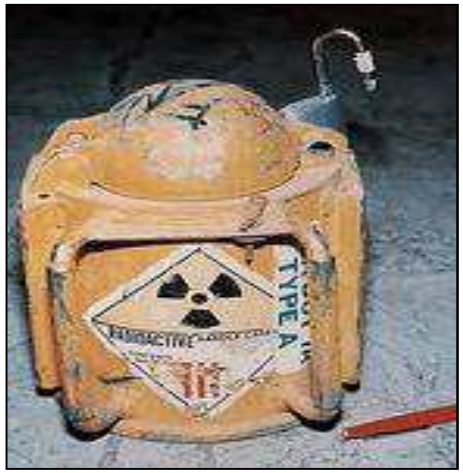
Radiation Source Recovery



Objectives

- Examples of Threats
- Response Planning
- Dose Assessment
- Contamination
- Identification
- Shielding and Handling
- Planning Source Recovery
- Executing Source Recovery

Keys to Success

- *The key to a successful source recovery operation is careful planning and preparation for the activity*
- *Gather as much information as possible prior to the start of the operation*
- *Practice with actual equipment and simulated source*
- *Minimize exposure to response personnel*

Examples of Radiological Threats

Examples

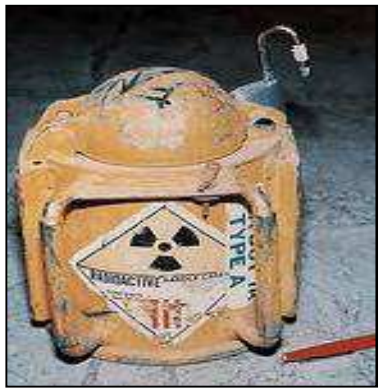
Radiography cameras

Well logging sources

Radioisotope thermal generators (RTG)

Industrial sources

Orphan sources (1000's worldwide)



Activities likely encountered

Up to 200 Ci (7400 GBq)

Examples of Radiological Sources

Cesium-137

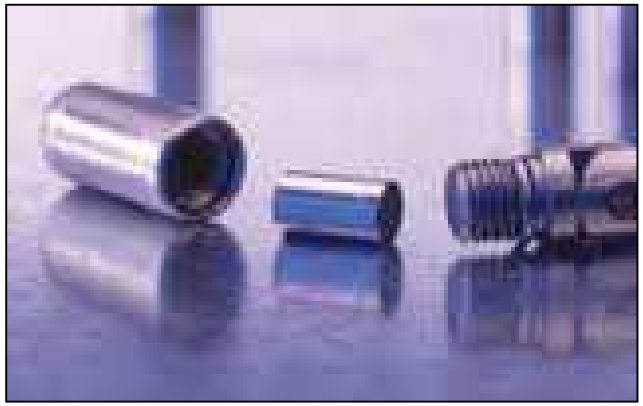
Cobalt-60

Strontium-90

Iridium-192

Americium-241

Radium-226



Source Size

Can vary from less than 1 cm x 1 cm to a large Radioisotope Thermal Generator (RTG)

Radiography source

RTG

High Activity Sources

High activity sources require specialized equipment (i.e. manipulators, robotics) and the operational knowledge of the vendor or specialists for emergency handling.

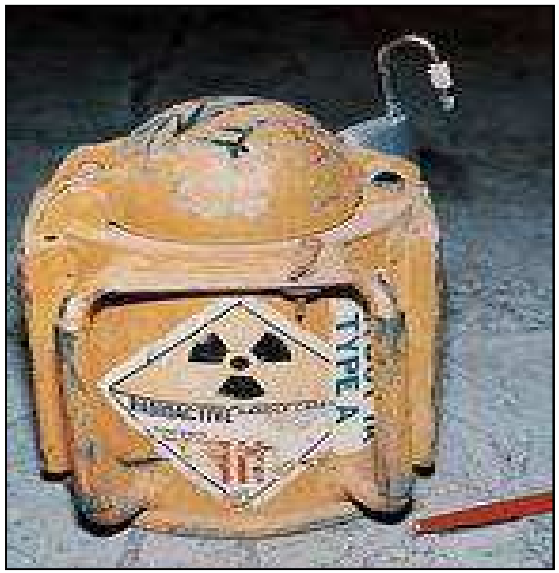
High Activity Sources, > 200 Ci (7400 GBq)

- Sterilization irradiators
- Medical teletherapy units
- Radioisotope thermal generators

The capability to handle these situations is typically not resident within most organizations. Best practice is to pre-arrange agreements for emergency response support with companies that produce and handle these types of units.

