# Integration of Nuclear Material Accounting Data and Process Monitoring Data for Improvement on Detection Probability in Safeguarding Electrochemical Processing Facilities

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**ABSTRACT:**

The KAERI advanced spent fuel conditioning process (ACP) process is a critical component of the US-South Korean nuclear cooperation and the following "123 Agreement." Its development has received considerable attention in both countries. The ACP is an electrochemical processing (pyroprocessing) that recycles over 96% of the used nuclear fuel (UNF). It is also intrinsically proliferation-resistant in theory. In normal operation, the U/TRU product is very hot radiologically. In addition, the Cm provides a high level of spontaneous neutrons, making the product unsuitable for weapon use. However, as pointed in some study, "the need for safeguards to protect against the diversion and misuse of separated plutonium applies essentially equally to all grades of plutonium." As pointed by many studies, the well-established traditional Nuclear Material Accounting (NMA) approach cannot be directly applied to electrochemical processing because of the lack of an input accountability tank, the non-continuous material flow, and the unsatisfactory level of confidence in sampling methods. Therefore, nuclear safeguards remain a grand challenge in the developing of commercial electrochemical separations facilities, especially around the heart of such facilities, the electrorefiner (ER) systems.

In contrast to NMA data, process monitoring (PM) data is normally an indirect measurement of the SNM and is acquired much more frequently. In a broad sense, PM includes monitoring by various types of equipment, e.g. radiation detectors, cameras, voltage, current sensors. Because it is already being collected by the operator, the additional cost to safeguards is low. It has long been believed that PM data can supplement NMA data and help improve safeguards, although the benefits are hard to quantify. The U.S. DOE's Material Protection, Accounting, and Control Technology (MPACT) campaign has made substantial investments into innovative PM sensor technology and predictive model development for real- or near real-time measurement and prediction of molten salt density and level, salt composition and actinide concentration especially Pu, the cell voltage, and the cell current to supplement traditional NMA. For aqueous-based reprocessing facilities, it is reported that PM, integrated with traditional NMA, have a high detection probability for specific diversions. For electrochemical reprocessing, preliminary studies have shown that PM data can support traditional NMA in various ways by providing a basis to estimate some of the in-processing nuclear material inventories. Despite early success, further studies on fusion of PM data and NMA data are still needed, which is the goal of this proposed work.