaginable progress in all kinds of technology—communications, data management, manufacturing and energy generation, to name a few. So the question arises: If there have been no new nuclear power plants in the United States recently, does the design of components needed to restart the nuclear industry lag? Will pumps, valves, seals, electric actuators, gear boxes and other components be available for next-generation nuclear plants that offer the reliability, safety and performance that designers will demand?

Keeping Current Means Staying Active

In fact, product development and improvement did not stop with the last domestic nuclear power plant. With a large installed base of products with long-time customers, component suppliers such as Flowserve have had a chance to continually refine products to improve reliability of existing plants and secure plant life extensions and power upgrades. There are also ongoing opportunities to work with industry organizations such as the Electric Power Research Institute (EPRI) to keep offerings current. And the continued growth of nuclear power in parts of Europe and Asia has provided ample opportunity and motivation to keep product design moving forward.

Close working relationships with key technology developers around the world ensure that products will continue to keep pace with the requirements of new nuclear plant designs. Peter Gowin, a knowledge management specialist with the International Atomic Energy Agency (IAEA), reported to the European Nuclear Conference in Brussels, September 2007, "We do see a lot of joint undertakings now, not just in the R&D side but in the commercial side as well, and it is transnational. Not only nuclear power plant parts, but project management, product development, and other technical and service aspects of a nuclear power plant are coming from different countries."

MSIV

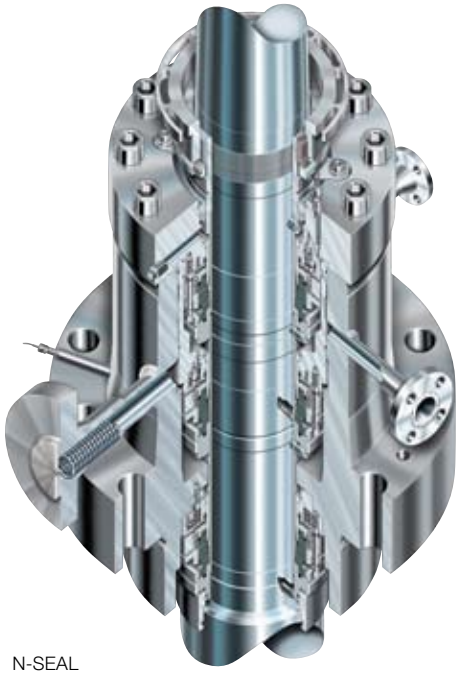
Experience Counts while Technology Moves Forward

Of course, the ability to develop the right new products depends on having the experience and expertise to keep up. For example, Edward Valve, a precursor to Flowserve, supplied the main steam isolation valves (MSIVs) to the Shippingport, Pa., Atomic Power Station, the world's first full-scale atomic electric power plant devoted exclusively to peacetime uses. That began an uninterrupted history of service to the industry that continued worldwide even when the nuclear power plant construction stopped in the United States. Since 1985, Flowserve has supplied more than 80 percent of the world's MSIVs. The company also offers late-generation pumps and mechanical seals for virtually every application required in a nuclear power plant. One key to this success is making sure senior experts, including those newly retired, are transferring knowledge to newer engineers so there is no information gap.

Keeping technology current also extends to manufacturing. More advanced products often require more advanced production techniques.

Flowserve has proven its commitment to current manufacturing technology with the installation of modern, high-performance machining centers at its nuclear manufacturing locations. One example is found at the Raleigh, N.C., plant, which can completely machine complex parts such as valve bodies without intermediate steps and handling. This increases capacity, reduces the time the part is in queue or on machines and reduces the potential for machining errors. With flexible manufacturing and potential capacity around the world, Flowserve is ready to shift production of commercial products to different manufacturing sites in order to free up capacity in its nuclear-qualified plants.

Computer technology not even dreamed of 30 years ago is commonplace today. Now there are software tools that speed the time from initial concept through design to production. This speed and design flexibility allow for continuous product improvement. Computers improve consistency and minimize the human element, speeding production and reducing errors. Information technology also makes the job easier for plant designers and specifiers. Software for product sizing and selection makes it simpler to specify the right component and, again, minimize errors.

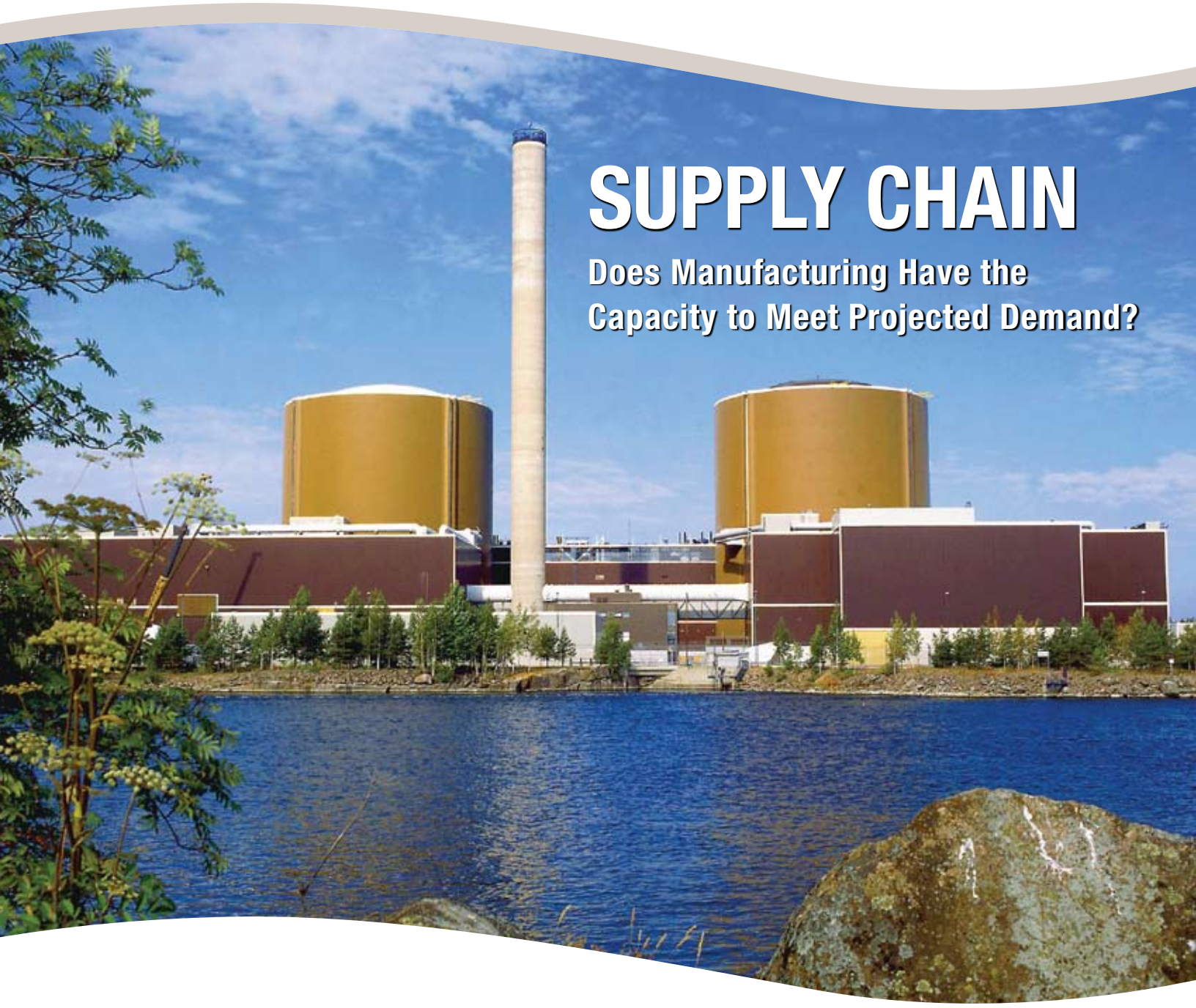


N-SEAL

Relationships Matter

Component manufacturers also depend on relationships with their own suppliers to keep product design current and meet anticipated demand. Flowserve is strengthening relationships with suppliers, many of which date back 50 years. With alliances and purchasing agreements already in place with key suppliers, the company is positioned to meet market needs for the latest products.

So it is the companies with the longest histories that are best positioned to meet the latest design requirements now and when construction of nuclear power plants begins again in the United States. They are the ones with the experience and knowledge base to keep up with demand. They have global presence that keeps product development current. They maintain the key relationships with technology developers, customers and suppliers. And they have the manufacturing technology and clout to stay on the cutting edge. Darren Wolz, a director and a nuclear power subject matter expert with Flowserve for gate, globe and check valves, explains, “Those component suppliers that have kept pace with product development have done it in the same fashion as Flowserve—by staying involved in the industry. Suppliers trying to jump into the market now will lack the experience and designs to perform well.”



