SUCCESS STORY

EPRI NUCLEAR DATABASES DELIVER BENEFITS TO POWER PLANTS

EPRI members are increasingly benefiting from EPRI databases, including the Fuel Reliability Database (FRED), Steam Generator Degradation Database (SGDD), and Chemistry Monitoring and Assessment (CMA) database. Synergies between these databases promise to unlock significant future value.

DATA SHARING ENHANCES INFORMED DECISION MAKING

Fast, secure and straightforward sharing of comprehensive, pre-compiled data helps nuclear plants make informed decisions that can have significant impact on their bottom line.

“Aristotle said that the whole was greater than the sum of its parts, and we definitely see that with three EPRI nuclear databases,” explains Brenden Mervin, technical leader for EPRI’s Fuel Reliability Program. “We have created user-friendly, web-based platforms for easy access and control of data from our FRED, CMA, and SGDD databases. What’s more, we’ve recently coupled the databases to automatically share data to reduce duplication of utility users’ efforts, enhance overall accuracy, and provide multi-disciplinary datasets that are capable of delivering value above and beyond the goals of each dataset on its own.”

Figure 1: Trending comparison of plants operating without grid-to-rod fretting (GTRF) failures alongside the percentage of plants that have implemented fuel designs which are considered GTRF-resistant.
The data within EPRI’s databases is used to develop and support industry guidance, advise research and regulation, and provide fleet-wide reliability trends. It helps inform industry action plans to enhance and maintain a level of excellence in nuclear reactor reliability, performance and safety.

**FRED-RELATED SUCCESS**

More than 10 years ago, EPRI released the Fuel Reliability Database (FRED) to serve as a single location for comprehensive fuel reliability and performance information that members could view and query on command, and support event-free nuclear fuel performance through timely industry-wide sharing of ongoing and historical data and events.

Over the years, FRED data has provided the foundation for several EPRI products, including an overall analysis of fuel reliability data, assessment and inspection guidelines for plants, a review of fuel failure trends and diagnostic processes, and guidance related to foreign material-related fuel failures.

“The immense amount of information available in FRED helps members throughout the industry evaluate fuel and related system component performance and reliability issues,” explains Mervin. “And now, the behind-the-scenes conversation between FRED and CMA means users don’t have to enter chemistry data twice. Once it’s in the CMA database, it is automatically shared with FRED.”

Exelon, a key FRED contributor from the outset, provides one recent example of how FRED and CMA enabled fleet-wide investigation of fuel reliability trends. “To better understand fuel failures that we were experiencing at Exelon, our team used data from FRED to assess debris failures across the entire U.S. fleet,” said Phil Wengloski, Exelon’s Director of Fuel Design Technology. “We wanted to see which factors were common among plants and find out how Exelon’s failure rate compared with the rest of the industry. Having ready access to current data was key to our success, and EPRI personnel were extremely helpful as we reviewed, parsed, and analyzed the data.”

Access to fleet data helps companies like Exelon better understand current and past operating experience and determine the right actions for their specific plant types. “Being able to review and process prior assessments has the added benefit of focusing the future inspections on either areas of concern or areas where there may be a distinct lack of data,” Wengloski explains. “With the complexity of arranging and scheduling fuel inspections, it’s imperative that we use all available resources to optimize the inspection plan. Additionally, review of the data may justify the extension of an inspection window that avoids expenditures of resources and dose.”

To help ensure the overall success of FRED, utilities must deliver timely and accurate data entry into the system. Exelon’s Wengloski notes that his company’s initial experience with the integrated FRED and CMA databases has been positive—saving time and effort.

“It has optimized data entry and our data stewards are more comfortable with the process,” he states. “Having the data extracted from an existing database helps ensure accuracy and relieves a burden from the FRED administrator.”

**AS OF 11/20/2019, THE FRED DATABASE CONTAINS:**

- **2,209 cycles of fuel reliability data**
- **Equivalent to more than 2,900 years of operating experiences**
- **From 105 PWR plants and 66 PWR plants**

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Figure 2. Analysis of debris-induced failures, comparing boiling water reactor (BWR) plants with pumped-forward and cascading drain types
Exelon’s experiences are just one example of the industry-wide return on investment that can be seen from collaboration and data sharing via FRED. Alongside several key Fuel Reliability Program guideline documents, it can help member plants save millions of dollars in unnecessary inspections and risk/margin assessments. Moreover, the identification of adverse trends related to fuel failures can produce additional millions of dollars in savings across the industry.

**SGDD-RELATED SUCCESS**

EPRI’s Steam Generator Degradation Database (SGDD) allows for web-based collection, storage, and reporting of relevant information that contributes to safe and reliable steam generator operations. Data from SGDD helps inform decisions regarding inspection scope, tube repair activities, and the effectiveness of steam generator corrective actions, such as chemical cleaning.

Exelon recently turned to the SGDD to help prepare for an inspection outage of the steam generator tubes of its Braidwood 2 pressurized water reactor (PWR), in Illinois, to verify tube integrity and help prevent primary-to-secondary leakage. Eddy current—the primary inspection method—can detect flaws in tubes before leakage occurs. When large flaws are detected, an equipment- and personnel-intensive in-situ pressure test can determine if the flaw exceeds the plant’s NRC-approved technical specification limits.

