DOE/NV/03624--1017

Case Studies:
Nuclear Accidents and Government Response

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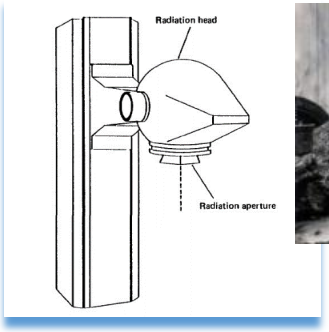
Case Studies:

Radiological Accidents and Government Response

- **Goiânia**
  - Goiânia, Brazil (1985)
- **Harborview Hospital**
  - Seattle, WA USA (2019)

Goiânia Accident: *Incident Summary*

http://helioseismic.blogspot.com/2011_01_01_archive.html



http://uraniumfilmfestival.org/en/film/berlin-2012-berlin-2013-munich-2013-new-delhi-2013-new-york-2014-rio-2011-rio-2012/caesium-137

- In Sept. 1987, a 50.9 TBq ^{137}Cs source was removed from a teletherapy unit at the IGR clinic
  - In 1985, Insituto Goiano de Radioterapia (IGR) relocated to a new clinical location, abandoning a Cesapan F-3000 ^{137}Cs unit
  - The facility was mostly demolished, leaving only the therapy room containing the teletherapy unit intact
  - (Sept. 10 - 13) Two men (P1 & P2) entered the remains of the facility looking for metal to sell for scrap
    - The shielding head of the teletherapy unit was removed and taken home
    - (Sept. 13) P1 and P2 began vomiting (assumed to be food poisoning)
    - (Sept. 15) P1 sought medical assistance. Diagnosed with and allergic reaction to something he ate
  - (Sept. 18) P2 attempted to dismantle the shielding head, puncturing the source capsule containing the CsCl source. The metal was sold as scrap, and the powder kept as a curiosity
  - (Sept 18 – 28) Neighbors and acquaintances were shown the source capsule with the “glowing blue powder”, resulting in significant spread of contamination.
  - (Sept 28) Doctors at the Tropical Diseases Hospitals begin to suspect that the number of patients with skin legions and tropical disease symptoms may have been exposed to radiation

Poll Question

Question

If this event had occurred in your country, what is the most likely way the incident would be discovered?

Answers

A. Inspection of licensed source by regulatory agency finds missing source

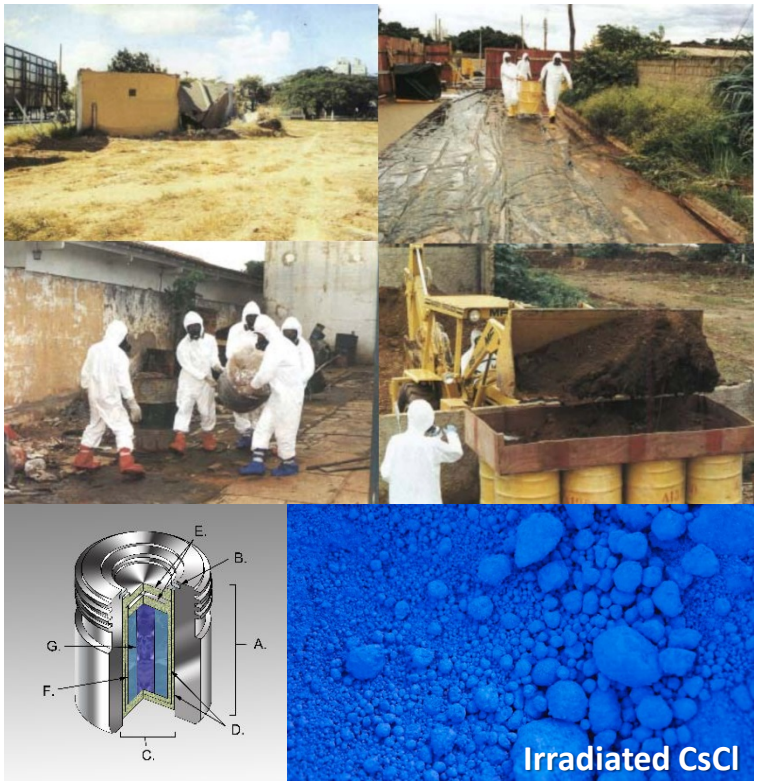
B. Scrapyard radiation sensor alarms when shielding head was sold for scrap