SUPPLY CHAIN

Does Manufacturing Have the Capacity to Meet Projected Demand?

From the 1960s through the 1980s, nuclear power plants around the world were being built at a rapid pace, with some 300 gigawatts capacity in operation by 1990. More than 100 nuclear power plants were operating in the United States alone, providing 20 percent of its demand for electricity and making the United States the world's largest generator of commercial nuclear power.

But safety fears emerged following the 1979 Three Mile Island incident, which led to heavy U.S. government regulations and soaring costs. Nuclear plant construction eventually ground to an abrupt halt in the United States, and the number of companies building nuclear components declined rapidly.

In other countries, however, nuclear power plant construction continued and is, in fact, accelerating. In all, 16 countries produce nuclear power with a total of 439 nuclear plants in operation generating 16 percent of all electric power. France, Japan and the Russian Federation lead the world in numbers of nuclear power plants

after the United States. Another 32 plants are under construction worldwide with Asia—especially China and India—leading the way. Both countries plan dozens of new plants over the next decade.

New construction appears set for significant growth in the United States as well. The chairman of the Nuclear Energy Institute, Adm. Frank "Skip" Bowman, estimated that the United States needs to build and operate 60 new nuclear plants within the next 10 years. That level of activity has yet to be seen. However, 17 companies have signaled plans to build more than 29 new units in the United States, according to Secretary of Energy Samuel W. Bodman in a recent speech.

Already several companies have applied for nuclear licenses, and the Tennessee Valley Authority's Watts Bar Nuclear Plant resumed construction on a second nuclear reactor as recently as October 2007. Notably, when Watts Bar's first nuclear reactor began producing electricity in 1996, it became the last plant in the United States to do so.

Construction of new plants is inescapable, according to many experts, since existing nuclear power plants have already begun to reach the end of their operating permits. Already, some 7,000 megawatts of generating power have been taken offline because of age and the economic costs of refurbishing or re-licensing. The life of most nuclear plants, however, is being extended with upgrades and increases in capacity.

Capacity Declines

Since the last U.S. plant was completed in the mid-1990s, the nuclear industry has experienced degradation of manufacturing capacity in nuclear components.

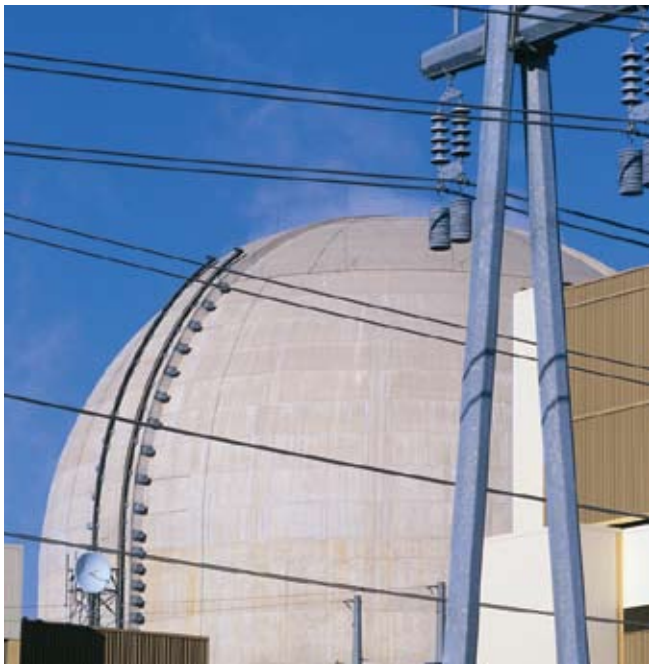
"This country hasn't built really a whole lot of infrastructure in 20 years, and it hasn't licensed a new nuclear plant in 30 years," Entergy Nuclear CEO Gary Taylor said in 2006 in an interview with *The New York Times*. "Most of the hard manufacturing moved offshore. In many ways, that may be a bigger challenge than anything else."

In his June 2007 speech to the Nuclear Energy Agency Forum in Paris, U.S. Nuclear Regulatory Commission Chairman Dale Klein said that manufacturing capacity is one of many challenges facing the commercial nuclear power industry. "As industry pushes ahead with plans to build new reactors, I am concerned about the ability of the manufacturing sector to supply high-quality components in a timely way. While the nuclear manufacturing industry used to consist of several national companies serving the world's needs, over the years these companies have merged or been bought out to form multinational companies. Still other companies migrated away from support of nuclear power in light of declining market opportunities in their countries in the past decade. This consolidation of manufacturing could potentially become a bottleneck for future growth.

"Moreover," Klein continued, "not only have the number of firms decreased, but many or even most of them are now operating at capacity. Right now, the lead time for delivery of reactor vessels is upwards of four years, and other key components have equally long backlogs. In the face of those long lead times, nuclear projects will need to get in line and scour the globe for available components and materials."

In 1985, some 600 companies in North America were certified by the American Society of Mechanical Engineers (ASME) with an "N" Stamp to produce nuclear-grade components in compliance with ASME's Boiler and Pressure Vessel Nuclear Codes and Standards. Today fewer than 100 companies possess an "N" Stamp. But while the number of companies has shrunk in North America, worldwide the number of companies has been growing. In China alone, more than 80 companies have an "N" Stamp. Twenty years ago, there were none.

Flowserve is just one of a handful of companies left that continues to manufacture nuclear power plant pumps, valves, actuators, gearboxes and seals. Jim Halligan, Flowserve global sales director, Power Group, Flow Control Division, shares in the concerns that a capacity gap could soon exist. "We're near capacity right now in all our valve factories. The biggest demand currently is coming from oil and gas companies."



Adds Steve Corcoran, Power Group, Asia-Pacific, Flow Control Division, "Everybody is looking to do so much so quickly; if all these projects move ahead in materials and expertise, it [the capacity shortfall] will quickly become a challenge requiring resources and expertise to address it."

Manufacturing Capacity Set to Grow

But Halligan says Flowserve plans to expand capacity as demand rises. "We will be ready. Our corporate leadership has recognized the fact that this is coming. Each nuclear power plant represents hundreds of millions of dollars in potential for valves, electric actuators, gear boxes and pumps. That's pretty big. So we have plans in place to grow capacity, and we will make the necessary capital investments to make that happen. We have a number of strategies we're looking at to grow capacity." Halligan hinted that Flowserve is also considering acquisition strategies and joint ventures to complement its existing resources.

The company is already adding new equipment and personnel to its Raleigh, N.C., valve manufacturing plant, says John Chappell, the plant's general manager.

"The facility in Raleigh has gone from 225 to almost 400 people in the last five years," says Chappell. "We're going to make some additional increases this year in capacity. We do have some time [for ramping up capacity] because order placement will be one or two years ahead of when valve manufacturing must begin."

Flowserve's Pump Division is adding to capacity by setting up a joint venture in Asia that is specifically geared to the nuclear market. "We are working with another company that has a manufacturing company in China," says Fred Grondhuis, marketing manager, high energy and nuclear industries. "We bring the nuclear products, the technology and the expertise that they don't have. So we're looking at taking some manufacturing capacity and moving it to where the projects are in China."

One particular area of concern is the shrinking number of companies that cast valves—only a few are nuclear qualified. Zoran Heruc, the purchasing director for Nuclear Power Plant Krsko in Slovenia, can attest. He says the issue of manufacturing being able to meet nuclear demand is "definitely present, especially forgings."

Flowserve recently grew its casting capacity with the purchase of Canada Alloy Castings (CAC), providing Flowserve with a secure source of supply and significantly shortened lead times on critical castings.

Flowserve is also in a fortunate position as a large global customer of these key foundries. The foundries produce products for Flowserve customers in many industries such as oil and gas, petrochemical, aerospace and mining. Flowserve is in a position of being able to adjust its demand as many industries tend to be counter cyclical.

Heruc notes the importance of power plant operators like his "maintaining good relationships with our vendors and making sure our purchase orders remain attractive versus those from 'new build' plants and the obsolescence [factor of older plant designs]."

One aspect concerning the building of future nuclear power plants that could help capacity is that the world has effectively settled on a small number of nuclear designs. Fewer styles of plants are being built because of the need to standardize the equipment, to keep it simple and gain capacity by having multiple manufacturing companies making the same components.

