

PROJECT NARRATIVE



System Description

Application: Hydroelectric

Initiation: 1997

Completion: November 1998

Major Ovation Components:

- 8 Ovation controllers (Big Creek 1, 2, 3, 4, 8, Portal, Dam 7, MMPH)
- 10 dual screen operator consoles
- 5 fully redundant Ovation controllers (Eastwood)
- 4 dual screen operator consoles (Dispatch control center)
- 3 computer servers used for software, historian and data base management.
- 1 fully redundant server for economic Load Allocation and Pond Control

Distributed Control System I/O

Point Count:

- 7200



Big Creek Power House #8

SOUTHERN CALIFORNIA EDISON

Big Creek Hydroelectric Project

Located in Sierra Mountains, Fresno, Calif.

Big Creek Hydroelectric system, a major power resource for Southern California Edison (SCE), consists of 23 generating units in nine powerhouses. With as much as 60 miles between sites, Big Creek's powerhouses divert water through a series of tunnels and penstocks that connect the system and redirect water from the upper to lower lakes as needed. When SCE embarked on a plan to incorporate remote operation capabilities and improved efficiency, they faced the overwhelming task of coordinating control of multiple sites over a vast area.

Because of the geographical challenges associated with the numerous individual facilities, SCE didn't want to implement a traditional distributed control system. Big Creek required a flexible system design that incorporated an open architecture that could capitalize on changing technology. However, a goal of the Big Creek project was to accomplish this without rebuilding the communications infrastructure.

Southern California Edison turned to Emerson Process Management for a versatile control system that could remotely control, program, and perform data acquisition and control of each powerhouse from a central location. Using state-of-the-art global configuration features of Emerson's Ovation[®] expert control system, as well as standalone functions similar to those used with SCADA systems, Emerson addressed Big Creek's geographical challenges with ease.

Coordinated Control

At the nine Big Creek powerhouses, 14 Ovation controllers perform stand-alone local control functions in the SCADA systems. These controllers are capable of operating in a fully networked mode to receive and broadcast data in real-time, thereby allowing site-wide coordinated control capabilities.

Plant Description

- *9 powerhouses with a total of 23 turbine generators with a combined capacity of 1006 MWs (968 MWs without spill).*
- *11 reservoirs and ponds for a total storage of 560,234 Acre Feet*
- *Numerous miles of tunnels and connecting water works*
- *3 tightly integrated water chains: Huntington - Shaver - Mammoth*
- *33 governors controlling reaction and impulse type hydro turbine generators (13745 MW reaction turbine generators with one governor each, 10 double hung 261 MW impulse turbine generators with two governors each)*

Local controllers at each site provide automatic control and information monitoring functions, including level measurements, turbine flow, spill flow, ramp rates and breaker status. Each powerhouse has a dual-screen operator console that provides real time access to all data throughout the complex by displaying all data including process displays, trends, logs, and historical data.

With the master controller initiating the sequences, remote local controllers perform the majority of control sequencing. The master controller performs unit loading control, pond control, and monitoring

Communications Infrastructure

By using off-the-shelf industrial Pentium PCs, Ovation's evolutionary design incorporated existing I/O devices including Opto 22, Modicon, and WDPF Q-line I/O, and reduced SCE's expenses on hardware and installation. This allowed Big Creek to retain all of the existing I/O components, while being fully integrated into a single system.

Data flow is heaviest within the dispatch control center and in the Eastwood site. The Ovation system uses a high-speed FDDI/CDDI network to accommodate the increased data flow needs. The dispatch center master control system includes a fully redundant Ovation controller, four dual-screen operator consoles, and three computer servers used for software, historian, and database management. The Eastwood site includes five redundant Ovation controllers, with four controllers housing Q-line I/O retained from the plant's previous WDPF control system. The fifth controller interfaces with the site's existing Modicon PLCs.

The other eight Big Creek sites each have a single Ovation controller that interfaces to the existing Opto 22 I/O. Communications to and from the dispatch center flows through a FDDI/CDDI concentrator and transitional bridge that converts the signals to 10 Mb/sec Ethernet. Data is then communicated through the balance of the Ethernet network.

The Ovation system also provided links via a software server to existing standalone computers that provide water management data to the site and act as a gateway to SCE's corporate information network. In addition, links are provided to four additional remote locations equipped with Modicon PLC controls and eight additional sites using OPTO 22 I/O for remote monitoring.

Pond Control and Economic Dispatch

The Big Creek project required two major and critical functions at each plant: Pond Controls and Economic Load Allocation. The pond controls included: 1) The control of levels in nine ponds under three modes of operation, 2) megawatt load scheduling that met the contracted megawatt-hour production each hour, and 3) off-schedule functions such as mid-hour corrections to load.

The economic load allocation includes an online function that receives the total plant megawatt demand signal from the pond controls and optimizes the load distribution among the available

units at each plant. This ensures that the system was achieving the most economical use of water as possible.

Since optimization is based on efficiency curves for each unit, it was critical to keep the efficiency curves current. Because many conditions and events might degrade the sufficient data is available, the curves are updated, manually water, data is continuously gathered to update the efficiency curves in an off line mode. When reviewed for reasonableness, and downloaded to the online program.

Because of the highly integrated information and the calculations required, both Pond Control and Economic Load Allocation (ELA) were implemented in a centralized, redundant server, rather than in remotely located plants. Unit load control is outside the scope of pond control and ELA and was implemented in local controllers at each separate plant.

Increased Information, Increased Efficiency

Big Creek's extensive network of tunnels provides three separate chains for moving water through selected powerhouses and turbine generators. Operators configure the chains each day to meet 24-hour load schedules provided by SCE's generation operation center. With the old system, lack of centralized data and the inability to view data points in real time often made making changes to the daily schedule difficult. It often took three to five minutes to make the necessary output changes and system inputs in order to balance the needs of the grid with chain configuration requirements.

With the new Ovation system, operators can view real-time data from all 7,200 points in the system at a single computer screen. All data is centralized and equipment status changes are seen immediately. Prior to Ovation, there was a 35 to 40 second lag time before status changes were perceptible. By automatically adjusting setpoints to maintain a voltage inputted by the operator, the Ovation system also allows operators to better control voltage to correspond to the MW schedule curve. The Ovation system controls reservoir levels automatically update on an "integrated chain" basis, detecting and highlighting scheduling discrepancies, and calculating the results of schedules on reservoir levels.

Additionally, prior to the Ovation system, much of the raw data (tunnel, stream flow, and reservoir gauge heights) could not be automatically read by the control system. Operators had to manually interpret the data, using flow tables, and then had to enter the results into the system. With the new system's ability to integrate all of the site's various types of I/O in a comprehensive architecture, pertinent operational data is collected in real-time in the centralized database. Plant operators can access this database on line and can display detailed graphical trends of key parameters to help improve performance or quickly respond to process changes.