Nuclear Value Guide – NVG-014

Remote Monitoring and SMART Chemistry to Improve Plant Operating Efficiency

SUMMARY

EPRI research has supported the development of online monitoring technology for water chemistry at nuclear power plants, enabling reduced labor costs associated with sampling and analysis and with data entry for operating plant chemistry control.

To date, several nuclear plant owners have successfully adopted portions of this technology to automate certain portions of their chemistry monitoring. Additionally, an international nuclear utility has adopted the full complement of the technology and was awarded a 2024 Technology Transfer Award for innovative remote monitoring and SMART Chemistry applications. SMART is an acronym based on the following attributes:

Sensor-based

Monitoring

Analytics

Response

Technology

Applicability

All nuclear plant single sites, or fleets

Value

EPRI's demonstrated automation technologies represent the benchmarks used in nuclear power plant chemistry automation efforts.

EPRI Program

Chemistry and Radiation Safety

Background

Historically, the effort associated with monitoring water chemistry is labor-intensive and results in radiation dose accumulation. Automating these activities provides data more frequently and can support the adoption of data analysis techniques that improve and enhance automated equipment issue diagnosis.

EPRI's Role

EPRI research results provide example technologies used in operating nuclear plant demonstrations that, in combination, can fully automate the chemistry sampling, monitoring, and analysis involved in operating a power plant. These technologies can reduce operations and maintenance (O&M) costs, which make up a significant portion of nuclear plant expenses.

EPRI's Role (continued from page 1)

EPRI's remote monitoring and automation research focuses on:

- Wireless Sensor Networks: Enabling continuous monitoring of equipment like turbines and valves, replacing periodic manual inspections. For example, vibration sensors can provide early warnings of mechanical issues.
- Distributed Antenna Systems: Improving wireless communication within thick-walled nuclear facilities, enabling real-time data transmission.
- Digital Tools for Maintenance: EPRI has developed interactive 3D apps and virtual training tools to help workers understand and maintain complex components more effectively.

EPRI's SMART Chemistry program supports the automation and optimized monitoring of water chemistry in nuclear power plants to facilitate:

- Materials integrity: Preventing corrosion and degradation of reactor components.
- Fuel reliability: Protecting fuel cladding and optimizing performance.
- Worker safety: Reducing radiation exposure from activated corrosion products

In working with an international member, EPRI developed a business case evaluation of the automation implementation. Considerations included the cost of installation of the technologies, the resulting labor savings, and impacts upon enhanced issue notification and diagnosis. The evaluation (EPRI report 3002020440) also considered situations of "avoided costs" where automation and enhanced issue diagnosis leads to mitigation or elimination of costs due to lost power generation.

Value

Of the nuclear plant owners that have successfully used the EPRI guidance in the implementation of chemistry automation technology, all have recognized savings in labor costs as well as benefits related to issue identification and diagnosis.

EXAMPLE

At one international nuclear plant, an intelligent system was developed to monitor and diagnose chemical conditions in real time. By using more than 300 signals, this system replaced manual processes, enhanced data accuracy, and reduced labor costs by $220,000 annually.

The same plant also applied EPRI's SMART Chemistry research to develop and implement its own SMART Chemistry project, incorporating advanced technologies such as online ion chromatography.

This application has set benchmarks for automation and intelligence in nuclear operations, further promoting efficiency and safety and improving power plant quality. By applying this technology, the problems of low efficiency and human error management caused by manual supervision and control were solved and unnecessary manual intervention time and human error probability were reduced, along with the risk of power reduction or even shutdown.

Collectively, these innovations have lowered power reduction risks, improved operational efficiency, and enhanced safety across multiple facilities, setting new benchmarks for operational excellence, scalability, and sustainability in the nuclear industry.

Resources

- 2024 Technology Transfer Award, *Innovative Advances in Chemistry and Radiation Safety Realized through Remote Monitoring and Smart Chemistry Applications at CNNP*
- 3002002455, *Nuclear Power Plants Optimize Water Chemistry with EPRI Software*
- 3002014085, *SMART Chemistry Demonstration Skid Design*
- 3002014377, *SMART Chemistry Quick Guide: Online Ion Chromatograph*
- 3002015805, *SMART Chemistry Quick Guide – Steam Generator Blowdown Monitoring Automation*
- 3002020440, *Plant Modernization Business Case: Automated Chemistry*
- 3002020441, *SMART Chemistry Plant Demonstrations*
- 3002023121, *SMART Chemistry Quick Guide: Online Boron Analysis*
- 3002023964, *SMART Chemistry Quick Guide: Data Trending/Evaluation/Transfer*
- 3002023965, *Online Coolant Isotopic Monitoring: High Purity Germanium Demonstration at Monticello Nuclear Power Station*

IMPLEMENTATION GUIDANCE

The related EPRI research and development (see Resources above) provides the details required for selecting, installing, and operating these technologies, as well as the expected costs and savings related to the installation and operation of the technologies. In particular, the Quick Guides and Business Case Analysis can assist plant owners in evaluating the selection and placement of monitoring equipment, as well as in assessing the site-specific viability of SMART Chemistry technologies. Plant owners also may want to engage EPRI subject matter experts to assist in these evaluations.

Access Additional Value Guides and Examples of EPRI R&D Application:

https://interactive.epri.com/nuclear-value/p/1

Advanced Nuclear Technology

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