Flowserve Services and Solutions focuses on providing customers with uncompromising technical service and engineering support, wherever and whenever needed. Dedicated to delivering the highest quality support, Flowserve Services and Solutions integrates hydraulic, mechanical and materials engineering knowledge with creative equipment, system and business solutions.

A worldwide network of Quick Response Centers staffed by highly skilled engineers and technicians is available around the clock, seven days a week to respond to customer queries, to evaluate and troubleshoot problems and to provide reliable solutions with quantifiable business results.

INTEGRATED SOLUTIONS THAT SUPPORT THE COMPLETE LIFE CYCLE

Typically, 90% of the total life cycle cost (LCC) of a flow management system is accumulated after the equipment is purchased and installed. Flowserve offers a comprehensive suite of services and solutions designed to provide customers with unprecedented value and cost savings throughout the life span of the system.

- **Aftermarket Parts and Services**
  - Repair and maintenance
  - Replacement parts and components

- **Engineering and Technical Services**
  - Engineering support
  - Technical assessments
  - Equipment performance improvements

- **Education and Training**
  - Customer site
  - Learning Resource Center
  - Online

- **Asset Management and Optimization**
  - Business assessments
  - Asset data management
  - Asset optimization solutions

90% Operating Cost
ASSET MANAGEMENT AND OPTIMIZATION SOLUTIONS TO DRIVE IMPROVED OPERATIONAL PERFORMANCE

A partnership with a manufacturer should go beyond the equipment it sells. Flowserve has developed the human resources, technology platforms and business alliances to help customers realize more payback from their plant operations. With a holistic view of the operation bolstered by thorough life cycle cost analysis, Flowserve can provide customers with a range of asset management and optimization solutions, from industry benchmarking to customized asset optimization solutions that address some of the industry’s most perplexing issues.

Business Assessments ........................................... Page 6
Based upon well substantiated sources, including current industry reports and benchmarks, Flowserve business consultants work with plant management teams to document and compare business processes and operational performance to established industry standards. Whether a plant is looking to achieve performance on par with industry standards or elevate performance to world-class levels, Flowserve can help define the metrics and implement the necessary steps to achieve specific goals.

Asset Data Management......................................... Page 8
Flowserve employs a comprehensive collection of tools and technologies to ensure all relevant data becomes part of the decision-making process – at the equipment, unit or plant level. Whether employing a wireless monitoring system or data cleansing software or making sense of disparate sets of historical data, Flowserve can help customers get a more complete view of all their data, including live operational parameters.

Asset Optimization Solutions .................................. Page 12
Plant operators face the pressures of increased productivity and profits which are seemingly at odds with the everyday realities of decreased operating budgets, rising energy costs and increasing operational costs. That is why Flowserve has evolved its capabilities to go beyond simply selling equipment to include a suite of resources and tools designed to relieve the stresses and reduce the life cycle costs of equipment reliability, inventory, energy and environmental issues.
A HOLISTIC VIEW of the Operation

While most manufacturers focus on selling and maintaining the equipment they offer, Flowserve is uniquely positioned to support customers with the extensive list of issues that add cost to their operations, unnecessarily burden resources and decrease operational efficiencies.

RESOURCES AND TECHNOLOGIES THAT DRIVE PERFORMANCE

An unparalleled stable of technical resources and industry experts comprises the core of Flowserve asset management and optimization solutions. This combination of resources and expertise, along with a technology infrastructure uniquely developed to the requirements of flow management equipment and systems operation, allows Flowserve to develop and lead initiatives aimed at improved asset performance. Asset management and optimization solutions from Flowserve help customers on a variety of levels to uncover opportunities for asset improvement. Flowserve assists in:

• Benchmarking operation performance against comparable operations and industry peers
• Collecting, examining and understanding data to reveal hidden opportunities for asset improvement
• Implementing programs focused on identified asset improvement opportunities
• Developing unique commercial agreements to deliver quantifiable business results with win-win scenarios for improved performance
COMPREHENSIVE ASSET MANAGEMENT AND OPTIMIZATION CAPABILITIES

Business Assessments
- Industry Benchmarking
- Business Analysis
- Performance Trends Analysis
- Physical Assessment

Asset Optimization Solutions
- Reliability
- Energy
- Inventory
- Maintenance
- Availability
- Workforce Competency
- Safety, Health and Environmental

Asset Data Management
- Data Acquisition
- Data Cleansing
- Data Analysis
- Data Visualization
Flowserve business assessments identify underlying business issues and uncover the full life cycle cost savings opportunities available to customers. Business assessments provide the means for customer operations to continually improve:

- Equipment reliability
- Energy consumption
- Inventory efficiency
- Maintenance practices
- Operations availability
- Workforce competency
- Safety, health and environmental (SH&E) concerns

The result of a business assessment from Flowserve is a self-financing roadmap to increased operational performance.

