



Alstom Power

Designed for Success

Results

- Increased reliability and efficiency – achieving nearly 100% uptime
- Reduced maintenance and spare parts costs
- Improved diagnostics for less downtime and faster return to service
- Improved reporting features
- Optimized turbine start-ups and performance
- Realized target process improvements with faster CPU performance
- Significantly reduced cycle times with faster data synchronization
- Quick, easy migration to new controller platform

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Stephen Altman
Control System Product Engineer
Alstom Power

Power Ties

Alstom Power upgrades aging turbine controls, yielding higher reliability and efficiency, utilizing GE Fanuc PACSystems RX7i

Recently, a major paper manufacturer selected Alstom Power to overhaul an aging turbine generator that powers one of its mills, using technology from GE Fanuc Automation. With the newly retrofitted generator and faster controls, the plant has been able to increase reliability and efficiency by optimizing turbine start-ups and performance, and constantly monitoring and adjusting for thermal design constraints. Additionally, the plant has been able to reduce maintenance and spare parts costs, improve diagnostics for less downtime and faster return to service, improve regulatory reporting, and provide nearly 100% uptime to power its mill.

Power to the Paper

The plant's turbine-generator dated to the early 1980s – and obsolete spare parts and maintenance issues were causing an increase in unplanned downtime. Power supply is critical to the mill and its efficiency. Taking advantage of a planned outage, the plant decided to replace the outdated electronic and hydraulic systems on the unit, and contacted Alstom Power for expert assistance.

“Alstom has well-established project management processes that allow customers to complete upgrades on schedule,” explains Stephen Altman, control system product engineer with Alstom's CONCOM group. “We offered a common platform for the turbine and generator controls – and have a well-known reputation for local service.”

The Alstom Power Controls and Commissioning (CONCOM) department based in Midlothian, Virginia, put together the plan for the Turbine Control System (TCS) upgrade. The scope of the work included



upgrading the TCS with a redundant turbine controller, auxiliary controller, protection controllers, Automatic Voltage Regulator (AVR), and a new Human Machine Interface (HMI) solution. The control system solutions are part of Alstom's P400 Turbine and Generator Control System family, which utilize the latest GE Fanuc controllers and HMI software.

The plant's turbine-generator is a single-casing, three-pressure section machine, capable of running at full load with steam inlet conditions of 1800 psi at 1000 degrees F and 800 Mpph (million pounds per hour) steam mass flow. The system features the following principal components:

- Steam turbine High Pressure
- Intermediate Pressure
- Low Pressure
- Condenser
- Generator
- Two controlled extractions
- Live steam piping
- LP exhaust

The TCS is divided into two systems: the closed-loop turbine controller and open-loop turbine safety system and auxiliary controllers. The safety system provides a second line of protection against potentially dangerous service conditions such as overspeed, loss of vacuum, and bearing oil supply failure. In the case of the turbine tripping, the safety system gives additional impulses to the turbine control system.

The Alstom advanced turbine control solution incorporates speed control, load and pressure control, automatic turbine run-up, thermal stress calculations, and protection (or "limiter") functions into a single controller platform. To achieve the highest reliability and uptime possible, Alstom incorporated a GE Fanuc hot standby redundant controller configuration, featuring the PACSystems® RX7i Programmable Automation Controllers. Alstom was able to migrate existing code from its previous TCS designs to the PACSystems RX7i and PACSystems Control Memory Xchange (CMX) – providing the plant with execution time dropping from 40 msec to 14-16 msec and helping to realize target process improvements through faster CPU performance.

"By migrating our design to the PACSystems RX7i Hot Standby CPU Redundancy solution, we achieved a tremendous improvement in system performance," Altman notes. "The improved processing speed translates to tighter regulation of the turbine and greater efficiency. Synchronized data flows much, much faster, significantly reducing our cycle times. For the plant, this means a bumpless system – operations will stay up, and the machine won't trip.

Easy-to-use tools, such as Proficy™ Machine Edition, helped to speed the controller migration, which aided system design within the scheduled timeframe. According to Altman, Proficy Machine Edition offers a powerful set of development and management capabilities such as multiple target support per project, a toolchest, data monitor and watch windows, all combining to make project creation and execution an efficient process.

"The GE Fanuc development tools provided a powerful and flexible means to design the custom functions used by the power industry," Altman explains. "We were able to utilize the C programmer's toolkit and parameterized subroutine block feature to design a custom function library using industry standard control algorithms – to develop a much more capable system in a shorter amount of time."



No Power Trips

To further ensure uptime and reliability, Alstom implemented GE Fanuc Proficy HMI/SCADA – iFIX® in a redundant operator interface configuration. The HMI system provides an easy-to-use means of accessing the controls with graphical screens in a familiar Microsoft Windows® environment. Rapid supervisory control and monitoring permit faster response to any process issues. The system's flexibility allows for unlimited alarm areas, exception-based alarms, priorities, and remote management of alarms – which helps to reduce troubleshooting time and increase uptime. Additionally, iFIX collects and manages data easily and reliably, stores historical data and exports data to common databases – with the ability to quickly connect to a plant-wide historian, as database needs and analysis change. The system offers an automatic and long-term means of sampling, storing, reporting, and displaying the turbine process data, all in an easy-to-use environment that reduces training time and speeds response.

