



# MPACT

Materials Protection Accounting and Control Technologies

# Quarterly Newsletter

FY2026 | Q3

## PROGRAM MANAGER NOTE



Thanks for reading our quarterly newsletter! Please don't hesitate to drop us a note and say hi.

### Tansel Selekler

MPACT Federal Program Manager

*Happy spring & summer everyone! Personally, I am happy that the long and cold East Coast winter seems to finally be over. As temperatures are warming, it also feels like U.S. nuclear is thawing and starting to grow. I am excited about all the advanced reactor work that is underway along with the associated nuclear fuel cycle activities. We, here at MPACT, are doing everything we can to be responsive to this growth and support the nuclear technology innovators as they develop and build these advanced reactors. While our focus is on the front and back-end of the nuclear fuel cycle, it will take all our combined efforts to be successful.*

In our last newsletter, I talked about the technology R&D underway in FY26, including molten salt sampling technology, domestic safeguards performance models, and our four-part domestic safeguards education modules. In this newsletter, I would like to talk more about what our thoughts are for FY27. One of our biggest drivers, is thinking about how MPACT can most effectively help advance U.S. nuclear. We are a small program, which means that we need to carefully consider how to best apply our resources. By resources, I mean people. Our researchers from the national laboratory complex, industry, and universities are our most important resources. Without their ideas and dedicated efforts, there would be no MPACT program. Therefore, as we think about FY27 activities,

we will ensure that we listen to our researchers. We are also speaking with the U.S. nuclear industry. While this is an exciting time for nuclear, it is also a challenging and exceedingly fast-paced environment. No one feels this pressure more than the nuclear industry. Throughout these discussions, some common themes keep popping up such as the need to be able to support the rapid development and implementation of Material Control and Accountancy (MC&A) plans for new facility types and their successful defense to U.S. regulators. This means that we need to utilize our technical expertise to identify likely MC&A requirements and develop the necessary tools to meet those requirements. I would like to think about how we best identify the likely requirements and how we can shorten

## IN THIS ISSUE:

1 Program Manager Note

3 Principal Investigator Profiles: Amber Polke & Mark Scott

4 Technical Update Highlight: Automated Molten Salt Sampling for Pyroprocessing MC&A

5 Technical Update Highlight: PSMC Upgrade

## PROGRAM MANAGER NOTE CONTINUED

technology development times. There were books written in the 1990s and 2000s on how to develop products in half the time or shortening the product development cycle that were written before Advanced Manufacturing (AM), Artificial Intelligence (AI), or Machine Learning (ML). It is a new world out there and we need to embrace it! We also do not

Meanwhile, closer to MPACT's traditional capabilities, in FY27 we will continue to develop technologies to support MC&A for fuel fabrication and recycling. These advanced reactors will need fuel whether they are oxide, metal, or molten salt. The fuel fabrication facilities are all new with vast measurement technology needs. One

a better measurement technique. One thing is for certain, we do not want to constrain ourselves only to our traditional capabilities.

If I had to summarize our FY27 plans right now, I would say that we are looking to do the impossible; better, faster, and cheaper. However, I am a realist, and I know that we can only tackle

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need to do everything by ourselves. MPACT is not going to develop an AI for domestic safeguards, but we can develop strategic partnerships with those who can apply new tools to our technologies with the goal of reducing how long it takes to implement an MC&A plan. Clearly, we have a lot to think through, and we would appreciate any feedback on the topic.

of our continuing goals is to develop technologies to push real-time accountancy using cost-effective means. This does not always mean better radiation detectors (although a lot of times it does), sometimes it means better process monitors or sampling techniques. Sometimes it means cleaning up the bulk material to facilitate

one or two and will need to utilize partnerships and emerging technology to achieve the third.