**GLOBAL BENCHMARKING. LOCAL IMPLEMENTATION.**

As a first step, Flowserve analyzes how a plant is operating on a business level, comparing performance to industry standards and establishing key performance indicators (KPI) against which future performance can be measured. Next, Flowserve reviews business procedures to identify potential problem areas. Finally, detailed data, trend analyses and physical assessments are utilized to provide the specific implementation plan for continuous improvement in identified problem areas.

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<th>Industry Benchmarking</th>
<th>Business Analysis</th>
<th>Performance Trends Analysis</th>
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BUSINESS ASSESSMENT OFFERINGS

Industry Benchmarking
Using well-substantiated sources, including current industry reports and benchmarks, Flowserve business consultants work with plant management teams to document and compare business and operational processes and costs to established industry standards. Parameters used for benchmarking include maintenance cost structures, equipment reliability standards, inventory turn averages, training costs and downtime standards to name only a few.

Business Analysis
Performed by experienced consultants, a business procedures review provides the first look at an operation’s workflows, maintenance strategies, monitoring practices, training procedures, risk exposures and many other processes. Customers can expect a comprehensive analysis of their business practices and identification of improvement areas. Linked to well-established life cycle costing methodologies, the review includes a presentation of the economic impact of inefficiencies.

Performance Trends Analysis
Specially trained commercial solutions engineers offer customers a detailed analysis of performance trends within the business. This step provides a deep understanding of historical records and operational data, identifying the most important trends and potential opportunities for cost savings and efficiency gains. Examples include work order cost, bad actor frequency, Pareto failure distribution, material usage, energy cost and lost opportunity cost analyses.

Physical Assessment
Physical assessments take the analysis to the actual operation – to the workshop floor, training classes, stock rooms, control rooms and plant floor. These individualized assessments lead to documented strategies and action plans for realization of improved life cycle cost. Engineering resources from Flowserv provide practical guidance and easy-to-implement programs that only come from decades of experience in reliability, training and workflow processes.
ASSET DATA Management

Flowserve employs a comprehensive collection of tools and technologies to ensure all relevant data become part of the decision-making process – at the equipment, unit or plant level. Whether employing a wireless monitoring system, leveraging its Technology Advantage™ Platform or making sense of disparate sets of historical data, Flowserve can help customers get a more complete view of all their data, including live operational parameters.

Once data is collected and/or cleansed, proprietary software from Flowserve allows customers to view actionable information using easy-to-understand graphical interfaces. Flowserve and customer experts can collaborate to determine the meaning of data and quickly deploy solutions that prevent equipment failures and system disruptions before they occur.

**Real-Time Operational Data**
- Permanent monitors and sensors
- Temporary monitors and sensors
- Control systems
- Maintenance activities

**Historical Data**
- Maintenance histories
- Bills of material
- Drawings
- Inventory records
- Performance data
ASSET DATA MANAGEMENT OFFERINGS

Data Acquisition
Wired or wireless, in situ or mobile, Flowserve has the products and technical resources to accurately collect and efficiently transmit data.

- **IPS Wireless™** – Intelligent Process Solutions such as IPS Wireless can be deployed to gather analog or digital data, where a wired system would not be economically feasible.

- **Condition Data Point Monitoring** – Flowserve offers Condition Data Point Monitoring (CDPM), a proactive, predictive monitoring program that tracks machine condition over time to reveal long-term trends and prevent conditions that jeopardize plant productivity and profitability.

- **Advanced Vibration Measurements and Diagnostics** – Flowserve has developed numerous field acquisition and analysis tools to rapidly and accurately determine causes of equipment issues related to vibration and pressure pulsation.

- **Special Field Performance Test Tools** – Flowserve engineers use proprietary technologies to determine hydraulic and thermodynamic equipment performance to troubleshoot system issues.

Data Cleansing
Flowserve offers sophisticated software and human support to identify missing data and flesh out anomalies. These tools and processes can be applied to both historical records and real-time operational data. By filling in data gaps, economic waste is more easily purged and the potential for decision-making errors resulting from faulty or incomplete data can be mitigated.

Data Analysis
Flowserve experts don’t just provide human review of operational data. They have also developed tools that incorporate algorithmic analysis of real-time data, enabling automated adjustments to equipment operation. By employing leading-edge tools and industry expertise, Flowserve helps customers identify early indicators of equipment failure, diagnose issues and take action to avoid equipment and system failure and, worse, plant shut-downs.

- **IPS APEX™** – Flowserve IPS APEX is the industry’s most sophisticated tool for data acquisition, intelligent control, condition monitoring and diagnostics – all packaged into a single solution. IPS APEX is equipped with advanced diagnostic algorithms specifically developed for process systems, high-speed data acquisition of dynamic sensor signals and flexible options for interfacing with customer DCS, PLC or other visual alert systems.

