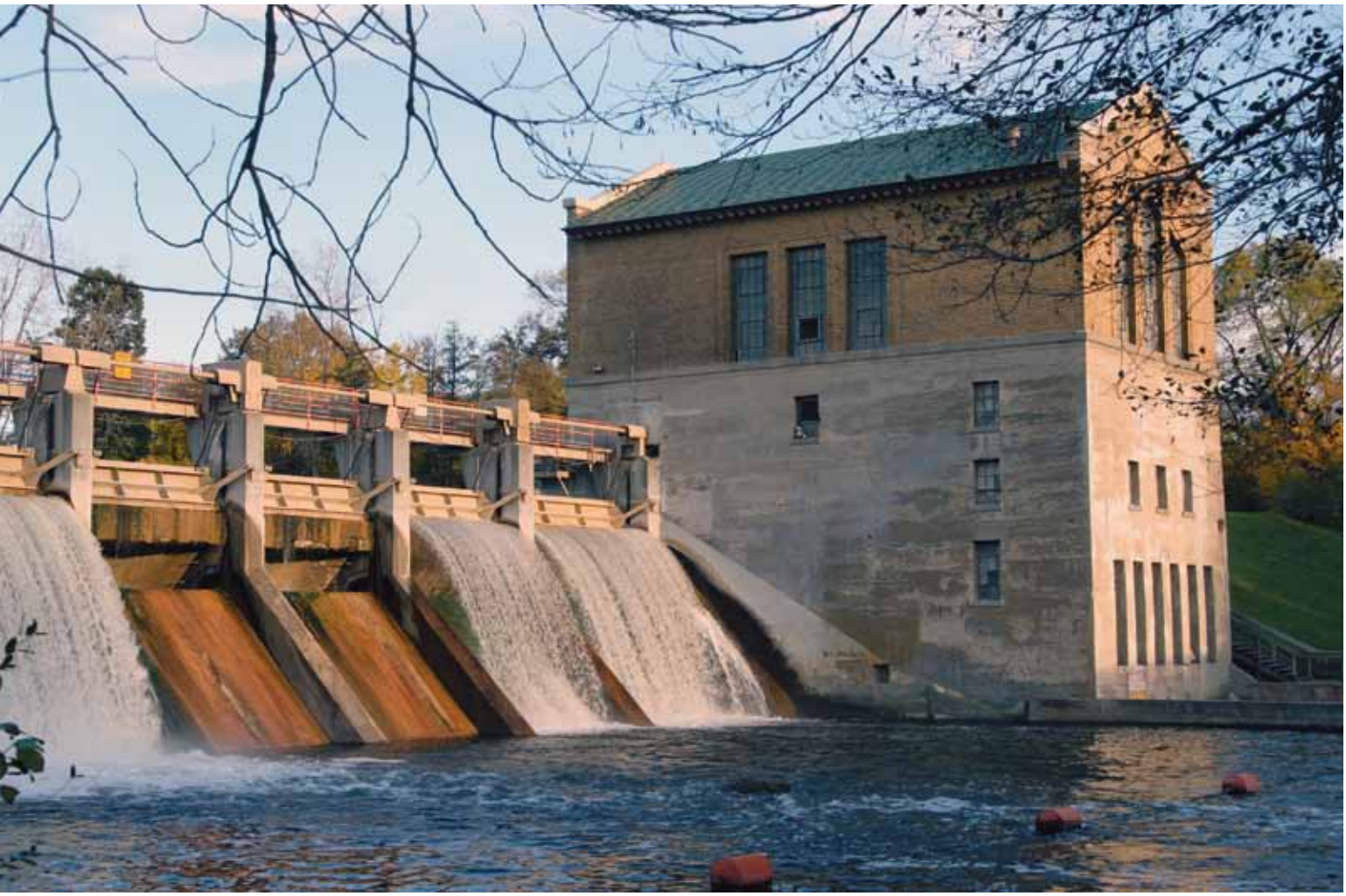
Powerful Hydroelectric Control Solutions



EMERSON™
Process Management

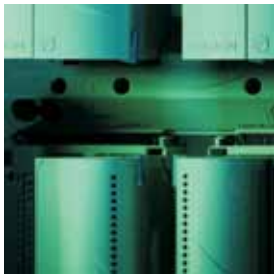
Unmatched Hydroelectric Control

Solutions

For five decades, Emerson Process Management Power & Water Solutions has energized the power industry with its process control innovations. As the premier source of proven control technology and applications expertise, Emerson delivers superior control and operational solutions. Emerson's strong focus on state-of-the-art technology has permitted safe and efficient plant operations throughout the world. Today, we continue our legacy of setting standards for the power industry with our leading Ovation™ control system, optimization technology, AMS Suite asset management software, bus-enabled technologies, and the latest control system hardware and software. As part of Emerson Process Management, we combine our technology and experience with a broad range of instrumentation, valves, actuators, and other products and services to offer the most comprehensive, knowledge-driven approach to improving performance.