**As always, thanks for reading our quarterly newsletter! Please don't hesitate to drop us a note and say hi, and don't forget to come visit us at this year's Global 2026 conference.**

## Principle Investigator Profiles



### Amber Polke

Amber Polke is a Principal Chemical Engineer in the Process Simulation and Safeguards Group at Argonne National Laboratory. She specializes in molten salt technology, safeguard sensors and sampling, and radiochemistry. Polke is recognized for her expertise in molten salt process monitoring, thermophysical property measurements, fuel salt qualification, and safeguards for pyrochemical reprocessing and molten salt reactors. At Argonne, Polke serves as principal investigator on high-profile projects, collaborating with industry, the Department of Energy's Office of Nuclear Energy and National Nuclear Security Administration, and multiple Argonne divisions. Dr. Polke also has light reactor experience as she worked as a radiochemist for Exelon's LaSalle Generating Station, where she led radiochemistry programs, ensured regulatory compliance, and managed effluent, environmental, and meteorological monitoring programs. Polke holds a Ph.D. in Inorganic Chemistry from Oregon State University (2017), and she earned her B.S. in Chemistry from Lewis University (2011). She also holds the title of Mom to Colin (6), Fiona (5) and Graham (2).

Under MPACT, she had led the development and deployment of the Automated Molten Salt Sampler used to extract salt aliquots for at-line and off-line analyses. The sampler was developed to use novel sample tube mechanisms to support rapid sample delivery to lower temperature/lower radiation areas for high-precision, non-destructive analysis. The sampler was successfully demonstrated at the Idaho National Laboratory's Hot Fuel Examination Facility in April 2026. Polke is currently fitting the sampler to a molten salt flow loop to improve the accuracy of analysis by enabling a larger cross section of bulk fluid. Polke is also currently developing the At-Line Integrated Analysis System (ALIAS) which combines multiple optical analysis methods for rapid near real-time sample analysis.



### Mark Scott

Mark Scott is a senior R&D engineer at Los Alamos National Laboratory (LANL) and leads the electronics and machine shop team in LANL's Safeguards Science and Technology group. He received a bachelor's degree in physics from Brigham Young University and a master's degree in nuclear engineering from Texas A&M University. Scott has more than 20 years of experience in technical nuclear forensics, nuclear nonproliferation, fuel cycle analysis, nondestructive assay and nuclear material measurement system development.

Scott's early career focused on technical nuclear forensics and reactor-related nonproliferation problems. His work included reactor and fuel cycle analysis, plutonium-production assessment, interpretation of nuclear measurement data, development of attribution tools and support for national security applications involving nuclear materials. He also spent three years in the Washington, D.C., area as a LANL technical liaison to the Defense Threat Reduction Agency and the Defense Intelligence Agency, helping connect laboratory technical capabilities with federal mission needs.

In his current role, Scott leads a multidisciplinary technical team that designs, builds, refurbishes and modernizes thermal neutron well detector systems for nuclear material measurement applications. His team supports multiple new detector builds and refurbishment efforts, bringing together detector electronics, mechanical design, machining, printed circuit board development, fabrication, testing and system integration. These systems are intended to improve reliability, maintainability and measurement performance for facility-relevant material accountancy and nondestructive assay applications.

Scott's work emphasizes practical engineering solutions that connect end-user needs with deployable instrumentation. His career combines hands-on technical depth in nuclear measurement systems with broad experience in nuclear forensics, nonproliferation analysis and applied R&D for national security missions.



## Automated Molten Salt Sampling for Pyroprocessing MC&A

MC&A for advanced nuclear fuel cycles requires accurate, timely, and representative sampling of process materials, especially in challenging environments such as molten salt electrorefiners. Traditional manual sampling methods are labor-intensive, hazardous, and often yield samples that do not accurately represent the bulk process material, limiting the effectiveness of off-line analysis for safeguards and process monitoring.

To address these challenges, Argonne National Laboratory has developed and deployed an automated molten salt sampling system designed for unattended, high-precision at-line characterization of reprocessing salt. This

system interfaces directly with electrorefiner (ER) vessels, enabling the extraction of representative samples while minimizing operator exposure and reducing statistical uncertainties in measurement.

