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Concepts for and Demonstration of Gamma-ray Process Monitoring for Reprocessing Facilities

Safeguards practices instituted by the International Atomic Energy Agency (IAEA) for reprocessing facilities address both techniques used for nuclear material (NM) control and accountancy (MC&A) and methods to maintain continuity-of-knowledge (CoK). Intense protocols have been developed to verify the declared composition and content of the NM solutions through Destructive Analysis (DA) performed on samples taken at Flow Key Measurement Points (FKMPs). A Solution Monitoring and Measurement System (SMMS) is installed across FKMP tanks to measure the solution density and volume. The results of these measurements are used to determine the operational status of the facility and for inspectors to verify quantities, maintaining CoK. To improve safeguards verification capabilities and to reduce the amount of time that IAEA inspectors are required to be at a facility, the Japan Atomic Energy Agency (JAEA) has been developing improved plutonium monitoring capabilities. One of these is a multi-scope concept to continuously monitor purified Pu and U solutions as well as spent nuclear fuel solutions by measuring the NM gamma rays (GRs) both at the solution tanks and along the transfer pipes. A demonstration of a GR pipe-monitoring concept was performed at the JAEA Plutonium Conversion Development Facility and confirmed that in-line solution monitoring enables both real-time flow measurements and Pu isotopic composition determination (of purified-solution batches) through passive non-destructive assay of the NM between FKMPs. The pipe-monitoring GR spectrum, flow-rate, volumes, and process timing would then be compared to similar measurements collected by established methods at the FKMPs to provide comprehensive CoK in an unattended, on-line mode. To further improve safeguards capabilities, a concept was developed to provide continuous composition verification by measuring the high-energy (>3-MeV) delayed GRs from short-lived fission products from fissile nuclides generated by neutron self-interrogation of the solution in the tanks. This paper will describe an overview of the JAEA gamma-ray process-monitoring concept, a summary of the pipe-monitoring demonstration, and the delayed gamma-ray development efforts and technologies to expand safeguards capabilities at reprocessing facilities.

Which ”Key Question” does your Abstract address?

NEW1.2

Which alternative ”Key Question” does your Abstract address? (if any)

NEW1.6

Topics

NEW1

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