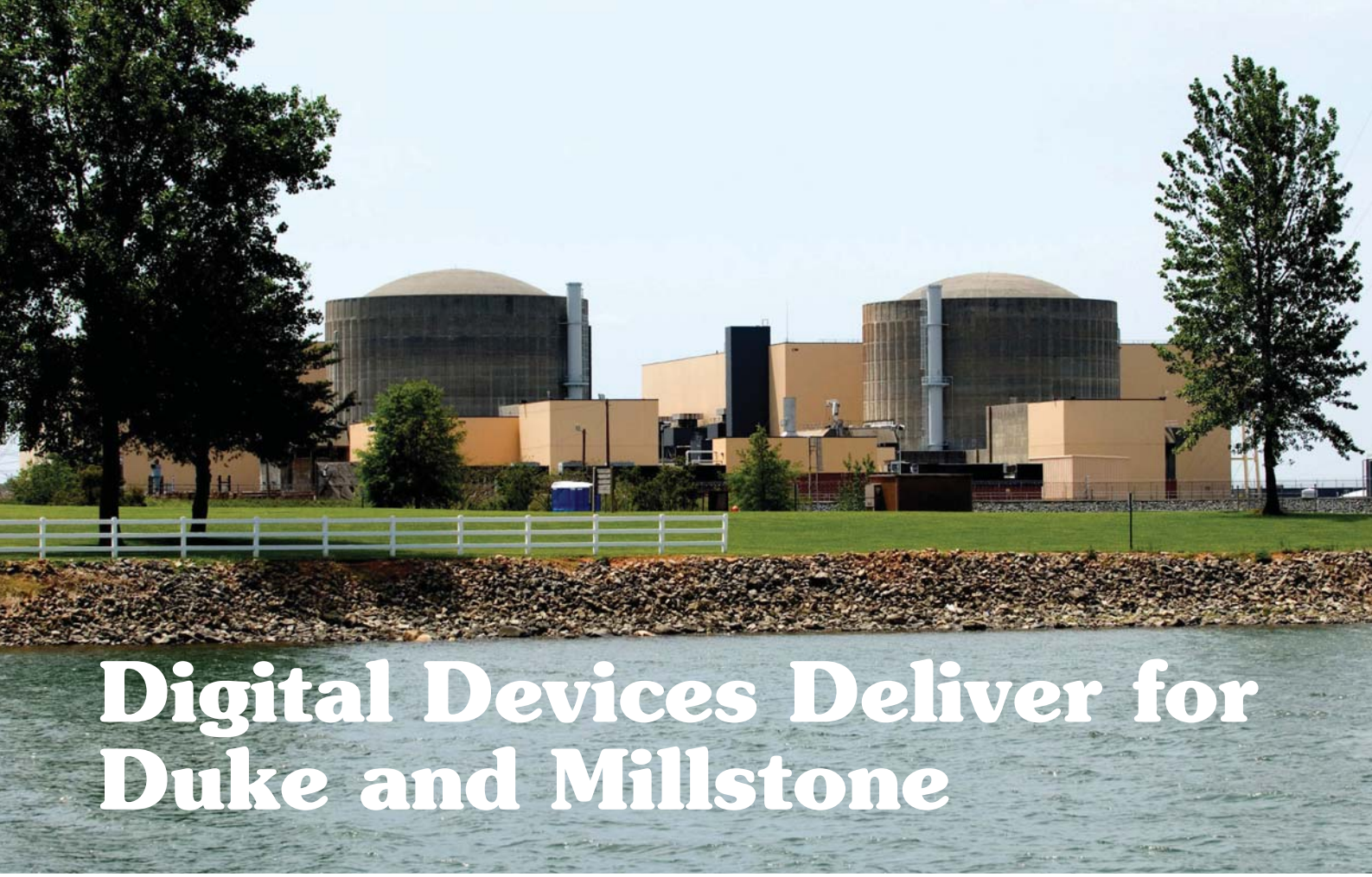

Digital Devices Deliver for Duke and Millstone

The Duke McGuire plant is working to more broadly apply on-line diagnostics. Photo: Duke Energy.

Digital positioners are seeing broader use in the nuclear industry. They are typically faster and more stable than the analog devices they replace, which translates into simpler control schematics and better process control. And on-line diagnostics provides an opportunity to improve the effectiveness of maintenance activities, while cutting down on radiation exposure for employees. This article will highlight activities related to upgrading to digital positioners at the Duke McGuire plant in North Carolina, and at the Millstone reactors owned by Dominion in the Northeast.