The Automated Molten Salt Sampler utilizes a rapid tube sampling technique that combines vacuum and tube sampling. A vacuum-filled chamber is installed on the process vessel. During sampling, molten salt is drawn into the chamber and an aliquot is split into a sealed sample tube using a controlled two-step vacuum process. This approach eliminates the risk of overfilling, reduces sample inhomogeneity, and avoids the need for complex actuation mechanisms in high-

temperature, high-radiation environments.

The system, shown in Figures 1 and 2, was installed on an engineering-scale ER at Argonne and operated over a 24-month campaign, extracting 80 samples. Key parameters such as tube diameter and buffer tank pressure were optimized to achieve consistent sample masses (2–3 g) suitable for both at-line and off-line analysis. Off-line analysis using ICP-MS and ICP-OES confirmed that the samples were representative of the bulk salt, with uranium concentrations measured to within 0.05 wt% across multiple samples.

The system, shown in Figure 2, was also installed at INL in an electrorefiner in the Hot Fuel Examination Facility, shown in Figure 3. A sampling campaign was performed over 3 days, extracting 15 samples. The sampling campaign demonstrated that the sampler was easy to operate with

manipulators, able to pull reproducible sample sizes, and performed sampling faster than traditional methods, allowing for higher throughput. Three samples were saved for analysis and will be compared to traditional sampling methods to investigate which sample method provides more representative samples of the bulk electrolyte.

The automated sampler enables safer, more efficient, and more accurate MC&A for molten salt reprocessing. By facilitating at-line analysis and reducing the time delay for high-precision measurements, this technology supports real-time safeguards and process monitoring objectives.

*Reference [1]: Polke, A., "Automated Molten Salt Sampling of Reprocessing Vessels", Advances in Fuel Recycle, ANS Annual Conference, Chicago, 2025.*

**"Argonne National Laboratory has developed and deployed an automated molten salt sampling system designed for unattended, high-precision at-line characterization of reprocessing salt."**

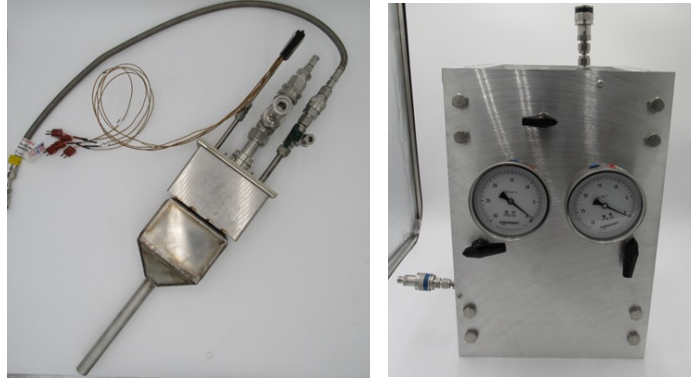
**Figure 1 – Automated Molten Salt System for engineering scale electrorefiner: vacuum filled chamber (left), charge tanks (center left), charge tube assemblies with mating couplers (center right), sampling line with three-zone heater (right) From ref. 1.**



# Technical Update Highlight



**Figure 2 – Automated Molten Salt System for hot cell electrorefiner: sampler(left), charge control panel (right)**



**Figure 3 – Collaborators from ANL and INL in front of the Hot Fuel Examination Facility during Automated Molten Salt Sampling testing. From left to right: Skyler James, INL; Austin Poole, INL; Amber Polke, ANL; Andrew Johansen, INL; Rodney Campbell, INL; Robert Hoover, INL; David Horvath, INL; Timothy Malewitz, INL; Cassie Anderson-Theuson, INL.**

## Plutonium Scrap Multiplicity Counter Upgrade

The Plutonium Scrap Multiplicity Counter (PSMC) is a high-efficiency thermal neutron well counter developed to measure neutron multiplicities from plutonium-bearing materials. The original PSMC design used 80 helium-3 tubes in a high-density polyethylene body and was developed for quantitative assay of plutonium in forms such as impure scrap and waste. Since its original deployment, the PSMC has remained an important example of high-efficiency neutron multiplicity counting for material accountancy applications.

