Overhauling the Snowy Scheme

Upgrading the legacy control and information system of Australia's Snowy Mountains Hydroelectric Scheme presents challenges on many fronts. Rockwell Automation's project engineering group has carved out a solution based on alliance-style cooperation and a commitment to the long term.

Located in Australia's Southern Alps, the Snowy Mountains Hydroelectric Scheme was built between 1949 and 1974 to realise two vital goals: to provide water for irrigation and electricity from hydroelectric generation. The waters of the Snowy and Eucumbene Rivers are diverted to the rich farming areas of the Murray-Darling Basin, and en-route pass through the Scheme's two pumping stations and seven hydroelectric power stations.

The power stations have a combined capacity of 3756MW and provide the Australian national grid with around 4500GWh of 'clean' hydro electricity per annum—providing a key source of rapid-response and peak electricity for eastern Australia. Representing 74 per cent of mainland Australia's renewable energy, the Scheme is set to grow in importance.

The huge challenge of overhauling the Scheme was taken up in 2005 by its owners and operators—Snowy Hydro—with the Scheme Modernisation Project. This seven-year, A$250 million upgrade is the Scheme's first major overhaul. The project comprises the installation of new high-efficiency turbine 'runners'; refurbishment of the turbine water passages, pumps, main valves and generator stator windings; plus the replacement of the control, protection and governor systems, HV circuit breakers and generator excitation systems.

The project engineering group of leading industrial automation solutions provider, Rockwell Automation, was selected to upgrade the control systems aspect of the Scheme Modernisation Project. Leveraging Rockwell Automation's Integrated Architecture strategy—with the Allen-Bradley ControlLogix programmable automation controller (PAC) at its heart—the project engineering group joined with the Snowy Hydro team to tackle the controls overhaul.

Information is empowerment

The controls and information systems in each Snowy power station support a multiplicity of ancillary systems associated with the 31 generator/turbine assemblies (known as 'units') and two pumping units. These are typically the systems supporting the units' cooling water, lube oil and hydraulic oil, bearing and winding temperatures, and diagnostics. The aim of the project was therefore to replace the legacy 1960/1970 hardwired relay logic control, basic mechanical gauging and switch-style condition monitoring with state-of-the art PAC and electronic operator interface (EOI) technologies.

Snowy Hydro's seven-year, A$250 million 'Scheme Modernisation Project' upgrade is the scheme's first major overhaul

According to Darryl Eager, Snowy Hydro's manager controls technology, the controls upgrade was essential in terms of maintaining reliability. In addition, collecting real-time operational information was an important goal. "The scheme was originally built with a healthy level of conservatism in its design," he says. "By collecting as much operational information as possible, we can safely gain access to extra capacity, and leverage it to our operational advantage."

An example was the runner upgrade. Model testing demonstrated that an additional 20 per cent power output could be achieved by upgrading the runners. This additional output capacity requires close condition monitoring of key major electrical plant, such as thermal monitoring of transformer busbar connections, partial discharge monitoring within the generator stator windings, and monitoring of dissolved hydrogen and water in the transformer's insulating oil. Rockwell Automation's control system collects these parameters to provide a 'heart-beat' indication of the electrical plant's health, if and when a generator needs to be pushed into the 'plus 20 per cent' operational margin.

Sold on ControlLogix

Snowy Hydro has an existing installed base of Rockwell Automation controllers, including the ControlLogix platform, which was introduced in 2003 at Tumut 1 (T1) station to replace the existing turbine electro-mechanical governors. Convinced of the power and stability of the ControlLogix platform, the company once again considered it for the Scheme Modernisation Project.

First, however, Eager and his team toured a number of power stations in the US, New Zealand and Australia to investigate similar hydro-upgrades. "Every one of them had used ControlLogix—there is a fairly large installed base in the power industry using this platform," he says.

But the clincher, according to Eager, was the platform's unrivalled connectivity to a wide range of communications protocols—most notably the Distributed Network Protocol (DNP3), which is used to relay essential operation information to Snowy's SCADA system at the Snowy Mountains Control Centre (SMCC) in Cooma, NSW. "ControlLogix could offer a DNP3 solution that worked with our SCADA system, whereas the other controllers really couldn't," he says.

