UCRL-PRES-149904

Radioactive Material Production, Transportation, Use, and Possible Misuse

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COUNTER-TERRORISM INCIDENT RESPONSE

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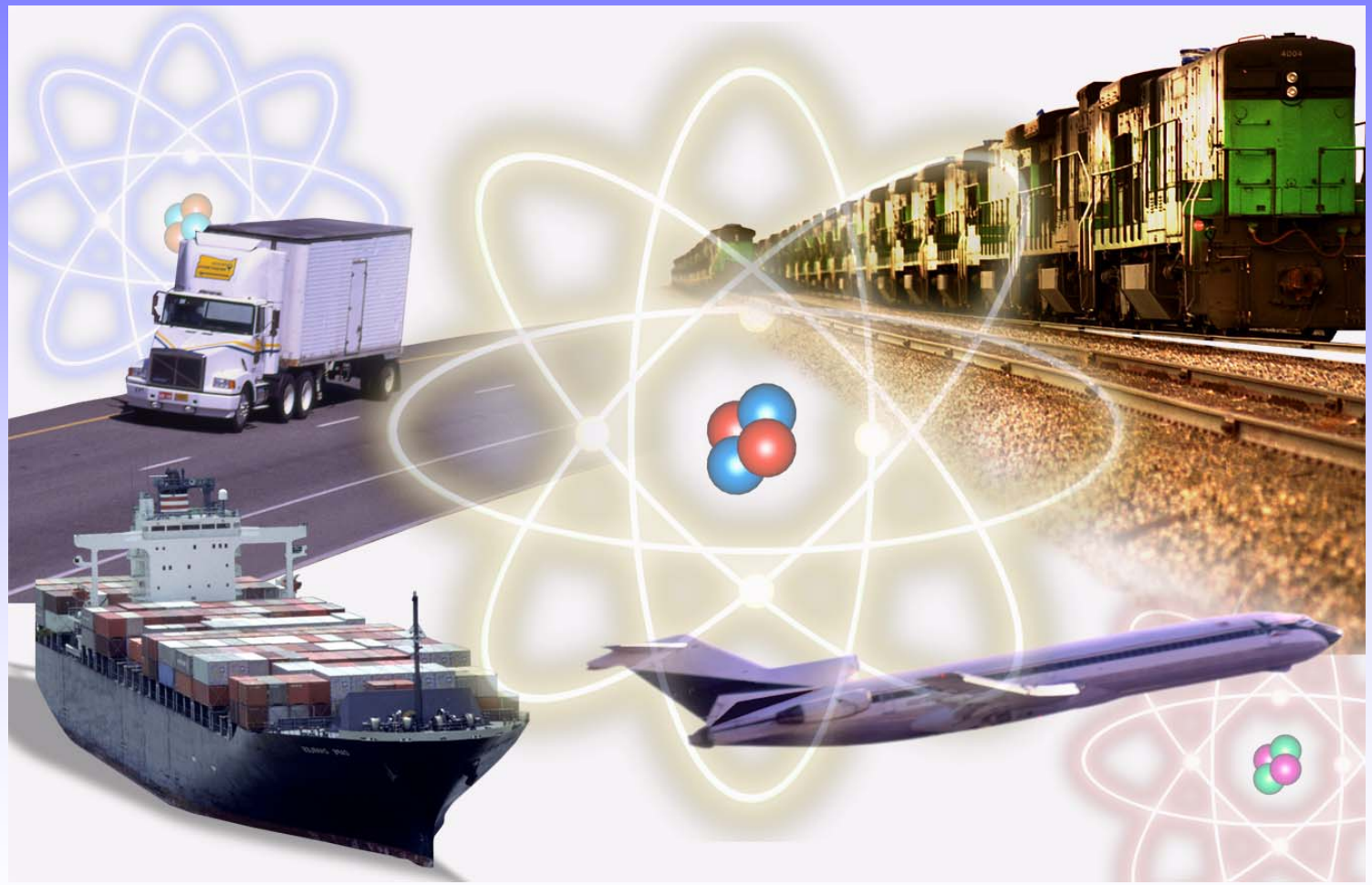
Radioactive Material Production, Transportation, and Use