Under MPACT, LANL and INL have completed a major refurbishment and electronics upgrade of a PSMC to extend the useful life of the instrument and improve its performance for modern material control and accounting applications. The work supports MPACT's broader mission to develop practical MC&A technologies that help U.S. nuclear fuel cycle technology developers address domestic safeguards requirements effectively and economically. The upgraded PSMC is intended to provide improved reliability,

improved maintainability and better performance at higher neutron count rates, where deadtime effects can limit assay accuracy.

A central part of the upgrade was replacing the legacy Amptek A-111-based electronics with LANL-designed KM-200 preamplifiers. The smaller KM-200 footprint allowed the number of amplifiers in the system to be increased to 42, reducing the number of detector tubes per amplifier and lowering the count-rate burden on each electronics channel. The KM-200 electronics also provides

faster response and improved pulse-shaping capability, helping reduce pulse pileup and double-pulsing artifacts that can affect high-rate neutron multiplicity measurements.

The completed refurbishment also modernized the internal electronics architecture. Instead of relying on extensive point-to-point wiring in the high-voltage junction box, the upgraded design uses printed circuit board assemblies to route high-voltage, signal and power connections more consistently through the detector. The final design includes thicker high-

# Technical Update Highlight



voltage PCBs, improved shielding around the KM-200 preamplifiers, linear 5-volt regulators, a harness PCB for signal and power distribution, optimized charge injectors for built-in testing and calibration, and mechanical guideposts to help ensure reliable pogo-pin contact. These changes were aimed at simplifying assembly, improving long-term reliability, reducing crosstalk and making the instrument easier to diagnose and maintain.



Figure 1 -Top: JAB-01 with Amptek A-111. Bottom: KM-200.

One of the most important new capabilities is an internal relay-based deadtime self-calibration concept. In this approach, detector signals can be redirected so that a measurement can be taken with a different amplifier loading condition. By comparing count-rate behavior under these conditions, the system can use the measured sample itself to help determine incident reaction rate and deadtime losses. This is especially valuable because traditional deadtime correction methods often rely on calibration sources that may not reproduce the count-rate, neutron-energy or correlation characteristics of the actual assay item. The upgraded system also supports list-mode acquisition, which provides a richer data stream for evaluating detector behavior, count-rate uniformity and future analysis approaches.

The hardware upgrade has now been completed, and the LANL/INL team is collecting the data needed to quantify the performance of the final system. Current testing is focused on stability, high-voltage plateau behavior, count-rate uniformity, linearity and validation of the relay-based deadtime correction method. A key remaining goal is to demonstrate how effectively the new relay concept determines deadtime compared with traditional calibration approaches. Those results will help define how the upgraded PSMC can be used for

higher-rate plutonium assay applications and how similar design principles could be applied to future thermal neutron well counters.

The team will present the upgraded PSMC work in a poster at the American Nuclear Society Global 2026 Conference in Chicago, INL in August 2026. After the performance data set is complete, LANL plans to publish a journal article describing the new PSMC capabilities, the final upgrade architecture and the measured performance improvements.

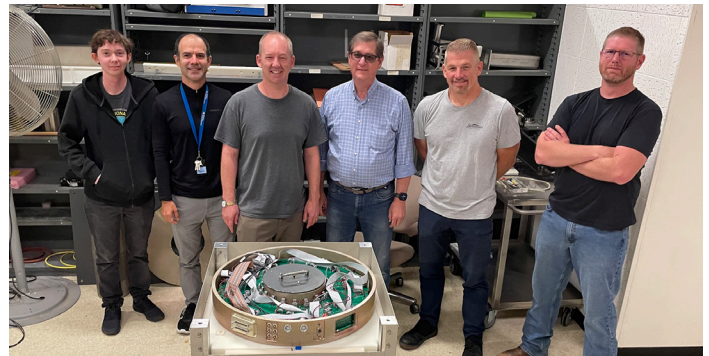


Figure 2 - PSMC Team from left to right: Victor Kelley, Metodi Iliev, Mark Scott, Dave Jones, Rob Natzic, Nick White

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*The MPACT newsletter is prepared by INL in coordination with all MPACT labs.*

Idaho National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratories, Argonne National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, Los Alamos National Laboratory.