New Developments in the Nuclear Forensic Reference Material Program

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6th Workshop on Isotope Federal Supply and Demand

November 15, 2018

NFRM Program

- *Nuclear Forensics Reference Materials* are analytical standards, produced to assure the accuracy of nuclear and radiological material analyses that are performed for the purpose of measuring critical signatures that will aid in the determination of a material origin and/or identity.
- The National Technical Nuclear Forensic Center (NTNFC) within the DHS Domestic Nuclear Detection Office (DNDO) initiated a program to produce nuclear forensic RMs in FY 2008.
- DHS has enlisted metrology labs to coordinate the program (first DOE's New Brunswick Laboratory, then NIST). The production and characterization of these materials has been a collaborative effort between NBL, NIST, the DOE National Labs and international partners (Canada, France, Sweden, UK)

NFRM Program

- Primarily funded under the NTNFC's Technology Advancement portfolio.
- Oversight was through NTNFC program manager and Biannual CRM Working Group Meetings.
- Formation of Countering Weapons of Mass Destruction Office announced.
  - Jan 24, 2018 Memorandum from Assistant Secretary McDonnell
  - DNDO integrated into larger CWMD Office
- CRM Working Group → Sub working group of Forensic Capabilities Working Group.

NFRM Program

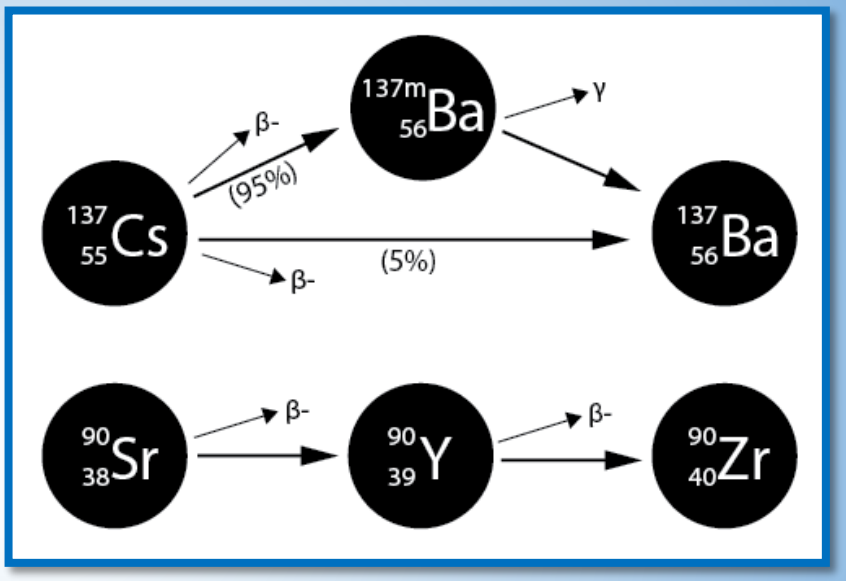
Reference Material	Status	Primary Use	Number of Units
CRM 125-A	NBL Certificate	U age and isotopics	146
NFRM 8611	Final Analyses in Process	Trace elements in Pu	100
NFRM 8612	Final Analyses in Process	Trace elements in Pu	100
NFRM Am-243	Complete	Am-243 IDMS spike	21
NFRM Ba-1	Characterization in process	Ba-134 IDMS spike	60
NFRM Cs-1	Complete (published values)	Cs-137 Age dating	185
NFRM Pa-1	Data Evaluation in Process	Pa spike calibration	110
NFRM Th-1	Complete (published values)	Th-229 IDMS spike	132
NFRM Pu-1	Final Analyses in Process	Trace actinides in Pu	150
NFRM Pu-2	Final Analyses in Process	Trace actinides in Pu	40
Pu-244 Tracer	Data Evaluation in Process	Pu-244 IDMS Spike	60
NFRM U045	NBL Report of Analysis	U isotopics	50
NFRM U-1	NBL Certificate	Trace actinides in U	118
NFRM U-2	NBL Certificate	Trace actinides in U	40
NFRM U-3-1	Data Evaluation in Process	Trace elements in U	180
NFRM U-3-2	Data Evaluation in Process	Trace elements in U	180
NFRM U-3-3	Data Evaluation in Process	Trace elements in U	180
NFRM U-233	Final Analyses in Process	U-233 IMDS Spike	80
NFRM U630 1-g	NBL Cert/Report of Analysis	U age and isotopics	44
NFRM U630 10-mg	NBL Cert/Report of Analysis	U age and isotopics	49

