Recruiting and Training the Next Generation of Nuclear Forensic Scientists at the Savannah River National Laboratory

Brian W. Ticknor
Senior Scientist, High Sensitivity Measurement Technology Group, Savannah River National Laboratory

Presentation to CSIS: Project on Nuclear Issues
SRS and the Savannah River National Laboratory

SRS founded in 1950s to make plutonium and tritium ~310 sq. miles
- 5 operating production reactors
- 2 separation canyons
- Fuel fabrication
- Tritium facility
- SR Lab supported process development for the Plant (Site)
  - Also provided environmental monitoring research

Designated a National Laboratory in 2004
- 3 primary technical directorates
  - National & Homeland Security
    - Nuclear Forensics Analysis Center (NFAC)
  - Energy Security & Engineering
  - Environmental & Chemical Process
Nuclear Forensics Analysis Center (NFAC)

- Currently housed in the National & Homeland Security Directorate, NTS
  - Brings together chemistry, physics, engineering, oceanography, meteorology, nuclear engineering, biology, material science
- Funding from
  - DOE-NNSA
  - DHS/DNDO
  - FBI
- Goal is to provide information about nuclear materials
  - What is the material? What threats does it present?
  - Where did it come from? Domestic or Foreign source?
- NFAC scientists do NOT do Attribution (analysts do that!)
  - When and how was control lost?
  - Who are the bad guys?
Current SRNL Analysis Capabilities

Instruments

- Thermal ionization mass spectrometer (not in rad. labs) most sensitive
- Inductively coupled plasma mass spectrometer (2 clean 1 rad.)
- Underground counting facility (4 ultra sensitive gamma spectrometers)
- Alpha spectrometers
- Liquid scintillation spectrometry (beta)

Some sensitivities

- Detection of Pu down to a femtogram (1x10^{-15} g)
- Able to obtain full Uranium isotopics down to ~1 nanogram (10^{-9} g)
- Detect Cs-137 down to 1 picoCi (10^{-12} Ci)
Challenges to Nuclear Forensics Mission

“\textit{At present, personnel skilled in nuclear forensics at the national laboratories are too few and are spread too thinly. Furthermore, a substantial fraction of the experienced personnel are retired, now eligible for retirement, or nearing retirement age. The university pipeline produces too few people in needed specialties…}”

from: \textit{Nuclear Forensics: A Capability at Risk}, Committee on Nuclear Forensics; National Research Council (2010)

- Across SRNL, expected retirement of 2/3 of workforce within 10 years
- Significant impact on NFAC program
  - If not addressed, will diminish existing capabilities
  - Loss of accumulated knowledge and experience
- Currently, few programs exist to train next generation of nuclear forensic scientists
- Need to recruit new people and develop new training programs
What is SRNL doing to address these issues?

- Fostering university collaborations at both the undergraduate and graduate level
- Successful post doctoral research program
- Recruiting highly qualified scientists from variety of scientific disciplines and exposing them to nuclear forensic science
- Goal: expand the available scientific talent pool and bring expertise from various scientific disciplines to nuclear forensics
Nuclear Forensics Scholarships

**Sponsored by** U.S. Department of Homeland Security Domestic Nuclear Detection Office (DHS/DNDO)

- **Nuclear Forensics Undergraduate Scholarship Program (NFUSP)**
  - Introduces nuclear forensics as a career option for students studying physics, chemistry, nuclear engineering, and materials science
  - Hands-on experience through 9 - 12 week summer research program at national laboratories

- **Nuclear Forensics Graduate Fellowship Program (NFGF)**
  - Supports graduate student research, in collaboration with SRNL scientists, to develop new analytical tools for applications in nuclear forensics
  - Simultaneously provide nuclear forensics training to graduate students early in their careers

*SRNL is participating and looking for good students!*
Current SRNL Collaborations

- **University of Missouri**
  - Signature development to attribute Ir-192 sources
  - Background work being performed by NF fellowship student
    - Dissolution method development
    - Background contaminants
  - Use developed methods in SRNL Shielded Cells to analyze real source

- **University of Maryland**
  - Analytical method development - determination of rare earth element isotope ratios to attribute source
    - Separation and purification methodology being developed at U MD
    - Use developed techniques to analyze spent fuel samples at SRNL

- **University of Cincinnati**
  - Validation of methods used for nuclear forensics at the SRNL
    - Age dating of nuclear materials
    - Initial method validation and spike calibration being performed at the UC by Nuclear Forensics Fellow
    - Perform analyses at SRNL on archived materials to provide validation data to sponsors using SRNL equipment and facilities
SRNL Post Doctoral Fellowship Program

- Fellowships available in a variety of research areas, not limited to nuclear forensics
- Currently ~25 Post docs working across SRNL, with ~ 4 participating in the nuclear forensic effort
- Includes chemists, physicists, materials scientists, nuclear engineers, and others, engaged in experimental and modeling research
- Several scientists originally hired as post docs in other SRNL research areas have become permanent laboratory staff members supporting the NFAC mission
Bringing New Scientists into the Field… Recent Examples

- **Education**: B.S. in Chemistry, PhD in Materials Science
  - Post Doc at SRNL in Energy Security Directorate
    - no formal nuclear forensics experience
    - skill set and interests are a good match for many aspects of the work
  - **Currently**: Senior Scientist, material characterization of nonproliferation signatures which involves regular analysis with a wide variety of analytical instrumental methods

- **Education**: B.S. in Chemistry, PhD in Physical Chemistry
  - National Research Council Post Doc at the Space Vehicles Directorate of the Air Force Research Laboratory
    - No previous experience in nuclear forensics
    - Extensive training in mass spectrometry
  - **Currently**: Senior Scientist, using MC-ICPMS to measure isotopic signatures

- Mentored by a variety of scientists with expertise in the broad field of nuclear forensics, including nuclear chemists, nuclear physicists, and reactor physicists.
Conclusions

- Availability of future work force with appropriate training is a recognized problem in the nuclear forensic field
  - Impending retirement of significant portion of current work force
  - SRNL and NFAC capabilities will be affected
- Currently adopting measures aimed at minimizing impact
  - Through DHS/DNDO, sponsor Nuclear Forensic Scholarship programs in conjunction with university partners to support promising students
  - Continue successful post doctoral research program to attract and train young scientists in nuclear forensics
  - Recruit scientists from a variety of backgrounds who posses appropriate skill sets to maintain continuity as well as support future growth of the field