invensys Wonderware

Success Story

Power

InTouch, IndustrialSQL Server, ActiveFactory

Wisconsin Public Service Creates Hybrid Control System with Wonderware Software

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Daniel Snyder
Instrument & Control Leader

Weston, Wis. — Serving more than 440,000 electric customers in 11,000 square miles of northwestern Wisconsin and an adjacent portion of Michigan's Upper Peninsula, Wisconsin Public Service Corp. (WPS) is one of the midwest's leading public utilities.

WPS operates a network of coal-fired, nuclear, hydroelectric, wind and natural gas peaking power plants that provide up to 2,000 megawatts (MW) of electric power, transmitted over more than 20,000 miles of distribution lines.

By developing an open-architecture equivalent to standard distributed control systems (DCS) that run other utilities' coal-fired plants, Wisconsin Public Service increased its efficiency and significantly reduced the cost of power production. WPS also helped raise the standard for other utility companies.

WPS's three coal-fired units at the Weston, Wis., complex exemplify the Wisconsin Public Service's leadership role. Its plant managers deployed personal computers (PCs), programmable logic controllers (PLCs) and innovative software packages to create one DCS. As a result, WPS saved money on system implementation, total lifecycle cost of ownership and maintenance.

The control room's original analog control systems have been replaced by a digital control system, using PCs and PLCs to run all Weston operations.

The DCS gave plant managers and operators integrated control of all three plants. It also gave them the ability to fine-tune operations because all three plants now share a common historian and two peaking units.

A Little History

It all started in 1954, with the opening of the Weston 1 generator unit. Then, in 1957, WPS built its first plant near the headquarters in Green Bay, Wis. Although another six units were added over the years, the Weston plant remains WPS' largest wholly owned production operation. WPS acquired partial ownership of additional generating plants in Sheboygan and Portage, Wis., in the 1960s and 1970s.

The incoming coal is fed into 1,000-ton hoppers before entering the coal pulverizers.

Weston Unit 1 is a 60-MW unit that used a pneumatic control system to manage power generation. Weston Unit 2 was added in 1960, providing an additional capacity of 96 MW. Weston Unit 3 came online in 1981, adding more than 320 MW. With each expansion phase, the control systems were duplicated so that operators would only have to be familiar with one control system regardless of the unit.

In the mid-1990s, WPS decided to replace its pneumatic systems with a network of Modicon® PLCs for equipment control and PCs running InTouch human-machine interface (HMI) software to give operators PLC control and enhance interaction between the units. The InTouch software came from the Wonderware business unit of Invensys Systems, Inc.

To emulate the functionality of a typical DCS system, WPS installed the ControlPlus™ distributed control software developed by Standard Automation, a Texas-based Wonderware-authorized distributor. GS Systems, Wonderware's distributor in New Berlin, Wis., provided the complete set of software products.

"This solution was exactly what we needed because it gave us all the functionality of a standard DCS system, but it was much less expensive to implement. It allowed us to integrate all the equipment we'd installed from various manufacturers over a 40-year period, under one control system," said Daniel Snyder, instrument and control team leader for WPS.

"We didn't have to worry about whether our steam generators came from Babcock & Wilcox or Combustion Engineering or whether our turbine generators came from Allis Chalmers or GE. Now, the off-the-shelf PLCs and ControlPlus software provide the power and flexibility we need for the control systems, and the InTouch software provides the visualization our operators need to monitor the plant equipment.

Massive pulverizers crush the incoming coal to a fine powder, the consistency of talcum, so it can be air-conveyed into the boiler furance.

"This hybrid control system saved us a lot of money because it helped us avoid the higher costs of proprietary hardware and software. Plus, its open architecture allowed us to make continuous improvements in the applications and expand them to accommodate new facilities," Snyder added. "This is important because, although we originally used it to control only Units 1 and 2, we could also control Unit 3 when we retrofitted its systems in 2001.

"We incorporated Wonderware's IndustrialSQL Server historian and added ActiveFactory reporting and analysis clients to fine-tune our operations. We also extended its use to our coal-handling systems for all three units."

WPS decided to update its Weston 3 facility because its control systems became obsolete.

"We upgraded the entire facility during our annual six-week shutdown for turbine boiler overhaul," Snyder recounted. "We selected Wonderware software because of our success at Weston 1 and 2. Our software techs found it very easy to use."

Power Generation Systems

The three Weston units represent the latest in modern coal-fired power generation technology. Once the nearly 4,000 tons of coal are delivered each day, giant conveyor systems load the coal into a coal-field, where it's stored in 1,000-ton silos. The coal is then gravity-fed into massive pulverizers, where it's crushed to the consistency

Dan Snyder is the instrument and control team leader/process advisor at the Weston plant.

of talcum powder. This fine powder is air-blown through pipes that feed the boiler, which produces the steam that generates electricity.