C. Doctors identifying a potential radiological exposure and notifying the authorities

D. Hospital/clinic finding contamination after patients were treated and notifying authorities

E. Other route or potentially missed event

Goiânia Accident: *Incident Discovery*



- Sept 29: Timeline for Discovery and Notification
  - (0800) Investigation of source left at Vigilância Sanatária begins
    - Initial dose rate measurements were assumed to be instrument error
    - Fire Department called in while the instrument was replaced
      - Physicist had to stop firemen from picking up the source and throwing it in theriver
    - Dose rate measurements (> 400 mGy/hr @ 1 m) confirmed at 1020
  - (1100) Evacuation of the Offices at Vigilância Sanatária
  - (1200) Investigation expands to include first junkyard
    - Dose rates measured off-scale. Indications of wide-spread contamination
    - Junkyard and surrounding area evacuated
  - (1300) Physicist and Doctor from VS attempt to notify State
    - Went in-person to the offices of the Secretary of Health for Goiás State
    - Eventually spoke with the Secretary. Formal incident response begins
  - (1500) Director of the Department of Nuclear Installations in the *Comissão Nacional de Energia Nuclear* (CNEN) contacted. He serves as the Coordinator for Nuclear Emergencies (NEC)
  - Note: NO plans for emergency response at this scale existed
    - Plans developed for minor releases from transport of sources
    - Plans developed for major accidents at the nuclear power plant (Angra)

https://kurioso.es/tag/el-incidente-de-goiania/ https://uk.pinterest.com/pin/560135890891507 84/ https://www.phactual.com/magical-blue-powder-the-goiania-radioactive-accident-of-1987/

Poll Question

Question

In your country, who would be tasked to investigate a potential release of radiation like this?

Answers

A. Trained Hazardous Materials Response team

B. National laboratory or university radiological experts

C. Police/Law Enforcement

D. Fire/Rescue

E. Military

F. Other or Don’t Know

Poll Question

Question

What kinds of equipment would the team likely have to use in the investigation?

(multiple answer)

Answers

A. Handheld dosimeters or pagers

B. Handheld contamination survey meters (GM probes, alpha/beta probes)

C. Portable gamma spectroscopy systems

D. Vehicle-mounted gamma detection systems

E. Aerial measurement systems

Goiânia Accident: *State/Federal Response*

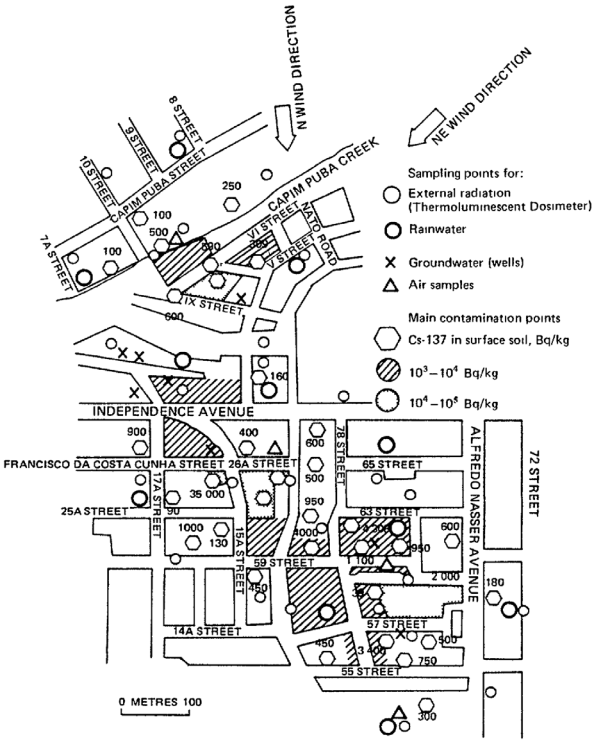


FIG 16. Plan of the Aeroporto section of Goiânia showing the locations of the principal sites of contamination and the sampling points.