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Duke Energy, McGuire, Lake Norman, NC

This is a twin unit site with 2 Westinghouse PWR's generating about 2200 MW's of power. It is located just north of Charlotte, NC. They are utilizing Fisher® Fieldvue™ Digital valve controllers (DVCs) on a number of applications, but the most important of these is on their unit 2 Feedwater regulation valves.

Duke decided to change to digital on this application for several reasons. First of all, they were transitioning to an Ovation digital control system at the plant and felt that these devices would interface better with the new system. They were also concerned about obsolescence and reliability issues with the old analog positioners. Furthermore, the old valve set up was not providing very good process control. These are essentially the most important control valves in the plant and are used to control feedwater level in the steam generators. Excessive swings in level can cause operating headaches for the plant, and if severe enough can cause a unit to trip.

Around five years ago the plant made the transition to digital positioners on both the unit 1 and 2 main feedwater and feedwater bypass valves. The team that worked on this included Ryan Printy, AOV Component Engineer; Michael Harazim, Project Manager; Robin Turpin, Lead Design Engineer and John Nettles, Design Engineer. They employed a dual redundant approach on the mains to provide for back-up operation in case one of the positioners failed, and used remote mount models so that the electronic portion of the positioner could be panel mounted with only the feedback device mounted on the valve. They used a single positioner approach on the bypass valves. Remote mount positioners were chosen based upon industry operating experience (OE) related to rotary potentiometer vibration issues, along with internal OE relating to packing leakage causing elevated temperatures above the packing box.

Figure 1. The dual redundant set-up and indicator station installed at the Duke Power site. Pictured are Mike Harazim (left), Robin Turpin, and Ryan Printy.

The local Fisher representative, RE Mason and Co, was used to help ensure the system operated as designed by building a mock-up, testing the response of the valve, and testing the auto-swap-over feature employed on the main feedwater valves. Figure 1 shows the panel mounting of the dual electronic modules for these valves. Figure 2 shows an example of the feedback modules that actually get mounted to the valve.

With the installation of the DCS a behind the scenes monitoring capability was made available to constantly evaluate the health of the positioners. If a monitored set point reaches an alarm status the control room is notified and if necessary the DCS will automatically "hot-swap" over to the backup positioner on the main feedwater control valves. This capability gives the control room operators the ability to reliably maintain steam generator level, plan to safely evaluate the problem, and correct it all while keeping the plant online. The control room can also manually swap positioners in support of online maintenance and has used this feature on several occasions with great success. The original installation employed remote mount DVC-6005 positioners with an XACT feedback. Unit 2 was recently transitioned to the non-contact linkage-less DVC-6200 and Unit 1 will be modified during the upcoming spring outage in 2013.

One of the major benefits of the digital positioners is the capability to be "tuned" to the exact response needed for the process in question. Duke used this tuning capability to mimic the old analog control system by slowing the positioner response to ensure a gentle rolling control of steam generator level versus a more pronounced jagged response that was possible if needed.

Digital positioners were also recently installed on their main steam to condenser dump valves. These valves must stroke very quickly during a full turbine load rejection, but also be stable during normal operation for start up and shut down. Using old analog positioners that employed volume boosters, it was a constant battle to tune the volume boosters hot for stroke speed while maintaining smooth control at slow speeds. Again RE Mason was employed to design and test a new control panel using DVC-6000 direct mount positioners that maintained the trip open speed of the valve while providing stable control. Due to the digital devices having higher air volume than most analogs McGuire was able to remove the volume boosters and vastly simplify the control scheme used on these valves. Deleting the volume boosters has also removed the requirement for maintenance to be at the valves with the plant hot to tune them. As an added benefit to the Ovation system a Valvelink snap-on was installed that can perform the same function as a standalone version of Valvelink without having to be at the valve locally to lift leads. This has given McGuire the ability to monitor and troubleshoot the valves from a controlled environment while minimizing time out in the field.