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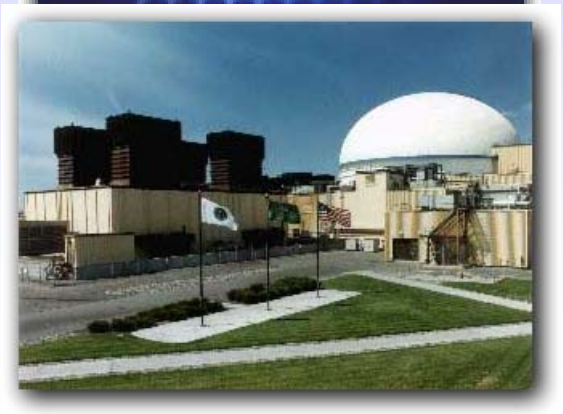
Radioactive Material Production, Transportation, and Use

- The creation, shipping, and use of radioactive material is **highly regulated** (IAEA, NRC, DOT, etc.).
- High Activity Sources can **only** be produced by sophisticated methods (e.g. reactors & accelerators).
- High activity sources can only be obtained after special licensing to ensure their safe use and their security.
- Similar regulations exist in other countries were radioactive material is produced or used.



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Shielding Requirements Limit Portability

- For gamma sources: the higher the activity, the more shielding you require to transport the source.

Small radiography sources:
- **typically 0.1 Ci to 200 Ci.**
- **30 – 50 Lbs**

Medium radiography sources:
- **Hundreds of Ci**
- **200 - 400 Lbs**

Large industrial source:
- **9,000 Ci**
- **3 tons of shielding**

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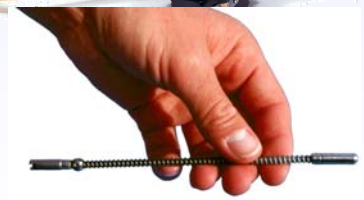
High Activity Radioactive Material

Fuel Assembly

Sr-90 RTG at Burnt Mountain, Alaska

- Spent Nuclear Fuel & High Level Waste
- Radioisotope Thermoelectric Generators (RTG)
- Medical & Radiographic sources



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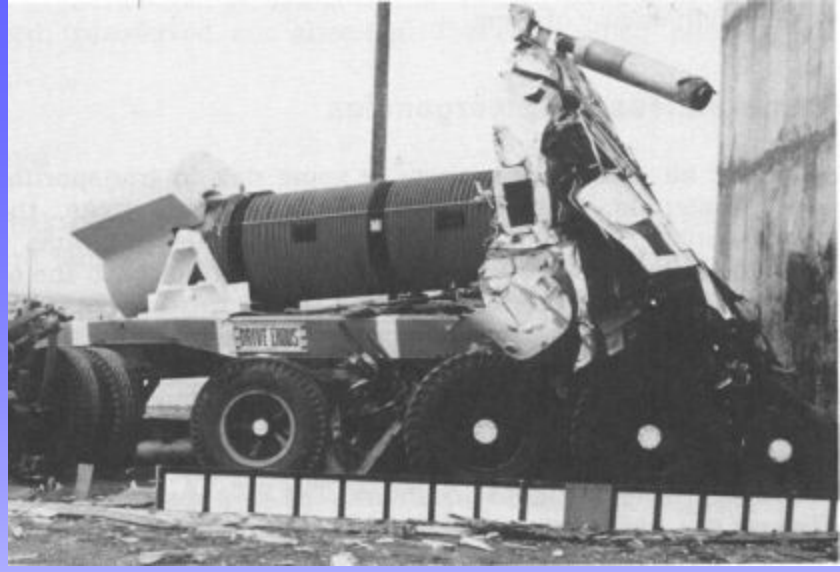
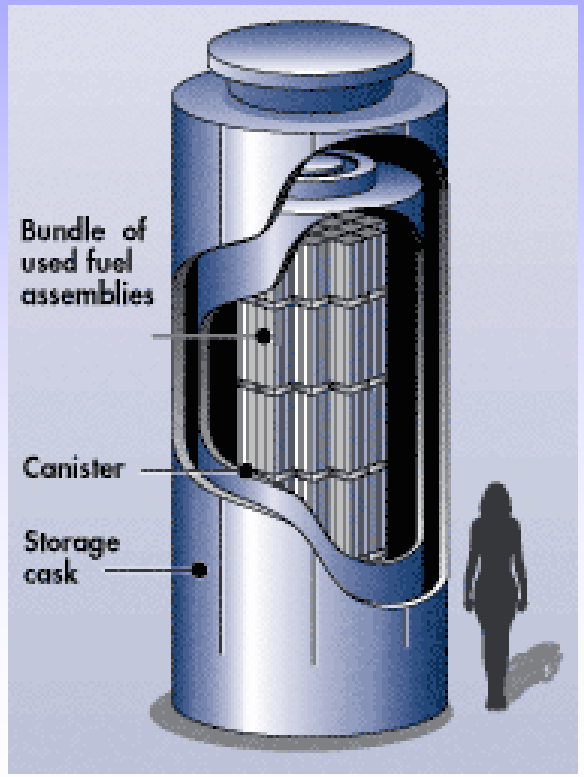
Spent Fuel



