PC-Based Remote Automation System Sheds New Light on Utility SCADA's Operation

In March of 1992, Transwestern Pipeline, an Enron Corporation affiliate, began a project to enhance the pumping of natural gas through its pipeline network that stretches more than 1,000 miles from natural gas fields in Oklahoma and West Texas to various points in Central and Southern California. The flow of natural gas is controlled by pumping stations with three large 5,000-horsepower compressor engines, each located at a series of 12 large pumping stations operating 24 hours a day.

Traditionally, each station was spaced along the pipeline and staffed around the clock, supporting three reciprocating compressor engines per station. To control the flow of gas, technicians are notified by telephone from Houston when to start a station's compressor engines, adjust their output, or shut them down. This manual process occurs day and night as the demand for gas from public utilities rises and falls with consumer demand.

Until recently, the compressor engines have been operated with a pneumatic control system. The old control system was designed with relays and a few single-channel controllers. There were several problems with this control system, including the inability to network easily with Transwestern's central operations in Houston, difficulty in programming updates with hardwire ladder logic code, limited reporting capabilities, and a poor operator interface.

In searching for a new solution, Transwestern Pipeline contacted automation system supplier Opto 22. A PC-based SCADA approach was suggested; one that combined a standard 486-based personal computer with the 32-bit Mistic 200 controller, its intelligent I/O bricks, sequential flowchart Cyrano control software, and Mistic man-machine interface software.

After evaluating alternatives, Transwestern decided that Mistic offered a better window into the process, greater programming flexibility, superior networking capabilities, and a simple operator interface — all at an attractive price/performance ratio. The modularity of the system allows flexibility for future system architecture updates. Transwestern selected its Thoreau, New Mexico station as one of the development sites for its new control system that eventually will replace equipment at the other stations.

Better Control Features

The Thoreau station was designed with a system total of 550 I/O points. Each of the three compressor engines utilize 144 Opto 22 I/O points broken into a mix of 80 digital and 64 analog points.

The new system was designed with four Mistic 200 controllers operating in a peer-to-peer configuration for data exchange. One of the Mistic controllers was designated as the master for the other three slave controllers (one per engine) — all were tied together via ARCNET. The master controller and the three engine controllers also have individual print dataloggers.

Using the new system via satellite links, Transwestern's Houston operations center can now directly initiate compressor engine start-up, adjustment, or stop commands to the master controller, which communicates with the individual engine controllers. The operations center also can monitor alarms for engine timing, temperature, and pressure at over 50 different points per engine via the individual PID loops, which report back to the controller.

Engine temperature PID loop control is performed at the I/O level with Mistic's intelligent analog I/O bricks. An air intake aftercooler radiant-type system provides engine cooling year-round day and night.

Intelligent I/O

The I/O bricks monitoring engine temperatures and pressures are linked to the controller by a single twisted pair wire, which also allows for large distributed systems.

Each brick contains optically-isolated 12-bit I/O modules and a plug-in brain board for local intelligence. The analog bricks are also capable of performing high-low limit monitoring, filtering, thermocouple linearization, waveform generation, totalizing, averaging, ramping, and more. For Transwestern, Mistic's intelligent I/O bricks offered important labor and cost advantages. Because the system must be fail-safe, the old control system required all the I/O to be hardwired from the engine room to the master control room.

Because Mistic's distributed bricks offer local control capability at the I/O level, only the three slave controllers needed to be wired to the master control room. A single intelligent I/O brick, communicating with the slave controllers, was set up to perform emergency shutdown in the engine room, which eliminated the need for an expensive hardwired relay showdown panel that would have taken a great deal of time to construct.

Hazardous Environment Operations

Mistic's certification for Class I, Division 2, hazardous environment operation allowed Transwestern to place the three engine-room controllers inside standard NEMA enclosures. Controllers without this certification for hazardous operation must be placed in gas-purge cabinets that are extremely expensive.

Transwestern programmed the Mistic controllers using Cyrano, Mistic's multitasking control software. Cyrano provides a clear visual representation of control logic through its flowchart screens. Applications are programmed by drawing a "to do" list with action blocks that contain one or more required commands, such as "Turn on Valve 1," and then they are connected with lines to condition blocks that test to see if the condition has been met, "Is Valve 1 on?" The connecting lines between the blocks indicate the sequence of execution.

The complexity of Transwestern's PID loops, which adjust internal engine temperatures and pressures, made floating point math an essential requirement. Cyrano supports IEEE floating math, with calculations executed by Mistic's math coprocessor at the controller level.

Another advantage of Mistic for Transwestern was in configuring the print dataloggers on each engine and the master controller. Using Mistic, there was no need for a separate ASCII module or the need to write programs in BASIC and ladder logic. All communication flows directly through Mistic's serial ports.

Man-Machine Interface Software

Transwestern programmed its operator interface using the new Mistic Man-Machine Interface (MMI) software. Mistic MMI accessed Transwestern's control layer tag names directly from Cyrano, which eliminated cumbersome cross-referencing while improving accuracy and reducing programming time over traditional operator interface software.

With Mistic MMI, Transwestern had access to I/O, control variables, monitor alarm status, log data to disk, trend real-time information, and more. Mistic MMI provided Transwestern with a sophisticated object-oriented drawing environment and included a symbol library with 3-D graphics and the standard ISA symbol library. These features made developing Transwestern's operator interface a straightforward process.

Transwestern operators will use the Mistic MMI on-site for each system. When problems are detected, the operator will easily be able to determine the cause and send for the appropriate mechanical or instrumentation technician.

Operators for the first time will also be able to program updates to both the MMI and Cyrano control layer software. The ease of programming means operators will not need to be highly trained programmers to make the most simple maintenance changes.

With the Thoreau station installation complete, Transwestern is starting work to update its control system using Mistic at a third pumping station in Arizona. This station is expected to go online in several months. Plans call for the remaining stations to be converted over a period of several years.