Other Challenges: Localization, Test Labs, Steel, Electric Motors

A different challenge exists for manufacturers doing business in developing countries that are looking for vendors to make commitments to localization and technology transfer, according to Dave Mathewson, nuclear products director, Flowserve Pumps Division. "That presents a challenge in being able to find companies that are willing to do that. How do you protect your intellectual property and designs?"

Capacity will also be strained at the test labs that certify equipment for nuclear power use, Chappell says. "For every product family that we build, we have to take a representative sample of valves and put it through a pretty stringent test program that can take two years to approve." Flowserve is addressing this issue by qualifying new designs early and taking advantage of its extensive line of previously qualified products.

Uncertainty about raw material supplies and the capacity constraints of nuclear-qualified suppliers of bar, plate, castings and forgings are major concerns. As an established customer, Flowserve is afforded priority status when casting and forging houses are fully loaded. Flowserve has dramatically increased the scope and size of its Global Sourcing Teams that develop and support regional supplier growth, especially in Europe, China and India. This expansion allows Flowserve to meet increased demand for qualified materials as well as satisfy local code and delivery requirements.

Yet another shortage in capacity exists with electric motors. The number of suppliers that provides nuclear-qualified motors for electric actuators and pumps is limited.

Positioned for Growth

Flowserve is one of only a few companies that has retained a strong presence in the nuclear power industry. Since the 1960s, Flowserve still has most of the facilities that supported the buildup of nuclear power around the world, says Darren Wolz, a director and nuclear power subject matter expert with Flowserve for gate, globe and check valves. "We've grown, added more products, added more facilities on a global basis, and a lot more people. We have all those resources to draw from as we need more capacity. We can draw on capabilities in material sourcing, quality assurance, human resources, design capability, field support, customer service and order management—all the way from the beginning of designing a product and testing it, qualifying it clear through to managing orders and shipping the product and supporting it throughout its life cycle."

Chappell adds that new construction is nothing new to Flowserve but will be for a lot of manufacturers. "We do big business supporting existing plants around the world. We have critical valve equipment going into every pressurized-water reactor (PWR) built in France over the last 20 years. We have equipment in Korean PWRs that have been built, including the ones that are under construction. We're doing new projects in China. We've got contracts for a project in Finland, and we've received several orders for critical valves for a project in France."

Mathewson adds that the Pump and Seal Divisions of Flowserve have also continued to prosper. "When you look at the major pump services in operating light water reactors today, Flowserve has about 80 percent of the installations in the U.S. and about 30 percent of them worldwide. That has generated all sorts of upgrades and new pump opportunities. Plus, we've been successful in the Europe and Asia-Pacific regions. We're supplying innovative solutions to problems that require a lot of technology development and a lot of engineering expertise. We've had a very active role in Korea and Japan, with upgrades to primary pump seals and primary pumps."

Still, many questions remain unanswered as to just how strong the demand for nuclear components will actually be. "Everybody's talking about how many plants are going to be built," Chappel says. "But we don't know for sure how much of this is going to be real."

The next two or three years could well be the time when these questions are largely answered.

BROWNS FERRY & Reduces Costs & Improves Performance

Flowserve Helps Bring Browns Ferry Unit 1 Back to Life Despite Obstacles.

For 17 years, Unit 1 at Browns Ferry nuclear plant on the north shore of Wheeler Reservoir in northern Alabama sat dormant. One of three operating Tennessee Valley Authority (TVA) nuclear plants, Browns Ferry is a three-unit GE design and began commercial operation in 1974, just 11 years before it was shut down in 1985.

When the TVA decided in 2002 to return Browns Ferry Unit 1 to operational status, extensive decontamination, repair and replacement work were necessary to bring the unit up to present-day standards. The TVA chose Flowserve to help them tackle the unique challenges associated with bringing Unit 1 back online.

Radiation Hazards

High radiation levels required repairs and modifications to take place at an off-site facility. Workers transported equipment in secure containers with lead shielding to Westinghouse Electric Company's Waltz Mill Nuclear Repair Center in Madison, Penn., where radiation was reduced to workable levels. It was also necessary to jockey large components in and out of storage multiple times due to space restrictions.

"This was a joint project between the Flow Control and Pump Divisions at Flowserve," says John Chappell, Flowserve Raleigh general manager. "We were reworking valves in the facility, while at the same time also doing some pump components."

Lead Times

The TVA's ambitious schedule did not permit standard or even the typical expedited lead times. A standard lead time for replacement bonnets for four 28-inch recirculation gates is 26 weeks. Even expedited lead times are at least 16 weeks. However, through extensive coordination with the foundry and Flowserve's Raleigh, N.C., facility, Flowserve cut lead times down to just six weeks.

"For us, the biggest issue a lot of the time is raw material lead time—getting what we need from sub-suppliers," explains Chappell. "We spent a lot of man-hours working with suppliers to improve lead time."

John Underwood, senior manager at TVA Browns Ferry Nuclear, saw Flowserve's ability to deliver on time as an area where the company excelled. "Meeting [TVA's] deadlines for installation of components helped make the project successful," he says.

Go with the Flow

Adapting to changing circumstances as the repairs were under way was also critical to Flowserve's success. During the project, four of the 14 valves to be decontaminated were found to be beyond repair. Flowserve's Flow Control and Pump Divisions manufactured the four new valves over the course of the next year. They also completed new bonnets for four of the 10 decontaminated valves as well as RWCU pump impellers. TVA ordered an additional 10 replacement valves for critical service inside the containment.

"We think we did a really good job at Browns Ferry," says Chappell. "It was a pretty difficult project with a lot of difficult times, but when it was all done, TVA thanked us for sticking with it."

Electropolishing

Flowserve also gained its first nuclear experience with electro-polishing, the electrochemical removal of microscopic irregularities from metal surfaces, which TVA required for all decontaminated and new valves, including bonnet and body parts, and the pump impellers ordered from Flowserve. Electropolishing minimized rough surfaces where radiated contamination might adhere, reducing hot spots in the system. The extra step will reduce radiation exposure for workers during future maintenance activities.

"Electropolishing was new for us in nuclear valve manufacturing," Chappell says. "We had to work things out not just from a schedule standpoint, but also physically figure out how we were going to do it. It makes for a beautiful product—really smooth and shiny. There is no place for radioactive byproducts to accumulate."

A Partnership

Flowserve Flow Control Division worked closely with the Pump Division to make the project a success. The Pump Division helped realize one objective of the project, which was to increase plant power output by about 20 percent. This increase in output required the replacement of the existing high-speed 8,500-horsepower reactor feed pumps originally supplied by a Flowserve heritage company. Flowserve worked with the TVA to develop a design that would not only allow the reuse of existing steam turbine drivers but would also minimize modifications to existing piping, resulting in significant cost savings. Flowserve manufactured the pumps in Spain and tested them at full power and speed in California.

"The pumps met and exceeded TVA's specifications," says Fred Grondhuis, Flowserve Pump Division high energy and nuclear products marketing manager.

The Pump Division also worked with the TVA to replace the inner assemblies of the Flowserve reactor recirculation pumps with a patented upgrade called the Fourth Generation design. Total value of the work done at Unit 1 for the Flowserve Pump Division exceeded $15M.

"The 'Fourth Gen' is the definitive solution to thermal fatigue shaft cracking, which has been an industry-wide issue in this service," says Dave Mathewson, Flowserve Pump Division nuclear products director. "By providing a turnkey change-out, Flowserve was able to control the installation and manage the project of replacing the reactor recirculation inner pump assemblies under budget and on schedule."

Browns Ferry Unit 1 was finally brought back online in 2007. Currently, Unit 1 provides 1,155 megawatts of power, and the TVA plans to eventually increase each unit's capacity to 1,280 megawatts. The TVA is also in the middle of construction on Watts Bar Unit 2, which will add another 1,180 megawatts of power when completed.

GLOBAL GROWTH AND THE REGULATORY ENVIRONMENT

Preparing for the Next Phase of Commercial Nuclear Power Generation

While countries with well-developed civilian nuclear power programs have established regulations and standards, a long list of countries actively considering development of nuclear power programs is still determining the structure of their regulatory bodies. According to the World Nuclear Association (WNA), an international trade association for companies involved in the nuclear fuel cycle and nuclear power generation, more than 30 countries, ranging from those with "sophisticated economies to developing nations," are seriously exploring nuclear power (see sidebar: *Future Nuclear Nations?*). In fact, according to the International Atomic Energy Agency (IAEA) forecasts, the world will see an increase in global energy consumption of more than 50 percent by 2030, with 70 percent of this growth expected to come from developing countries.