- Currently stored "onsite" at locations throughout the country.
- Spent Fuel containers extremely rugged and made to withstand extreme accident conditions.
- For thirty years, > 5,000 highly-radioactive fuel assemblies have been shipped without radiation release (despite several accidents).
- Security measures are taken.



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Radioisotope Thermoelectric Generators (RTG)

Self heated
Plutonium 238

Sr-90 RTG at Burnt Mountain, Alaska

- The heat generated by the radioactive decay is used to generate electricity
- Used when maintenance free power is need for decades (satellites, ocean bottom, and arctic applications)
- RTGs most often made from Sr-90 (0.46 kW/kg) or Pu-238 (0.54 kW/kg).

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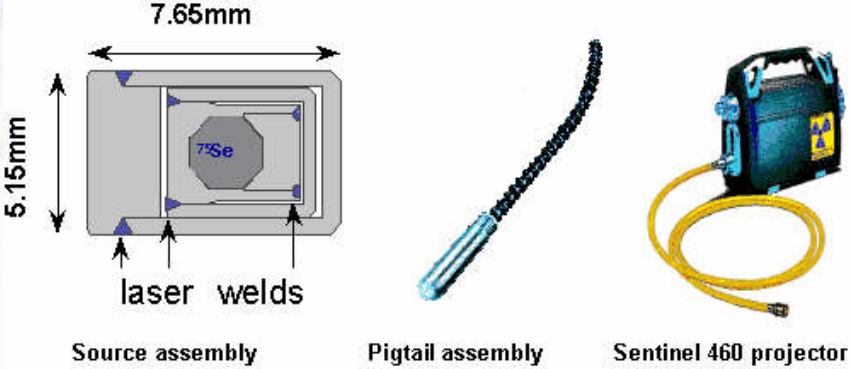
Portable Radiography Sources

- "Top strength" industrial radiography sources can burn fingers and cause radiation sickness within a few minutes.
- Effects drop off dramatically with distance. Outside of 3 meters, acute effects rare even after hours of exposure.
- Sources are constructed to meet rigorous testing standards. A typical source is encapsulated in two (2) TIG welded Stainless Steel Capsules.
- Source Material itself is often metal (Cobalt or Iridium) or embedded on non-soluble ceramics or "microspheres" to prevent inhalation of radioactive material if the source encapsulation is breached.



Facility Based Irradiators

- These sources can have 10 to 100 times more radioactivity than radiography sources
- Found in food irradiators, medical sterilizers, etc.
- The shielded enclosures that hold the sources weigh more than a ton.
- Difficult to remove source from the facility or equipment.