- Total Number of NFRM Units: 2025

^{134}Ba and ^{84}Sr IDMS Spike Reference Materials

Project Description

- Production of a highly enriched ^{134}Ba and ^{84}Sr isotopic spikes.
- Determination of spike assays and isotopic compositions.



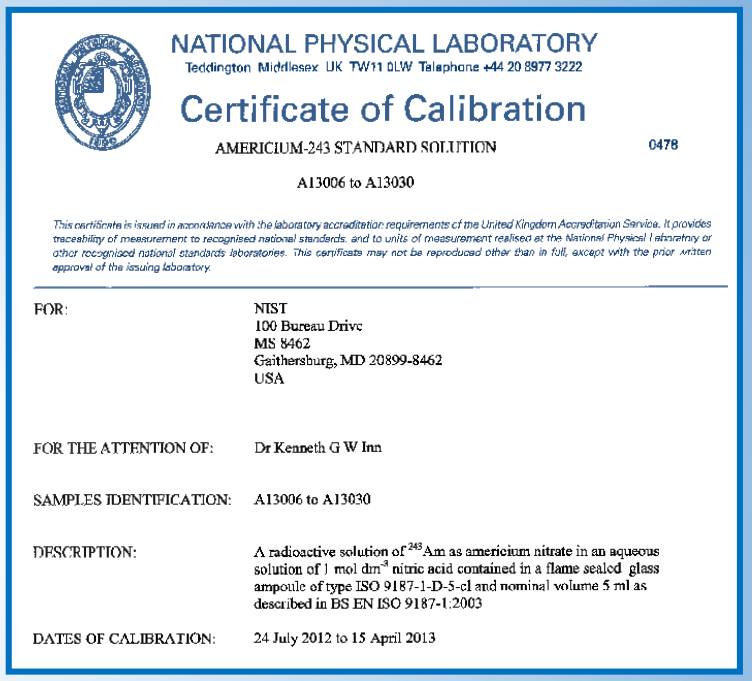
Purpose: Isotopic tracer for precision measurement of sealed source materials or daughter products.

Current Efforts: ^{134}Ba characterization measurements are in process and ^{84}Sr Project plan under development.

^{243}Am IDMS Spike Reference Materials

Project Description

- Highly enriched ^{243}Am isotopic spike.
- **^{243}Am Enrichment (99.998593 ± 0.000044)%**
- **^{243}Am Amount Content (0.3957 ± 0.0028)•10^{-9} mols g^{-1}**



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Certificate of Calibration

AMERICIUM-243 STANDARD SOLUTION 0478

A13006 to A13030

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

FOR:	NIST 100 Bureau Drive MS 8462 Gaithersburg, MD 20899-8462 USA
FOR THE ATTENTION OF:	Dr Kenneth G W Inn
SAMPLES IDENTIFICATION:	A13006 to A13030
DESCRIPTION:	A radioactive solution of ^{243}Am as americium nitrate in an aqueous solution of 1 mol dm^{-3} nitric acid contained in a flame sealed glass ampoule of type ISO 9187-1-D-5-cl and nominal volume 5 ml as described in BS EN ISO 9187-1:2003
DATES OF CALIBRATION:	24 July 2012 to 15 April 2013

Purpose: Isotopic tracer for measurement of ^{241}Am in nuclear materials - ^{241}Pu-^{241}Am-^{237}Np radiochronometry and trace actinide in U.

Current Efforts: NPL Project. Completed, waiting on revised certificate from NPL.

^{229}Th IDMS Spike Reference Material

Project Description

- Highly enriched ^{229}Th isotopic spike.
- **^{229}Th Enrichment (99.9566 ± 0.0010)%**
- **^{229}Th Amount Content (1.1498 ± 0.0016)•10^{-10} mols g^{-1}**

Purpose: Isotopic tracer for measurement of thorium in nuclear materials - ^{230}Th-^{234}U radiochronometry.