"Being able to 'speak DNP3' with the SCADA

system was certainly an essential element of this project," confirms Carl Prowse, Rockwell Automation's technical project manager. "It was also essential that our Integrated Architecture solution seamlessly interfaced with other systems and protocols used, such as Modbus for the protection and excitation systems."

Targeting 33

The hard work began in 2005, when the first of the 33 unit control upgrades commenced. A 'standard' unit control architecture was developed, featuring two ControlLogix processors (one for the unit's governor and the second for the remainder of the turbine/generator), plus a third for the transformer associated with each pair of generators. It also included a PanelView Plus 1500 EOI for local control and monitoring, and an Allen-Bradley Powermonitor 3000 power quality and sub-metering monitor to oversee critical generator power parameters.

DeviceNet communications link the controller to generator floor devices, including Allen-Bradley E3 Plus intelligent motor protection, and Allen-Bradley XM series temperature modules. The latter provide connectivity and monitoring of the unit's resistance temperature devices and support the unit protection and control systems.

Dual-redundant ControlNet peer-to-peer communications links the controller to remote I/O chassis, PanelView Plus EOI and Powermonitor 3000, while EtherNet/IP facilitates controller monitoring and maintenance, together with unit-to-transformer and unit-to-unit communications. The MVI56 DNP interface module from Rockwell Automation Encompass Partner, Prosoft, enables DNP3 connectivity with the Scheme's SCADA system and protection relays.

The Rockwell Automation project engineering group site team analysed and fine-tuned each and every element of the proposed design. Every single circuit had to be looked at, considered, refined and proven.

Redundancy vs 'run-on' mode

While reliability was the primary objective, Eager and his team are great proponents of the 'unitisation' principle—where each unit is operationally independent of the other. It was ultimately resolved that redundancy is inherent in the multiplicity of units in each station, where each unit acts as a 'spare' for the others. "There is a huge amount of redundancy in hydro-generation. This drove us down the path of avoiding the complexities of control system redundancy," says Eager.

The importance of keeping a unit running in the event of a fault was also highlighted. "In the electrical industry we always strive to keep producing, while it is safe to do so," explains Warren Heard, Snowy Hydro's operations coordinator at Cooma. "This is unique to this industry; we don't store or stockpile our 'product'—we have to instantaneously generate exactly what is demanded."

The importance of 'keeping the unit running' inspired a project design strategy—'Run-on mode'—conceptualised by Rockwell Automation. "Rockwell Automation determined precisely what components needed to be kept operational to keep the generating unit running," Heard says. "And this 'run on' was achieved through an elegant design."

The application of 'run-on mode' is demonstrated in the use of the Allen-Bradley E3 Plus intelligent motor protection with DeviceLogix. The starter circuits have each been designed so that the onboard I/O and logic configured within the E3 Plus intelligent protection relay can do all that is required, from a 'run-on mode' perspective, in the event of a DeviceNet communications or main controller failure. "The DeviceLogix in the E3 Plus ensures that we can tolerate all sorts of failures, and still allow the unit as a whole to continue operating for a period long enough to start another unit," says Prowse. "People are often surprised when we open the motor starters on site and they see how little is actually in there. This was our goal—to simplify the design as far as possible."

Integrated Architecture advantages

While ControlLogix was a key attraction, Eager notes that the Integrated Architecture approach has brought many benefits. "Everything is driven by the same Rockwell Automation software tools—it all has the same look-and-feel. This really helps our guys in learning and maintaining the systems," he says. "It also provides Snowy with access to the latest technologies."

A case-in-point is Snowy's recent deployment of Rockwell Automation FactoryTalk AssetCentre—a powerful software tool for monitoring and maintaining automation assets. "Every day here in Cooma, I interrogate more than 40 PACs across the scheme, then get an email if anything has changed," says Eager. "Having compatible control platforms across the Scheme makes this possible."

