Case Study: Bureau of Reclamation

Upgrade to Opto 22 SNAP PAC System Proves Key for Monitoring and Controlling Water Treatment Processes

Background

Situated at the uppermost origins of the Arkansas River in the heart of the Rocky Mountains, the city of Leadville, Colorado was founded in 1877. At an elevation of 10,152 feet, Leadville is this country's highest incorporated city and is most famous for its rich deposits of gold, silver, copper, and other valuable metals.

Dating back to the 1860s, when gold and silver were first discovered in the surrounding areas, Leadville had its origins as a mining camp for local prospectors. Over the next several decades, the adjacent areas became saturated with metal mines that penetrated horizontally and vertically deep into the mountainsides. At that time, there was no easy way to get natural and rain water out of the mines, so horizontal channels were built underneath the mining infrastructures so water could flow down and out to the Arkansas River.

By the 1980s, tremendous amounts of water had accumulated in abandoned and deteriorating mines, and the metals had made this water very acidic. This problem worsened to the point where the river and other nearby waterways had become so contaminated that the water was actually scalding the feet and legs of animals that waded through. After a U.S. Environmental Protection Agency assessment, multiple areas in and around the Leadville Mining District were declared unsafe for human occupation and designated as Superfund sites.[1]

The U.S. Bureau of Reclamation constructs dams, power plants, and canals, and brings water to more than 31 million Americans

The Leadville Tunnel

The Leadville Mine Drainage Tunnel (LMDT), completed in 1952, was built by the U.S. Bureau of Mines to drain off water from certain areas of the mining district. The tunnel runs approximately 120,000 feet south/southeast to an area just outside of Leadville.

Since 1992, the Bureau of Reclamation (which acquired the tunnel in 1959 and assumed sole responsibility for it after the Bureau of Mines was disbanded by the federal government in 1996) has treated the water flowing out of the tunnel—removing dissolved metals and bringing the water quality into compliance with regulatory laws and standards, so it can be safely discharged into the Arkansas River.

Interior of one section of the LMDT

Eugene Csuti has been principally responsible for the automation and electronics for this water treatment plant since 1996. Among other things, he has specified, implemented, and maintained a comprehensive process control system for Reclamation to monitor water levels, warn of changing conditions, and remove metals, such as cadmium, lead, silver, and zinc. The system also adjusts the water's pH, reduces water turbidity, and otherwise treats the water before releasing it cleaner even than everyday drinking water.

1. *Superfund* is the common name for a U.S. environmental policy officially known as the *Comprehensive Environmental Response, Compensation, and Liability Act*, which provides broad federal authority to clean up releases of hazardous substances that may endanger public health or the environment, at the expense of the parties responsible for the contamination.

To accomplish this, Csuti began by re-examining the installed Opto 22 *mistic*™ control platform, which included multiple G4LC32 controllers (one of the very first programmable automation controllers developed for the automation industry) and opting to upgrade to the more advanced SNAP PAC System, the latest generation hardware and software from Opto 22, which features faster and more powerful controllers, straightforward, Microsoft®Windows®-based programming, and an easy to use HMI development tool.

Because Opto 22 products are designed to be backwards compatible, Csuti was able to upgrade to the new hardware and take advantage of its new features and added commands, without having to alter his still functioning field wiring and I/O.

Csuti worked with Opto-Solutions, an engineering and design firm specializing in machine automation, building and energy management, and other applications, which assisted Csuti in upgrading his entire system to Opto 22's flagship SNAP PAC System platform. The new system features Opto 22's signature distributed architecture with standalone controllers communicating to more robust I/O that monitor and control thousands of points. Opto 22 I/O is unique in that it includes individual I/O processors capable of time-critical, processing-intensive, and repetitive tasks, such as high-speed counting, input latching, quadrature counting, and, perhaps most significantly, PID loop control.

Control room at the LMDT

PID Control

Part of Leadville's treatment process consists of adding sulfuric acid and other chemicals to the water, which helps contaminants solidify so they can be pumped out as sludge. Using PID loop control effectively regulates this sulfuric acid injection process and helps keep the water's pH in the acceptable range, typically from 7.8 to 8.0.

"Our Opto system connects to chemical dosers and PID control speeds up or slows down the injection process to keep the pH correct," explains Csuti.

Distributed Architecture

Significantly, the PID loop control that this process relies on is not performed by the Opto 22 PAC controller, but instead, is executed by the remote processors (also known as *brains*.) Offloading the processing-intensive PID loop control to these brains, which are on-the-I/O-rack units situated throughout the facility, effectively pushes control to the I/O level, and this type of distributed architecture offers Csuti many benefits. OptoSolutions President Anthony Dern, who consults regularly with Csuti on implementation and support issues, explains:

"With Opto's distributed SNAP PAC System, the central controller runs the control programs or 'strategies' and delegates many functions to the remote brains—from simple I/O reads and writes, to more advanced functions like high-speed counting, pulse generation and measurement, and thermocouple linearization. So by design, the SNAP PAC System reduces the chances of a system-wide failure, because if the host PAC should malfunction in any way, you still have independent cells operating and performing their own set of tasks without interruption, indefinitely."