- <u>Sept 29: Response Timeline</u>
  - (1600-2000) Initial Response Actions
    - Hospital notified of radiation exposures and contaminations
    - Civil Defense Forces notified (Police, Fire, Ambulance, etc)
    - Olympic Stadium designated to receive contaminated personnel
    - Initial sites (VS and Junkyard 1) resurveyed
  - (2200) Site Investigations Expand
    - Additional contamination sites are identified
    - 22 additional exposed individuals identified and send to Stadium
- Action Levels Established by State
  - Evacuation Limit: 2.5 µSv/hr
  - Access Control Limit: 10 µSv/hr
- Sept. 30: Source Entombed
  - Source at VS entombed in concrete to reduce dose rate
- Evacuations completed by Oct. 3

Statements for Public Outreach

- The next slides and surveys will include statements that the mayor has drafted for his upcoming press conference to address the local population. They have asked you to review the statements prior to the address

- Select True (or A) if you agree with the statement and think the mayor should include it as is
- Select False (or B) if you disagree with the statement or think it needs significant revision before being released to the public

Poll Questions – True/False

1. Residents are advised to shower upon returning home. Clothes should be bagged until they can be washed. Shoes should be left in an isolated location near the door.
2. If you are in the evacuation area, please grab any essential medication and immediately go to the reception centers
3. If you have any of the glowing blue powder in your home, place it in a bag and bring it to the authorities at the reception centers.
4. If you are living within the exclusion zone, please go directly to the local hospital for evaluation.

Goiânia Accident: *Recovery*

- Evacuation Limit Relaxed to 10 µSv/hr
- Remedial Dose Limits Established
  - Dose to critical group should not exceed 5 mSv in year 1
    - 1 mSv due to external exposure inside houses
    - 3 mSv due to external exposure from contaminated soils
    - 1 mSv due to internal exposure from contaminate food/water
- Action Levels Established to Ensure Dose Limits are met
  - For homes
    - 37 kBq/m^2 internal surface contamination limit
    - 0.5 µSv/hr external dose rate limit
  - For Soils
    - 430 kBq/m^2 (surface) or 22.5 kBq/kg (top 15 mm)
    - 1.0 µSv/hr external dose rate limit
- Decontamination
  - 85 homes, 45 public areas, and 50 Vehicles were decontaminated
  - 3500 m^3 of radioactive waste was generated by clean-up