Data Visualization
The Technology Advantage Portal is a data/information aggregation system that offers a unique view of key performance indicators for critical plant assets. Through this portal, customers and Flowserve technical experts can collaboratively view a centralized repository of plant asset information aggregated from any source. Problems and performance issues can be quickly diagnosed and ongoing performance metrics can be monitored through easily interpreted visuals.
A Technology Infrastructure for Plants and Equipment

Flowserve has committed to developing a platform of information technology and sensor-based solutions to streamline the collection, storage, interpretation and use of essential plant and equipment data. This suite of technology-enabled capabilities – the Technology Advantage Platform – is unique in industry since all aspects focus on process systems and equipment. User interfaces, software algorithms and control methods are all designed specifically so plant operators can easily integrate various components of the platform into their day-to-day operations. The Technology Advantage Platform consists of:

- Wired and wireless data acquisition
- Specialized data management software
- Intelligent monitoring and control equipment
- Data cleansing software
- Centralized data visualization portal

Example of Technology Advantage Platform Deployment
TECHNOLOGY ADVANTAGE PLATFORM

Diagnostics, Benchmarking, Reporting and Project Management

The Technology Advantage Platform includes two proprietary Web-based software applications – Flowstar.net and Technology Advantage™ Portal – to help customers collect, store, manage and interpret asset data to achieve meaningful business results. These information aggregation systems can integrate with both customer and Flowserve business systems to provide a holistic view of plant assets from individual equipment details to global plant analysis. Customers, Flowserve technical resources and other authorized parties can easily:

- View ongoing performance metrics through easily interpreted visuals
- Monitor real-time equipment performance
- Conduct predictive analysis
- Recommend corrective action based on facts and verifiable data
- Review historical equipment information
- Manage timing and costs for equipment change-outs, repairs, preventive maintenance and commissioning
- Receive alarms and notifications via email, SMS text and smart phone applications

Flowstar.net

Flowstar.net is a secure, Web-based application used to help customers implement comprehensive reliability improvement programs. This application tracks performance data such as mean time between failure (MTBF) and offers real-time access to equipment databases with powerful filtering and sorting capabilities. Using Flowstar.net, customers can gain insights into conditions that affect plant performance through intuitive interfaces, reports and graphs. Key features include:

- Life cycle cost and energy savings calculations
- Equipment drawing repositories
- Inventory management features
- Failure mode reporting

Technology Advantage Portal

The Technology Advantage Portal is a data/information aggregation system that offers a unique view of key performance indicators for pumps, other rotating equipment and critical plant assets. Easy-to-interpret visuals show real-time operational data obtained from customer control systems and onboard sensors, comparing actual data to expected performance levels. The centralized view can also include:

- Installation and operation information
- Bill of material data including drawings
- Historical data including parts usage, upgrades and maintenance records
- Parts and service availability from Flowserve Quick Response Centers
Flexible Ways to Do Business

A partnership with Flowserve can include one of several commercial agreements depending on customer goals. From traditional transactional arrangements to performance-based, risk-reward contracts, Flowserve has experience designing and administering agreements that help achieve business goals.

- Improving equipment reliability and performance
- Reducing energy consumption
- Managing inventories
- Reliably maintaining process equipment

Asset optimization solutions are tailored to address any combination of these issues according to customer priorities and business strategies.

ASSET OPTIMIZATION Solutions

The business and operational challenges within a process plant are numerous. Plant operators face the pressures of increased productivity and profits which are seemingly at odds with the everyday realities of decreased operating budgets, rising energy costs and increasing operational costs. That is why Flowserve has evolved its capabilities to go beyond simply selling equipment to include a suite of resources and tools designed to relieve these stresses and reduce the asset life cycle costs associated with:

- Improving equipment reliability and performance
- Reducing energy consumption
- Managing inventories
- Reliably maintaining process equipment

- Increasing plant availability and output
- Developing and enhancing workforce knowledge
- Improving the safety and environmental impact of operations
LIFECYCLE ADVANTAGE™ – THE METHODOLOGY THAT DRIVES ASSET MANAGEMENT AND OPTIMIZATION

At the foundation of every Flowserve asset optimization solution is LifeCycle Advantage, a formal methodology for evaluating an operation and implementing programs that take into account the complete life cycle of the equipment and systems that comprise a customer unit or plant. In practice, the LifeCycle Advantage methodology results in a strategic partnership, whereby the customer and Flowserve establish mutually compatible goals and key performance indicators. Regular reviews of these indicators ensure progress and results.