Prior to on-site implementation, Alstom conducted a complete and aggressive Factory Acceptance Test (FAT) with the plant. The team tested all systems against Alstom's proprietary turbine simulator, which allows for accurate modeling of turbine behavior when all characteristics are known about a unit. With the FAT completed, the team speeded through implementation – with minimal changes during commissioning.

"Since the upgrade, the plant has recognized benefits such as increased availability and reliability," Altman says. "The team has been able to minimize spare parts issues and reduce training as well as predict a decrease in maintenance costs."

With the new system in place and the team getting a charge from the results, the plant can ensure reliable, efficient power to its mill.

At a Glance: Turbine Control System Design and Functionality

Redundant Turbine Controller (Alstom P400-Turbine Control)

PACSystems RX7i in the Hot Standby CPU Redundancy configuration with communication to protection controllers via Genius® network. Communication to the auxiliary controller over a fiber-optic ring, utilizing PACSystems CMX modules.

- Turbine primary speed governing. This includes proportional speed control, speed limitation and acceleration limitation.
- Turbine run-up speed control (auto and manual) from turning speed to synchronous speed.
- Turbine speed control (auto and manual) during no load operation to permit synchronization with the grid system (by external synchronizer, also supplied by Alstom Power)
- Valve position manual control
- Closed loop MW load control. The operator sets a target load set point. When the load control is engaged with the unit synchronized, the load control function will act to maintain the generated load at this set point.
- Live steam pressure control. The turbine is unloaded in proportion to decreasing inlet steam pressure until a pre-set minimum load is achieved. This includes using minimum live steam pressure limiter and live steam pressure gradient limiter.
- Exhaust steam pressure control. The turbine is unloaded in proportion to rising exhaust steam pressure until a pre-set minimum load is achieved
- Coordinated boiler and turbine load control
- Hydraulic system reset
- Stop valve control
- Frequency adjustment (60Hz ± 0.05Hz)



Auxiliary (Open Loop) Controller (Alstom P400-AC)

PACSystems RX7i in the standalone controller configuration with expansion I/O rack.

- Auxiliary systems control (lube oil, jacking oil, turning gear, etc.)
- Turbine start-up program
- Field measurement conditioning
- Automatic system testing (lube oil, safety, control fluid, etc.)
- Synchronizing function group
- Turbine generator auxiliary control

Three-Channel Turbine Protection System (Alstom P400-TP)

Three Series 90™-30 PLCs with the CPU364 processor, processing the same field inputs and executing the same core logic. Communicate over Genius network to turbine controllers and provide 2oo3 voting for signals that may trip the unit.

- Three Channel overspeed protection
- Remote turbine trip according to I/O specification
- Protection system tests as required by process, typically:
 1. Digital overspeed protection tests
 2. Stop valve movement tests
 3. Stop and control valves tightness tests

Binary Signal SOE Recording (Alstom P400-SOE)

Series 90-30 PLC with sequence of events recorder CPU from Horner Electric, connected to another Series 90-30 PLC with a data concentrator module also from Horner.

- Records binary signal COS with timestamps
- Communicates data to HMI
- Synchronizes on-board clocks

Data Concentrator

Series 90-30 PLC communicating over Ethernet to the protection, auxiliary, and turbine controllers, as well as over Modbus to a legacy DCS.

- Providing setpoints and reading process data from all TCS controllers
- Data collection from Bentley Nevada vibration monitoring equipment

Redundant Automatic Voltage Regulator (Alstom P400-AVR)

Two Series 90-30 PLCs processing the same field inputs and executing the same core logic. Hardwired signals used for redundant process synchronization. GE Fanuc Datapanel operator interface mounted on front door of the excitation equipment for maintenance and local information. Communication over Ethernet with the HMI.

- Automatic Voltage Regulator
- Manual regulator
- Automatic voltage built up with progressive voltage raise (soft start)
- Over excitation limitation
- Under excitation limitation
- Volts / Hertz limitation
- Supervision of generator measurement voltage for the automatic voltage regulator

- Positive droop: compensation of voltage drops induced by active and reactive currents.
- Negative droop: reactive balance for two generators working in parallel.
- Field flashing sequence in case of self excited generator
- Local information through a digital control panel connected to the regulator
- Excitation logic sequences, (field breaker control, Start, Stop).
- Generator stator current limitation
- Reactive power or power factor superimposed control
- Communication with another control system, like plant HMI, through a TCP/IP link

Redundant Operator Interface

GE Fanuc Proficy HMI/SCADA – iFIX provides process visualization, data acquisition and supervisory control over manufacturing and production processes.

- Supervisory control: rapid process monitoring allowing rapid response to process issues
- Advanced alarming: reliable, flexible and easy-to-use system, with unlimited alarm areas, exception-based alarms, alarm priorities and remote management of alarms
- Data Management: ability to collect and manage data, store historical data and export data to common databases.
- Historical data: automatic and long-term means of sampling, storing, reporting, and displaying process data.

Alstom Power

This project is one of many P400 systems installed and commissioned by Alstom. For further information regarding the P400 TCS, please contact Alstom using the information below.

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Additional Resources

For more information, please visit the GE Fanuc web site at:

www.gefanuc.com

