The Importance of Technical Reachback in the Adjudication of Radiation Alarms

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Outline

- The worldwide concern over the possible terrorist use of nuclear or radiological material and weapons
- The increasing use of radiation detectors in Preventive Radiological/Nuclear Detection (PRND)
- The radioactive world
- Graded response to radiation alarms
- US PRND and technical reachback architecture
- Example incidents
- Summary

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Concern over possible terrorist use of RN material or weapons

- Bin Laden operatives reportedly tried to acquire fissile materials since 1993—clearly interested since early 1990s
- He has declared the acquisition of WMD a "religious duty"
- Willingness and intent to engage in mass destruction has been clear since the 1993 WTC bombing
- There are no insurmountable technical barriers to designing and building an IND
- Acquiring a ***sufficient quantity*** of weapon usable material is the key barrier

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The increasing use of radiation detectors in Preventive Rad/Nuke Detection (PRND)

- An increasing number of radiation detection systems are being deployed in the United States and throughout the world
- The primary purpose of these systems is to detect illicit radioactive material that could pose a threat
  - They have also proven helpful in detecting health/safety hazards (e.g., contaminated foodstuffs, orphan sources in scrap streams)
- Potential threat and health/safety risk materials are a miniscule fraction of legitimate, benign radioactive material movements
- To recognize genuine threats and expeditiously resolve benign radiation detection events, we must thoroughly understand the world “the way it is” with regards to radioactive materials in commerce

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The Radioactive World—causes of detection alarms

- Naturally occurring radioactive materials (NORM) including Technologically Enhanced NORM (TENORM)
- Legitimate industrial/medical/scientific sources in transit
- Radiopharmaceuticals in patients or in waste
- Contaminated items or loss of control (typically orphan sources in scrap)
  - Accidental
  - Dumping/circumvention of statutes
- Souvenirs (radium-dialed clocks, altimeters, etc.)
- Equipment malfunction/detector interference/human error
- Possible nefarious illicit nuclear/radiological trafficking

USA TODAY Business Standard

Radioactive steel dulls engineering exports to Europe

Govt convenes meeting after contaminated containers land in Germany. Fresh cases of radioactive steel in exports to Europe,

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Radioactive material shipments are common

- There are about 3 million packages of (DOT-regulated) radioactive material shipped annually, just in the U.S.
  - This is a small fraction of the approximately 400 million packages of hazardous materials shipped annually in the US.
- U.S. radioactive shipments can be grouped into the following categories:
    - Industrial isotopes
    - Nuclear medicine isotopes
    - Nuclear fuel cycle materials
    - Nuclear waste
    - Government (DOD/DOE) movements

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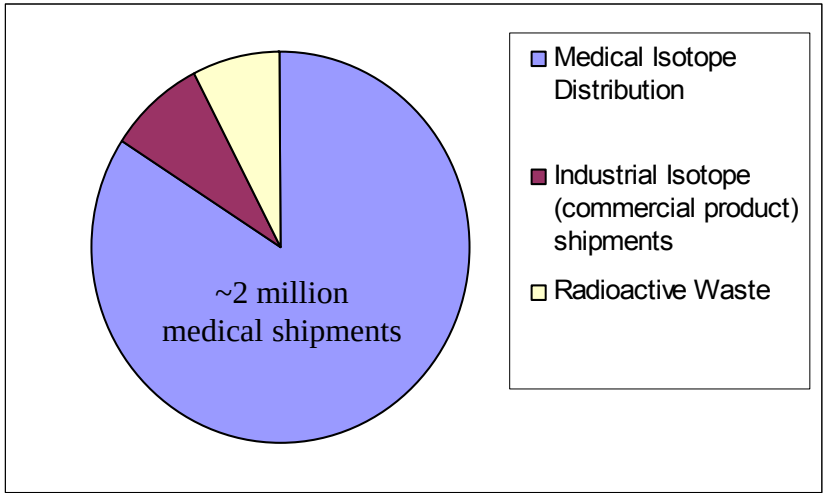
Types of radioactive material in commerce

- Number of shipments is dominated by medical isotopes

- The vast majority of radioactivity in shipments is due to imported Co-60 for use in industrial irradiators



All industries have a "life cycle" involving few shipments of high activity, and a much higher number of shipments of lower activity to (and among) end users

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Seizures and illicit trafficking

- Only about 15 illicit trafficking incidents have involved *seizures* of a noteworthy quantity of weapon usable nuclear material (WUNM)
- There have been many hundreds of seizures of
  - Natural, depleted or low-enriched uranium (non-WUNM)
  - Ionization sources with microgram quantities of plutonium
  - Other radioactive sources (not uranium or plutonium)
- There have undoubtedly been thousands of incidents (including the seizures above) where buyers or sellers claimed access to or interest in genuine weapon usable nuclear material

Incidents involving genuine WUNM are unusual, even in known illicit trafficking incidents, making high confidence determination of incidents of concern that much more difficult

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Graded response to radiation alarms

- The world abounds with radioactive material—detectors will alarm
- The vast majority of these alarms are innocuous in nature, but the consequences of a “false negative” could be enormous
- This reality calls for a rigorous but graded approach to adjudication and appropriate response
- Easily identified and “low concern” alarms can generally be resolved quickly and locally by personnel at the detection site
- Identifications or context that generate concern can be escalated, using a technical reachback capability that applies additional expertise and technology to resolve the alarm

