The U.S. Department of Energy's Light Water Reactor Sustainability Program, led by Idaho National Laboratory, works closely with utilities to improve outage efficiencies and enable nuclear to go "toe-to-toe economically" with other energy sources.

The Race for Outage Efficiency

By Eric Williams

There are numerous similarities between auto racing pit crews and the people in the nuclear power industry who get us through outages: Pace. Efficiency. Diagnostics. Teamwork. Skill. And safety above all else.

To Paul Hunton, a research scientist at Idaho National Laboratory, the keys to successfully navigating a nuclear plant outage are planning and preparation. "When you go into an outage, you are ready," Hunton said. "You need to manage outage time. You want to avoid adding delays to the scheduled outage work because if you do, it can add a couple million dollars to the cost."

Hunton was the principal investigator for the September 2019 report *Addressing Nuclear Instrumentation and Control (I&C) Modernization Through Application of Techniques Employed in Other Industries*, produced for the U.S. Department of Energy's Light Water Reactor Sustainability (LWRS) Program, led by INL. Hunton drew on his experience outside the nuclear industry, including a decade at Newport News Shipbuilding.

The LWRS Program is but one initiative by the DOE, its national laboratories, trade associations, and of course, the commercial nuclear power industry, aimed at modernizing nuclear power generation stations. For example, one group of nuclear utilities, the Utilities Service Alliance (USA), is working with the LWRS Program on a project on remote monitoring (more below), which was awarded through the DOE's U.S. Industry Opportunities for Advanced Nuclear Technology Development funding opportunity.

USA is a Kansas-based nonprofit co-op that facilitates collaboration between its eight member utilities representing 14 reactors and 15,000 MWe of generation. Its work is broader than addressing outages, explained John Christensen, president and chief executive officer. But downtime is always a major consideration.

"When you staff up for an outage, you bring in a whole bunch of fire watch personnel" to ensure work such as grinding metal doesn't spark a blaze, Christensen said. "Individuals conduct fire watches 24-7 during an outage." USA is working to automate that process by using advanced fire-detection sensors and automated methods to replace or augment manual fire watch activities—a project led by Talen Energy's Susquehanna Steam Electric Station.

Conducting fire watches is, of course, a task grounded in safety. Another core aspect of improving reactor operations is reducing costs, and INL's Bruce Hallbert believes making outages more efficient while maintaining safety is an important key to success.

While it's not exactly news, Hallbert, national technical director of the LWRS Program, said the fact remains that "We've got to be able to go toe-to-toe economically" with other energy generation technologies. The DOE is an equal-opportunity deployer, as evidenced by the agency's research on fracking playing a role in plentiful and inexpensive natural gas as well as its work on next-generation wind and solar technologies.

Of the multiple ongoing DOE-sponsored projects, two in the LWRS Program plant modernization area, Hallbert said, are particularly geared to address outage-related issues:

- **Advanced Remote Monitoring for Operations Readiness (ARMOR)** research is developing automated monitoring systems that gather data and detect process anomalies before something goes awry, in order to avoid forced outages. In one project, LWRS Program researchers collaborated with Cooper Nuclear Station (operated by USA member Nebraska Public Power District) to develop machine learning methods capable of detecting anomalies before they occur. The research showed that it is possible to use process data from components, coupled with machine learning, to detect deviations in fan-coil units days ahead of an actual failure.
- **Instrumentation and Control (I&C)** architecture modernization research provides specific ways to reduce operation and maintenance costs, improve operational performance, and maximize worker productivity through digitization of plant control systems. With collaborators Duke Energy and Honeywell Process Solutions, DOE researchers are developing effective techniques—including updating digital control system hardware while the plant continues operating—to reduce outage times for equipment modernization.


Cooper nuclear power plant

The need for technology transition

"Obsolescence" is a word nobody likes to use to describe their industry, and at the same time it describes an issue that nuclear must wrestle with to be cost-competitive.

"Many nuclear plants have focused on sustaining older technology to control costs and produce power," said INL's Hunton. "While this has worked in the past, legacy I&C system obsolescence costs and the lack of advanced labor-saving features are now threatening economic viability."

The DOE released its Addressing Nuclear I&C Modernization report in 2019. It notes that attempting to sustain the existing fleet by doing the same things with the same equipment "has created an institutional inertia within the nuclear industry I&C community that has constrained efficient application of non-nuclear OT [operational technology] in a way that hinders nuclear from realizing the benefits of these technologies as demonstrated in non-nuclear applications."

continued

Consider stopwatches, for example. USA's Christensen pointed to scenarios in which stopwatches have long been used, such as during LOOP (loss of off-site power)/LOCA (loss-of-coolant accident) testing.

"You announce 3-2-1 mark, and the switch is flipped to start the test," he said. People stationed throughout the plant to time critical elements of the test click their stopwatches on this mark. "Yet you don't realize how easy it is to double-click a stopwatch, and in some cases, if certain data are missed, you have to completely redo the test," Christensen said. "It sounds archaic because it is."

The work of USA and others takes on hurdles as basic as stopwatches and simultaneously grapples with broader changes needed to transform the industry.

"We're working from a more labor-intensive business model, based on older technology," Hallbert said. "We're unique in this way today, as other power generation sectors have made more complete technology transitions from analog to digital systems."

Making the transition from that business model and older technologies will equip the workforce to become more efficient and less reliant on manual efforts to accomplish work. This will enable plants to become more cost-competitive and sustainable in current and future energy markets.

Everyone involved, Hallbert said, is working toward sustainability with modern technology using the skills of a highly trained and tech-savvy workforce.

The quest for nuclear sustainability

For Clint Carter, the multifaceted drive for improvement is in concert with "Delivering the Nuclear Promise." The initiative—led by the Nuclear Energy Institute and launched in 2014—was designed, according to NEI, to "strengthen the industry's commitment to excellence in safety and reliability, assure future viability through efficiency improvements, and drive regulatory and market changes so that nuclear energy facilities are fully recognized for their value."

Carter, who ran Luminant's groundbreaking Power Optimization Center and is now a loaned executive to USA in charge of fleet modernization, said sustainability is achieved by people deploying technology, not yielding to it. "Computers only do what humans program them to do," Carter said. "With that in mind, there is the opportunity to apply algorithms, computer code, and machine learning to allow us to see things, to see anomalous behavior we don't see now."

Broadly, that's the approach that flags deviations in fan-coil units at the Cooper Nuclear Station days ahead of failure.

"When we identify some anomalous behavior, we apply human expertise to figure out what that was. We then take that learning and fold it into the algorithm," Carter explained. "Over time, the intelligence and capabilities of that machine learning advance, and we improve operational efficiency while maintaining safety."

Hallbert said that much like a high-performance auto racing pit crew, various sectors of the nuclear community working cooperatively to achieve competitiveness—always toward the same goal—will ensure success.

Eric Williams (haukcc@yahoo.com) is a contract science writer for INL.