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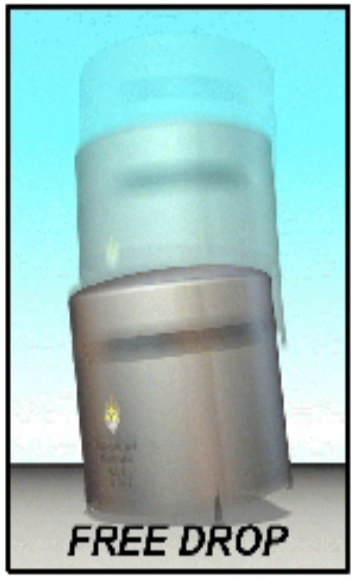
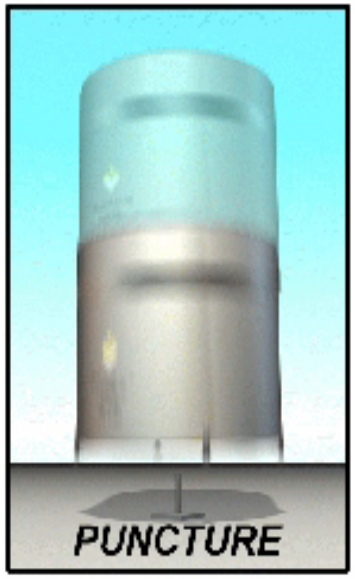
High Activity Source Transportation

Containers that ship high activity sources are meant to withstand very punishing accident conditions.

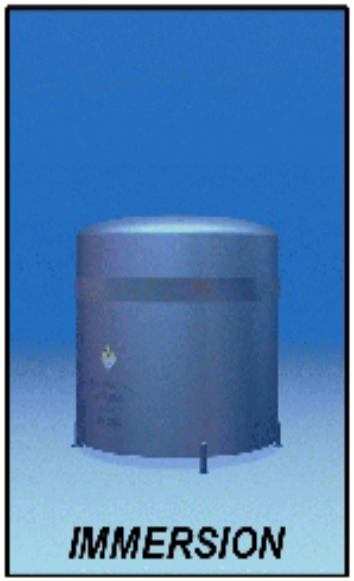


A 30-foot free drop onto a flat, un-yielding surface so that the package's weakest point is struck



A 40-inch free drop onto a 6-inch diameter steel rod at least 8 inches long, striking the package at it's most vulnerable spot.

Exposure of the entire package to 1475° for 30 minutes.



Immersion of the package under 50 feet of water for at least 8 hours.

Conclusion:

Radioactive Material Production, Transportation, and Use

- High Activity Radioactive Material is highly regulated.
- Industrial Sources are very robust and made not to leak.
- When dangerous quantities are shipped, the material is put a a container capable of withstanding harsh accident conditions.
- Very high activity industrial/medical sources are facility based and difficult to remove.

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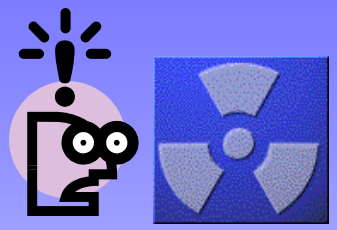
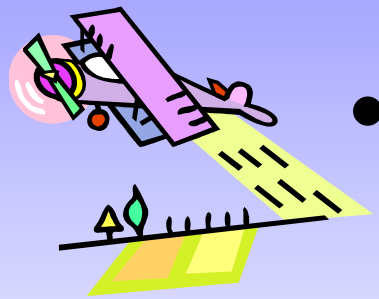
How Might High Activity Radioactive Material be Misused?

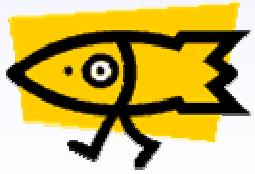


- Expose people to an external source of radiation.



- Disperse radioactive material using conventional means.

- Explosively Disperse radioactive material [a “Dirty Bomb”].



- Create a Nuclear Weapon (this requires special nuclear material)

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Potential consequences of dispersal of radioactive material into…

Facility ventilation systems

- Inhalation (Internal) Dose hazard
- Interruption of 'normal life'
- Expensive cleanup costs

The general environment ("dirty bombs", crop dusters, fire, sprayer, etc..)

- Low likelihood of acute radiological effects
- May require population shelter or evacuation
- May be difficult to clean outdoor areas

Water supplies

- High Dilution
- Individually significant doses would ***not*** likely result.

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WHAT IS A 'DIRTY BOMB'?

