Nuclear Control Room Annunciator System Upgrades – D.C. Cook

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— Nick Neumann, Digital Systems Engineer

Organization: American Electric Power's Donald C. Cook Nuclear Plant is located on Lake Michigan's eastern shoreline in Berrien County, Michigan.

Challenge: The annunciator system at D.C. Cook dates back to its inception. Many of the components and parts are obsolete and require replacements.

Solution: A new annunciator and plant process computer system were installed. Digital displays replaced the original analog panels and alarms. Each display includes between 50 to 100 alarms which monitor all aspects of the plant.

Results: D.C. Cook's new annunciator system is more efficient, more reliable, and eliminates single points of failure. Operators can quickly research and resolve issues. The system includes a fully redundant "seamless failover" environment. Finally, redundancies facilitate the transfer of functionality between the primary system and the backup system.

Nuclear power plants rely on annunciators to provide immediate visual and audio indications of plant systems and equipment. Annunciators keep operators apprised of information collected from critical systems throughout the plant. The information is combined logically to alert operators of any remedial actions that may be required.

When American Electric Power needed to upgrade the annunciator systems at its Donald C. Cook Nuclear Plant, it retained Curtiss-Wright to replace these systems in both nuclear units. Previously, the D.C. Cook plant used a card-based alarm system that dated back to the origin of the plant. The original system was based on a Rochester Instruments Model AN-100. It included 23 lamp boxes, six logic cabinets, and three audible horns in the control room. Due to the age of the system, which dates back to the early 1970s, most of the components and parts were no longer supported.

According to Nick Neumann, a digital systems engineer at the D.C. Cook plant, in the first phase of the project, the implementation team determined which parts of the old system they were replacing, and what the requirements for the new components would include. "We opted to essentially leave everything 'as is' on the field side—all of the relays, all the field terminations, and to replace everything from the logic cabinets out into the control room," he explains.

D.C. Cook's implementation team replaced existing analog lamp box indicators with touch screen displays that fit over the old control panel cutouts. They kept the wiring intact but replaced cabinet doors and offsets. New equipment included DC power supplies, digital input cards, digital output cards, bulls eye indicators, and horn relays. The team also installed a temporary alarm system to facilitate continuous monitoring during the outage.

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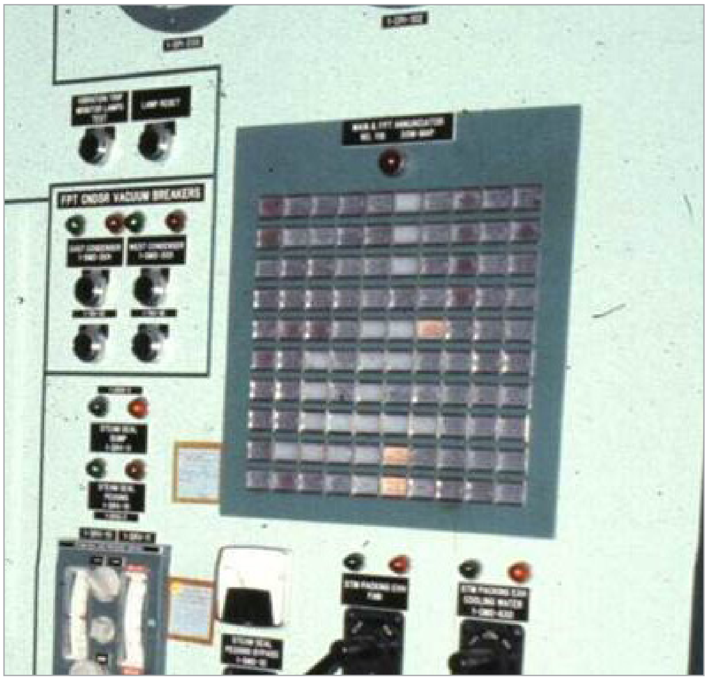
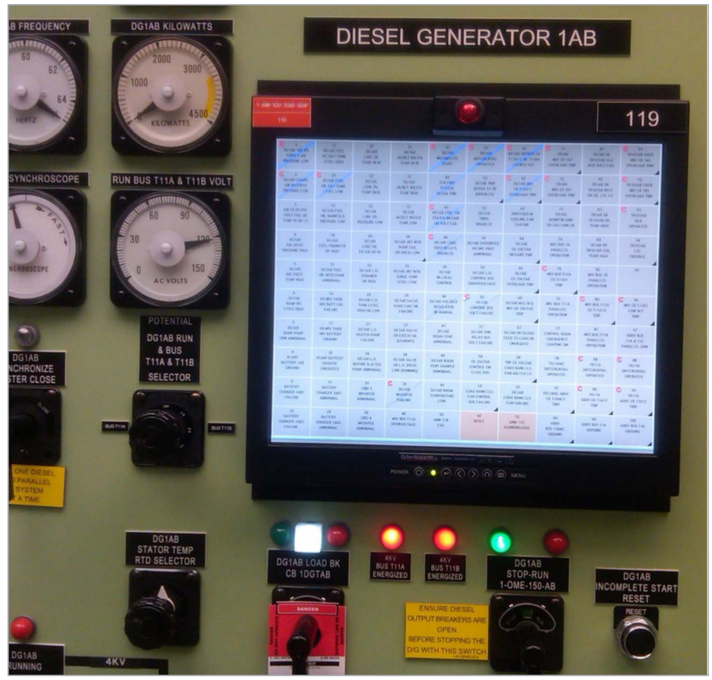