Throughout 2009, the project has been progressing well. "There's been an understanding by Rockwell Automation from the very beginning that this is going to be the same upgrade 33 times," says Eager. "Effectively, what Rockwell Automation has done is automate the automation!"

A mid-2008 independent study of the control system reliability for the first two completed units demonstrated very positive outcomes. The upgraded units are approaching 'five nines' control reliability, with measurable improvements in reliability, availability and forced outage rates.

"Reliability has always been our main goal, and we have clearly achieved it," says Eager. According to Eager, Snowy Hydro now has around ten times the amount of real-time operational data coming back to the SMCC in Cooma, which paves the way for future improvements. Importantly, a model that will see the controls upgrade element of the Scheme Modernisation Project successfully completed through to 2012 is now well established. AT

The controls upgrade included the replacement of legacy relay logic controls and analogue gauging, with state-of-the-art PAC and electronic operator interface technologies.

DCS Migration Made Easy

Indian chemical plant replaces a legacy DCS solution with the Rockwell Automation Integrated Architecture for Process Control to improve system performance.

Godrej Industries Limited is a leading Indian manufacturer of natural oleochemicals used in industries such as cosmetics, pharmaceuticals, personal care, rubber processing and oil drilling. The company produces more than 100 chemical products derived from vegetable oils.

The chemicals division operates two process plants in India, one at Valia in the state of Gujarat and a second at Vikhroli in suburban Mumbai. The Valia facility has an installed base of 30,000 tonnes per year for making natural fatty alcohols from feedstock such as palm kernel oil. To manufacture fatty alcohol, the raw oil must first be converted to fatty acid.

The conversion takes place through a chemical process called "fat-splitting," which is achieved by subjecting the raw oil to extremely high temperatures and pressures within a reactor or splitting tower. Heat and pressure are again applied to reduce the fatty acid to aldehydes. Next, in a process called fractionation, the aldehydes are converted to fatty alcohol in a high-pressure reactor in the presence of a catalyst.

To control and monitor this process, Godrej Industries installed distributed control systems (DCSs) from two DCS vendors. The systems were selected to run the pH conductivity and other operations in the water demineralisation tanks and to maintain constant flow, levels, pressure and temperature in the reactors. In addition, a conventional relay-based control system was installed to run the three boilers in the plant.

As time progressed, the company became aware of their existing control systems' shortcomings. For example, the DCS systems were difficult to maintain, and the wiring was so complex that troubleshooting was difficult. In addition, the DCS systems were proprietary and difficult to modify and upgrade. Also, the multiple systems did not integrate easily. Godrej received only limited hardware and software support for obsolete systems from the original vendors.

Godrej Industries had a limited number of Rockwell Automation® products installed in their plants and turned to Servilink Systems Limited, the local Rockwell Automation system integrator, for a plant-wide process control solution. The Rockwell Automation team recommended a solution based on the company's Integrated Architecture™ for process control.

PlantPAx Process Automation System

The Logix control platform serves as the basis for the solution and runs the control systems for the water demineralisation tanks, reactors and boilers. Godrej Chemical also elected to install a new Intelligent Motor Control solution for the boiler feedwater pumps based on PowerFlex® drives.

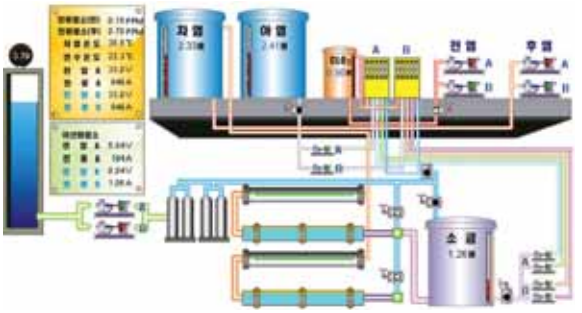
The system is monitored by FactoryTalk® View Human Machine Interface (HMI) software on PanelView™ Plus operator workstations. The solution runs on ControlNet™, Data Highway Plus™ and EtherNet/IP. Via EtherNet/IP, the system is integrated to enterprise-level systems.