The U.S. utilizes a National Reachback system

- Utilizes two tiers of spectroscopic experts from U.S. laboratories
  - Regional
  - National
- In support of the Department of Homeland Security, the DHS Domestic Nuclear Detection Office and its Joint Analysis Center utilize nuclear smuggling and nuclear threat assessment expertise from the DHS Nuclear Assessment Program to coordinate and integrate
    - Spectroscopic analysis
    - Nuclear smuggling, R/N threats, potential WMD terrorist groups, etc.
    - Other subject matter experts as needed

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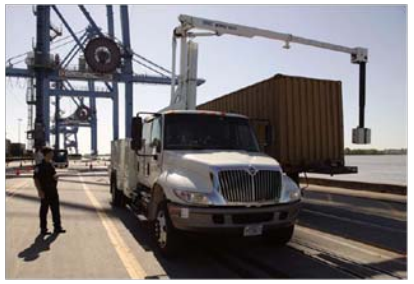
Example DHS national reachback response

- An alarm occurs at a U.S. port of entry
  - It cannot be resolved locally and incident information, including spectra, manifests and other data is sent electronically to DHS Primary Reachback
  - Primary has residual concern that warrants secondary (national) reachback
  - Reachback system is activated, verifies receipt of incident information, coordinates with subject matter experts and schedules conference call
  - Analysis is conducted and coordinated in the conference call, conclusions and recommendations conveyed back to Primary (typically within one hour of activation)



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The National Reachback program includes crucial QA components

- On-going quality assurance and data mining/trend analysis efforts
  - Characterize the real world
  - Learn from experience
  - Identify trends
  - Train, practice and certify
  - **Continuously tune the detection architecture**

Goal: Significantly improve our ability to recognize the "threat" needle in the haystack, without unacceptable cost or impact

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Incidents and resolution

- One advantage of technical reachback is situational awareness for the enterprise
  - Reachback personnel will have the broad experience of resolving alarms throughout the system
  - Alarm resolution issues and information can be disseminated to PRND locations, expanding their effective experience and allowing more alarms to be resolved locally

Some recurring and interesting issues addessed via reachback activities are highlighted in the following slides

Incidents – neutron alarms in scrap

- ALARM:
  - Scrap materials have caused a neutron portal monitor alarm; there are no readily identifiable gamma rays in the spectra
  - The presence of threat material or a threat device cannot be readily discounted
  - The scrap materials are not easily devanned from a railcar or container

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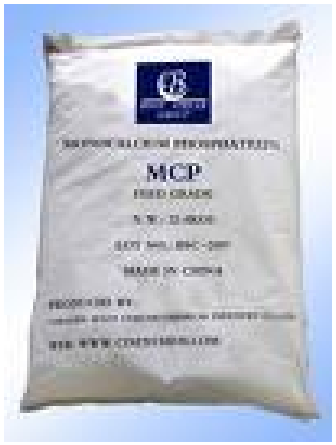
Incidents – neutron alarms in scrap

- RESOLUTION:
  - Experts can analyze the data for other indicators that further reduce the likelihood of threat materials in the load, but this is a serious recurring problem
  - If the gamma-ray spectra extends to high enough energies, one can postulate the presence of an Am-Be source through the presence of the $^{9}Be(\alpha,n)^{12}C$ 4.43-MeV gamma ray and its escape peaks (3.92 and 3.41 MeV)
  - An alternative means of resolving this type of incident is the availability of neutron multiplicity measurements to differentiate between fission (potential threat) and “alpha-n” neutrons
  - In most cases like this that have generated concern, an Am-Be source was found in the load or indicated by the detection of $^{9}Be(\alpha,n)^{12}C$ gamma rays; the remaining cases are unresolved (load returned to point of origin)

Incidents – calcium monophosphate

- ALARM
  - Feed-additive commodity: loads manifested as calcium monophosphate cause alarms that indicate enriched uranium



Incidents – calcium monophosphate

- RESOLUTION
  - Many phosphate deposits contain (depending on economics) recoverable quantities of uranium
  - Phosphate leaching/milling often involves sulfuric acid
  - Sulfuric acid is also used to leach uranium ores
  - Leaching the phosphate will carry along uranium in the concentrate
  - The uranium has its decay daughters washed away in the leaching process
  - One of these daughters, Pa-234m, is the source of the 1001-keV gamma-ray line that is commonly used to measure the presence of U-238 (which lacks easily measurable gamma rays)
  - This reduction in protactinium results in a spectroscopic indication of enrichment in the uranium

Uranium – Both an element of concern and a commonly encountered radioactive material in commerce

- As a fuel cycle commodity (both natural and enriched):
  - Uranium ore concentrate, uranium ore, yellowcake, U_3O_8 or uranyl peroxide (UO_4)
  - Calcined uranium, fuel assemblies, fuel pellets, UO_2
  - Uranium hexafluoride, UF_6
  - Uranium trioxide, UO_3
  - And less often - uranium tetrafluoride(UF_4), and uranyl nitrate
- Depleted uranium - as radiation shielding material:
  - For radiography projectors (e.g., Ir-192)
  - For shipment of intense sources
- Occasional HEU target material or fission chambers containing HEU

Detection of uranium will always warrant concern, but there are a great many uranium detection incidents associated with legitimate streams of commerce

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Summary

- Given the:
  - Widespread and growing use of radiation detectors
  - The frequency and variety of radioactive materials that are naturally or legitimately in streams of commerce
  - The frequency and variety of allegations of illicit trafficking in nuclear and radiological materials
  - The magnitude of the threat due to illicit trafficking of materials for nuclear or radiological terrorism
- It is important that radiation detection capabilities include protocols for technical reachback to adjudicate alarms that cannot be resolved locally

Technical reachback should include subject matter expertise in nuclear spectroscopy, radiation safety and radioactive commodities, and, at the top level, law enforcement and intelligence context and awareness

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