Millstone 2&3, Waterford, CN

Millstone is a two unit PWR site, generating about 2100 MW's of power, located near Waterford Connecticut. One unit is a Westinghouse design, the other is Combustion engineering. This customer has also used this updated digital technology on a number of key valve applications, but the one we'll center on here is the feedwater regulation bypass

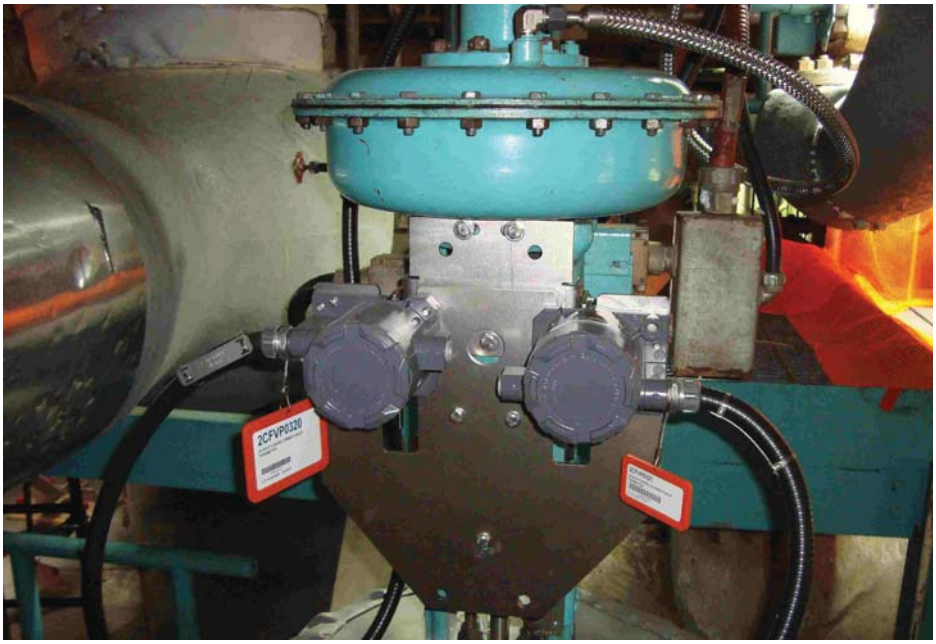

Figure 2. The dual redundant feedback sensors on the valve.

Figure 3. The original feedwater recirculation/startup valve assemblies at Millstone included problematic positioners, exhausts, and solenoids. The unreliable combination of instruments required manual control during startup and resulted in costly delays or plant trips.

service on Unit 3. There are four valves in parallel that provide for effective control of the steam generator levels during start up and shut down.

The original configuration used traditional analog positioners, but due to their slow response, volume boosters and quick release valves had to be added to the pneumatic circuits to meet some very demanding stroking time requirements. These devices, by their very nature are hard to "tune" and one can end up with valves that are alightly unstable, which results in poor process control. What this translated into for the plant was that the valves required manual control from the operators during start-up and shutdown to maintain proper Steam generator level. In 2010, the Unit experienced a reactor trip where the root cause was determined to be inadequate design of the valve controls. Specifically, the modulating and quick closure function needed to be separated and larger instrument air piping was required to support the large actuators and prevent the pressure drop that was being experienced.

The Millstone team decided to investigate a digital positioner upgrade on these four valves. The first very positive thing that they discovered was that due to the higher flow rates in the new Fisher® Fieldvue™ positioners, they could eliminate the volume boosters completely and run with just the positioner directly connected to the actuator. They were also able to eliminate the quick release valves by re-routing the exhaust through a separate line controlled by a solenoid valve.

Working with the local Emerson/Fisher sales office, New England Controls, they came up with a much simpler, more straightforward design for the pneumatic circuits. Then they went one step farther, and engaged Emerson specialists to model the process and used that modeling to fine tune the dynamic response of the digital positoner and the characteristic of the valve to perfectly match it. (See figure 4 which shows the new approach.)

The result was a simplified schematic which was easy to set up, and a quick and stable valve response, enabling the plant to start up on automatic control without the operator intervention required with the old hardware. The positioner is capable of on-line performance diagnostics so that they can easily track performance of the positioner, the valve, and the process and look for signs of problems as they develop. With fewer components to maintain, and this predictive approach to maintenance should greatly reduce maintenance spend in the future. In summary: better process performance and lower costs, an ideal combination.

Conclusion

Digital positioners are delivering some great benefits to the nuclear industry, facilitating better process performance while reducing maintenance spend, and downtime. If the industry is to continue to compete in the global power generation market, it will have to leverage new technology like this to improve overall financial performance. These plants are demonstrating that it can be done.

Figure 4. Since the digital valve controllers and high-capacity solenoids were installed, the Millstone plant has experienced no trips. The instruments provide data about valve performance and alert operators of any problems.