
Integrating Data Sources for Improved Safeguards and Accountancy of Electrochemical Fuel Reprocessing Streams

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ABSTRACT:

In April 2010, the U.S. Department of Energy (DOE) issued a report to Congress entitled, *Nuclear Energy Research and Development Roadmap*. One of the four objectives listed for the DOE's nuclear energy research and development activities is Objective 4: "Understand and minimize the risks of nuclear proliferation and terrorism." A vital area for further development is in characterizing and reducing the uncertainty in material accountancy measurements for electrochemical separations processes (commonly known as "pyroprocessing"). The ability to monitor actinide content within the salt serves an essential role both in determining departure from nominal operating conditions as well as providing a valuable tool for material accountancy, particularly under conditions that challenge conventional safeguards approaches.

We propose an innovative strategy of leveraging high-fidelity used nuclear fuel source terms within an electrochemical separations flowsheet with realistic performance models of candidate measurement systems as a means of better characterizing (and therefore reducing) overall uncertainty in safeguards decision-making. The proposed research will develop and evaluate data fusion methods for extracting actionable knowledge from a combination of traditional nuclear material accountancy measures with proposed online measurements, supporting the development of safeguards and security by design for advanced fuel systems.

Specifically, the proposed project will

- a) *enhance* an existing electrochemical processing safeguards model with a suite of simulated online measurements and assay test results including appropriate error and noise characteristics;
- b) *develop* a robust framework for integrating all available data streams to provide greater situation awareness for process monitoring and accountancy;
- c) *evaluate* the improvement in standard error of the inventory difference afforded by the integration of process data with traditional accountancy measures; and
- d) *demonstrate* the efficacy of this approach to simulations of normal and off-normal facility operation, including both benign (e.g., equipment failure) and malicious (e.g., material diversion) off-normal conditions.

The resulting framework will provide a robust tool to support the design of domestic and international safeguards of current and future electrochemical reprocessing facilities. Data fusion algorithms will provide a foundation for extracting actionable information from disparate measurements across an electrochemical reprocessing facility, directly supporting the MPACT Campaign's 2020 Milestone of a virtual testbed for domestic safeguards and security R&D.