Optimization Technology Contributes to Ramp Rate Improvement

Minnkota Power Co-op can now respond more efficiently to load swings.

By Dana Stumpf, Minnkota Power Cooperative, and Jeff Williams, Emerson Process Management

The Milton R. Young Station, a two-unit, lignite-fired power generating facility located near the town of Center, N.D., consistently ranks among the nation's lowest-cost coal-fired generating plants.

Young Unit 1 is owned and operated by Minnkota Power Cooperative, which provides electricity to 11 associated distribution cooperatives in eastern North Dakota and northwestern Minnesota. Young Unit 1 is the primary source of electric energy for approximately 110,000 customers. The 250 MW unit, which began operation in 1970, is equipped with a Babcock & Wilcox (B&W) cyclone boiler and General Electric steam turbine generator.

For years, Young Unit 1 operated as a baseload unit where megawatt production levels remained relatively constant, but that changed when Minnkota began participating with the Midwest Independent Transmission System Operator (MISO), an operating environment in which revenue is dependent on a station's ability to quickly and efficiently respond to constantly changing market demand. This environment was particularly challenging for Young Unit 1, which was now required to offset megawatts whenever recently added wind farms were unable to meet demand.

The regulation fine-tuning typically involved small load swings—ramping up or down by 10 MW. However, the unit's response to load setpoint changes often resulted in over/undershoot and lagging load response, both of which contributed to lost revenue. To help resolve this issue, in the fall of 2007 Minnkota implemented Emerson's SmartProcess unit response optimization (URO) technology to meet fluctuating demand.

At Young Unit 1, the SmartProcess URO is embedded within the unit's Ovation expert control system. Using nonlinear dynamic feedforward and model predictive control, the optimization technology builds upon Ovation's existing unit coordinated control capability to enhance boiler and turbine response for tighter overall control and more efficient operation.

The URO technology can help Minnkota hit targeted setpoints with minimal megawatt overshoot, contributing to reduced fuel costs and giving the co-op a chance to compete in the ancillary power services market. Using optimization technology can also translate into less stress on critical equipment, further enhancing unit reliability and availability.

Installing the URO

The SmartProcess URO uses plant operating data to create a model of dynamic boiler and turbine responses and other unit characteristics. Emerson engineers worked with Young Unit 1 operators to collect unit-specific data. After observing normal unit operation, operators ramped the unit up and down, typically in 20 MW intervals, to capture dynamic response characteristics. Parameters measured included steam temperature and pressure, throttle pressure, valve positioning, megawatts, fuel flow, drum levels, air flow, boiler master output and turbine master output.

Emerson analyzed the data collected and designed models that reflected the process dynamics of Young Unit 1. Control modifications were designed to support the new operational philosophies and their integration into the existing Ovation system control structure. As part of this integration process, Emerson designed several sheets of control logic modifications.

In most cases, URO optimization technology is installed while a plant is in normal operation with no downtime required, but because Young Unit 1 was performing a software upgrade to its Ovation system during a scheduled outage in the fall of 2007, the URO was installed at that time.

After commissioning, the URO ran in advisory mode a few hours each day. Emerson engineers refined the models and fine-tuned the control logic and proportional–integral–derivative (PID) loops. After two days of advisory-mode operation, the URO was put into service in closed-loop mode, running automatically without operator intervention, and it has been running continuously ever since.

Unit Response has Improved

The results include a 70 percent improvement in ramp rate, from 2 MW/min. to 7 MW/min.; a 2 MW reduction in over/undershoot; and a 4 PSI average decrease in throttle pressure, contributing to overall machinery health. The SmartProcess solution has also been instrumental in helping Young Unit 1 pass its routine MISO turbine steam inlet valve tests.

Emerson recently finished installing URO technology at Young Unit 2. This optimization project was initiated to address concerns similar to those at Unit 1, but temperature variability issues at Unit 2 made this difficult and additional logic was added. The initial results show improvements in sliding pressure operation and an increase in ramp rates. pe

Authors: Dana Stumpf has been with Minnkota Power Cooperative for 28 years, first as a technician and now as technical supervisor. Jeff Williams leads the development of optimization technology and advanced applications at Emerson Process Management.

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