The Foundations of Regulatory Policy

From the day the first civilian nuclear reactor was planned, the industry has recognized the need for stringent regulations to assure safe, responsible growth and reliable operations. In that time, as civilian nuclear power has expanded around the globe, a network of regulatory bodies has developed based in large part on the foundations established by the pioneering nuclear countries.

The Nuclear Regulatory Commission

In the United States, the Nuclear Regulatory Commission (NRC) is charged with reactor safety oversight and reactor license renewal of existing plants, materials safety oversight and materials licensing for a variety of purposes as well as waste management of both high-level waste and low-level waste. NRC regulations have served as a model for many subsequent regulatory bodies in other countries.

With the 2005 National Energy Policy (NEP) Act, the federal government sought to expand domestic nuclear power production by streamlining the process of obtaining licenses to build new nuclear facilities and extending the licenses of existing nuclear plants. Today, as the NRC works to implement those mandates, it too must cope with many of the same staffing and capacity issues facing private-sector industries as they prepare for a resurgence in applications for licensing.

How much is the "business" of regulation expected to pick up? According to a report issued by the Government Accounting Office (GAO) in October of 2007, the NRC is anticipating as many as five applications for licensing nine reactors in first-quarter fiscal 2008, and nine other applications through the end of FY-08 for 13 reactors. An additional six applications, for a total of nine new reactors, are expected in FY-09 (Source: *Nucleonics Week*, October 4, 2007).

Future Nuclear Nations?

Nuclear power is under serious consideration in more than 30 non-nuclear countries:

Europe: Italy, Albania, Portugal, Norway, Poland, Belarus, Estonia, Latvia, Ireland, Turkey

Middle East and North Africa: Gulf States, Yemen, Israel, Jordan, Egypt, Tunisia, Libya, Algeria, Morocco

Central and Southern Africa: Nigeria, Ghana, Namibia

South America: Chile, Venezuela

Central and Southern Asia: Azerbaijan, Georgia, Kazakhstan, Bangladesh

Southeast Asia: Indonesia, Philippines, Vietnam, Thailand, Malaysia, Australia, New Zealand[1]

[1] Source: "Emerging Nuclear Energy Countries" – World Nuclear Association online, January, 2008, http://www.world-nuclear.org/info/inf102.html.

From designers and manufacturers to constructors and operators, the focus on global markets reflects the tremendous opportunities for the expansion of commercial nuclear power. To succeed in these markets, it is important to understand the landscape of regulation and licensing. This article will combine a summary of the established regulatory environment with a look at emerging and changing markets and how their regulations are evolving.

The relevant issue for component manufacturers is the NRC's system of codes and standards that has evolved in the last two decades. When new codes and standards are issued, for example, a Regulatory Guide (Reg Guide) is released for each, together with dialogue on its acceptance, restrictions or interpretations. If manufactured components are involved, the plant licensee assumes responsibility for interpreting the revised requirements and passing them on to the component supplier.

With pump and valve designs, for example, the licensee or designee (NSSS or AE) specifies the appropriate requirements for components that support the design basis of the plant as documented in the safety analysis and tech specs. These include details on type, application, function, materials, design conditions, fabrication, inspection and non-destructive testing requirements.

The American Society of Manufacturing Engineers

Founded in 1880, the American Society of Mechanical Engineers (ASME) is a key player in working with the NRC to oversee codes and standards for the engineering and technology community in general and for the commercial nuclear industry in particular. Nuclear accreditation from ASME, known in the industry as the "N-Stamp" program, means that the authorized vendor has produced the commercial nuclear-grade components in accordance with the ASME Boiler and Pressure Vessel Nuclear Codes and Standards including the ANSI/ASME QME-1-2002 Qualification of Active Mechanical Equipment Used in Nuclear Power Plants.

The 2004 ASME Boiler and Pressure Vessel Nuclear Codes and Standards - Section III - Rules for Construction of Nuclear Power Plant Components, consists of 11 volumes.

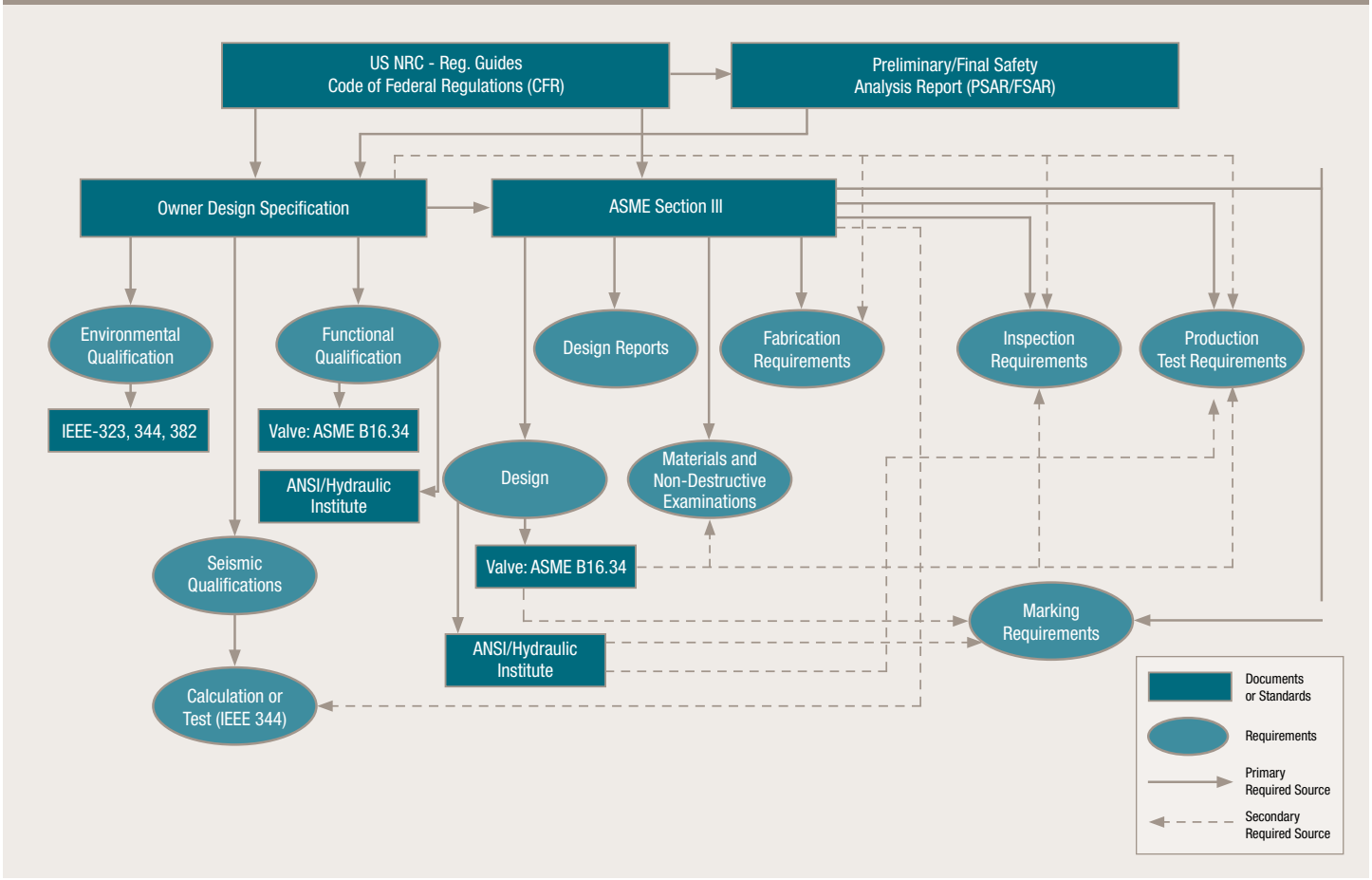
Codes and standards typically encountered in the nuclear industry include:

- ASME Section III: Rules for Construction of Nuclear Facility Components includes requirements for pump and valve design/ pressure ratings, design reports, allowable stress levels, pressure retaining materials and their non-destructive examinations, fabrication, inspections, production testing and valve marking.
- ASME B16.34: Valves – Flanged, Threaded and Welding End.
- ANSI/Hydraulic Institute 2000 - American National Standard for Centrifugal Pumps.
- ASME QME-1: Qualification of Active Mechanical Equipment Used in Nuclear Power Plants[2] includes testing under a plant's normal and accident conditions including cold system and hot system conditions, pipe bending/end loads and static seismic loads, dynamic seismic conditions and maximum flow conditions.
- Institute of Electrical and Electronics Engineers (IEEE) Standards[3]:
  - IEEE 323 Standard for Qualifying Class 1E Equipment for Nuclear Power Generation Stations
  - IEEE 344: Recommended Practices for Seismic Qualification

[2] This standard (including its predecessor, ANSI B16.41) was released in the early 1980s, which means current U.S. nuclear plants built before the release did not require their use to functionally qualify equipment. Later international plants built to the ASME Codes in Korea included ASME QME-1 qualification. As a result, most U.S. equipment suppliers have not qualified their equipment according to these requirements.