Goiânia Accident: *Lessons Learned*

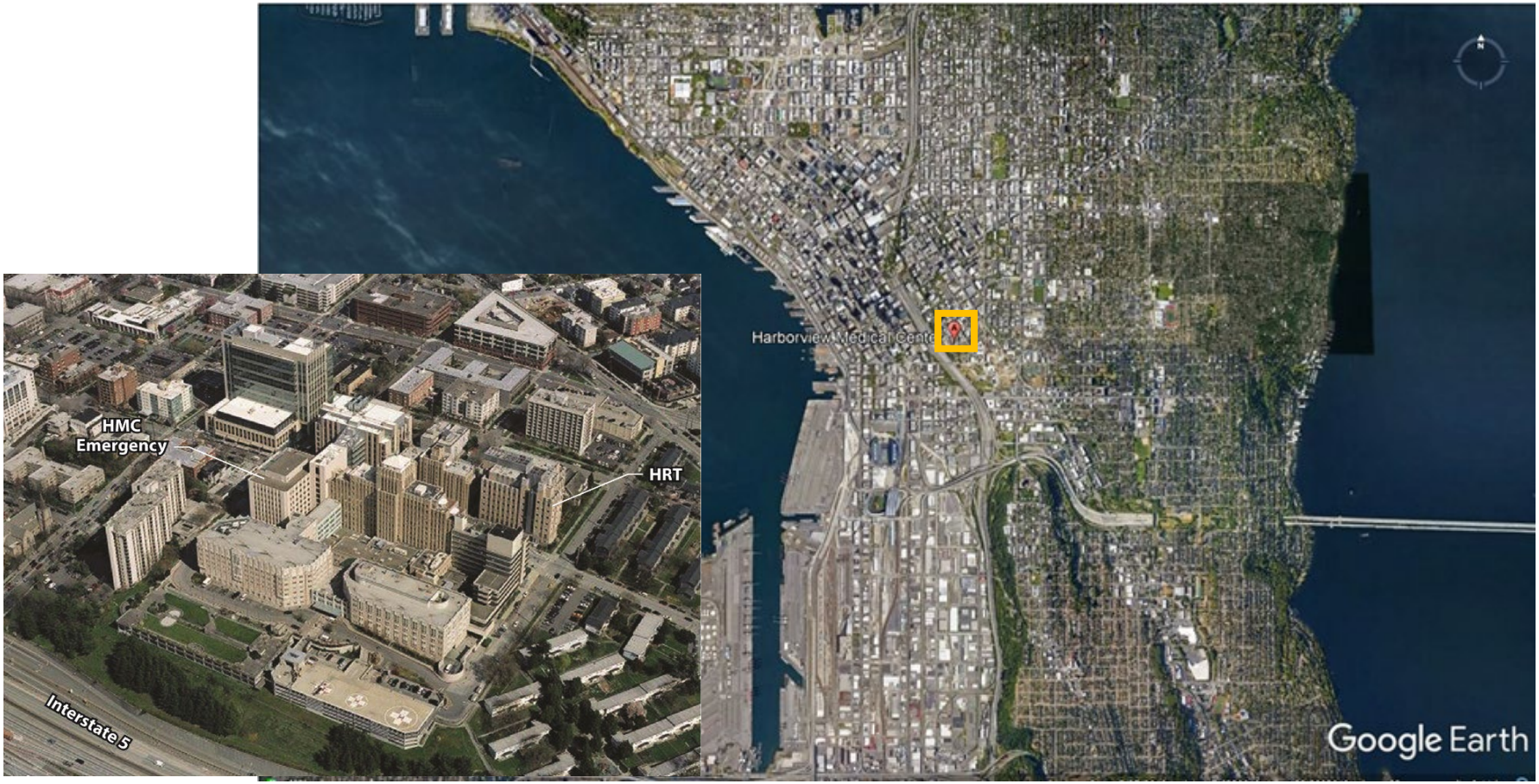
- <u>Root Cause</u>
  - Lack of Institutional Control of Source
    - Control of source lost when IGR moved to new facility
      - Uncertainty about legal status and ownership of source
      - No requirement to notify Regulator following inventory of sources
    - No/Infrequent Inspections by Regulatory Agencies
- <u>Lessons Learned</u>
  - Easily Identifiable Markings of Radiation Hazard Required
  - Communication with Public is Essential
    - NO public statement issued even as areas were evacuated and isolated
    - Decontamination and Medical personnel need training for communicating with the public
  - Emergency Planning and Drills/Practice are Essential
    - Chain of Command and Information Flow must be established
    - Detection Equipment and Trained Personnel need to be available
  - Training of Medical Personnel
    - Medical personnel not well trained to identify potential radiation exposures
    - Misdiagnosis of early patients delayed identification of release by days