Emerson helps hydroelectric utilities efficiently convert the flow of water into electricity.

With more than 27,300 megawatts of hydroelectric generation controlled by our systems around the world, Emerson has the applications, experience, and technology to provide unsurpassed hydroelectric solutions.



The significant increase in the cost of fossil-based fuels has driven energy producers around the world to tap existing water resources as a source of cost-efficient, environmentally friendly electricity to meet growing demands for power.

With the help of Emerson solutions, hydroelectric power producers (HPPs) are meeting requirements with never-before-seen performance results, stemming from reliable control and accurate flow of information.

Traditional hydroelectric power plant control consists of unique panels at each power house. Emerson's control systems and solutions help to maximize water usage efficiency, manage load, and control critical applications with the latest automation technologies.

Outstanding Control Solutions from Emerson

The Ovation™ control system offers unparalleled information and control to help hydroelectric plants of all sizes achieve operational excellence and create a sustainable competitive edge. Through embedded applications for turbine control, pond control, energy management, equipment protection, and much more, the Ovation system ensures fewer shutdowns, faster startups, and efficient load dispatch. Ovation powers a wide array of control solutions from Emerson, including AMS Suite asset management solutions, SmartProcess™ optimization technology, and bus interfaces like Foundation fieldbus, DeviceNet, and Profibus. With embedded advanced control, digital bus technologies, and industry-standard hardware and software, the Ovation system is the undisputed leader in process control for power generation.

Centralized Operations

Ovation offers control and monitoring from a single, centralized control room, with integrated device monitoring, historical logging and reporting of data, remote access, and SCADA technology.

Intuitive and User-Friendly

Ovation Operator and Engineer Workstations offer redundant communications to the Ovation Network. With sophisticated graphics support, workstations access dynamic points and deliver full multi-tasking operations. Operator graphics are intuitive and fully configurable to match changing plant requirements. Workstations enable simultaneous engineering of control, databases, and graphics through multiple windows.

Plant-Wide Control

The Ovation control system offers application solutions for all levels and sizes of hydroelectric power plant technologies. Ovation is powerful enough to handle turbine control, excitation systems, equipment protection, and a long list of other applications.

Emerson Systems Control All Major Hydroelectric Applications:

- Main Electrical System
- Pump/Turbine/Generator System
- Governor/TSO Actuator System
- Lubrication System
- Penstock Water System
- Cooling Water System
- Sumps and Drains System
- HVAC/Fire/O2 Systems
- Compressed Air System
- Vibration Monitoring
- Temperature Monitoring
- Protections
- Hydraulic Pumping Unit
- Gateway Position
- Metering
- Ancillary Equipment
- Electrical Measurements
- Exciters
- Electrical Relay Protections
- Power Systems, including UPS
- Local Control Panel
- Wicket Gates
- Outlet Chambers
- Water Levels
- Substations

Control Philosophy

Emerson's technologies offer the hydroelectric industry unparalleled automation of wicket gates, outlet chambers, water levels, substations, pump houses, and much more.

The Ovation™ control system incorporates state-of-the-art networks, controllers, I/O, databases, and workstations with the latest software to produce the most efficient control technology available for small, medium, or large hydroelectric plants. Ovation incorporates a multitude of options specialized for hydroelectric facilities, including hardware and software for local unit control, emergency hydroelectric units, LV auxiliaries, metering systems, and HV substations.

Mechanicals

The Ovation system provides predictive maintenance for critical mechanical components, such as turbo-generator sets, compressors, pumps, lube oil systems, and hydraulic systems.