Orphan Sources

- Improperly disposed of, lost or stolen radiation sources are a common problem that often require special handling
  - Hospital/Medical Sources
  - Well Logging Sources
  - Density/Level Gauges
  - Industrial Radiography
  - Radioisotope Thermal Generators



Isotopes of Interest

- **Radioactive material defined as special nuclear material (SNM)**
  - Plutonium
  - Uranium enriched to 20% or higher of isotope U-235
  - U-233

- **The radioactive isotopes which are likely to be used in illicit trafficking**
  - Americium-241(Am-241)
  - Californium-252 (Cf-252)
  - Neptunium-237 (Np-237)
  - Cesium-137 (Cs-137)
  - Cobalt-60 (Co-60)
  - Iridium-192 (Ir-192)
  - Plutonium-238 (Pu-238)
  - Uranium-235 (U-235) less than 20%
  - Radium-226 (Ra-226)
  - Strontium-90/Yttrium-90 (Sr-90/Y-90)

Planning Considerations

What is known about the source?

Isotope, activity, labeling, age, documents

What are the dose rates?

Life threatening or manageable rates

Is the source or area contaminated?

Personal protective equipment requirements

Establish an exclusion area and stabilize site

Hot line required?

What detection equipment required?

Dose rate meter, contamination survey, identification

What monitoring is required?

Air sampling, personnel, contamination

What personal dosimetry is required?

Gamma, neutron, alarming dosimeters

Dose Assessment

Dose Assessment

Use a calibrated high dose rate teleprobe detector extended to 4 meters to minimize dose to responder

Measuring Range
1.5 µSv/h – 10 Sv/h

Establish Dose Limits (IAEA Guidance)

Turn Back Limit – 10 R/h (100 mSv/h)
Total Dose Limit – 5 R (50 mSv)

Develop Stay Times

Stay Times to Receive Dose					
Dose Rate	**1R (0.01 Sv)**	**5R (0.05 Sv)**	**10R (0.1 Sv)**	**25R (0.25 Sv)**	**100R (1 Sv)**
5mR/h (0.05 mSv)	200 h	6 wk	12 wk	30 wk	2 y
100mR/h (1 mSv)	10h	50h	100h	250h	6wk
1R/h (100 mSv)	1h	5h	10h	25h	100h
10R/h (0.1 Sv)	6min	30min	1h	2.5h	10h
100R/h (1 Sv)	36sec	3min	6min	15min	1h