Old annunciator control panel



New annunciator control panel

Integrating Digital Information Systems

The annunciator project was performed in tandem with a plant process computer (PPC) system replacement project, which involved upgrading the plant's data acquisition equipment, servers, and workstations. HP servers were connected to an RTP3000 data acquisition system. The database and display sets for the annunciator were implemented in R*TIME. The project also included seismic and EMI/RFI testing for monitors and I/O equipment.

R*TIME interfaces with the annunciator system to bring in time-stamped information. Data is presented on touch screen annunciator Video Display Units and three separate workstations. This enables the engineering staff to analyze and correct all types of issues, from repetitive anomalies to spurious nuisance alarms. It also provides multiple layers of redundancy.

Curtiss-Wright developed the system and performed factory acceptance testing at its Idaho Falls facility, with oversight from AEP. Curtiss-Wright then shipped the system to AEP, where a multi-discipline project team that included AEP, Hurst Technologies, and Curtiss-Wright installed the system and conducted further tests during the scheduled unit outages.

"Once the in-house annunciator system came online, the project team made sure that the RTP and R*TIME components were programmed correctly and running smoothly," Neumann says. "Any software bugs or deficiencies found during testing were presented to Curtiss-Wright. They supplied resolutions for those issues, which were then reviewed by the in-house team."

The annunciator system mimics the performance of the old system, along with some useful enhancements that the old system didn't have. The information received from the RTP3000 is digital, but it may represent analog data. Multiple inputs can be combined into a single alarm, which has allowed D.C. Cook to develop multiple input alarm "drops."

The annunciator system has replaced the original 23 alarm panels with new digital displays. Each display has from 50 to 100 alarms, governing everything from safety relief valves to steam generators, pumps, turbines, and fire protection systems (see figure on next page).