http://physique.henry.free.fr/pages/dechets/nucleaire.htm

https://panji1102.wordpress.com/2012/02/20/cesium-radiation-goiania-brazil/

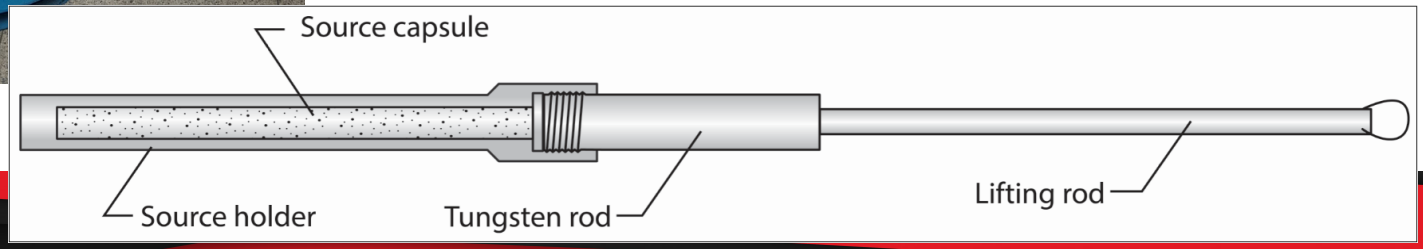
Harborview Hospital

Seattle, WA USA

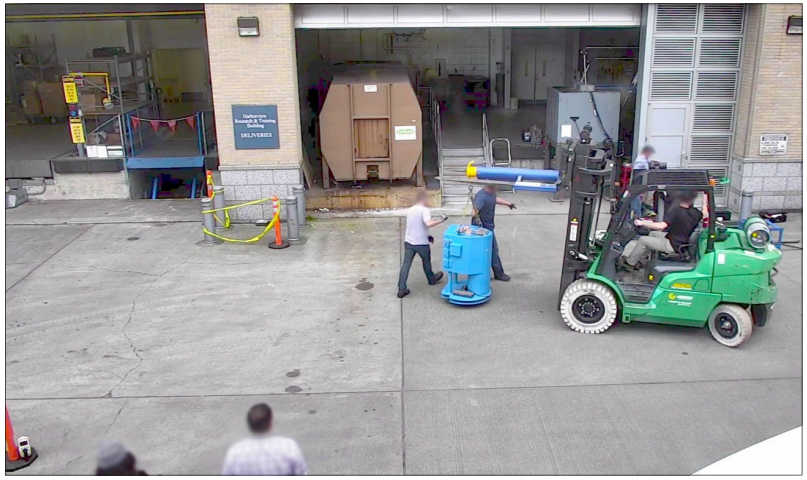


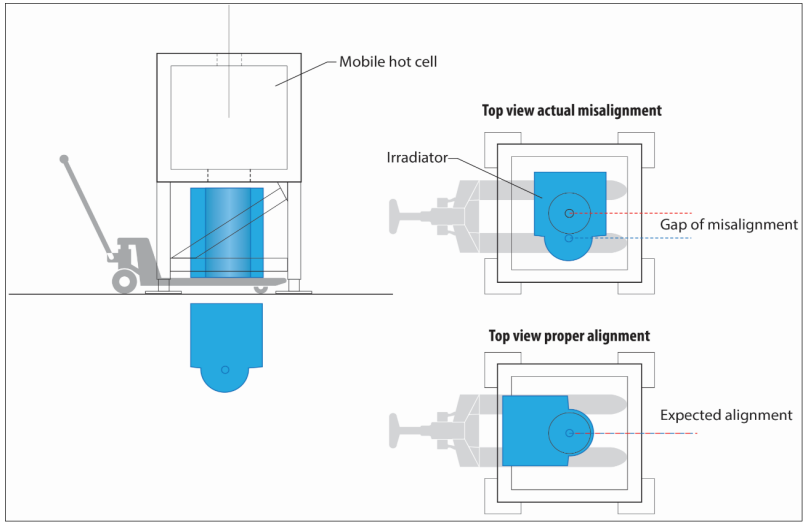
Harborview Source Recovery Plan:

- Summary:
  - University of Washington agrees to decommission a Cs-137 Blood Irradiator currently in use in the Harborview Research and Training (HRT) facility on the Harborview Hospital campus in Seattle, WA (USA).
  - Removal specialists plan to remove the Cs capsule containing 2900 Ci Cs-137 from the irradiator to transfer to a shielded transportation cask for removal from site and transfer to disposal location
  - The Mark I irradiator design is known to be incompatible with the portable hot cell and shipping cask the contractor plans to use for the recovery.
  - The contractor has a procedure to cut the source capsule free from the lifting rod to allow it to be moved into the hot cell and shipping cask



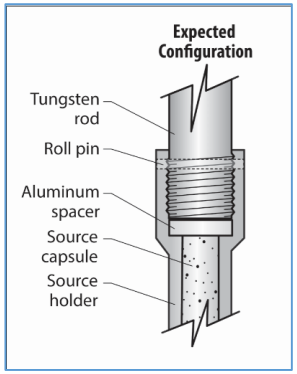
Harborview Pre-Event Chronology (May 2, 2019):

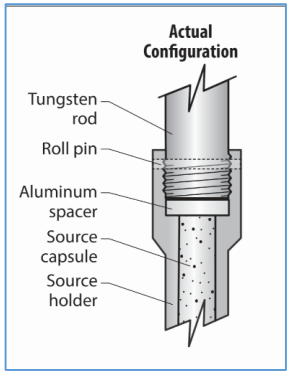


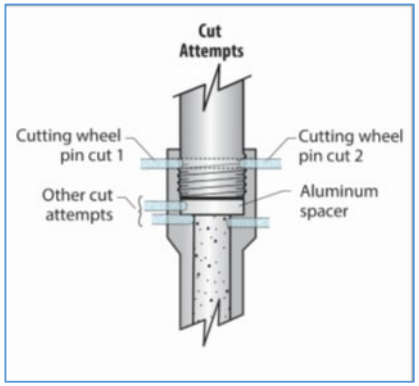


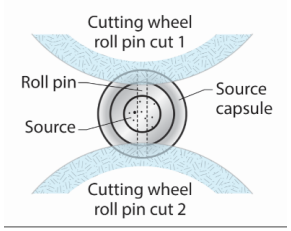
- (1600) Irradiator moved from the storage location to loading dock using a forklift, engine hoist, and pallet jack
- (1715) Recover team attempted to mate the irradiator to the bottom of the modular hot cell. They determined:
  - Lifting rod was too long to bring the source assembly into the hotcell in a single unit
  - Remnants of the IDD safety system prevented mating the irradiator to the hotcel, requiring the removal of the shielding donut from inside the hotcell
  - Loading bay door was partially closed to limit light leakage to cameras in MHC
- (1825) Multiple cuts were made by hand to the lifting rod to allow the source to be moved into the hotcell.
- (1845) The source was lifted from the irradiator into the MHC. This resulted in higher-than-expected doses (400 mR/hr at 1 m from bottom of MHC). Team added additional shielding and posted area as a radiation area.
- Team elected to continue operations even though ambient dose rates were 10X higher than expected from pre-job planning.

