New Software Helps Diagnose Nuclear Plant Issues Before Problems Occur

Nuclear plant managers can make better informed decisions about the upcoming needs of their plants with new diagnostic software tools from EPRI.

Diagnosing potential problems at nuclear plants can take significant time and plant resources. Several companies, including Exelon and Duke Energy, are piloting EPRI's Fleetwide Prognostics and Health Management (FW-PHM) suite software. This cutting-edge technology, scheduled for full release in the second quarter of 2014, can significantly reduce the time it takes to diagnose problems, allowing system engineers to focus their time on solving them.

The Need for Faster Diagnostics and A Formal Problem-Solving Process

Advanced Pattern Recognition (APR) technology was developed in the 1990s to identify plant anomalies at an early stage, and nuclear utilities have adopted the technology with great success. But because APR technology still requires plant experts to first diagnose the problem, plant engineers and operators spend valuable time on data collection and fault diagnosis. Explains Rick Rusaw, senior project manager at EPRI, "The process of determining what is causing the problem can take days or weeks. You can't repair or solve the problem until you know what is causing it. Meanwhile, the damage can accumulate quickly."

Moreover, most nuclear plants do not have an automated learning structure in place for capturing the experience gained while troubleshooting and then solving problems. As a result, repetitive issues can often go through the same lengthy diagnostic process again and again.

Test Sites Key to Software Development

Informed by input from participants in EPRI's Fleetwide Monitoring Interest Group, Rusaw led an effort to create an automated monitoring diagnostic engine that could identify and diagnose problems. EPRI has been supporting and developing monitoring technologies for nearly 20 years, and nuclear plants involved in EPRI's research have invested in the necessary infrastructure to support advanced monitoring software.

Building new software for the nuclear industry is a lengthy process. The FW-PHM application first underwent independent testing by the U.S government's Idaho National Laboratory. Next, the prototype was installed at several nuclear facilities in a joint EPRI and Idaho National Lab pilot project. [A video describing the software is available on EPRI's [YouTube channel](#).] These pilot applications will help EPRI determine additional modifications to the software suite. For instance, some utilities would prefer manual installation for security reasons, rather than the automated installation that is currently available.

The software is supported by an "expert knowledge" database maintained by EPRI. To help populate the database, each utility participating in the project chose a different major equipment

Duke Energy's Fossil Maintenance & Diagnostics Center in Raleigh, NC. Photo courtesy of Duke Energy.

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~ Bernie Cook, *Duke Energy*

area for the software's application. At Exelon's Braidwood Nuclear Station, the software was installed for the health management of the plant's emergency diesel generators. At Duke Energy's Harris plant, the software was applied to the generator step-up transformer. Electricite de France and Luminant are also participating in the project.

"The addition of real-time diagnostic and prognostic capabilities will significantly advance our M&D center's ability to detect equipment anomalies and predict failures," says Bernie Cook, director of maintenance and diagnostics for Duke Energy's Power Generation-Central Engineering Services. "In addition, everyone in the industry will benefit from everyone's experience as we start to expand the fault databases."

A Smarter Tool for Better Decision Making

Advanced monitoring is designed to identify plant issues at an early stage and perform diagnostics at the source. The FW-PHM suite software allows nuclear plant managers to make better informed decisions about their plant's needs. For example, an unusually high temperature reading for a pump or motor bearing can be the first sign of equipment problems, but when corrected promptly, extensive damage can be avoided. The software notes the high temperature reading automatically and alerts the user to the possible problems causing that condition. The software then interacts with the user to establish the other information needed to determine which of the possible problems must be corrected. To that end, the software suite can:

- *Mitigate equipment failures.* By proactively enabling the plant staff to anticipate and avoid potential equipment issues, the tool helps mitigate problems that could limit plant production or reduce asset remaining useful life.

- *Improve reliability and productivity.* The tool helps develop troubleshooting plans for the plant that can be used until the fault can be remedied. The tool continues to ask questions as new information is presented, helping the plant engineer determine the most important information to gather next.

- *Create a more formal record of the diagnostic experience.* When a systematic cause is determined, plants can change their response so that the problem doesn't continue to occur.

- *Vastly expand knowledge.* Through continuous database development, the software learns more every time it is used. Although each plant has its own monitoring center, EPRI will collect the new troubleshooting information from the plant experiences and their centers, compile the information and provide it back to all users.

- Boost plant health. By capturing the knowledge of experienced engineers – many of whom have been running their plants safely and reliably for decades – the tool helps provide continuous asset health management.

"The application is designed to capture the knowledge of experienced engineers and transfer it to junior engineers," explains Mohammed Yousuf, senior staff engineer at Exelon's nuclear headquarters in Warrenville, Ill. "The Prognostics and Health Management program will help us efficiently utilize our plant experts' time in data analysis rather than data collection. Exelon is looking forward to testing and finally adopting the technology for its nuclear fleet."

The Basics of the Software

The Web-based FW-PHM software suite includes:

- Diagnostic Advisor – Identifies impending failures by comparing asset fault signatures with operating data

- Asset Fault Signature Database – Organizes asset fault signatures collected from across the industry for each asset type

- Remaining Life Advisor – Provides risk-informed estimates of how long an aging or faulty asset will continue to provide reliable service

- Remaining Useful Life Database – Organizes asset remaining life signatures collected from across the industry

Associated Material

- FW-PHM Suite Software – May 2013 Release
  EPRI Product No. 3002001490

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