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Combined Radiation Detection Methods for Assay of Higher Actinides in Separations Processes: Quarterly Progress Report: January-March 2006

Denis Beller
University of Nevada, Las Vegas

Warnick Kernan
University of Nevada, Las Vegas

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UNLV Transmutation Research Project Task 27
Principle Investigators: Denis Beller, Ph.D. and Warnick Kernan, Ph.D.

Purpose and Problem Statement

Monitoring of higher actinides (HA--includes neptunium, plutonium, americium, and curium) during the separation of used nuclear fuel has been identified as a critical research area in the U.S. Advanced Fuel Cycle Initiative (AFCI). Recycling of used fuel by chemically separating it into uranium, fission products, and HA would be the first step in this new fuel cycle. The Material Protection, Accounting, and Control (MPAC) are necessary for materials accounting, criticality monitoring, and assurance of proliferation resistance. The objective of the MPAC project is to develop technology to detect and accurately measure quantities of higher actinides in used fuel assemblies and processing systems without taking frequent samples. Process systems may include separations batches, pipelines, storage tanks, and fuel fabrication equipment. A variety of measurements may be combined to calculate flow rates of actinide elements with a to-be-determined precision.

In the MPAC project faculty and students will investigate the potential to use combined neutron and gamma-ray detector systems to measure quantities and isotopic constituents contained during separations and intermediate storage. This will require knowledge of the nuclear and decay characteristics of materials during processing, the development of conceptual designs of monitoring systems, radiation transport studies to develop an understanding of operational regimes, and experiments to confirm performance. In addition, both passive and active concepts will be investigated, including collaborations with the Idaho Accelerator Center (IAC) at Idaho State University (ISU) to use electron linacs for producing photoneutrons in situ, for photon activation of HA, or for stimulating emissions processes (e.g. x-ray fluorescence).

Personnel

Principle Investigator: Dr. Denis Beller (UNLV Mechanical Engineering)
Co-PI: Dr. Warnick Kernan (UNLV Physics and Remote Sensing Lab, Bechtel-Nevada)

Students: A new graduate student, Quinten Newell, joined the project in January. Quinten will focus on the design and analysis of a large neutron slowing down spectrometer for assay of entire fuel assemblies and/or fuel rods. Pavan Kumar Attur, Electrical and Computer Engineering Department, continues to test and upgrade the NMDS. Lawrence Lakeotes, a graduate student in Mechanical Engineering, is employed part time to conduct literature searches, concept development, and radiation transport studies. Mr. Brice Howard, an undergraduate student in

Mechanical Engineering, used MCNPX to model detector performance for measuring neutron emission rates and neutron multiplicity with actinide containing processes. However, he has taken a full-time position and has left the MPAC project.

National Laboratory Collaborators: Dr. Mark Schanfein (Safeguards and Security Group, Los Alamos National Laboratory) and Dr. James Laidler (National Technical Director Separations and Waste, Argonne National Laboratory).

DOE Collaborator: Dr. Thomas Ward (UNLV Russian Collaboration Science Adviser, TechSource, Inc.)

Summary Report for October-December 2005

The ^{3}He Neutron Multiplicity Detector System (NMDS) that was developed as part of Task 6, including a new data acquisition system (DAQS), has been transferred to the MPAC Project for use in radiation detection systems. The NMDS was re-configured for neutron multiplicity measurements and additional counting of a weak source as well as natural radiation was completed with both the old and new data acquisition systems for comparison. A new connector board was acquired to interface the remaining 32 detectors to the FPGA board, such that the entire NMDS can now be operated with either the Russian DAQ or the new high-rate DAQ. Comparison testing is ongoing.

Students continued developing concepts for combined neutron-gamma and passive-active interrogation systems using the NMDS. One of these is to use multiple sets of NMDS along a length of pipe containing "stream 16" of the UREX-3 flow sheet. Another is to develop a massive neutron-slowing-down spectrometer with active and passive neutron multiplicity measurements.

Technical staff from N-1 Safeguards Science & Technology Group, N-2 Advanced Nuclear Technology Group, and N-4 Safeguards Systems Group at Los Alamos National Laboratory visited UNLV to discuss ongoing and potential MPAC projects, to tour labs, and to meet with students.

Three students attended a MCNPX class at UNLV offered by Los Alamos National Lab.

Publications/presentations:

"The UNLV Neutron Multiplicity Detector System," T. Beller, D. Curtis, D. Beller, A. Rimsky-Korsakov, and T. Ward; *Proceedings of the Eighth Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation*, OECD/NEA, Paris, France, pp 687-698 (2005).

"Combined Radiation Detection Methods for AFCI MPAC Project," D. Beller, W. Kernan, M. Schanfein, T. Ward, A. Rimsky-Korsakov, F. Harmon, Q. Newell, L. Lakeotes, T. Beller, B. Howard, and P. Attur, invited, accepted for oral presentation at the Institute of Nuclear Materials Management 47th Annual Meeting, Nashville, Tennessee, July 16-20, 2006.