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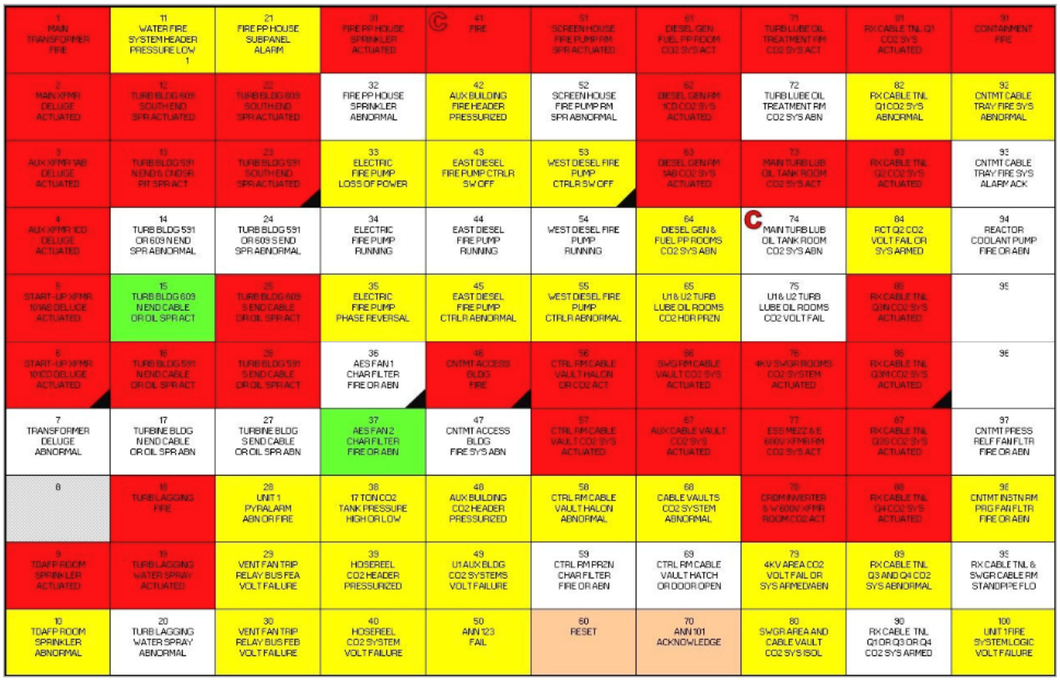

VDU displays (alarm inputs)

"It works the same way as the old system, but we can find information more quickly," Neumann says. "If something breaks out in the field and we have to do a failure investigation process, it's so much easier to determine when the alarms came in. By pushing a couple buttons, we can build a timeline of the period we are investigating."

Tallying the Benefits

According to Neumann, the old logs contained much of the same information, but they were tedious to sort through. "The old logs were manually produced by the operators, whereas the new logs are automatically generated by the system, which is much more efficient," he adds. "We can monitor trends to see what data is coming in over a designated time period. The data historian keeps that information, so we can go back and study it if we need to research something. Operators can resolve issues quickly using comprehensive search capabilities and trend reports."

Finally, the system is more reliable, since all annunciator logic functions are executed in a self-contained, fully redundant "seamless failover" environment. Dual-redundant processors ensure integrity of alarming functions in the control room should a primary display failure occur. These redundant controls also ensure seamless transfer of functionality between the primary system and the backup system. The new annunciator system eliminates single points of failure and alleviates the former obsolescence issues.

Working with Curtiss-Wright – Past, Present, and Future

American Electric Power has also contracted with Curtiss-Wright to implement a Reactor Controls and Instrumentation (RCI) system. As part of this project, Curtiss-Wright supplied components for 12 instrumentation racks. Old controls were replaced with new digital components including power supplies, servers, network switches, and input/output devices. Curtiss-Wright also developed an HMI interface that mimics the old control panel controllers. This established a redundant method of control should the primary controller became unavailable.

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Annunciator overview functions

As with the annunciator system and the PPC system, the RCI system uses the same RTP NetSuite I/O hardware and the same R*TIME software—three separate and distinct systems that share a common architecture. This modern infrastructure delivers real-time data for controlling every facet of the operation—as well as more precise methods for adjusting configuration parameters with greater granularity than before.

Curtiss-Wright continues to support D.C. Cook through a yearly maintenance contract.

A Philosophy of Continuous Improvement

Neumann and his team are applying lessons learned from all of the previous digital upgrades to determine the best way to extend the life of various plant systems and to be as efficient and economical as possible with future upgrades. "We have to think about how we can get the most longevity out of these systems," Neumann says. "This will most likely include newer industrial computers that don't have any moving parts. We also want to make R*TIME and RTP more efficient—to harden the system to get as much life out of it as we can. For example, with the annunciator, we are considering an architecture that is similar to what we did with RCI, in which the panels are fed directly from the RTP chassis, or possibly a different PLC," he says.

The team plans to modify configurations of systems, including the annunciator system, during planned refresh projects. "As a station we need to assess the strengths of each software and hardware platform when implementing digital modifications," Neumann concludes. "This includes revisiting old systems to improve them if necessary. We need to find the right balance so we can get the most value out of our technology assets."

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