Typical LifeCycle Advantage Program Methodology

LIFECYCLE ADVANTAGE AT WORK – MTBR IMPROVEMENT

Improving the reliability of critical flow management equipment can be a daunting task in any industry, especially when a large installed base of equipment must operate in arduous conditions. That’s why Flowserve has developed systematic LifeCycle Advantage programs for mean time between failure (MTBF) improvement. One industry that must constantly contend with equipment reliability issues is oil refining. High temperatures, extreme pressures and unpredictable operating parameters are among a few of the conditions that can lead to premature equipment failure. Flowserve has deployed numerous LifeCycle Advantage programs to address the issue of mean time between repair (MTBR) in major global refineries. These programs account for the many factors that impact MTBR, from equipment operation to maintenance to inventories. In one such case illustrated here, Flowserve engaged with a major North American refinery to more than double its MTBR from 37 months to nearly 80 months through a comprehensive LifeCycle Advantage program. In addition to the achievement of improved plant uptime, cumulative cost savings for the customer exceeded U.S. $3.8 million.
ASSET OPTIMIZATION SOLUTIONS

Rotating Equipment Performance

Increased equipment reliability ensures enhanced plant availability and reduced downtime cost. The result is a double savings: lower maintenance cost and higher throughput. Flowserve is constantly innovating to enhance performance and reliability, and ultimately to extend the productive life of rotating equipment. Through the measured application of mechanical and hydraulic upgrades with a focus on a life cycle cost payback, Flowserve can affect an immediate change in plants where bad actors, rework and low mean time between planned maintenance are unnecessarily burdening plant operations.

Energy Optimization

Pumps and other process equipment are enormous consumers of energy. Over time as process parameters change and equipment degrades, significant amounts of energy are squandered, driving up operating costs. With energy costs estimated at two and a half times more than maintenance expenses over the life of most rotating equipment and with increasing pressures to decrease carbon dioxide emissions, an energy improvement program from Flowserve is often the first step in an asset optimization solution. Flowserve energy audits review all aspects of the process system and establish baselines and future performance metrics. Field performance testing tools, expert hydraulic system design including CFD analysis, flow visualization and comprehensive pump system analysis software can all be employed to achieve energy optimization.

Inventory Optimization

Over time, process, operational and technology changes often lead to changes in equipment designs and materials, making inventory obsolete or underutilized. An inventory optimization program can deliver immediate short-term operating savings as well as longer-term life cycle cost reductions. In addition to achieving lower carrying costs and cost reductions associated with idle or misidentified components, these programs ensure availability of components for mission critical assets. Further, this ensures improved plant uptime and unit throughput by more effectively supporting maintenance needs. Standardization programs and processes include:

- Equipment survey
- Standardization evaluation and plan
- Inventory analysis and optimization
- Inventory reduction
- Inventory cost tracking
- Vendor managed stock
- Consignment
- Obsolescence and shrinkage mitigation
- Supply chain optimization
Sustained reliability and availability improvements are only feasible if they are supported by a business-focused maintenance strategy. Utilizing its global Quick Response Center (QRC) footprint and maintenance expertise, Flowserve can develop and execute maintenance strategies to help customers achieve best-in-class performance. The broad range of maintenance services offered by Flowserve include:

- Workflow and equipment criticality consulting
- Preventive and condition maintenance strategy development
- Equipment installation and commissioning
- Repair and overhaul services
- Preventive maintenance and condition monitoring services

By their nature, critical assets dictate plant uptime. Supported by state-of-the-art technology and its global QRC network, Flowserve has developed Online Assurance programs solely focused on increasing critical asset uptime. Features of these programs include:

- Custom-designed algorithms to predict failure modes and life expectancy
- Technology Advantage portal to visualize live conditions and project manage asset activities
- Global access to Flowserve industry experts
- Local QRC capabilities for quick turnaround and ensured equipment availability
- Wireless process condition support
- Consigned or vendor-managed inventory programs

To help customers achieve best-in-class performance, Flowserve has implemented an innovative workforce competency program that provides customers with direct, on-site access to pump and process system experts. By placing a Flowserve expert on-site, customers benefit from immediate access to:

- Hands-on supervision of maintenance practices
- Real-time guidance concerning proper equipment operation
- Ongoing, structured, on-site training programs to develop required skill sets within the customer workforce
- Life cycle cost reduction expertise
- A direct global conduit to Flowserve subject matter experts

Environmental protection and regulatory compliance often top the list of plant operations issues, especially where volatile organic compounds or hazardous substances are part of the process stream. Flowserve experts can design programs that monitor, control and reduce emissions from process equipment as part of a systematic, metrics-based program. Flowserve can also help design and implement safety programs for many aspects of system operation and equipment handling to protect plant personnel and mitigate risks associated with undocumented or incomplete procedures.
To find your local Flowserve representative:

For more information about Flowserve Corporation, visit www.flowserve.com or call +1 937 890 5839.