[3] IEEE 323, 344 and 382 cover environmental and seismic qualifications of safety-related actuators and safety-related electrical components. These standards require the actuators/components to be aged to their "end-of-life" condition and then verify functional capability under accident conditions, seismic and Loss of Coolant Accident (LOCA) or Main Steam Line Break (MSLB) environmental conditions. Aging includes effects due to normal temperature, pressure, functional cycles and radiation.

Codes and Standards in Today's U.S. Regulatory Environment



of Class 1E Equipment for Nuclear Power Generating Stations

- IEEE 382: Standard for Qualification of Actuators for Power Operated Valve Assemblies with Safety-Related Functions for Nuclear Power Plants

Global Expansion - A Survey

As early participants in the development of nuclear power expand and/or maintain their stable of reactors, emerging nations are adding to the potential market for valves, pumps, and other equipment and systems.

France

With 59 nuclear power plants generating nearly 80 percent of their electric power, France has assumed a leading position in the world in the development of commercial nuclear power. The French equivalent to the ASME, the French Society for Design and Construction Rules for Nuclear Island Components (AFCEN) has established standards for the French nuclear industry. The most relevant code for the nuclear industry is the RCC-MR, the Design and Construction Rules for Mechanical Components of the Fast Breeder Reactor (FBR) Nuclear Island, while valve and pump are specifically covered by RCC-M nuclear piping codes. Electric motors are covered by RCC-E.

As other countries have moved to develop their commercial nuclear power capacity, they have tended to pattern their guidelines on either the ASME or AFCEN models, with the exception of the former Soviet Union countries (see *An Eastern European Overview* on the next page).

Germany

According to the World Nuclear Association, Germany currently has 17 operating nuclear power reactors including six boiling water reactors (BWR) and 11 pressurized water reactors (PWR). Together, they provide 20.6 percent of the country's installed capacity. Germany, along with Sweden and Belgium, is currently committed to eventually eliminating nuclear power from its energy grid. The future of that policy, however, was called into question in the summer of 2007 when German Chancellor Angela Merkel announced her intention to reverse that decision to help meet targets for the reduction of CO2 emissions. Whatever course Germany follows, there will still be a sizable market for equipment needed to keep existing reactors operational. Other European countries considering nuclear power programs include Italy, Portugal, Norway, Ireland and Turkey.

An Eastern European Overview

While the Ukraine leads the region with 15 reactors, the Czech Republic (6), the Slovak Republic (5), Hungary (4), Bulgaria (2), Romania (2), Armenia (1), the Republic of Lithuania (1) and Slovenia (1) all operate reactors. Eastern European countries considering nuclear power programs include Albania, Poland, Belarus, Estonia and Latvia. With most of the existing reactor base in this region having been constructed while the countries were under the influence of the former Soviet Union, their design standards (as well as the current regulatory agencies governing their operations) continue to be very much in line with their Russian counterparts.

Russia

In Russia, 16 percent of their electricity production currently comes from nuclear power. Russian nuclear capacity is expected to grow with announced targets of 23 percent nuclear by 2020 and 25 percent by 2030. In response to these goals, the regulatory environment in Russia has shifted. In an article in *Nucleonics Week* (December 6, 2007, page 9), it was reported that then-Russian President Vladimir Putin had instituted changes to their regulatory structure designed to "allow implementation of Russia's ambitious federal program of nuclear power development." According to the article, the new agency, the "State Corporation for Atomic Energy" retains the familiar reference of "Rosatom" while restructuring to reflect the tighter alignment of "state" and "commercial" interests. Russia's new president, Dmitry Medvedev is not expected to alter the new arrangement. The article reports that Russia plans "to build up to 10 1,000-MW-class PWRs and begin construction on 10 more." And while Western involvement in construction of Russian reactors has been limited, that is expected to change as global markets expand.

China

The world's fastest-growing economy is also the world's second largest consumer of energy, making China the focal point of expansion efforts by manufacturers, constructors and operators. The two major utility companies in China include the established Guangdong Nuclear Power Group Co. and the newer China National Nuclear Corp. (CNNC). On the regulatory front, the National Nuclear Safety Administration (NNSA), established in 1984, is known as "China's Nuclear Regulatory Commission." The NNSA is responsible for standards/regulations, construction permits/operating licenses, monitoring plant operations and conducting joint research on nuclear safety with other countries.

The Pacific Rim and Beyond

The Far East, Southeast Asia and the Indian continent constitute the most active regions in the world for the development of new commercial nuclear power. Anchored by established nuclear power programs in the Republic of Korea, Japan, India and Pakistan, new reactors are being proposed in Indonesia, the Philippines, Vietnam, Thailand, Malaysia, Australia and New Zealand. In each case, standards are governed by local regulatory bodies, most of which are working within existing guidelines established by the major regulatory entities.

Understanding the regulatory environment is essential as business expands and cooperative agreements are reached to help spur growth in power generation to meet the needs of a growing global economy. With its long history of involvement in the commercial nuclear power industry, Flowserve is well versed in regulatory issues and global strategies. Over the years, Flowserve employees have lent their expertise to the development of sound standards and codes by serving on domestic committees and governing bodies of related organizations. As globalization continues, Flowserve will expand its role in helping emerging markets maintain standards that will assure the development of safe, economical and environmentally responsible energy production.

Filling the Skilled Labor Gap.

New Solutions for a New Workforce.

In an article published on August 24, 2007 ("Help Wanted in the Nuclear Industry"), *The Wall Street Journal* described the current dilemma facing the nuclear power industry: "Faced with an aging, dwindling workforce, U.S. nuclear power companies are competing for young workers…" The article goes on to pinpoint the specific jobs where the shortages are most acute. "Chief among the nuclear industry's concerns is that a shortage of skilled technicians and craftsman will make new nuclear plants more difficult and expensive to build."

The Nuclear Energy Institute (NEI – www.nei.org) estimates that roughly half of the nuclear industry's workforce will be eligible for retirement in the next 10 years. That, together with the expected growth in the global commercial nuclear power industry (See *Global Growth and the Regulatory Environment* on page 12), leads the NEI to conclude that the nuclear industry is facing "an unprecedented recruitment effort throughout the industry."

As part of a series on the resurgence in the domestic commercial nuclear power industry, "Energy Options: Nuclear," Nightly Business Report on PBS devoted an entire segment to "Nuclear Power and Jobs." In the report, correspondent Diane Eastabrook points out "experts say a worker shortage could be one of the biggest roadblocks for a nuclear energy revival in the United States." In one instance, Eastabrook cited a billboard campaign, part of a joint effort between a company and a college "touting lucrative careers at nuclear power plants."

The situation is one of global proportions. In 2007, the employment services company, Manpower, published a global "Talent Shortage Survey"[1] that identifies the jobs that employers are having difficulty filling in 27 countries and territories. In country after country, the positions of skilled manual trades, technicians, engineers, and machinist/machine operators ranked in the top 10 of difficult-to-fill jobs.

Addressing the Need

The good news is that the need for skilled workers is being addressed on a number of fronts by a number of organizations. Flowserve, for example, has developed a multifaceted effort to address the current and future need for skilled engineers and machinists. According to Darren Wolz, a director and nuclear power subject matter expert with Flowserve, the company has established internal systems to retain valuable knowledge from the more experienced workers for the benefit of the new generation of engineers, machinists and managers. "We've developed a series of measures that include incentives for employees to remain past their standard retirement dates, consulting options for those who do choose to retire, and training programs designed to capture what we call 'tribal knowledge.'"

In 2006, the American Nuclear Society (ANS), a not-for-profit, international, scientific and educational organization, issued a position statement, "Maintaining a Viable Nuclear Industry Workforce." In it, the ANS urged its membership, representing 1,600-plus corporations, educational institutions and government agencies, to take positive steps to promote careers in critical areas. These steps include the following recommendations:

- Promote and improve the education, knowledge and qualifications of the nuclear workforce.

- Continue efforts to effectively capture, manage and transfer critical knowledge between successive generations of workers.
- Develop self-sustaining efforts to attract new, well-qualified workers to ensure future industry workforce needs are met.

Promoting Global Technical Education

Around the world, countries are addressing the need by working to align their educational programs with their manufacturers' needs for skilled labor. Emphasis is being placed on technical education to train workers for careers such as skilled manual trades and machinists.