This boiler system isn't like systems from the old days. Unlike the old cylindrical water tanks that were heated from a fire below, these modern boilers are six-story-tall rectangular units surrounded by water pipes. From all four corners of the rectangular boilers, powdered coal is blown into the fire chamber, creating a hundred-foot rotating fireball. The water pipes then produce steam, which rises to the top of the boiler and pipes into the steam turbine. The turbine rotates the generator to create electricity. Then, an exciter controls the generator voltage and current sent to the substation for delivery over WPS distribution lines.

These boilers are closed-loop production systems. As the steam exits the turbine, it goes into a condenser, where up to 20,000 tubes turn the vapor back into water. This reclaimed water passes through condensate polishers that purify it, so nothing will corrode the pipes in the boiler. The water is purified so thoroughly that it won't even conduct electricity. Then it's returned to the boiler pipes and the steam generation cycle repeats.

"All of these processes are 100-percent automatic," Snyder explained. "Production has become so sophisticated over the last decade that there's no way human operators could coordinate all the critical steps involved. With the InTouch HMI, ActiveFactory tools, IndustrialSQL Server historian and ControlPlus software, we can now monitor every stage of the process, and intervene if necessary.

"The IndustrialSQL Server historian maintains complete records on every step in the process, so we have an audit trail on everything that's done by the control system," Snyder said. "The trending software allows both operators and management to quickly and easily view and analyze any stage of the process. With this system, we can even prevent potential problems. We are extremely efficient now because we can fine-tune the process as it's running."

These condensate polishers purify water so well that it won't even conduct electricity. High purity is required to minimize corrosion in the closed-loop steam generation/condensation system.

This hybrid control system also helps monitor and maintain environmental systems. Before the boiler exhaust goes up the chimney stack, it passes through a large bag-house to remove any fly ash in the exhaust air. This ash, along with the bottom ash that drops out of the boiler system, is collected for recycling for applications such as cement production and highway paving materials.

"We're pleased to say that all of our Weston units were in compliance with the Federal Clean Air Act before it became law," Snyder remarked. "This new control system has benefited us greatly, by helping us maintain compliance with environmental regulations, in addition to making production enhancements. With this system, it's easy to make incremental changes to the process."

Continuous Process Improvements

"Our company is big on process improvement, so the Wonderware software is a valuable tool," said Roger Zimmerman, Weston plant manager. "I can remember when we had chart recorders in the plant who tracked temperature changes up to 1,000 degrees. When they

A massive turbine engine (center) generates electricity. The steam condensate return is on the right. To the left is the exciter that controls voltage and the amperage of the output.

were supposed to monitor two- to three-degree swings, they simply couldn't. The pen width itself was five degrees. With these systems, we can track temperatures down to 1/100th of a degree.

"Our operators are using Wonderware software to better control the power generation process," Zimmerman added. "Now they can make small adjustments in real time and see instant results. One of the biggest improvements is the ActiveFactory software. It simplifies troubleshooting by allowing us to drag information from anyplace in the database into a trend screen. We can change the scaling or the time base and analyze the data to anticipate problems.

"It's not just valuable at engineering workstations or at the operator level. Even plant engineers and shift leaders can use it remotely, right at their desks. We can even spot something that's drifting from a target value and take corrective action. The InTouch HMI allows us to go in and create alarms so that, if anything deviates from a value, an alarm can be triggered."

As an example of problem indicators, Zimmerman cites boiler leaks as they relate to water usage trends.

"Before, something would have to happen before we could respond. We reacted to emergencies like a drop in the boiler drum level," he explains. "Now, when we notice that we're using more water than we should, we can investigate the cause before it becomes an emergency situation. InTouch and ActiveFactory software are good tools for making people more effective."

Even though power generation is a bit cyclical in nature, the WPS process control system has helped keep the Weston units operating at peak capacity.

"If our electrical demand increases or decreases, system control can respond right away, regardless of the time of day. It's similar to turning a faucet on or off," Snyder said.

"In emergencies, when we need the load immediately, we can quickly switch on the gas peakers, which can run at full load within seven minutes, at the press of a button. This makes us extremely efficient in producing power." Snyder added.

In the process of creating its own DCS system, Wisconsin Public Service has changed the industry, according to Jason Ford, senior project manager for Hi Tech Control Systems.

"When WPS started Weston 1 and 2, everyone told them it was impossible to control a power plant with PCs, PLCs and HMI software. So, basically, they've done the impossible," says Ford. "Beyond that, they've changed the industry because other producers now use very similar systems based on the Microsoft® Windows NT® operating system. The industry has evolved from what once seemed impossible to advanced DCS systems that are now an industry standard."

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