Ovation enhances turbo-generator set functions by promoting subsystem communications to a control center. With Ovation, excitation systems, electrical protections, electronic turbine controllers, mechanical protections, cooling water, and vibration monitoring systems send and receive data through a centralized network. This flow of information helps minimize forced shutdowns and prevent system malfunctions, while permitting immediate operator access to information.

Third-Party Integration

By seamlessly integrating third-party hardware and software, Ovation offers a level of flexibility that surpasses industry standards. It's the embedded relational database infrastructure and inherent separation of hardware and software that makes third-party integration strategies, such as built-in interface mapping, straightforward.

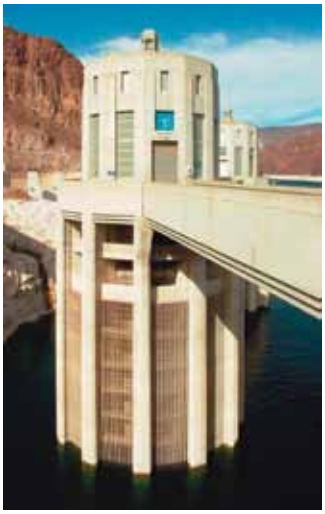
Communication Across Distances

Hydroelectric processes are often spread across long distances. This makes it impossible to run fiber cabling to geographically dispersed applications, which makes a traditional DCS architecture hard to accomplish. Emerson's hydroelectric solution incorporates advanced, expanded, high-level SCADA technologies that can use and maintain existing equipment already installed in the hydroelectric plant.

With SCADA, an existing hydroelectric communications infrastructure talks to remote sites using our Ovation I/O or third-party I/O, without sacrificing the Ovation system's enhanced capabilities.

Emerson offers two-way communications via a hydroelectric plant's existing microwave, radio, or satellite protocol. Essentially, Emerson's control system expands distributed control technology into a higher-level SCADA solution, using and maintaining much of the existing plant equipment.

Fast, powerful, flexible



Simplified Operation

Plant engineers, operators, and technicians can build, monitor, implement, and download Ovation control from a single, central location or locally at each site. This can reduce the number of trips to powerhouses and other remote locations and enhances staff efficiency.

Automated Control

Ovation performs automatic sequences for unit startup, shut down, and emergency shutdown. Automatic start/stop functionality seamlessly brings the unit from one operating condition to another, such as loading, synchronizing, running but not synchronized, and standstill.

Start/stop sequences consist of a number of steps, including stop commands that are activated to meet different process objectives. When the sequence encounters a stop command, the next step will not be activated until the conditions of the previous one have been completely fulfilled. In addition, start/stop sequences include built-in automatic megawatt loading and unloading functions.

Emerson also offers hydraulic accumulators, actuators, and valve positioning equipment. Complete retrofits of the hydraulic systems are available. These are custom-designed to match the scope of functionality needed for modern, load-following plants.

Software

Ovation provides state-of-the-art programming features, alarming capabilities, engineering tools, and data collection within its standard software applications.

In the past, traditional engineering functions in hydroelectric plants were coded using programs that few people understand. The Ovation system can bring the existing control logic into the engineer workstation, permitting simplified modifications and new enhancements from a client server.

Real-time processing is made possible through the Ovation system; workstations communicate to controllers and I/O that are located off-site. Using enhanced functionality, the Ovation Workstations interface to modems, PLCs, and other third-party communications equipment. The design enables monitors to display all equipment, no matter where it is located.

Ovation offers a relational database management system (RDBMS) that provides real-time processing and simplified integration of third-party systems. Real-time multitasking capabilities, redundancy, and reliability for mission-critical applications are just a few of the system's features enabled by the RDBMS.

Functional Applications

Emerson's technology offers the highest levels of water management for superior efficiency and availability.

Turbine Control

Emerson's Ovation control technology replaces unreliable, vintage turbine governor controllers to offer the highest level of water control and management, maximizing turbine life. With Ovation technology, hydroelectric plant operators have access to a clear, concise view of key turbine parameters, such as:

- Speed feedback loop
- Megawatt feedback loop
- Operator-adjustable speed or megawatt demand and rate selection
- Initial load pickup at breaker closure
- Flow feedback loop
- Load limiting
- Critical speed detection
- Valve test capability
- Valve calibration
- Individual valve curves
- Valve position indication
- Synchronizer interface
- Remote control interface

With Emerson's hydroelectric control solutions, generating units can be automatically started or stopped with a single click, which initiates a sequence that starts auxiliaries, operates valves, performs safety checks, and synchronizes to the power grid. In addition, a manual mode allows for operator commands.