Through its program of low-interest loans, grants and private sector investments, the Asia Development Bank (ADB) helps build infrastructure and improve essential services for the nearly 1.9 billion people in the region still living on $2 or less a day. On its website, www.adb.org, the ADB describes a project where, in 1995, the Malaysia Technical Education Department proposed a quantitative and qualitative expansion of the country's secondary technical and vocational schools. Completed in 2002, the program has benefited both the population and industries in the region, including those involved in nuclear reactor development currently being proposed by the Malaysian Nuclear Agency.

In a 2006 gathering of the World Skills Leader Forum, representatives from nations as diverse as Finland, Australia, India and Singapore described their efforts over the last decade to enhance vocational technical education.

Innovative Approaches

Is today's emerging workforce shying away from careers in manufacturing because of a less-than-desirable image? That's the premise of an innovative program in the United States called "Dream It/Do It" developed by the National Association of Manufacturers (NAM). The program is designed to "help young adults find careers that they can be passionate about in one of manufacturing's many exciting sectors.[2] Using testimonials and an entertaining series titled "Cool Videos of Stuff Being Made,"[3] NAM is hoping to reverse the negative attitudes that have kept students from considering careers in the skilled trades.

Some companies have developed different strategies for attracting qualified employees. In her story on Nightly Business Report on PBS, Eastabrook reported that "General Electric recently moved its nuclear division to Wilmington, North Carolina, from California, hoping the South might be more appealing to prospective workers," a fact that Andrew White, president and CEO of GE Nuclear, confirmed. "We've recruited people experienced in the industry to a place that is much more cost-effective for the people," said White. "It's a much more friendly place to work for business."

Flowserve: Strategies for Meeting Demand

Through their affiliation with trade organizations such as the Energy Power Resource Institute (EPRI), Flowserve and other companies are working to provide the information and incentives needed to spur interest in careers in nuclear engineering. Ensuring a qualified workforce is key to future productivity and expansion.

Long-range planning is one thing. To meet the immediate need of guaranteeing the skilled labor force for producing the specialized valves, actuators and pumps needed for nuclear applications, Flowserve has developed global alliances that shift production of non-nuclear related products to other facilities to allow those with "N-Stamp" certification to concentrate their efforts on the most critical projects. Through this optimized usage of existing capacity, Flowserve expects to be able to meet demand in all its key sectors.

[1] Talent Survey Shortage, 2007 Global Results; http://www.manpower.com/research/research.cfm
[2] http://www.dreamit-doit.com/content/campaign/thestory.php
[3] http://www.dreamit-doit.com/content/videos/index.php

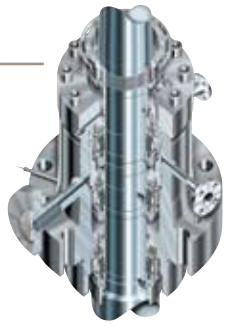
Flowserve Nuclear Power

From the start, a trusted partner to the nuclear power industry.

NUCLEAR POWER (PUMPS)

Boiling Water Reactors (BWR)—ABWR, ESBWR
Pressurized Water Reactors (PWR)—AP1000, EPR, VVER
Pressurized Heavy Water Reactors (PHWR)—ACR 1000

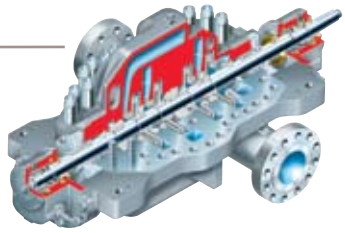
N-SEAL



- Nuclear Seal for Class 1 Service (RCP, RRP, PHT)

The N-Seal is specifically designed for RCP class 1 service. Its numerous features make it ideal for retrofits. It is the only seal in the market that meets Station Blackout requirements

DMX

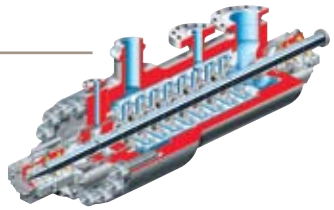


- Between Bearing
- Axially Split
- Multistage Pump

Applications: D_2O Feed Pump, High-Pressure Booster

The Flowserve DMX is an axially split, multistage pump. DMX pumps are particularly well suited for charge and injection services, where uncompromising reliability over wide ranges is imperative. The DMX features a dual volute design with opposed impellers, which balances the hydraulic thrust.

Multistage Barrel (CSB)



- Between Bearing
- Radially Split
- Multistage Pump

Applications: High-Pressure Injection, Emergency Feed Water

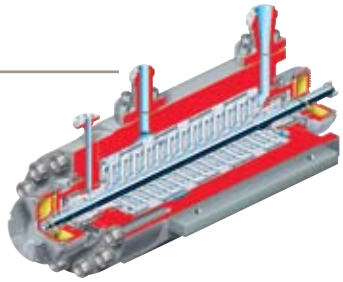
The CSB is a multistage, diffuser barrel pump.

Radially Split, Multivane Diffuser Construction results in balanced radial loads over the entire flow range, including partial-load operation.

Continuous Cross-Over Diffuser precisely converts velocity energy to pressure energy throughout the entire streamline from impeller discharge.

Rotor designed using advanced dynamic analysis and manufacturing techniques to ensure it is the most solid and dependable in the industry.

CAM



- Between Bearing
- Radially Split
- Barrel Casing
- Multistage

Applications: CVCS, Charging, High-Pressure Safety Injection

The Flowserve CAM high-pressure safety injection pump is designed specifically for nuclear charge service. This between bearing, radially split, multistage design complies with ASME Section III, Class 2.

Patented Modular Impellers result in a unique, compact design that provides low-flow stability and reliability over a wide range of flows without surging and pulsations.

Ball-ball bearing construction does not require external forced feed lube oiling system.

FLOWSERVE

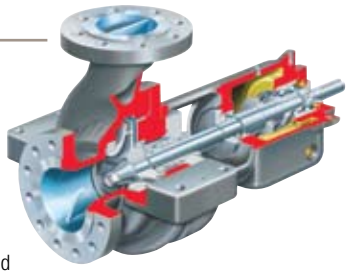
Since the birth of nuclear power, Flowserve has been a leading supplier of pumps, valves, seals and solutions for the nuclear industry, including the most critical applications.

Today, with 439 reactors online worldwide and another 34 in development, Flowserve products and solutions are hard at work, helping assure safe, economical and environmentally responsible energy production throughout the world.

NUCLEAR POWER (PUMPS)

Boiling Water Reactors (BWR)—ABWR, ESBWR
Pressurized Water Reactors (PWR)—AP1000, EPR, VVER
Pressurized Heavy Water Reactors (PHWR)—ACR 1000

HPX

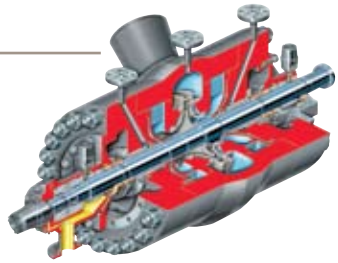


- Overhung Impeller
- Centerline Mounted
- Single Suction

Applications: Fuel Pool Cooling, Reactor Water Cleanup

This overhung impeller, centerline-mounted pump offers the most comprehensive range of hydraulic coverage available in the industry. The HPX is used in a wide range of applications with unmatched versatility, reliability and safety.

CN/HDR

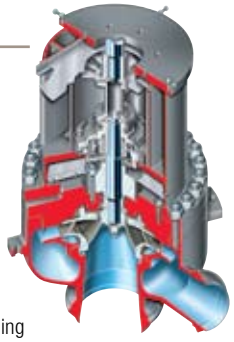


- Between Bearing
- Radially Split
- Barrel Casing
- Single Stage
- Double Suction
- High-Speed Design

Applications: Reactor Feed and Steam Generator Feed

Designed specifically for nuclear reactor and steam generator feed service, these barrel pumps feature forged casings. This pump is available with controlled leakage bushings or mechanical seals.

WDF



- Vertical Overhung
- Radially Split
- Single Stage
- Forged Casing

Applications: Containment Spray, Residual Heat Removal, Low-Pressure Safety Injection, Shutdown Cooling

Flowserve's WDF pump is used in pressurized and boiling water reactors for "N-Stamp" safety applications.

Unique coupling design allows ease of maintenance for quick mechanical seal replacement in harsh environments.

VCT

- Vertical Pump
- Radial Split
- Single and Multistage

Applications: Condenser Cooling, Essential Service Water

The Flowserve VCT is a vertical mixed-flow pump designed for a wide range of operating conditions and sizes.