Contamination Concerns

Monitor for Contamination

Use a calibrated health physics probe to monitor for alpha, beta contamination

Use an air sampler if suspect airborne contamination or re-suspension

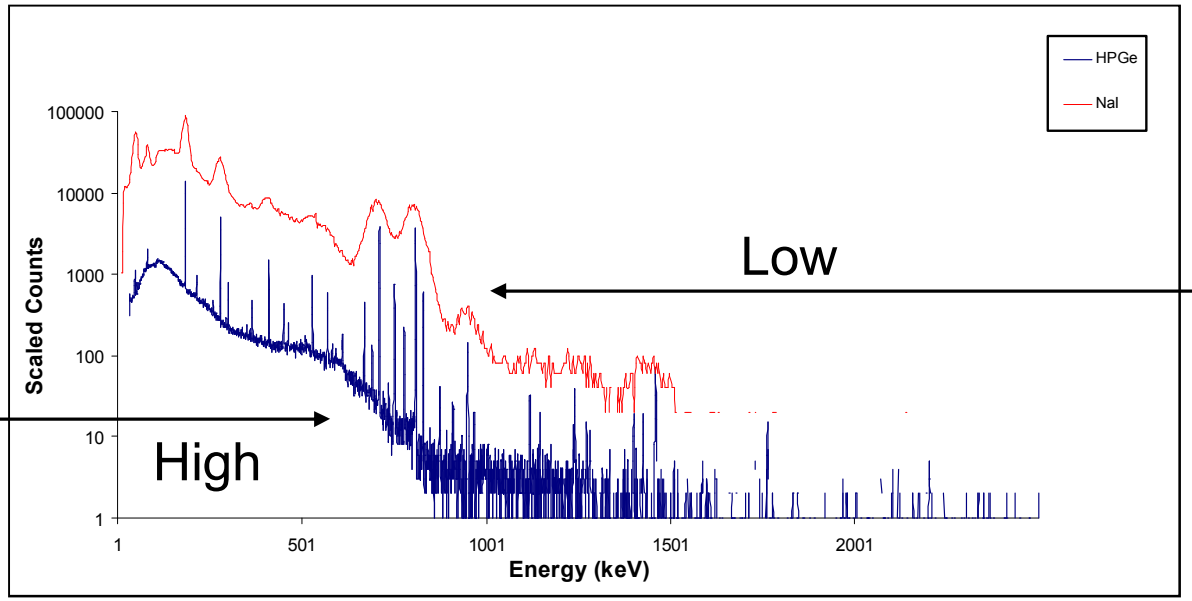
Personal Protective Equipment

Determine appropriate protective equipment - Tyvek suit, gloves, booties, respirator

Radioisotope Identification

Use identification instrumentation to identify the radioisotope and quantify the approximate activity of the radiation source

HPGe

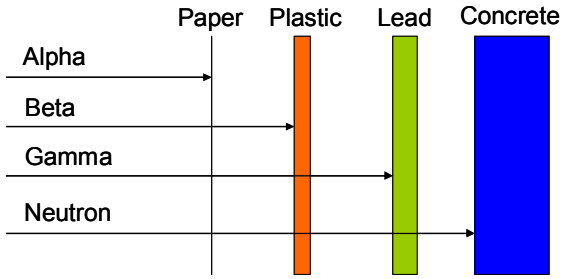


NaI

Comparison of a sodium iodide spectrum (low resolution) to a high purity germanium spectrum (high resolution)

Radiation Shielding

Shielding Options for High Dose Rate Sources



Temporary Shielding

Use multiple 5 kg bags of lead shot, bricks or lead blankets

Transport Shielding

Emergency lead containers are available that can shield 200 Ci (7400 GBq) sources and semi-portable

Remote Handling

Remote Handling

A high activity source can be handled using long tongs

Minimize Exposure

Plan and practice the operation to minimize exposure to responders; use natural shields like a vehicle, wall, ground, etc.

(building materials like brick, gravel, concrete are about ¼ as dense as lead)

Containment

Transfer source quickly to the lead pig using the long tongs

Isotope handling tongs available with 1 to 3 meter lengths

Search and Recovery Planning

- **Search plan should include:**
  - Sources potentially in search area
  - Actions to take upon initial location of source
  - Plans for consolidated packaging operation
- **Assumptions**
  - Sources, once located, will be identified and characterized
  - Packaging will be completed when all search teams are done and all sources to be managed are located
- **Work plan has three phases**
  - Initial search and response to located sources
  - Determination of packaging needs
  - Packaging and preparation for transport

Initial Search and Response

- ***STOP*** *– when a source is located, move a safe distance and request assistance to ensure safety*

- Take measurements – dose rates and contamination monitoring
- Control access – use barriers
- Identify source/device
- Read data on labels/markings
- Identify radionuclide and original activity
- Record all information - take pictures

- *Once source has been located, marked and area secured, you will typically have time to refine the recovery plan and take proper precautions to ensure response personnel safety*

