

CONTROL SYSTEM UPGRADE CENTRALIZES PLANT OPERATIONS

Purdue University's central utilities plant has four boilers that provide 710,000 lb/hr of saturated steam for power generation and heating. The plant also has two 40 MW steam turbines, five chillers, a cooling tower, air compressors and potable water wells.

The initial decision to embark on a controls upgrade was driven by a desire to centralize and optimize control, boost reliability and to meet Y2K requirements. Upgrade of the control system is being carried out in stages, as funding becomes available. A contract systems integrator provided the initial control philosophy, programming and graphics.

PEAKING BOILER THE FIRST TEST

Of the four boilers, a peaking unit was an ideal candidate for beginning the upgrade program. The boiler, which can be gas or oil fired, is used just 30 to 45 days a year for peak shaving and backup. Combustion control was manual via pneumatics and the burner management used a newer programmable logic controller (PLC).

A compact and modular controller for combustion control, complete with 4-20 mA analog and 24V discrete I/O modules, was installed in a former pneumatic cabinet adjacent to the boiler. All pneumatic equipment was replaced with electrical/electronic instruments, including the valves, switches and cables. A serial link interfaces the controller to the burner management PLC. An Ethernet 802.3 network using Category 5 cabling ties the controller to the automation's PC workstations located in the control room.

Because there was little or no documentation, the integrator had to develop new P&ID's and logic. The integrator graphically configured the new automation, with its global database, using an IEC 61131.3 function block diagram and sequential function chart languages. They also used the new control system's pre-engineered strategies, devices and display element libraries. Using the libraries was easier and less complex than programming a PLC system from scratch in ladder logic and then mapping a separate workstation database.

To assure operator familiarity and input, an operator spent over six weeks, during the installation and startup, working with the integrator's engineer and installation crew. The operator's input helped translate the nuances of the boiler's operation into several modifications to the initial control philosophy and graphics.

Despite the new technology, startup was smooth. A clear hierarchy of graphic displays topped by a main operating screen with a menu for drilling down through sub-screens simplifies navigation. Purdue's operators received just 1½ hours of formal training. This was followed by having the operators start, run and shut down the boiler a number of times. Because the operators were familiar with Windows, the computer environment was not intimidating.

CONTROLLING THE FLUIDIZED BED BOILER

Success with the peaking boiler led to the upgrade of the fluidized bed boiler controls, a project of entirely different scope. This boiler was, and still is, controlled by a non-Y2K compliant legacy DCS. However, the integrator overcame the Y2K deficiency without the need to replace the hardware or software. The existing DCS controller and field devices were also reused. Because the UNIX mini-computer workstation was not Y2K capable, it was replaced by an Emerson Process Management DeltaV workstation.

The legacy controller was linked to the DeltaV controller via a serial bus. Because the system integrator was familiar with the legacy system's communications, he was able to transfer the boiler's 1500 points into the PC workstation. This was accomplished by using customized faceplates and modules to transfer the data between the two systems.

By integrating the new control system's conventions into the old process controllers, the screens for the old system and the new system appear almost identical. Faceplates, alarms, error status all look and act the same as the old system. Although the newest workstation accesses an otherwise incompatible control system, it is essentially transparent to the operators.

To convert from the old to the new workstation without shutting down the fluidized bed boiler, both monitors were run in parallel while their set-points and graphics were checked. Once the new monitor was proven, the old system was disabled.

COOLING TOWER, CHILLERS AND TURBINE-GENERATORS

To keep the six-cell Marley cooling tower in operation the controls were upgraded one cell at a time. Two new controllers, located near the



Peaking boiler control cabinets. Photograph courtesy of Fisher-Rosemount Systems, Inc.

CONTROLS UPGRADE



DeltaV PC workstations installed in control room. Photograph courtesy of Fisher-Rosemount Systems, Inc.

tower, were connected by an Ethernet fiber optic cable to the Ethernet LAN in the plant.

To avoid tripping the tower, the new and old controllers and monitors were paralleled before changing over from the old system to the new one. The status LEDs on the controller's I/O modules and a temporary PC workstation at the controller site were used for loop checking and coordinating the live changeover.

Serial links connect the two electric chillers' proprietary controls into the new platform. Graphically presented status and control points for the chillers are now available to operators. The controls of the remaining three steam driven chillers have also been integrated.

As the new control system platform has expanded, so too have the number of workstations. The control room presently has two sets of five PCs, and any monitor can access any controller on the network. One set of monitors is on a primary Ethernet hub while the other set is on a secondary hub. Loss of either hub will not affect the operation of the plant. Because of increasing data traffic, the hubs are being replaced with switches to direct traffic and minimize future collision problems.



Purdue's remote cooling tower controls are connected to the control room workstations by an Ethernet fiber optic cable.

BENEFITS OF THE NEW CONTROL SYSTEM

Purdue has noted very few instances where another language can not be incorporated into the platform through a serial interface. This means that most proprietary control packages and plant PLCs can be operator-transparent additions. Future OEM equipment will be specified with DeltaV control where possible or at least a PLC or black box with an open serial, FOUNDATION fieldbus, AS-I bus, or DeviceNet port.

Except for tuning the system, alterations to the plant's legacy DCSs were only made when a major problem arose and then only during a scheduled outage. With the new platform, modifications are carried out while the equipment is running. Consequently, the engineers are able to respond better to operator requests.

Modifications can also be made on a point-by-point basis. As an example, a pressure controller setting can be altered by putting its valve in manual, making the change in the graphical configuration, downloading the change, testing it on line, and then switching the valve back to automatic.

DOCUMENTATION

Online documentation helps the plant to operate more efficiently and, except for backup, hard copies are no longer required. In addition to providing up-to-date information, the documentation also aids troubleshooting. The system's historian lets operators improve the plant's control by reviewing and accessing the previous

shift's operations. Engineers with the control system's software on their PCs use the real-time and historic data to write production reports, make efficiency calculations, and correct processing and equipment problems.

Purdue has plans to either upgrade, or port all remaining utility plant systems to the new automation platform within the next two years. Near term, installing FOUNDATION fieldbus instruments is being considered. 

Biographies:

Mark Nethercutt has a BSME from Akron University, Ohio and is currently employed as a project manager in the engineering, construction and utilities department at Purdue University. Prior to joining Purdue in the fall of 1989 he worked for Babcock & Wilcox and for Fort Howard Paper Co. in Green Bay Wisconsin.

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