Emergency Response:



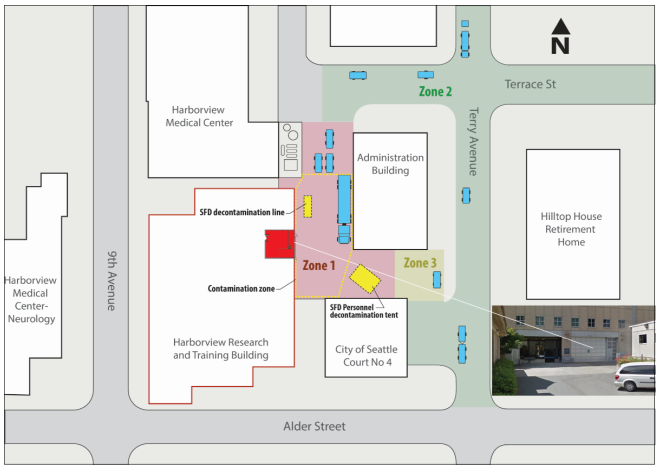






- (1931) Team began a series of cuts on the assembly to allow source capsule to be unscrewed
- (2005) Team was still not able to unscrew source capsule. They believed threads were oxidized, and began performing circumferential cuts to free source.
- (2015) White spots can be noted in the HRT security feed. This was not available to the workers in the room.
- (2127) Assembly moved to transfer location prior to end of shift after 27 separate cuts. Movement observered between source and source tube
- (2129) Team notified UW radiation control officer of a potential breach of the source. RCO turned on the contamination meter in the room and confirmed breach with a large area wipe that “pegged” the meter at over 500 kcpm.

Emergency Response Phase



- (2134) The roll-up door to the loading bay was closed to prevent further release through doorway.
- (2146) Large area surveys of the area were performed, confirming significant release. A box of Nitrile gloves was found in the loading dock. This is the first PPE used by the team.
- (2225) Seattle Emergency Response notified of accident. Hazmat team dispatched.
- (2230) Primary building ventilation shut down. Secondary ventilation, including exhaust systems, left operational.
- (2328) Damaged source transferred into shipping cask for storage and eventual removal.
- (2230) HAZMAT team arrives and begins set up to contain incident. DECON support requested, and a decon tent set up by 2359

Poll Question

Question

What should the first priority be for the HazMat team when they arrive on site?

Answers

A. Establish a 100 µSv/hr perimeter boundary around the accident site

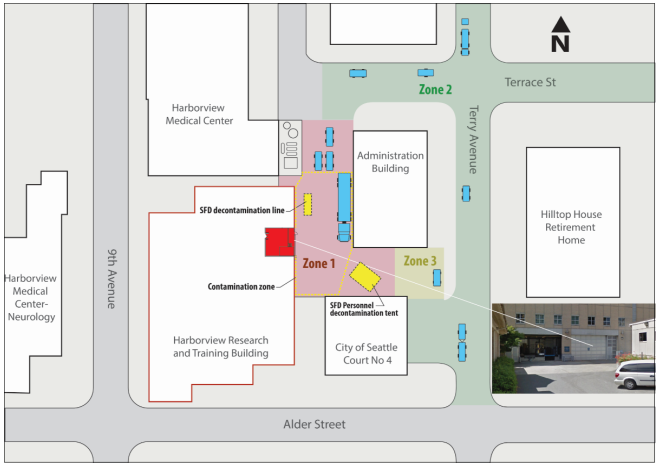
B. Establish containment around the building to prevent the release and further spread of material

