The Role of Nuclear Forensics Supporting Law Enforcement Investigations and Nuclear Security Vulnerability Assessments

David Kenneth Smith

Division of Nuclear Security

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What is nuclear forensics?

Nuclear forensic science, referred to as nuclear forensics, is a subset of forensic science.

Nuclear forensics is the examination of nuclear or other radioactive materials, or of evidence contaminated with radionuclides, in the context of legal proceedings under international or national law related to nuclear security.
Nuclear forensics is not a contingency plan……

**NOTE:** enrichments have not been independently verified for all seizures.
The evolving nuclear security threat ....

**Past**

- Wide use of nuclear and radioactive material
- Prevalence of radioactive sources
- Global transportation of NM and RM (incl. RS)

**Context**

- Insiders threat
- Growth of international terrorism
- Emergence of new adversary groups

**Future**

- Growth of cyber threats
- Organized smuggling networks
- Increased numbers of nuclear-capable or nuclear threshold States
- Emergence of additional nuclear staff
- Increased numbers of nuclear power plants in decommissioning stage
- Enlargement of amount and capacity of spent nuclear fuel storage
- Intensive development of civil nuclear programs in new-comer States
Nuclear forensics is one component of a nuclear security infrastructure.

Elements of a comprehensive national nuclear security infrastructure
Nuclear forensic capabilities support nuclear security response

Detection

Detection equipment, situational awareness

Categorization

Nuclear material (U, Pu) or other radioactive material ($^{60}$Co, $^{137}$Cs, $^{192}$Ir, ...)

Characterization

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An approach to the conduct of a nuclear forensics examination

- Incident Response
- Crime Scene Analysis
- Forensic Examination Plan
- Traditional Forensics
- Nuclear Forensic Analytical Plan
- Nuclear Forensic Analysis
- Nuclear Forensic Interpretation
- Nuclear Forensic Findings

Radiological Crime Scene Management

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Model Action Plan

**Nuclear Forensics**

- **Conduct of Operations**
- **Transport of Evidence**
- **Examination and Analytical Plans**

Iterative process: Analyses & Interpretation lead to Conclusions

- **Nuclear and Other Radioactive Material Analysis & Interpretation**
  - Traditional Forensics Analysis & Interpretation – radionuclides present
  - Traditional Forensics Analysis & Interpretation - no radionuclides present

**Radiological Crime Scene Management**

**Forensic Findings**
An array of forensic evidence can be examined.....

Traditional forensics
- Wax type
- Wax colorant
- Paper origin
- Lead metallurgy
- Lead isotopics
- Ampoule material

Nuclear material forensics
- Morphology
- Chemical form
- Impurity elements
- Residual radionuclides
- Age-dating
- U & Pu isotopics

Highly-enriched uranium (~3.96 grams uranium oxide)
Trace plutonium (2.8 parts per billion)
The IAEA does not conduct nuclear forensics examinations; we support state-of-practice of Member States. Focus on the security of nuclear and other radioactive materials only. Support criminalization for MORC. Promote development of the nuclear capacity within the Member States (model action plan, training, research, national library or database).
### Differences between processing traditional and radiological evidence at a nuclear security event

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<tr>
<th><strong>Traditional</strong></th>
<th><strong>Radiological</strong></th>
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<td><strong>Time</strong> - personnel typically have unlimited time to process the scene – <em>No Rush!</em></td>
<td><strong>Time</strong> - personnel must manage time spent on scene to minimize dose of radiation received – <em>Time Constrained!</em></td>
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<td><strong>Distance</strong> - personnel typically can get <em>as close as they wish</em> when collecting items or processing elements of the scene</td>
<td><strong>Distance</strong> - personnel typically must be <em>as far as possible</em> from items contaminated or potentially contaminated with radioactive material</td>
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<td><strong>Shielding</strong> - personnel typically require <em>minimal shielding</em> from the items that they are collecting or otherwise examining</td>
<td><strong>Shielding</strong> - personnel must use <em>physical measures to shield</em> themselves and others from any radioactivity</td>
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Using ALARA principle
Considerations to protect the public, the responders, the environment and the forensics evidence

- Establish scene control
- Perform common hazards risk assessment
- Reduce radiation hazards
- Maintain control over the nuclear and radiological material
- Preserve items of evidentiary value
- Implement forensics evidence collection plan
- Initiate chain of custody
- Collection, packaging, transit of evidence to the nuclear forensic laboratory
Confidence in findings

- Nuclear forensics analysis supports investigations that links suspects to MORC
- Laboratory analysis must be legally defensible
- Requires:
  - Written procedures and validated methods
  - Use of standards and certified reference materials
  - Trained personnel or demonstrated competencies
To conclude.......