- A "Dirty Bomb" is conventional explosives combined with radioactive material with the intention of spreading the radioactive material over a relatively large area.
- This is **NOT** a nuclear explosion, the radioactive material does not enhance the explosion.
- Very few deaths would be expected from acute radiological exposure (the greatest hazard would likely be from the effects of the conventional explosives).
- The contamination will hamper emergency response efforts and can delay hospital treatment.
- Widespread contamination can deny the use of facilities and areas and have a significant psychological impact on the exposed population.

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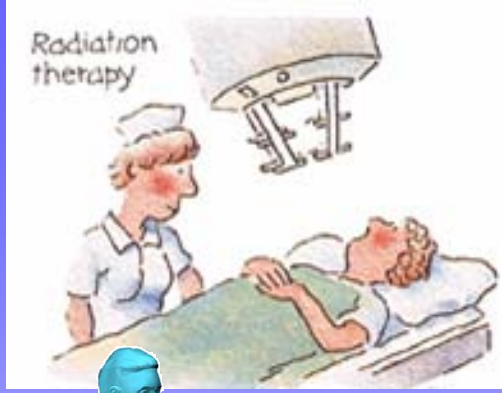
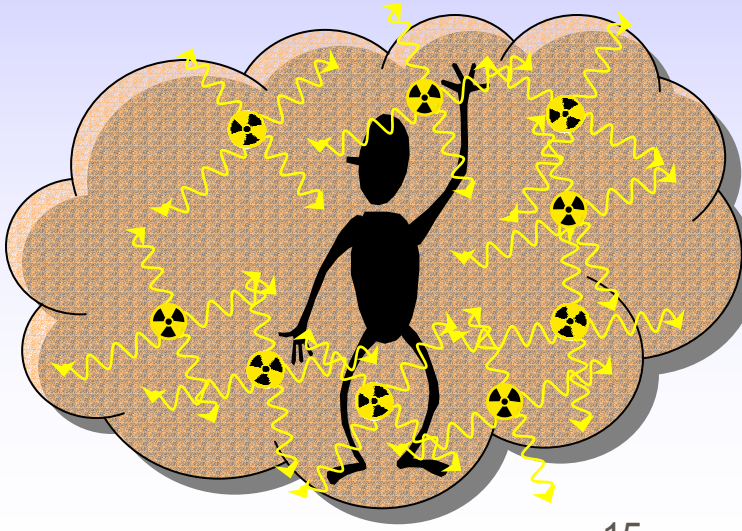
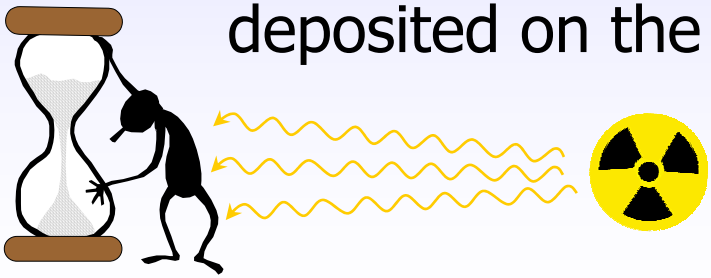
External Exposures



- Focused radiation or localized contamination can result in radiation effect to specific areas on the body

- Whole body exposure can result from:
  - A passing radioactive cloud or smoke
  - A large, distant point source
  - Exposure from contamination deposited on the ground