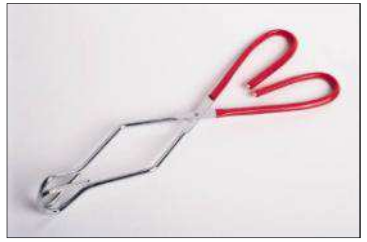
Initial Response - Cautions

- Keep exposure ***As Low As Reasonable Achievable (ALARA)***
- Use rakes or shovels *carefully* to locate sources while maintaining distance
- ***BEWARE*** - contamination from sealed sources is rare but it can't be ruled out without a survey

Initial response is complete when sources have been located, identified and characterized

Initial Search and Response

- **Radiological Precautions**
- Use an ion chamber when you need to accurately measure the dose rate of a source
- Measure dose rate at 1 meter – estimate contact dose rates using the inverse square law
- Check for contamination using tongs and swipes. Count the swipes with a contamination meter in a low background area
- Check any shield (or shutter) on the device to determine if open, closed or damaged



Interim Source Storage

- **Determine options for source storage**
  - Short term for safety, isolation – employ time, distance and shielding
  - Long term or temporary storage in a national storage facility
  - Source segregation, packaging, marking and labeling requirements for storage
  - Method of transportation to national storage facility

Container Selection

- **Container considerations**
- Type of package required for the radionuclide and activity
- Volume considerations
- Determine requirements for placement in storage
- Use appropriate shielding inside container to lower the external surface dose rate

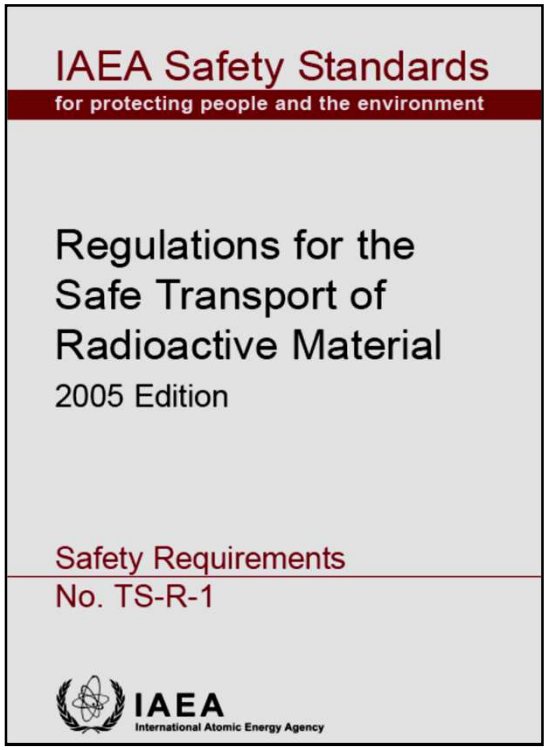
Source Handling and Packaging

- **Source handling**
  - Long handled tools, shielded enclosures and hot cells may be needed!
  - Limitations on field handling determined by national authorities
- **Segregation of sources in the field**
  - Type of source – alpha, beta-gamma, neutron
  - Collection into inner containers for placement in transport/storage container – later retrieval
  - Segregation may require multiple containers

General Transportation Requirements

- Packaging and transportation are governed by national requirements which should be consistent with *IAEA TS-R-1*

- TS-R-1 specifies:
  - Types of packaging
  - Limitations on content of each type of packaging
  - Labeling
  - Rules for transportation



Summary

- Plan and execute according to a plan
- Radiological protection – both minimizing exposure and controlling contamination is essential
- Packaging details will depend on the availability of containers and the type of transportation selected by the national authority
- Handling of sources for transportation is the final step of the search and recovery operation
- ***Be flexible – plans change based on real conditions!***

Radium Source Recovery
Kingston, Jamaica

October 25-27, 2009

Response to Radium Source

- Major shipping port at Kingston, Jamaica
- A 40-foot long container filled with scrap aluminum shipped to US set off radiation alarm at a portal
- Gamma spectroscopy readings by local authorities identified Radium-226 as the isotope
- Customs requested assistance with the source recovery through US State Department and Department of Energy
- DOE notified on October 23, 2009
- October 25, four members of DOE departed to aid in assessment and packaging the source
- Mission completed October 27