“Rather than making a costly, overly conservative outage plan or relying solely on expert opinion, Exelon decided to analyze data from the SGDD to make a more informed decision,” said Brent Capell, senior technical leader for EPRI’s Steam Generator Management Program (SGMP). Lee Friant, Exelon’s senior staff engineer responsible for the fleet’s steam generators explains, “Pre-mobilizing the in-situ pressure test team adds a great deal of cost to the outage, and if it turns out that the team isn’t needed, there is no return on that investment. On the other hand, if we don’t activate the team ahead of time and end up needing them, we’ll add extra expense and time to the outage. For our upcoming outage we decided to base our decision on actual historical data available in EPRI’s SGDD.”

The Exelon team studied industry-wide data related to its specific PWR model to provide a data-driven risk evaluation of the probability that an in-situ pressure test team would be needed during the outage. “Our analysis indicated that by not mobilizing the team on site, we will avoid paying the full $74,000 mobilization cost for an outage planned for early 2020,” said Friant.
CMA-RELATED SUCCESS

Initiated in 2006, EPRI’s Chemistry Monitoring and Assessment (CMA) database provides a single-source chemistry archive to support the development of various water chemistry programs, including managing and controlling radiation fields, enhancing materials and fuel performance, and improving steam generator reliability.

“This industry-wide CMA database helps EPRI continue to strengthen and improve our water chemistry guidelines as well as benchmark standards for chemistry operations,” explains Nicole Lynch, project engineer for EPRI’s Nuclear Fuels and Chemistry program. “And, it provides insight for our members as they tackle their specific water chemistry challenges. One study recently conducted by EPRI member South Texas Project (STP) looks at the effects of condensate oxygen concentration on corrosion product transport to the steam generators.”

To help maintain steam generator performance and integrity, it is important to minimize corrosion product formation in balance of plant components and subsequent transport to the steam generators. Additionally, high concentrations of dissolved oxygen have been shown to accelerate stress corrosion cracking (SCC) and intergranular attack (IGA) in steam generator tubing materials. EPRI’s PWR Secondary Water Chemistry Guidelines place limits on dissolved oxygen that is allowed to enter steam generators.

“We know that very low concentrations of dissolved oxygen in the condensate system can increase the transport of corrosion products to the steam generators,” explained Iain Duncanson, STP’s Chemist. “When our engineer, Coleton Teplicek, an expert on ferric ammonium citrate, introduced the idea of a potential condensate system modification that could help with this problem, we used data from EPRI’s CMA database and SGDD to review condensate chemistry experiences of other plants to evaluate changes we plan to make in 2020.”

Specifically, STP wanted a quick rundown of how the PWR industry controls condensate pH and dissolved oxygen levels, as well as which plants run with copper alloys in their condenser tubes or tube sheets. The team used CMA and SGDD data to provide industry benchmarking and plant material usage input to bound its chemistry evaluation.

“Ultimately, we are designing a modification that allows for increased oxygen in the condensate system while a deaerator reduces the oxygen levels that enter the steam generators,” said Duncanson. “Our goal is to cut costs by decreasing overall corrosion product transport while still maintaining sufficiently low levels of oxygen to ensure the risk of SCC/IGA in the steam generators is minimized.”

THE PROMISE OF SYNERGY

Data-driven decision making (3DM) becomes increasingly powerful when more data can be cross correlated. The three databases—FRED, SGDD, and CMA—all serve specific customers but the ability to link the databases to understand trends will improve even more with the connections now in place. For example, it will be possible to look for changes in chemistry that have impacted fuel reliability and how they impact steam generator inspections. This is the essence of the synergy now possible using these EPRI databases. Another added benefit will come from linking data back to the technical area in which it originated, and not having multiple independent copies of similar data in different databases. The overall quality of the aggregate dataset improves significantly since more eyes are now focused on the same data point instead of three different data points. Having high-quality data is an important prerequisite to enable 3DM.
# RELATED EPRI PRODUCTS

<table>
<thead>
<tr>
<th>Title</th>
<th>Product ID</th>
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<tbody>
<tr>
<td><strong>FRED</strong></td>
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<tr>
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<td>Analysis of Fuel Reliability Data</td>
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<td>Fuel Reliability Guidelines: Fuel Surveillance and Inspection, Revision 3</td>
<td>3002010738</td>
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<td>Boiling Water Reactor Fuel Reliability Monitoring and Failure Evaluation Handbook</td>
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<td><strong>SGDD</strong></td>
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<tr>
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<td>Steam Generator Progress Report, Revision 19</td>
<td>3002013120</td>
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<tr>
<td>Steam Generator Integrity Assessment Guidelines, Revision 4</td>
<td>3002007571</td>
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<tr>
<td>Steam Generator In Situ Pressure Test Guidelines, Revision 5</td>
<td>3002007856</td>
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<tr>
<td><strong>CMA</strong></td>
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<tr>
<td>Chemistry Monitoring and Assessment Database Web Application (CMA Web), Version 3.0</td>
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<tr>
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<td>3002010645</td>
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<tr>
<td>Pressurized Water Reactor Primary Water Chemistry Guidelines: Revision 7, Volumes 1 and 2</td>
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<tr>
<td>BWR Water Chemistry Guidelines (BWRVIP-190): Revision 1</td>
<td>3002002623</td>
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*Note: This reference will be superseded in September 2020 with the release of Version 6.0.

# FOR MORE INFORMATION

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