C. Extract, decontaminate, and provide medical support for the contaminated personnel

D. Start surveying the surrounding neighborhood to see if any contamination has spread away from the building

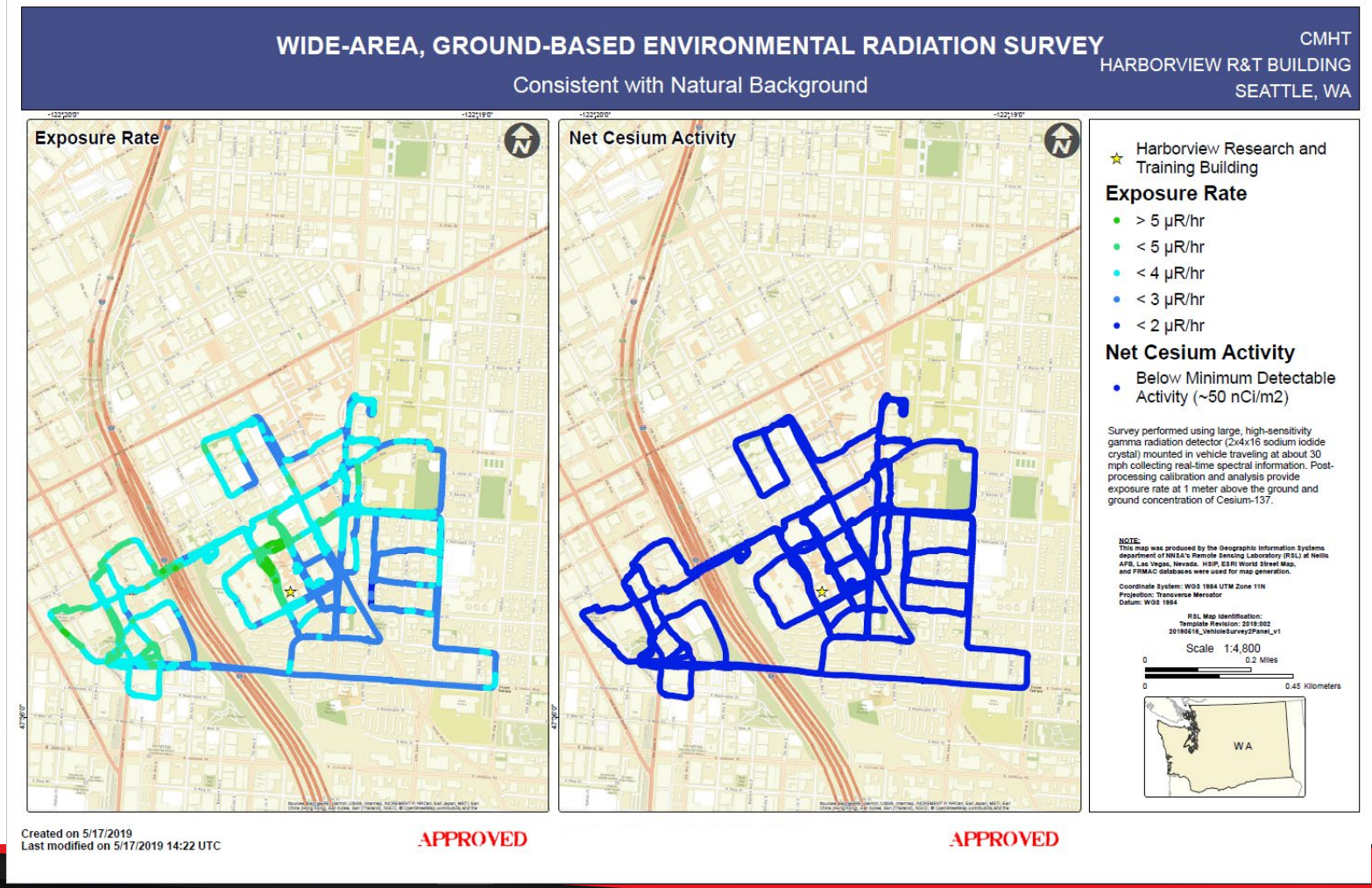
E. Eat all of the donuts before the police arrive on-scene

Immediate Response Phase



- (May 3) Federal Radiological Assistance Program team dispatched to Seattle to support event
- Surveyed interior of building to determine habitability and extent of contamination
- RAP team discovered contamination on the coils of multiple refrigerator and freezer units in the building on multiple floors.
- Identified multiple exhaust systems still operating from fume hoods, biological storage cabinets, and equipment rooms
- Identified contamination from elevator shafts on multiple floors.
- Located and isolated multiple spots of contamination on the pavement outside the loading dock roll-up door.

Supplemental Response



Questions?