Since the Logix solution is based on network connectivity, it helped decrease the company's wiring costs during installation by more than 10 percent. Programming and training time were also minimised since RSLogix 5000 and FactoryTalk View software could be used throughout the entire application. In addition, the plant can be monitored from a single workstation, and initial troubleshooting can occur from the control room. What's more, maintenance expenses have also decreased significantly since just one control system supplier is being used for the entire plant.

K. S. Malwania, manager of instrumentation, Godrej Industries, says, "The integrated workstations provide us with the information we need, when we need it. Therefore, our new system is much easier to diagnose and maintain. Rockwell Automation has a history of migrating their technology in a logical way. We're confident we made the right choice." AT

Korean Purification Plant Cuts Operating Costs

The Hwado Water Treatment Facility reduces operating costs 13 percent by migrating from a legacy DCS to the Rockwell Automation PlantPAx system.



The Han River in Korea stretches 514 km, flowing through Seoul and merging with the Imjim River before it finally reaches the Yellow Sea. Although it is not a long river, it is an important one because it serves as the source of drinking water for several cities.

The Hwado Purification Plant in the city of Namyangju, Gyeonggi Province, is responsible for purifying and supplying safe and clean water to residents and businesses in Hwado, Hopyung, Pyungnae, Soodong and Choan. It pumps more than 55,000 m^3 a day, relying on a control system to handle various water treatment processes. These include water intake, coagulation, flocculation, sedimentation, filtration, purification (disinfection) and distribution.

Prior to 2005, the plant employed a distributed control system (DCS) to run these operations. However, maintenance costs for the DCS were high, and it was not always easy to get prompt and consistent technical service.

The plant faced another challenge with the human-machine interface (HMI) software used with the DCS system. In the water-purification process, controllers turn pumps off and on, open and close valves, and send operating conditions – temperature, electricity, flow level and other relevant data – to a master controller in the main control room. HMI software is critical since it allows operators to monitor and track all of these parameters.

However, the database software the plant had in place was not able to display more than 20 days of data at once. Due to a high volume of traffic, retrieving the data over the network also took a long time. Furthermore, when making modifications or adding operations in HMI, the software had to be updated on all of the controllers on which it was installed.

The Hwado Purification Plant decided to update its control solution. Rather than invest in another DCS system, however, it migrated to programmable automation controllers (PACs) based on the Rockwell Automation® Integrated Architecture™.

The plant installed fully redundant CompactLogix™ and ControlLogix® controllers. The fully redundant architecture helps protect critical processes from unexpected shutdowns, allowing programs to be automatically cross-loaded from the primary to the secondary controllers. If the primary controller fails, control is automatically switched to the secondary system.

The system runs on an EtherNet/IP network. RSLogix™ 5000 software is used to program the PACs.

"We definitely needed to change our control platform because we were not satisfied with the high maintenance cost of the DCS system. We searched for a more cost-effective and flexible solution. "The Rockwell Automation PACs based on ControlLogix, along with advanced Ethernet/IP networking, ran our facility effectively," says Ji, Eung-Su, plant manager of the Hwado Water Treatment Facility.

Since the Hwado Water Treatment facility experienced significant cost savings and productivity, it desired an HMI that was interoperable with the PACs. It adopted the FactoryTalk® View suite, which lets operators configure applications anywhere on the network and easily make changes to a running system.

After the plant installed FactoryTalk Site Edition 4.0 in late 2007 and upgraded to Site Edition 5.0 in early 2008, it decided to install FactoryTalk Historian to collect data at high speeds in real time. This solution optimises processes through the analysis of historical data. "We did not hesitate to adopt Historian after our positive experience with Rockwell Automation's controllers and HMI software," explains Ji, Eung-Su.

Migrating from a DCS system to the Rockwell Automation process system has helped cut operation costs by 13 percent over 2 years. Similarly, installation costs were reduced by more than 50 percent, improving total cost of ownership. Overall, the solution based on the Rockwell Automation Integrated Architecture has helped the Hwado Water Treatment Facility concentrate on its job – delivering safe and clean water. AT