Radioactive Waste Characterization and Management

Est. Length: approx. 6 hours
Objective Review

- **EO 1** - For the following radioactive waste types, state their most common source:
  - Uranium tailings, Low-level waste, Intermediate-level waste, High-level waste, Transuranic waste

- **EO 2** - For the following radioactive waste types, determine what items typically make up the waste and the hazards associated with them:
  - Uranium tailings, Low-level waste, Intermediate-level waste, High-level waste, Transuranic waste
Objective Review

- EO 3 - Regarding low-level radioactive waste, state the classifications including the defining characteristics of each one.

- EO 4 – State the two common types of high-level radioactive waste.

- EO 5 – Discuss the generation, processing, and storage of the two types of high-level radioactive waste.

- EO 6 – For the following areas of Radioactive Waste Management, describe their importance to the operator and the information is involved in each area:
Objective Review

- **EO 7** – Discuss the guiding principles and core functions of Integrated Safety Management.

- **EO 8** – Discuss radioactive material shipping package types, including integrity, typical contents, and testing.

- **EO 9** – State the responsibilities and duties of an operator at a nuclear facility.

- **EO 10** – Describe the certification process for a fissionable materials handler.
Waste Characterization

- From multiple industries:
  - Mining
  - Defense
  - Medicine
  - Science
  - Nuclear Power

- Each waste is unique

- Can remain dangerous for thousands of years
Radioactive Waste Types

- Uranium Tailings
- LLW
- ILW
- TRU
- HLW
Waste by Volume

Relative waste volume

- 90% low level waste
- 7% intermediate level waste
- 3% high level waste

low level waste
intermediate level waste
high level waste
Waste by Activity

Total conditioned waste volumes from each business activity. Total volume 1,750,000 m³

- 2% Ministry of Defence
- 9% Research & Development
- 30% Commercial Reactors
- 57% Commercial Reprocessing
- 1% Medical & Industrial
- <1% Fuel Fabrication & Uranium Enrichment
Uranium Tailings

- From extraction of U for reactor fuel
- Stored in large piles
- Can contain high levels of heavy metals
- NRC regulations
From:
- Industry
- Medical
- Research
- Labs
- Nuclear power
LLW Waste Classification

- **Class A**
  - Low concentration
  - Short half-life (<30 years)
  - Background levels in 100 years
  - By NRC
  - 95% of LLW

- **Class B**
  - By NRC
  - From reactor sites
  - Background levels in 500 years

- **Class C**
  - DOE regulates
  - <1% of all LLW
Where are low-level waste disposal sites?

Each state is responsible for disposing of its low-level waste. Most States formed compacts with other States because 50 sites are not needed.

Four low-level waste disposal facilities are in:
- Richland, WA
- Clive, UT
- Barnwell, SC
- Andrews, TX
ILW

- Typically produced during reactor operations
  - IX material (sludge)
  - Irradiated materials

- Long-term stewardship

- Requires shielding
HLW

- Two common types:
  - Spent reactor fuel
  - Waste from fuel re-processing
    - Commercial, and
    - Defense

- Highly radioactive
  - Dangerous, and
  - Thermally hot
Spent Fuel Rods

Sources:

- Spent reactor fuel
  - Underwater for cooling and shielding

- Stored on-site
Spent Fuel Disposal

- After cooling in fuel pool (typically about 10 years)
- Shipped to long-term storage (not available yet)
Fuel Reprocessing

Two reasons

- To re-use remaining uranium on fuel rods
- To extract Pu and U for nuclear weapons
Fuel Reprocessing Sites

- Three Locations in US
  - West Valley, NY
  - Savannah River Site, Aiken, SC
  - Hanford Site, Richland, WA

- Millions of gallons of liquid and sludge requiring processing and disposal

- Vitrification Process
Vitrification Process

- Sludge and liquid in tanks cannot be transported or stored
- Transformed into glass (solid) for safe transport and disposal
HLW Vitrification On-Site Storage

- Necessary due to no permanent repository.

Radioactive waste is separated from liquid and mixed with glass forming agents.

When heated, molten glass is poured into casks and cooled.

The 14-foot casks will be stored on site. But where, and how, is still to be determined.
TRU Waste

- High curie content
- Low dose rates
- Alpha emitters
- Still extremely dangerous

Figure 2. TRU Defense Waste Generating and Storage Sites
Radioactive Waste Management

- DOE order 435.1

- Each waste type must be managed to the requirements
Many elements but the most important are:

- Con Ops
- Criticality
- Emerg. Mgt.
- Env. Monitoring
- Packaging and Transporation
- Radiation Protection
- Safety Management
Conduct of Operations

- Encompasses all work activities in specific chapters:
  - Organization and Administration
  - Shift Routines and Operating Practices
  - Control Area Activities
  - Communications
  - On-shift Training
  - Investigation of Abnormal Events
  - Notifications
  - Control of Equipment and Status
  - Lockout and Tagouts
Conduct of Operations

- Encompasses all work activities in specific chapters:
  - Independent Verification
  - Logkeeping
  - Turnover and Assumption of Responsibilities
  - Control of Interrelated Processes
  - Required Reading
  - Timely Instructions/Orders
  - Technical Procedures
  - Operator Aids
  - Component Labeling
Criticality Safety

- U-235 and Pu-239
- Fissile material
- Special Controls
- Accidents
- Typically not survivable
Emergency Management

- Training for on-site and off-site personnel
- Communication Plans
- Emergency Responders
- Local hospital staff
- Law enforcement
Environmental Monitoring

- Both continuous and emergency response
  - Water
  - Air
  - Ground
Radiation Protection

- Governed by Federal Rule
- Establishes control limits and boundaries
- Protects workers and public
- RCTs manage day-to-day activities
Integrated Safety Management

- 7 Guiding Principles
- 5 Core Functions
- Work together
Radioactive Material Packaging

- 24 hours/day and 7 days/week, radioactive material is moving.
  - Highway
  - Rail
  - Air
  - Water
Package Types

- Excepted – may survive an accident
  - Manufacturer packaging (cardboard)

- Industrial – may survive an accident, no releases allowed during normal handling (metal or wooden box)

- Type A – Designed to survive an accident

- Type B – Designed to survive a rail accident
Excepted Packages

- **Package** - The packaging with its radioactive contents as presented for transport
- **Packaging** - The assembly of components necessary to enclose the radioactive contents completely

![Image of packages](image-url)
Industrial Packages
Type A Packages
Type B Packages
Package Testing
Radioactive Waste Handling

- DOE requires handlers to be trained and qualified
Fissionable Material Handlers

- Must be certified:
  - Testing
  - Evaluation
  - Continuing Training
  - Proficiency
Questions??
Review

- Chemical Hygiene Plan – chemical safety
  - Elements
  - Training
  - Monitoring
  - SDSs
- Lab Safety
  - Chemical Safety
  - Exposure
  - Physical hazards
- Basic Lab Equipment