Ovation turbine control also offers the ability to raise and lower speeds, increase and decrease power, and choose from a number of control modes.

Pond Control

Emerson offers reliable pond control, allowing hydroelectric utilities to avoid spill and excessively low water levels. All spill is measured either directly or indirectly using gate positions, pressures, levels, and rating tables, and all spill flow is channeled to the next pond downstream through open streams. Ovation provides control of pond levels under multiple modes of operation, megawatt load scheduling to meet the required megawatt-hour production, and off-schedule functions, such as mid-hour corrections to load.

Excitation System

The excitation of a hydroelectric plant is a critical element in ensuring that the generated power is supplied to the power grid. With Ovation, block and network availability is increased through the use of redundant, Fast Ethernet networks, Intel-based controllers, and dependable I/O. Ovation communicates with the existing automatic voltage regulation (AVR) technology, providing voltage control to bring the voltage build-up level close to the rated value and multiple control modes, such as power factor control and VAR control modes.

Energy Management
Emerson's electrical control and energy management system (ECMS) satisfies plant process electrical demands and provides a precise response to electrical disturbances such as loss of tie-line and generator tripping to restore stable conditions. The following applications are included in the system:

- Generator load control
- Tie-line control
- Load shedding
- Synchronizing
- Voltage and reactive power control
- Remote breaker control

Equipment Protection
As part of our leading PlantWeb digital plant architecture, Emerson offers intelligent devices to protect and preserve the generators, transformers, turbines, gearboxes, lubrication systems, oil pump units, and compressors. These intelligent devices combine with the Ovation control logic to form protection schemes that safeguard breakers and the switchyard and monitor DC power supplies. The Ovation Operator Workstation monitors activity and utilizes PlantWeb alerts to indicate a potential issue with smart instrumentation. In addition, AMS: Intelligent Device Manager can predict potential device failure, allowing plant personnel to investigate and correct a problem before it can adversely affect operations.

Generator Synchronization
Ovation balances synchronization between grid requirements and other power demands. With customized synchronization schemes, hydroelectric utilities can distribute the power they need, such as to maintain energy partnership agreements with local industries, while supplying the power grid for fluctuating demands.

Sequence of Events (SOE)
The Ovation system includes integrated, full-featured sequence of events with system-wide accuracy of one millisecond for SOE collections, plus 16 digital channels per card to monitor the state of digital inputs or contacts in the field. Ovation's SOE system offers 1/8 millisecond event time tag resolution and four millisecond contact debounce/chatter for each channel. With a small addition of software switches, discrete input modules and the built-in software, hydroelectric utilities can take advantage of the benefits of the sequence of events system with minimal configuration across all generating units.