Engineered to customer specifications.

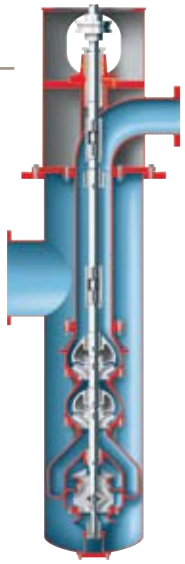
Above- or below-grade discharge configurations.

Pullout and non-pullout designs available.

NUCLEAR POWER (PUMPS)

Boiling Water Reactors (BWR)—ABWR, ESBWR
Pressurized Water Reactors (PWR)—AP1000, EPR, VVER
Pressurized Heavy Water Reactors (PHWR)—ACR 1000

APKD/QLQC



- Canned Vertical
- Radial Split
- Multistage Pump
- Double-Suction First Stage

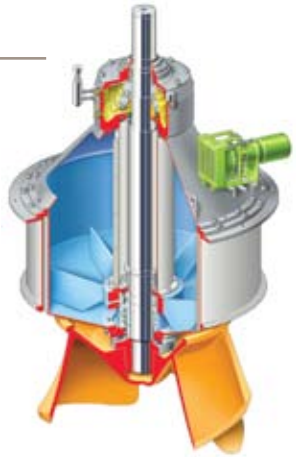
Applications: Condensate Extraction, Heater Drain, High-Pressure Core Flooder, Residual Heat Removal

The APKD/QLQC is a vertical, double-suction pump specifically designed for applications where NPSH is very low.

Heavy-Wall Twin-Volute Casing minimizes radial loading on liquid end bearings due to large waterways and low liquid velocity.

Double-Suction Impeller features balanced hydraulic thrust and large waterways for a stable performance curve with low shutoff pressure.

BSV/BCV

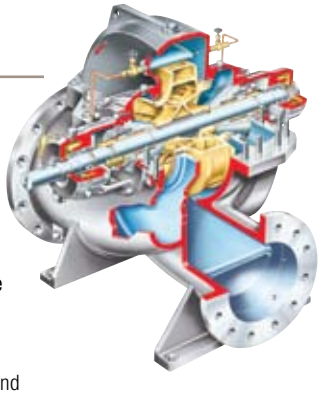


- Vertical Pump
- Single Stage
- Open and Closed Impellers

Applications: Circulating Water, Condenser Cooling

The Flowserve BSV and BCV concrete volute pumps are a vertical, wet pit design used for large flow applications requiring continuous operation. The massive concrete volute substantially reduces noise and vibration, offers high corrosion and erosion resistance, significantly increasing pump life.

LNN

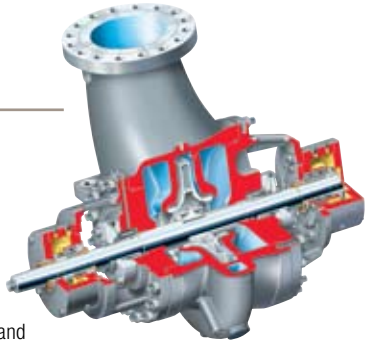


- Azially Split
- Single-Stage Pump
- Between Bearing
- Double Suction

Applications: Condensate Booster, Component Cooling Water, Essential Service Water

The Flowserve LNN is an axially split, double-suction pump design featuring 145 impeller and volute combinations resulting in quiet operation, low NPSH requirements, and high-efficiency operation in all water applications.

HDX



- Between Bearing
- Radially Split
- Double Suction

Applications: Feed Water Booster

The HDX pump complements flow and pressure requirements between overhung and multistage process pump lines. The HDX is engineered for safe, reliable performance at the elevated temperatures and pressures of power applications.

NUCLEAR POWER (VALVES)

Equiwedge Gate Valves

- Bolted or Pressure Seal Bonnet Designs,
- Integral Satellite Seat, Disc and Backseat
- Two-Piece Body-Guided Wedge
- Flanged or Butt-Welded Ends

Applications: Main Steam Isolation, Main Feedwater Isolation, Feedwater Heater Isolation, Critical, High-Pressure Isolation

Wedging action of the Flowserve - Edward Equiwedge gate valve provides tight sealing even at low differential pressure. Wedge guiding by grooves in the body minimizes seat wear and damage, since seating surfaces of the wedge and body are in contact during less than 5% of the total wedge travel. Two separate, flexible wedge halves are free to align with seats even when they are tilted or rotated due to thermal effects or piping loads.

Flex Wedge Gate Valve

- Bolted or Pressure Seal-Type Bonnet
- Uniformly Flexible around Entire Circumference of Wedge
- Broad Range of Sizes and Pressure Classes
- Flanged or Butt-Welded Ends

Applications: RHR Shutdown Cooling, RWCU Suction Containment Isolation, Critical Service Applications

The Flowserve Anchor/Darling Flex-Wedge gate valve is supplied in sizes from 2-1/2 to 24 inches and pressure classes ranging from 150 to 2500. Wedging action of the Anchor/Darling Flex-Wedge Gate Valve provides tight sealing even at low differential pressure. The body includes two drop in seat rings. The seat rings and wedge have hardfacing on their seating surfaces.

MSIV/MFIV

- Integrated Valve and Actuator by the Same Manufacturer
- Simplified, Modular Design
- 12-Year Maintenance Cycle
- Fire-Safe, Personnel-Friendly Hydraulic Fluid

Applications: Main Steam Isolation, Main Feedwater Isolation

Flowserve MSIVs are either the Equiwedge gate valve or a Flite-Flow (Y-Globe) valve and are designed to close the valve in 3 to 5 seconds.

The Type-A hydraulic actuators are self-contained with the capability to close the MSIVs even with failure of support utilities. The Equiwedge gate valve has been functionally qualified to QME-1 and the actuators are environmentally and seismically qualified for their applications per IEEE 323, 344 and 382.

Double Disc Gate Valve

- Bolted or Pressure Seal Bonnet Designs,
- Low Pressure Sealing and Between-Seat Sealing
- Critical Surfaces Hardfaced for Long Wear
- Rapid Closure and Ease of Maintenance

Applications: Feedwater Heater Isolation, HPCIS Steam Supply Block, Shutdown Cooling Suction, Main Steam Drain, Critical Service Applications

The Flowserve Anchor/Darling Double-Disc gate valve employs an exclusive disc-and-wedge design, which assures tight closing and smooth operation over a long service life.

Both discs are independent and free to move. With the application of internal sealing pressure between them, equally tight shut-off is possible on each of the parallel seats.

Other advantages of the Anchor/Darling Double-Disc gate valve include positive closing, uniform wear distribution, parts interchangeability, in-line maintenance and application versatility.

NUCLEAR POWER (VALVES)

Tilting Disk Check Valves

- Replaceable Seat Rings
- Quick Responding
- Non-Slam Design
- Horizontal and Vertical Installations

Applications: Condensate, Cooling Water, Extraction Steam, Service Water, Feedwater, Areas Susceptible to Marine Growth

Flowserve Anchor/Darling and Edward check valves provide the piping designer greater flexibility, thanks to the various check valve types and body types available. An inherently rugged design, the Flowserve Anchor/Darling and Edward Tilting-Disc check valves provide quick responding, non-slam performance to reduce potential system pressure surges.

Swing Check Valves

- Tight Sealing
- Low Pressure Drop
- Horizontal and Vertical Installations
- In-Line Maintenance

Applications: Auxiliary Feedwater, Feedwater

Flowserve Anchor/Darling's Swing Check valves provide the most economical reverse-flow protection with minimal pressure drop for normal applications. This design check valve is best suited for applications requiring tight sealing and shut-off.

Piston Check Valves

- No Body Penetration
- Full Disc Guiding
- Seal-Welded Seat Ring
- Easy Maintenance, In-Line Maintenance

Applications: RCICS Turbine Exhaust Check, HPCIS Turbine Exhaust Check

Flowserve check valves incorporate time-proven design features such as equalizers for full lift at lower flows; body guided disc-piston assemblies for seat alignment and stable operation; integral Satellite seating surfaces for long life and tight sealing and streamlined flow shapes for low-pressure drop. An aspirator is also available with an adjustable valve to control disc opening and closing speed.

