Xcel Energy—Tolk Station

Utility Power Plant, Muleshoe, Texas, USA

Systems Integrator—Siemens Energy, Loveland, Colorado

Application—Woodward MicroNet™ TMR on Westinghouse 540 MW Reheat Steam Turbine

Plant Information

Xcel Energy's Tolk Station is a coal-fired, steam-electric generating station, with two operating units, built in 1982 and 1985. The station is named after Roy Tolk, who was president and chairman of the board when Southwestern Public Service Company (one of the predecessor companies to Xcel Energy) decided to build coal-fueled plants. The Tolk Station plant's two turbine generators have a total gross output capacity of 1080 MW, which will generate enough power to meet the needs of some 540,000 US households.

Air emissions are controlled at Tolk Station with the help of low-sulfur coal and baghouses. Baghouses act like giant vacuum cleaners, removing particulate emissions from the flue gas by more than 99 percent. The particulate or ash collected at Tolk is recycled as byproducts for construction, oil well "mud," and other uses rather than sending it to a landfill. Tolk Station is a "zero discharge" plant, which means no process waters are discharged off-site.

Plant Problem/Concern

Xcel Energy made the decision to upgrade the control system on its Unit 1 Westinghouse 540 MW re-heat steam turbine due to concerns over the obsolescence of their Westinghouse DEH, and lack of future support. Plant operations personnel noted that obsolescence is an important concern to many power producers in the US. Consequences from a failure of an obsolete system can be devastating in down-time and consequential loss of generating revenues. Obsolescence is a real problem today for outdated control technologies of mechanical-hydraulic controls (MHC), analog electronic control systems, and many other digital technologies. In the event of a failure, most maintainers of these outdated technologies "duct-tape" their system to keep them functioning, but often sacrificing reliability, performance, and safety.

Power producers like Xcel Energy are being proactive to maintain the high availability of their systems plus improve performance which could result in improved generation dollars. The big challenge then becomes what control architecture will best fit the producer's needs and how long this new architecture will last before it too becomes obsolete.

Reason for Choosing Woodward

When it was time for Xcel Energy's Tolk Station to upgrade the controls on their Westinghouse re-heat steam turbines, they looked for a turbine control architecture familiar to them, to minimize risk, and for redundancy to maximize reliability. This architecture is found with Woodward's MicroNet™ TMR system.

Of the available solutions to Tolk, the Woodward MicroNet TMR solution was the product of choice for many reasons, particularly the success and reliability they have had within the Xcel Energy fleet with Woodward control systems on similar turbines. The MicroNet TMR system allows them to meet the reliability requirements that they've learned to appreciate with other Woodward-supplied systems. Also, the ease of desired communications requirements with their Foxboro™ DCS for balance of plant played a large part in the decision. Even though the Foxboro DCS and Woodward TCS have changed throughout the years, Xcel Energy has not had any problems establishing the communication link between the systems on any new project.

An important consideration for Xcel Entergy and Tolk Station was the cost savings which they experienced in having a quick turn-around with an architecture they were familiar with and their comfort level in having the basic skill set for maintaining, programming, and adjusting Woodward's GAP™ (Graphical Application Program) software system.

When asked the reasons for the turbine controls upgrade and why they selected a Woodward control system for the retrofit of the Westinghouse units at Tolk, Xcel Entergy's Maintenance Resources Supervisor, Dennis Buchanan, replied:

"In all cases, the turbine control upgrades were justified by obsolescence of either the Westinghouse DEH computers or the GE AEH controllers.

"During our first retrofit in 1990, SPS did a comprehensive evaluation of distributive control systems for the purpose of integrating all controls into one system. At that time, Westinghouse was the only vendor that had a truly integrated system. Our evaluation, however, rated the Foxboro DCS superior to the other suppliers. Foxboro proposed a solution that included the Woodward NetCon® 5000FT controller with a 'seamless' interface. Foxboro, Woodward, and SPS jointly developed the interface between the two systems. This interface has proven to be safe and reliable. Since that time, Foxboro has tried to sell us on a Foxboro-based controller. Due to our success with, and the features of, the Woodward system (redundancy, security, reliability, driver cards, etc.), we have continued with the Woodward solution on all subsequent upgrades."