Current Efforts: Project complete. Materials recently repackaged.

^{231}Pa Calibration Material

Project Description

- High Purity ^{231}Pa calibration material.
- **^{231}Pa Amount per unit $(1.4592 \pm 0.0040) \cdot 10^{-10}$ mols**

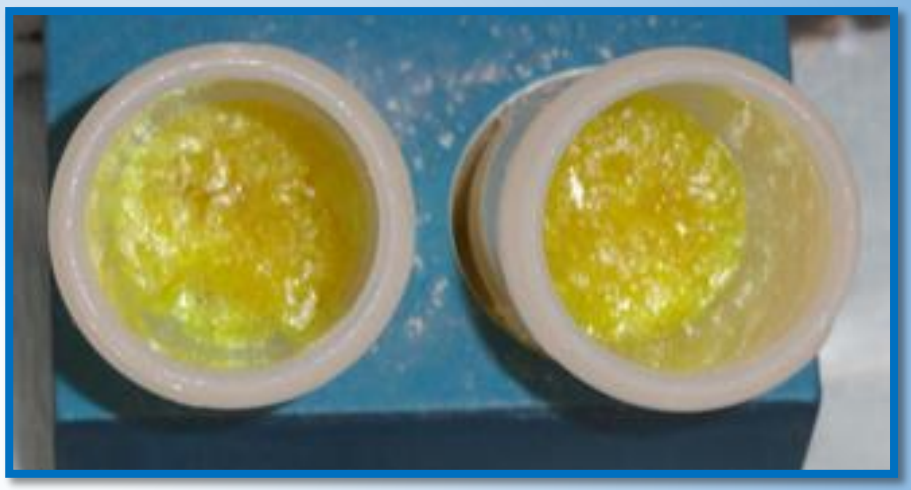
Purpose: Traceable calibration material for short lived ^{233}Pa spike used for - ^{235}U-^{231}Pa radiochronometry.

Current Efforts: Finalizing project report drafting manuscript.

Highly Enriched ^{233}U IDMS Spike Reference Material

Project Description

- Highly enriched ^{233}U isotopic spike.
- **^{233}U Enrichment (99.987375 ± 0.000027)%**
- **^{233}U Mass per unit (1.9891 ± 0.0022) mg**



Purpose: Isotopic tracer for precise measurement of amount and isotopic composition or trace quantities of U.

Current Efforts: Final verification measurement in process. Data evaluation and attribute values to be finalized.

^{244}Pu IDMS Spike Reference Material

Project Description

- Very highly enriched ^{244}Pu isotopic tracer.
- **^{244}Pu Enrichment (99.98502 ± 0.00019)%**
- **^{244}Pu Amount per unit (4.912 ± 0.012)•10^{-10} mols**

Purpose: Isotopic tracer for precise measurement of amount and isotopic composition or trace quantities of U.

Current Efforts: Finalizing project report drafting manuscript.

Potential Isotopic NFRM Projects

- Bulk ^{237}Np reference Material
  - High purity ^{237}Np oxide, >99.9% ^{237}Np
  - 100 mg Np per unit
  - Characterized for assay, isotopic, trace impurities

- ^{236}Np Isotopic Tracer Reference Material
  - > 90% enriched
  - Characterized for assay, isotopic, trace impurities

INL Isotope Separators

- NTNFC and FBI supported operation of limited isotope separation capability at Idaho National Laboratory.

- Two Electro-Magnetic Isotope Separators
  - 40 kV operating voltage, 1 meter radius, ~100 nA beam currents.
  - One configured for stable isotopes (produced 99% ^{134}Ba from natural Ba).
  - Second configured for radioactive isotopes (glove boxes for source and collector).

Conclusion

- The DHS-sponsored Nuclear Forensic Reference Material Program has produced a variety of analytical reference materials including several well-characterized isotopic tracers.
- These material were developed primarily to enhance measurement capabilities for nuclear forensics and nuclear safeguards.
- Units of reference materials are available to other USG users on a case-by-case basis.
- For more information contact DHSCRMInfo@hq.dhs.gov.