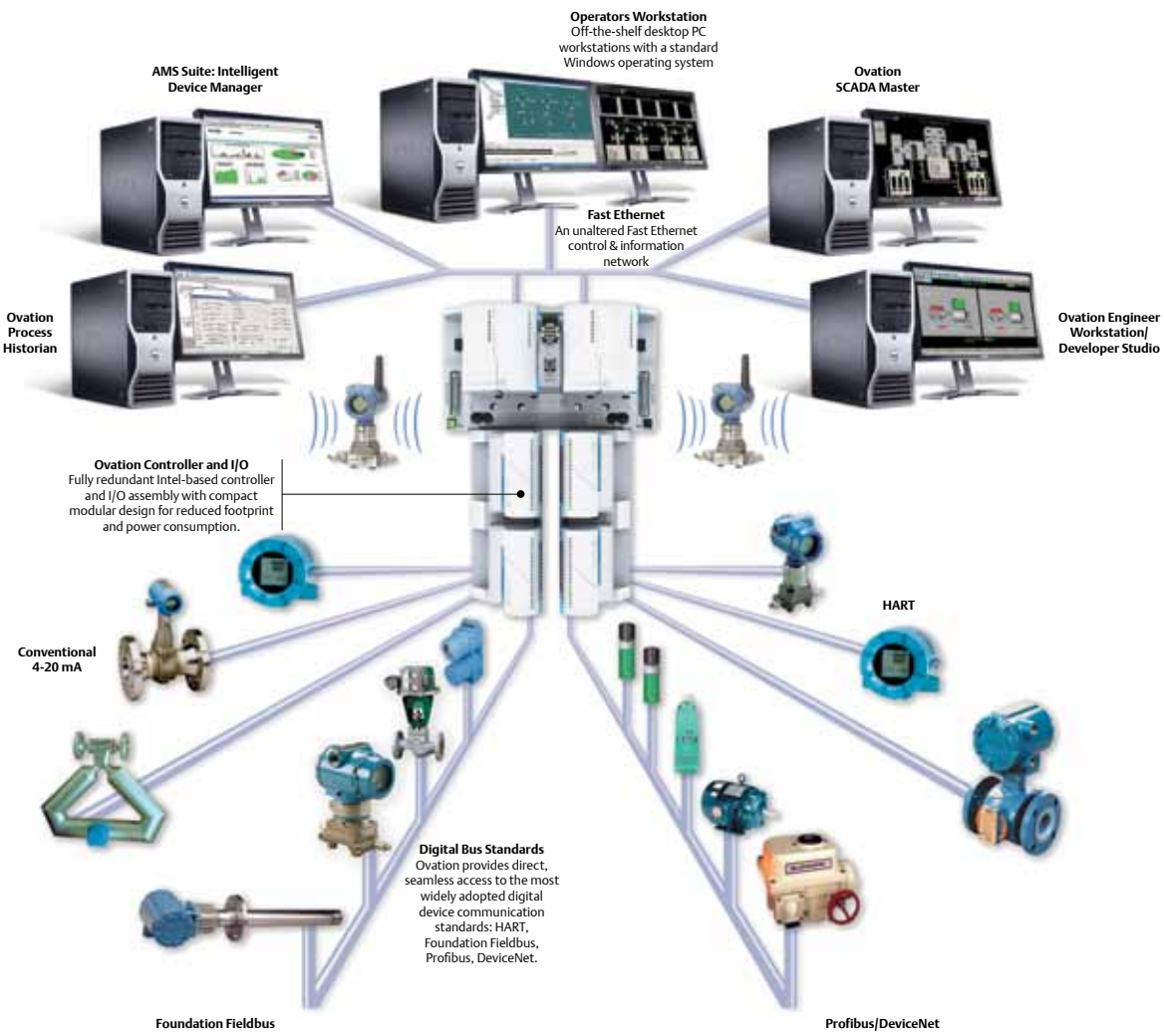
Time Synchronization
Ovation maintains time synchronization within the Ovation Controllers and throughout the Ovation system to within one-millisecond resolution. This is accomplished through the use of nested clocks, which include a standard network time protocol (NTP) server clock to coordinate system time, secondary drop clocks that allow each workstation and controller to maintain its own millisecond clock using on-board oscillators, and a third level of module clock, which is the SOE module's on-board clock.

Data Reporting and Historical Tracking
The Ovation Process Historian organizes vast amounts of real-time process data; calculates summary values; supports online storage and off-line archival; and presents meaningful information to operators, engineers, and maintenance personnel.

The Process Historian offers tight integration with the Ovation system to provide a historical record that includes significantly greater process information than generic, third-party historians. In addition, the Process Historian demonstrates scalable operation for 5,000 to 100,000 point values, providing flexible deployment options for a variety of system needs.

Reliable and efficient operation

For hydroelectric power plants, Emerson technologies offer unparalleled control of wicket gates, outlet chambers, water levels, substations, pump houses, penstocks, and much more. Ovation provides automatic control and information monitoring functions, including level measurements, turbine flow, spill flow, ramp rates and breaker status. Operator consoles provide real-time access to all data, including process displays, trends, logs, and historical data. Remote areas are controlled through SCADA (supervisory control and data acquisition) capabilities.



Adaptive optimization solutions

SmartProcess™

Optimized Performance Results

SmartProcess™ optimization technology from Emerson offers adaptive improvement solutions to help hydroelectric utilities achieve optimized equipment performance for improved water management, enhanced efficiency, and overall continuous operational improvement.

SmartProcess incorporates fuzzy logic, advanced analytics, and model predictive control developed specifically for the needs of our customers to offer the most advanced suite of optimization solutions available. By building plant-specific models to simulate process variations and changing load levels, SmartProcess identifies the precise control settings for continuous optimal performance. The plant model incorporates self-learning features that allow SmartProcess to adapt to long-term changes in the plant.