Globe Valves

- Body and Plug Designed to Minimize Cavitation
- Skirted Swivel Plug
- Full Body Guides
- Broad Range of Types, Sizes and Pressure Classes

Applications: Main Steam Isolation, Feedwater Bypass, Emergency Heater Drain, Feedpump Isolation, Condensate Pump Isolation, RCICS Steam Supply Block

Flowserve, Flow Control Division, manufactures 3 types of globe valve configurations (T-pattern, Angle and Y-pattern) enabling customers to select the best globe valve for their specific throttling requirements. Each configuration is designed to minimize destructive turbulence. State-of-the-art technology, backed by almost a century of engineering goes into each valve. Bodies are designed with large radius curves to ensure smooth transitions and eliminate abrupt changes in fluid direction. All four configurations are available in 2-1/2" to 36" diameter in pressure ratings from 150 to 4500 pounds.

NUCLEAR POWER (VALVES AND ACTUATORS)

Control Valves

- Reliable, Predictable Service
- Won't Stick and Shut Down
- Exceptional Shutoff
- Built for Toughest Service

Applications: Feedwater Control, Heater Level Control, Heater Drain, Feedpump Recirculation, Condensate Pump Recirculation, RCICS Test Return, HPCIS Test Return, Core Spray Test Return

Flowserve globe control valves offer superior performance in liquid, two-phase and gaseous services, while also permitting easy, fast and inexpensive maintenance.

The ZK-control valves offer severe service trims combined with zero leakage.

Spring-cylinder actuated valves provide stiffness and maintains high-positioning accuracy, repeatability, controlled high speed and faithful response. Our pneumatic cylinder actuators handle up to 150 psig (10.3 barg) supply air and have the thrust to shut off against much higher fluid pressures.

SMB Electric Actuators

- 40+ Years of Installed History
- Unmatched Durability, Dependability, and Flexibility
- Torque Output to 60,000 ft.-lbs. and Thrust Output to 500,000 lbs.
- Fully Qualified for Nuclear Applications to IEEE 323, 344 and 382
- Weatherproof, Explosion-proof and Submersible Constructions
- The Actuator for Critical Service and Severe Service Applications

Flowserve Limitorque SMB actuators provide reliable, long-term, proven operation in a wide range of environments, from nuclear safety related—inside containment service to the Arctic cold and desert heat.

Introduced in the early 1960s, the SMB and the spring-compensated SB actuators for high-speed and high-temperature service offer a wide range of gearing and motor selections to accommodate specific valve torque and stroke time requirements. The SMB and SB are at work in the vast majority of nuclear power generating facilities around the world, and virtually every other industrial environment. With rugged cast iron or ductile iron housings and precision-machined gearing, the SMB and SB actuators are recognized for their strength, durability and reliability.

BK Series Steam Trap

- Waterhammer-Resistant
- Corrosion Resistant with Integrated Non-Return Valve
- Easy Maintenance and Repair
- Integrated Strainer for Optimized Regulator Protection

Thermostatic steam traps with corrosion-resistant regulator unaffected by waterhammer. The trap features an integral strainer and non-return valve action. Automatic discharge. Installation in any position.

The factory setting enables the steam trap to discharge condensate with virtually no backing-up.

The thermostatic and spring characteristics of the stack of plates are balanced such that condensate is always discharged at a given undercooling temperature.

The trap provides automatic air-venting at start-up and during operation. BK Series can also be used for thermal air-venting in steam systems.

Nominal pressure: Up to ANSI 2500#

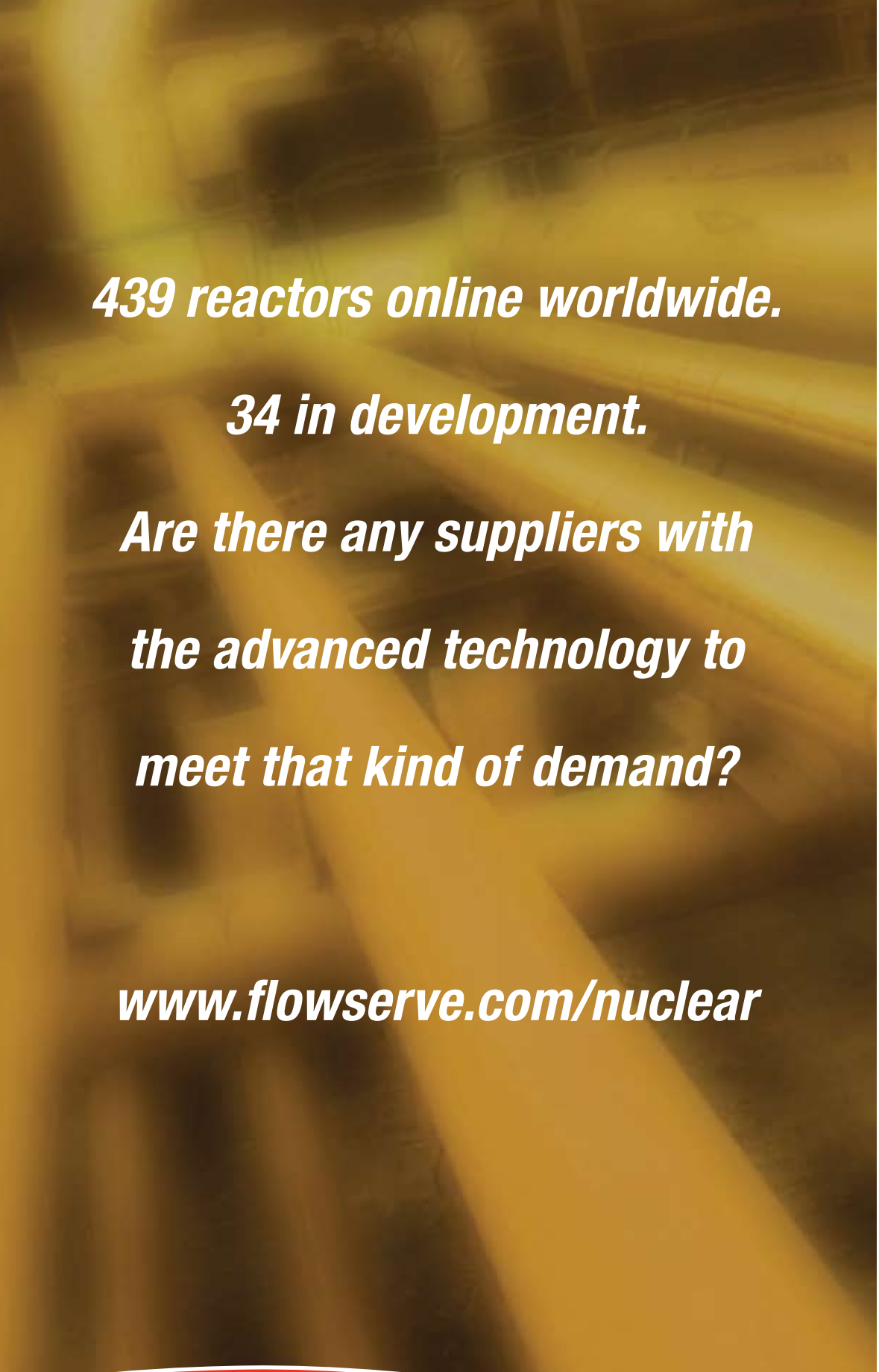
HBC Worm Gear Operator

- With the SMB, Qualified for Safety-Related, Inside-Containment Service
- Designed for Weatherproof, Submersible and Buried Service
- Meets AWWA Requirements for the Water industry
- Rotating Components supported by Low-Friction Bearings
- 40+ Years Installed Service

The Flowserve Limitorque HBC series of worm gear operators excel in demanding applications, ranging from nuclear power plants to critical service flow control in hydroelectric plants. Motorized with the SMB, L120 and MX electric actuators.

The HBC is available for quarter-turn valve applications such as butterfly, ball or plug valves, or multi-turn applications such as guillotine dampers and radial gates. Additive spur gear attachments, handwheels and wrench nuts are available for any manual or motorized application.

Produced since the early 1960s for torques ranging to 93,000 ft.-lbs., the strongest and most reliable worm gear operator on the market delivers consistent, trouble-free performance.



FLOWSERVE

Pumps • Valves • Seals
Actuation • Services

439 reactors online worldwide.

34 in development.

Are there any suppliers with the advanced technology to meet that kind of demand?

www.flowserve.com/nuclear

That's why we're a trusted partner.

There's a growing demand in the world for clean power, and that has the nuclear power industry on the move. The only question is whether manufacturing supply can keep up with demand. It's a question Flowserve has answered by continuing to invest millions in research, product development and manufactuing capacity. The result is an unsurpassed global presence with Flowserve products and solutions hard at work in over half of the world's nuclear reactors. Our partners have never taken their eyes off the future of nuclear energy. Neither have we.

To learn more about Flowserve's nuclear power offerings, visit www.flowserve.com/nuclearpower

Experience In Motion.

flowserve.com

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