Firing Up a Burner System

Addition of New Technology through Safety Instrumented System Brings Paper Mill More Advanced Diagnostics and a Big Boost in Security Features

BY GARY NORTHAM

There is an old saying that goes “out with the old and in with the new,” but at RockTenn’s St. Paul, MN, mill, they are thinking something a bit different -- more along the lines of melding the old with the new.

Located just a stone’s throw off the banks of the Mississippi River, the thriving mill opened in 1908 and has progressed to the point where it processes 350,000 tons per year of waste paper into coated recycled board and recycled corrugated medium.

Steam for the process is supplied from two field erected Riley Stoker boilers, with a B & W package boiler as backup. Safety and control systems began migrating to the existing DeltaV system in 2007.

By 2009, it was time to replace the old relay-based burner management system (BMS) on the field-erected boilers. The original BMS, installed 41 years before when the plant converted from coal, fell into the National Fire Protection Agency (NFPA) 85 Standard as a supervised manual system. The problem was the 2007 edition of the NFPA standard did not recognize supervised manual systems.

The project goals were to bring the BMS to NFPA standards, reduce the potential for unnecessary boiler trips, improve operator visibility to burner interlock and permissives, Continued
and capture trip event conditions to reduce the diagnostic time needed to restore the boiler to normal operation. In addition, the solution also had to integrate into the existing boiler control system. Requirements for the new system included valve automation, additional digital trip inputs, and updating of purge and low combustion air flow.

As a part of the project RockTenn decided to work with the engineering services firm Novaspect Process Management.

Valve Automation
It became clear very fast that quite a few of the existing valves did not meet current NFPA standards, so we decided to replace them as part of the valve automation. This part of the project included new double block and bleeds for the pilot gas system, a new double block and bleed for the main gas line (which allowed us to use four valves in place of 12), new valves for the oil shutoff, and an oil valve and steam valve for each of the burners.

BMS Solution
When it came time to decide on the BMS logic solver we had three choices: A standard DeltaV system, DeltaV SIS safety system, or a completely different system. Plant officials decided on the DeltaV SIS because of its advanced diagnostics and security features, the fact it could integrate with the existing DeltaV system but was still separate, and because the programming structure of DeltaV SIS seemed to fit the application. The DeltaV SIS standard function blocks fit well with what we wanted to do with the logic.

Operator Interface
The operator interface on the old relay system consisted of just a panel board out in the field. With a limited number of indicator lights, it was difficult to identify the true cause of any burner trip, which meant it took longer to get the boilers back in operation than would otherwise be needed.

Novaspect was able to use the DeltaV SIS advanced function blocks to configure the BMS logic in a way that gave a very clear indication of interlock status and the ability to capture the first out when a trip occurs to aid in troubleshooting. The Master Fuel Trip and Purge display showed all the trip conditions along the left side, with master fuel trip at the top, then ignitor gas trip, main gas trip, and fuel oil trip. Black would mean a normal operation while red would indicate an active trip. There is also a “first out” arrow that points to the condition that caused the last trip, which makes tracking down problems simpler. There is also a reset button to clear the first out when desired. All trips logged into the historian for documentation and reference.

The right side of the display showed the purge conditions used for startup. Before a boiler can restart you have to purge it out, which requires all the conditions listed to be good; the display clearly tells what has to happen to achieve purge conditions. The display also shows the combustion control side, so the operator can see what the trim air flow is, and what has to occur to achieve a purge air flow. The air flow data comes from the transmitters in the existing system, so, in accordance with NFPA standards, engineers hardwired the signal in to the SIS.

The Master Fuel Trip and Purge display shows all the trip conditions along the left side, with a “first out” arrow. On the right, the purge conditions are used for startup.

After the purge is complete, the operator shifts to the burner graphic for ignition sequences.

After the purge is complete the operator then shifts to the burner graphic for ignition sequences. This provides an overview of all four burners on the boiler and their current states. The valves use a standard red and green; green is open, red is closed.

The operator uses this graphic to open up the main gas header valve, then pick out a burner and initiate a light off sequence on it. The first step is to start up the pilot on the burner and then turning on main gas or oil, as desired. A yellow ring on a burner means gas is in use for that burner. There is a different symbol for oil and another one for the pilot.

In the spirit of familiarity, Novaspect customized several faceplates for the BMS. The first is a cause and effect matrix template similar to those used on the DeltaV systems, with the addition of a first-out arrow. It shows what trips are active, what are not active, and the history. It also has a reset button to clear the first out indicator.

continued on page 3
The cause and effect matrix faceplate template was modified to add a first-out arrow and a reset button.

The second custom faceplate is a step sequencer. The red “Not” symbol with the Permit indicates that you need a permit to start the sequence, and instructs the operator to go to the cause and effect faceplate. An active Permit is green, with a start and stop button to start up the sequence. The lower section of the faceplate shows the current state and the outputs.

**BMS Logic**

As mentioned, the BMS makes use of standard DeltaV SIS function blocks, including state transition diagrams and step sequencers (18 per boiler), cause and effect matrices (22 per boiler), and analog voters (eight per boiler). There are state transition diagrams and step sequencers for purge, main gas leak test, oil leak test and burner ignition. Cause and effect matrices are in use (in many cases like permissives) for master fuel trip, oil fuel trip and main gas fuel trip. There are trips controlled by analog voters for furnace pressure, low combustion air flow, high and low main gas pressure and high and low igniter gas pressure. As mentioned, the air flow data comes over separate hardwired lines from the transmitters in the existing system.

There are six DeltaV SIS logic solvers per boiler. These control the master fuel trip, the fuel header and each of the four burners. The fuel trips use analog and discrete inputs; engineers enabled HART functionality for diagnostics on the analog inputs and enabled line fault detection on the discrete channels.

Line fault detection was simple. Engineers were able to shunt a 12 kilohm resistor across the output of each discrete field device, and a 2.4 kilohm resistor put in series with the combination. With the contact closed, the circuit resistance is 2.7 kilohms, and when the contact is open the circuit resistance is 14.4 kilohms. A true open or short would indicate a failure condition.

This approach has advantages and disadvantages. On the plus side, it makes it simpler for the burner management system to check the health of its inputs, it reduces the wiring in the cabinet and, with it, the potential for future failure, and it enhances the ability of the SIS diagnostics to keep track of the health of the inputs.

The disadvantage is there is no effective resistor solution for connection at the field instruments; instead the resistors install in a box located as close to the field instrument as possible. This limits the portion of the sensing loop actually covered by the resistor method; and, since the resistors increase the effective impedance of the loop, they make it more susceptible to noise. When first connected, the 24 V wiring for the field devices ran through a wire way containing motor leads for variable-frequency drives. This induced so much noise in the lines that it caused occasional false trips. The solution was to install separate conduit to isolate the 24 V field wiring.

**Work Completed**

On June 29, 2010, the plant started up number 3 boiler using the new BMS, and on July 23 number 2 boiler fired up. We now have accurate, repeatable startup procedures, and FM Global has reviewed and acknowledged the system. The operators have accepted it wholeheartedly. Perhaps the biggest fan of the new system is the chief operating engineer. The old system required more finesse to restart a boiler or even change burners thus requiring more of his time. Since the new BMS installation, he has been able to greatly reduce the number of hours spent at the plant.

Gary Northam is the principal electrical engineer at the RockTenn, Saint Paul, MN, mill.