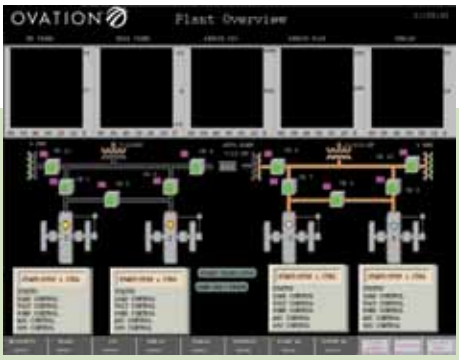
SmartProcess considers operating variables, such as water levels, pond control, local inflow, current value of energy, demand, short- and long-term schedules, operating constraints, and plant characteristics, to determine the most efficient, cost-benefiting levels in which to maintain operations.

Global Performance Advisor

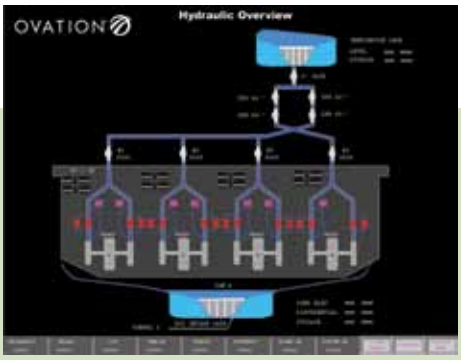
The SmartProcess Global Performance Advisor (GPA) allows operators to identify controllable losses, track equipment performance against design specifications, and quickly identify problematic process areas to reduce operating costs. This solution provides a complete set of turbine and mechanical performance calculations to match the specific plant equipment set. The GPA incorporates its own web server capability to display and communicate data such as graphics, trends, and results throughout the enterprise.

Economic Optimization

Managing elevations, flows, and load among a multi-unit, geographically disperse hydroelectric plant is a major challenge. Whether implementing the load dispatch at any given moment or for a future period of time, the SmartProcess Economic Optimization solution can help hydroelectric plants to optimize power generation across several generating units in a networked region, based on a number of factors, including operating costs, unit efficiencies, maintenance schedules, and operational constraints.



Ovation Plant Overview



Ovation Hydraulic Overview

Ovation Workstations offer a secure, standard operating desktop environment with an intuitive graphics configuration that can be modified to match changing plant configurations.

Leverage a reservoir of support

System Support, System Enhancement

Emerson stands by its customers, even after the project has finished. With SureService™ customer support programs, Emerson offers a suite of support modules that hydroelectric utilities can customize to meet their needs.

The SureService support program includes around-the-clock telephone support, scheduled and emergency onsite service, remote diagnostics, Internet information access, component coverage, web-enabled support, and lifecycle enhancement programs.

The SureService Customer Support Center is staffed 24 hours a day, seven days a week. When problems arise, a dedicated Emerson SureService engineer offers telephone support. If further onsite service is necessary, an Emerson field engineer will be dispatched to the plant site, in most cases, within 24 hours.

Choose the Services That Fit Your Unique Needs

With SureService, hydroelectric utilities can bundle any number of modules into a single, fixed price contract, eliminating unexpected maintenance expenses.

Telephone Support – 24 hours a day, seven days a week, trained SureService engineers are available by telephone when they are needed.

Scheduled Onsite Service – Ensure each unit continues peak-performance operation with a scheduled checkup.

Emergency Onsite Service – When troubleshooting doesn't provide the answers, an Emerson field engineer will come to the plant.

Software Update Program – Install the latest software revision to keep pace with changing technology and take advantage of new features and functions.

Component Coverage – A single, fixed fee covers all component repairs during the contract term, eliminating budget concerns and cost overruns.

Internet Information Access – Designed for plant staff, the SureService web site offers access to software release notes and the latest technical manuals.

System Security Assessments – SureService security assessments are designed to help customers identify, collect, and document key system parameters relating to system security.

Web-enabled Support – Comprising of Software Archiving, Software Updating, Online Tutoring, Application Enrichment, and System Diagnosis, the SureService package of web-enabled modules allows SureService engineers to monitor a system upon request.

Evergreen – The Evergreen program offers customized system enhancements by replacing obsolete workstations, networks, controllers, and system software with the latest available technology.

Training – With options for conventional classroom training or online tutoring, SureService training programs offer ongoing education.

Unparalleled service and support

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