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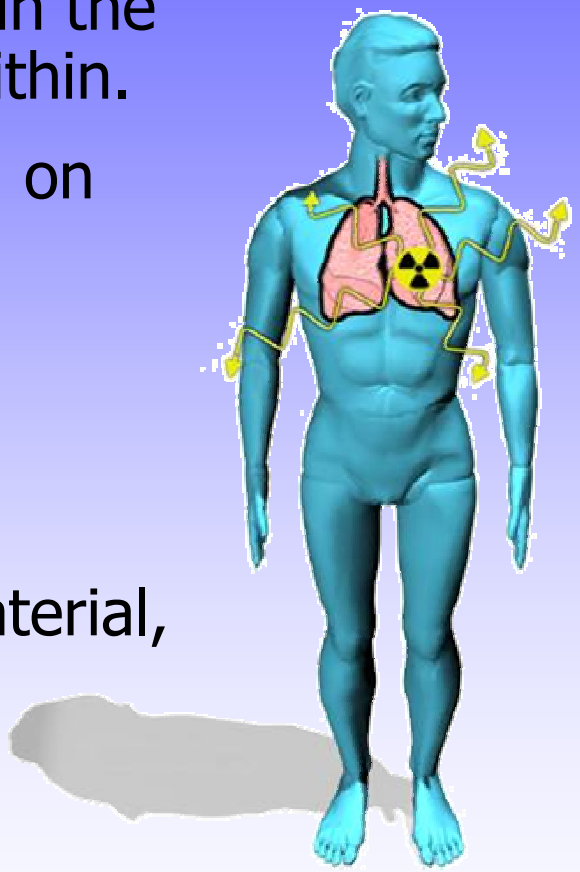
Internal Exposures

- Once radioactive material is deposited in the body, it can expose the person from within.
- The magnitude of the dose will depend on many factors:
  - How much material was deposited,
  - How it got into the body (ingestion, inhalation, absorption, or injection)
  - Chemical form of the radioactive material,
  - the radiation it produces,
  - How quickly it decays, and
  - How quickly the body eliminates the material



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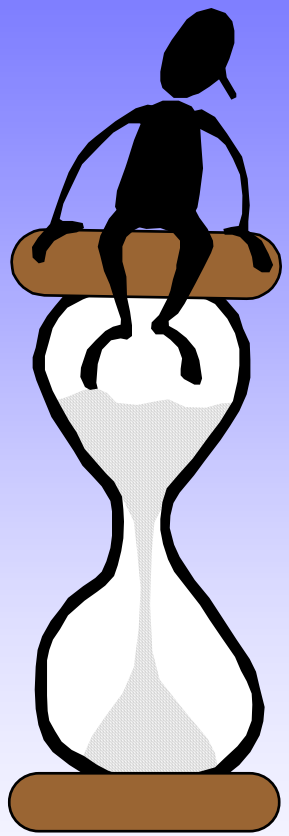
Internal Exposures

- Dose from internal depositions are usually expressed by **summing dose that will be received over the next 50 years from a one time internal deposition**.
  - Referred to as Committed Effective Dose Equivalent (CEDE).
  - This dose calculation/estimate takes into account factors on the previous slide.
  - Even with a large CEDE, there may or may not be acute effects from the exposure.



Do not use internal doses to predict acute exposure effects like nausea and vomiting.

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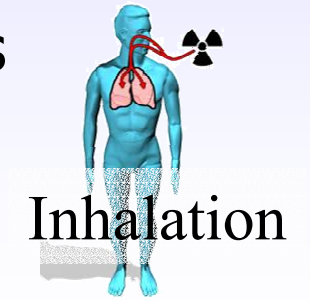
Types of Exposure & Health Effects

- **Acute Dose**
  - Large radiation dose in a short period of time
  - Large doses may result in observable health effects
    - Early: Nausea & vomiting
    - Hair loss, Fatigue, & medical complications
    - Burns and wounds heal slowly
  - Examples: Medical Exposures and accidental exposure to sealed sources

- **Chronic Dose**
  - Radiation dose received over a long period of time
  - Body more easily repairs damage from chronic doses
  - Does not usually result in observable effects
  - Examples: Background Radiation and Internal Deposition



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The Human Factor

- Concerns about radiation and contamination often produce an exaggerated emotional response.
  - Can't detect it with our 5 senses
  - Associated with cancer
  - Reminiscent of "cold war" fears
  - Science difficult to understand
  - Out of our control

- Possible results may be…
  - Unexposed people saturating the medical community
  - Health and economic effects from long term anxiety or depression in the community

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Conclusion:
Misuse of Radioactive Material

- High activity sources can cause health effects, but only to those in close proximity.
- Acute health effects from distributed radioactive material unlikely without prolonged, high-concentration exposure.
- Radiation or contamination will hinder response efforts.
- Denial of facilities and areas will have a major cost effect
- Public anxiety and it's effects may be the primary lasting health effect.

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