

Duke Power Station

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Marlon Dempsey,
Instruments and Controls Engineer,
Oconee Nuclear Station

Duke Power Upgrades Oconee Nuclear Station Turbine with a Digital Control System from Invensys Operation Management

by Invensys Operations Management

Goals

- Improve current diagnostic software to quickly pinpoint, locate and guide troubleshooting;
- Upgrade current hard-panel interface (cumbersome switches and meters, running tests, and acquiring readings) and enable operators to execute start-up and valve tests more efficiently than with the current analog system and stay in constant communication with the controller.

Challenges

- Locate a control solution to eliminate any single point of failure in the nuclear power production function and provide redundancy while reducing the cost of downtime and outages.

Solutions and Products

- Triconex Critical and Safety Systems;
- Wonderware InTouch HMI.

Results

- Helps in providing 17,000 megawatts of electricity to more than two million customers;
- New triple redundant system assists in the continuous safe operation, reliability and safety of the plant;
- Eliminated one of the top sources of system trips on one of its three turbines;
- The new digital system eliminated recalibration which took a week in the previous analog system.

Oconee, South Carolina – Duke Power operates three nuclear stations and has provided safe, reliable, and economically priced power to the Carolinas for a century.

The company delivers approximately 17,000 megawatts of electricity to more than two million customers throughout a 22,000 square-mile service area while balancing the region's growing electricity needs with care for the environment.

Oconee, Duke's Nuclear Station in South Carolina, has a capacity of 2,538 megawatts. Since its inception, Oconee has generated more than 495 billion kilowatt hours of electricity – more than any other nuclear station in the United States.

In 2000, Oconee earned further distinction as the second nuclear station in the country to have its licenses renewed by the Nuclear Regulatory Commission for an additional 20 years.

Client Challenge

Safe operation is the top concern of nuclear plants and reliability is a cornerstone of safety. Over thirty years ago, when most of the nation's nuclear plants were commissioned, analog control systems were state of the art and ensured plant reliability.

Analog control systems presented certain constraints, if a component failed under normal wear and tear, the entire system would be shut down. This would add risk and cost hundreds of thousands of dollars a day in downtime.

Marlon Dempsey, Instruments and Controls Engineer, said *"We found that our analog turbine control system was one of the top three causes of trips and transients, primarily because its components presented a single point of failure. We knew that introducing more redundancy at key points would enhance reliability considerably and found that digital technology could provide that redundancy while at the same time reducing the cost of downtime."*

After evaluating alternative turbomachinery control solutions, Duke Energy began implementing a fault-tolerant control system from Invensys Operations Management, contributing to safe and reliable plant operations.

The Need to Go Digital

Duke Power has a strong, proven commitment to plant safety and security, and strives to keep production costs among the lowest of all U.S. nuclear plants. The Oconee plant uses analog turbine controls provided by its turbine supplier, and with the age of the equipment, parts obsolescence and single failure vulnerabilities, Duke set out to evaluate digital control alternatives. Duke compared options provided by several control system suppliers including Invensys.

Finding the Right Technology

In addition to locating a control solution to eliminate any single point of failure in a critical nuclear power production function, Duke required a better alternative to its current hard-panel interface (cumbersome switches and meters, running tests, and acquiring readings). Duke selected the turbomachinery controls from Invensys to meet all their technology specifications, along with its flexibility and expertise to simplify and reduce implementation costs.

The Invensys solution controls variables such as turbine speed and valve operation in communication with field sensors. It also facilitates quarterly turbine-valve movement tests and monthly trip tests to ensure that the turbine will trip when necessary to protect the system.

Based on Triple-Modular Redundant (TMR) architecture, TRICON™ uses three isolated,



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parallel-control systems and extensive diagnostics integrated into one system. The system uses 'two-out-of-three' voting to provide high integrity, error free, uninterrupted process operation without a single point of failure.

In addition to cost and the willingness of Invensys to adapt its product to meet a customer's needs, the product appealed to Duke because of its technical features, capabilities, and its suitability for the nuclear industry.

Dempsey said *"Not only is the controller triple-redundant, where possible we also made critical field inputs triple redundant. This level of redundancy is typically found in nuclear safety related systems but not in older analog control systems. When you consider that the turbine can trip the entire plant, it makes sense to go for the highest quality system."*

Maintained Cabinet and Wiring

Because Invensys is the leading supplier of safety shutdown technology, its engineering teams are highly experienced and qualified in delivering the rigorous testing and attention to detail necessary for safe and reliable power operations.

Using existing cabinets and cabling were extremely important during the project. Other alternatives required relocating the turbine control system to a new location, which would have added cost, time, and risk to the project.

The overall cost of the project was significantly reduced by eliminating the need for new cabinets and cabling.

According to Dempsey, *"Physically adapting their systems to fit within our existing cabinet impressed us greatly. They used our existing wiring cabinets, where there was very little manoeuvring room, but they solved this by performing extra design work up-front. Our existing cabling was in good condition. Installing a whole new cabinet and pulling all news wires would have been both expensive and time consuming."*

Improved Control Design

The logic in the analog system was derived from



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individual circuit cards that took about a week to calibrate. By using the new TRICON digital system, recalibrating was not required.

"Because of the digital logic, we've essentially eliminated this task. Now we just verify that the version of logic running in the machine matches a controlled copy, which frees up a lot of time to allow personnel to do other work. We can make logic changes on our own because the digital technology makes it easy. Not having to rely on an outside vendor is a big benefit. We have more control to modify the logic design of the system to match the needs of our plant. Our old analog system did not allow for changes because it was hard-wired. With the digital control system, we can easily make enhancements," commented Dempsey.

Eliminating one of the top causes of trips, transients, improving diagnostics, and upgrading to a digital control system enabled operators to make changes to configurations without going back to the vendor.

Further, this provided a platform that enabled Duke Power to extend automation to other processes.

Interact with the Controls More Effectively

Invensys also provided Duke Power with Wonderware InTouch HMI (Human Machine Interface) software.

Previously, operators viewed the control system through a hard panel interface (characteristic of many of today's nuclear plants), with the new solution they now have a graphical user interface that provides much more information.

The Wonderware InTouch HMI software enables operators to execute start-up and valve tests more efficiently than with an analog system.

The new system automatically runs specific test and reports on the results. If any failures occur, the software notifies the operator where and why the failure occurred.

The system also aborts a test if a condition impacts the system performance or safety.

The visual touchscreens notify system operators about the incident and with ample diagnostic information.

Improvements in Diagnostics and Maintenance

Improvements in diagnostic software can now quickly pinpoint, locate and guide troubleshooting. High-speed data collection software now scans and collects data more efficiently so plants can analyze circumstances that lead up to an event. Using remote access software, Invensys can provide off-site technical support when necessary.

Leading the Industry

Duke is among the small group of nuclear plants now effectively using digital turbine controls, although all are considering doing so as their analog controls continue to age. By implementing the digital system, Duke has virtually eliminated one of the top sources of system trips on one of its three turbines.

*This document was realized thanks to the support of:
Duke Power Station.*