Area Conditions on Arrival

Majority of container contents removed to an adjacent warehouse

- Remaining material in the container, with radium source still inside
- Survey of outside of container showed highest reading about a third of the way from the back and on the left side

Preliminary Actions

- No hands-on work for preliminary survey, protective clothing minimal
- Begin contamination survey from trailer doors back to source.
- As work progressed to hands-on operations, more protective clothing was used, up to respiratory protection

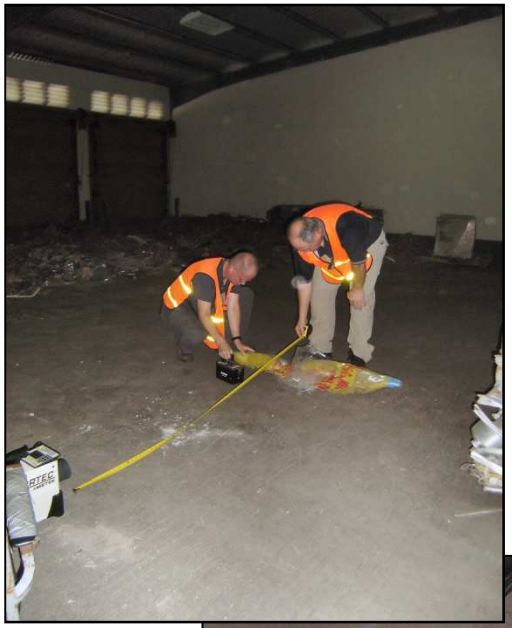
Radiation Source

- Aluminum bar, 55 in (140 cm) long and about 1.5 in (4 cm) wide
- Radium painted on one side
- Highest reading was 30 mR/h (0.3 mSv/h) contact
- Used in industry as a static eliminator
- Two additional small metal items were found to be cross-contaminated
- Radium paint flecks were found mixed with dust and dirt on container floor.

Activity Assessment

Lucky Break

- Special formula of radium paint patented in 1949
- Almost no contamination
- All contaminated material was double wrapped in plastic

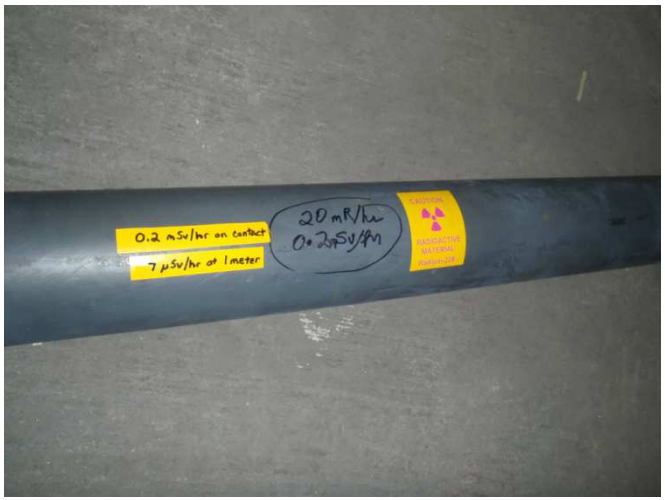


Total activity of radium estimated to be about 1 mCi (37 MBq)

Packaging

Series 40 PVC pipe, 2 m long by 10 cm diameter used as a container

- Caps glued on both ends to provide a watertight seal
- Radiation exposure readings gave highest spot identified as 20 mR/h (0.2 mSv/h) contact and 700 μR/h (7 μSv/h) at 1-meter.
- Material remained the property of Jamaican Customs
- Suggested that material be store in a locked room until proper disposal identified



Conclusions

- Radium sources recovered from a shipping container which alarmed at a portal
- Radioactive material was mixed in with scrap metal
- No evidence of major contamination
- Source was packaged for secure storage
- Dose rate readings relatively low and marked on package