Application Challenges

This project encompassed multiple design and installation challenges which the Siemens engineering team had to overcome. Each of the turbine's modulating throttle and governor valves required an interface using accurate valve positioners, for accurate speed and load control and fast action upon a load loss event. The Siemens application engineering team used the MicroNet TMR's integrated driver modules to interface with each of the system modulating valves to ensure both accurate operation and fast system response times.

Tolk management required that the new control system follow the OEM's start-up sequence and load gradient guidelines. The Siemens application engineers used the MicroNet TMR's GAP software to design the turbine's start sequence, load algorithms, and turbine protection logic per the original OEM's specifications.

As a cost-effective measure, multiple turbines were designed into the one turbine control system (TCS). The provided TCS was programmed to control both a 540 MW Reheat Tandem-Compound, Double Flow Westinghouse Mainline Steam Turbine as well as a Westinghouse Boiler Feed Pump Drive Turbine.

System Description

The TCS was designed to directly replace the original Westinghouse DEH control system. The new system includes both mechanical and electrical changes. Tolk's main turbine consists of 2 modulating Throttle Valves, 8 modulating Governor Valves, 4 Intercept Valves, and 2 Reheat/Stop Valves. The Governor Valves can be operated in a single valve (full arc) mode or sequential valve (partial arc) mode. After transferring from Throttle Valve control to Governor Valve control, single valve mode is used to synchronize and heat the turbine uniformly during initial loading. The control system is also set to single valve mode during TV/GV freedom tests. Sequential valve mode is used to open the governor valves sequentially so as to maximize the units' performance and improve controllability through precise valve positioning. Some of the desired values from the customer were:

- Increased reliability of all control components
  - TMR control system and speed measurement
  - TMR turbine protective systems including overspeed protection
  - Reliability of dual coil servo-positioning controllers with redundant LVDT feedback sensors.
- Performance
  - Speed control with 20 ms scan time (5 ms is available but not needed for this type of application)
  - More accurate load control
  - Greater operating reliability with fluctuating steam pressure and/or different load demands
- Efficiency
  - Turbine start-up in full arc mode (lower thermal stresses)
  - Partial arc operating mode increases efficiency at partial load
- Availability of common spares and controls familiarity
  - Other MicroNet TMR control systems installed in the plant
  - Similar Woodward controls used throughout fleet
- Reduced obsolescence risk
  - The Woodward MicroNet architecture with its industrial modules will be supported for many years to come. Subsequent to that, newer modules will be adaptable to the existing MicroNet TMR chassis to provide many more years of useful service to this architecture.
  - Most of the I/O modules are the same as or interchangeable with systems installed in the Xcel fleet.

New Control Cabinet

Previous Control Cabinet

Plant Results

Results of the installation and commissioning were very favorable to the plant. Installation and commissioning were accomplished within the scheduled outage.

The newly installed system proved itself when lightning struck a sub-station outside the Tolk station, and Unit 2 dropped from 540 MW to 277 MW (49% load drop) in three seconds. The DCS plant controls stayed in automatic and were able to bring the unit back to 530 MW within five minutes, largely due to the response of the new MicroNet TMR turbine control system and coordination with the plant control. Plant personnel among others were impressed and delighted about how the entire control system responded to such a drastic situation.

When Dennis Buchanan was asked if he felt the new turbine control's response helped to keep the turbine online, he responded by saying, "I don't have enough knowledge of that particular event to say for certain. In general, we have been able to ride through more of these types of events with the new control systems. The reason for this improvement is due to improved coordination between the two systems. The original turbine controllers were set up to take emergency actions based on their own inputs, with no regard to the boiler. Now, the turbine will respond in conjunction with the boiler controls and will not compound the effects of the external disturbances."

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