In Csuti's case, this means that if his central controller gets knocked off line or out of service for any reason, any SNAP PAC brains distributed across the facility won't be affected and will continue executing their PID calculations and dosing the water as prescribed.

Another benefit of Opto's distributed architecture relates to wiring, as Csuti's water treatment operations take place in a massive facility designed with a main

control room that communicates to six remote I/O, panels plus two remote sites that communicate via fiber optics. These are all wired to I/O that open and close valves, turn devices on and off, and monitor instrumentation. During the daytime shift, the system operates in manual mode and the panels are used for local control. After hours, overnight, and on holidays, the system is switched into automatic mode and the control room takes precedence. So, in effect, wiring is needed to two distinct locations. Also, for centralized control of the facility's 2500+ I/O points, many long wiring runs would need to be establishing and managed. All of this dictated that a distributed architecture would work best.

More than 2500 Opto 22 SNAP PAC System I/O points monitor and control water treatment processes around the clock

Parallel Wiring

One unique aspect of this water treatment application is that upgrading to the SNAP PAC System has meant that Csuti has had to wire the entire facility in parallel, literally duplicating the architecture that is already in place by installing the new hardware and wiring it to the I/O right alongside the old hardware. Although this approach has been more time-consuming than a typical hardware removal and replacement would be, the nature of operations at the LMDT, and the considerable impact these operations have on the health and well-being of the surrounding populace and environment, have left no other choice.

"Our plant is a 24/7/365 facility that processes about 2.8 million gallons per day and our water treatment operations are absolutely critical to this community," Csuti says. "We're in a position where we just can't shut things down for any significant period of time. As a result, we have fewer options in terms of how we can perform our system upgrade. Wiring everything in duplicate has been tricky. We've got I/O and components with jury-rigged mounting all over the place."

Ultimately though, the upgrade will be well worth it, as the new system is a hundred times faster, has better PID handling capabilities, and offers higher-density I/O that will save the Bureau a good deal of space.

With the entire control system configured in parallel as it is, Csuti is able to switch over from his old *mistic* architecture to his new SNAP PAC architecture, fine tuning it to his exact operating specifications and preferences. With the new system functioning, Csuti evaluates and makes note of adjustments that need to be made. He can then switch back over to the old system and make these adjustments, while still keeping the facility operational. Csuti plans to continue flip-flopping like this until everything is perfect, at which time, he will then strip away the old system—controllers, wiring, racks, modules, and other hardware—completely.

Fail Safes, Alarming, and Reliability

Regulatory bodies continue to monitor the water in and around Leadville. If too much metal is in the water, or it is otherwise unclean, Reclamation faces major fines. To guard against this, Csuti designed control strategies dictating that if any processes are not operating within their defined operational guidelines, the control system will issue commands to divert the water output from the river to a secure holding pond until the problem can be corrected and the system reset.

Similarly, when the plant is monitoring in automatic mode, if a valve is detected in a wrong position or any analog readings are out of their parameters, the control strategy has the system attempt a restart. If the system cannot restart normally, the entire process shuts down in a safe and orderly fashion. During emergency situations such as this, an autodialer activates and calls one of four individuals (a supervisor, an operator, a mechanical expert, or electronics expert Csuti), who immediately acknowledges the call and hurries on site.

The Opto 22 system also monitors generator sets for power outages—sending instant notifications if any should occur—and uninterruptible power supplies keep the controllers and control strategies running at all times.

"Extensive programming has enabled this system to respond to many different scenarios and conditions," says Csuti. "The sophistication of our strategies—close to eighty of them—and the decision-making that takes place within them, makes our system something of a living entity."

About Opto 22

Opto 22 develops and manufactures hardware and software for applications involving industrial automation and control, remote monitoring, and data acquisition. Opto 22 products use standard, commercially available networking and computer technologies, and have an established reputation worldwide for ease-of-use, innovation, quality, and reliability. Opto 22 products are used by automation end-users, OEMs, and information technology and operations personnel. The company was founded in 1974 and is privately held in Temecula, California, USA. Opto 22 products are available through a worldwide network of distributors and system integrators. For more information, contact Opto 22 headquarters at +1-951-695-3000 or visit www.opto22.com.

About Opto-Solutions

Opto-Solutions Engineering & Design, Inc. brings over 35 years of industry experience in implementing solutions as a manufacturer, consultant, and partner. As specialists in helping clients improve in efficiency and meet compliance, the company's expertise is diverse in industries that include biotechnology, machine automation, building and energy management, semiconductor, and agriculture. These solutions require high-level languages such as Visual Basic, C, Java, or SCADA in Microsoft Windows or Linux with SQL database.

Related Links:

- U.S Bureau of Reclamation Home Page
- Leadville Mine Drainage Tunnel and Treatment Plant Information
- Reclamation Successfully Tests Water Treatment Plant at Leadville Mine Drainage Tunnel
- Leadville Mine Drainage Tunnel Risk Assessment Findings Show Residents Are Safe

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