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Title: Project Overview: LA07-LAB072-PD02

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PROJECT Overview

WebPMIS Number	LA07-LAB072-PD02
Title	Final Report on Key Findings from Collections for Nuclear Materials Signatures Project at LANL
Years	2007-2011
Phenomenology	Solids - Particles
Fuel Cycle Stage	Pu Metal Production
Analytics techniques	SEM, ICP-MS, ICP-AES, Gamma Spectrometry, TIMS
Organizations (labs)	Los Alamos National Laboratory
Key Staff	Christy Ruggiero, Dan Schwartz, Lav Tandon
Summary	This project was a multi-year effort dedicated to interrogating Pu processing related particulate materials as the foundation for future signatures strategies providing insight into processing activities occurring within a facility. Emphasis was given to several operations (both mechanical and pyrochemical) as characterized for isotopic disruptions, trace elemental differentials, morphological distinctions and distribution of aerodynamic diameter.
Classification Guides	
Author & email	Floyd Stanley, Ph.D. floyd@lanl.gov
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References	• C. Ruggiero, D. Schwartz, L. Tandon. Final Report on Key Findings from Collections for Nuclear Materials Signatures Project at LANL. LANL Report LA-CP-11-00290. (2011). • L. Colletti, C. Ruggiero, L. Tandon. Effluent Source Signatures from Plutonium Reprocessing, Final Project Report. LANL Report LA-CP-14-20223. (2014).

PROJECT DETAILS

Goal: The goal of this project was to identify and characterize sources of plutonium processing signatures, and understand how fate and transport impact these signatures, with an emphasis on establishing a foundation for the use of aerosolized particle characteristics as indicators of historic and current activities within a facility. Targeted activities included: 1) Pu metal reprocessing via direct oxide reduction, 2) Breakout of α-phase and δ-phase materials, 3) CNC machining of alloyed, δ-phase Pu metal, and 4) Low speed cutting of unalloyed, α-phase metal and alloyed, δ-phase Pu metal.

Motivation: Historically, related morphological signatures efforts have been hindered on several fronts, including a limited knowledge base for data interpretation, availability of source collection comparators, and appropriate sampling guidance driven by previous trials/processing specific experience. The current effort sought to establish the basis of a usable particle-process signatures basis set and outline experimental methodologies address challenges noted above.

Technical Approach/Innovative Idea: The technical approach for this work centered upon particle collections of aerosolized Pu, using Marple cascade impactors, in conjunction with known operations at LANL's plutonium processing facilities and "pedigreed" materials available for characterization at all

stages of effort. Collected materials were subjected to a variety of analytical characterization methodologies, including inductively coupled plasma mass spectrometry and atomic emission spectroscopy, thermal ionization mass spectrometry, and scanning electron microscopy. Specific captured parameters included: 1) aerosolized mass, 2) aerodynamic diameter and distribution of resulting particles, 3) morphological properties such as aspect ratio and particle area, and 4) trace elemental differentials and isotopic disruptions, including chronometric relationships, arising from processing activities and correlating with separate characteristics. These features were considered in complement as potential identifiers of the employed process

Project Objectives: The stated key project objectives were directed towards addressing two central challenge questions:

1. Can particle signature data be used to determine the processing activities that may be currently occurring in an undeclared or unknown facility?
2. Can the presence of certain particles or particle characteristics indicate details of the processing activities that have historically occurred in an undeclared or unknown facility, and distinguish these from activities that are currently occurring?

Several supporting questions were provided to drive the objective of answering these challenge questions. These included:

1. Do production processes produce aerosol particles of value that can be collected?
2. Can accurate and meaningful chemical and isotopic analysis be performed on the samples of collected particles? If so, how do we get the best results from these analyses?
3. What chemical and isotopic data from the particle analysis are most useful for generating process signatures?
4. Can the results of the particle analysis be used to unambiguously relate the particles to the specific production process that generated the particles? That is, are there process signatures in particle characterization results?

Impact and remaining challenges: The central impact of the supported effort is proof of concept for the use of morphological signatures strategies in conjunction with specific Pu processing activities. Potentially exploitable, process dependent differences stated in the final report included: 1) total aerosolized material generated, including total Pu, 2) particle size and diameter distribution characteristics, 3) particle structure, 4) trace element distributions, and 5) isotopic content and chronometric relationships. The principal remaining challenge noted in this work is the wide variety of observable combinations potentially available for use in Pu production activities and the need to account for these possibilities comprehensively; authors suggested collection trials against all key operations in plutonium production from reprocessing through weaponization.

Outcomes: The summarized report precedes a follow-on project titled “Effluent Source Signatures from Plutonium Reprocessing” (LA11-PF4012-PD02). The goal of this subsequent work was to develop a signatures capability applicable to determining the operational status and history of a plutonium reprocessing facility, using the TA-55 plutonium facility at Los Alamos National Laboratory for controlled experimentation. The final project report (LA-CP-14-20223) for this effort was submitted as of 30-Sept-2014.