Transportation of Radioactive Materials



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Types of Radioactive Shipments

Uranium ores

Isotopes

- Medical
- Industrial
- Research

Weapons-related materials

Radioactive "waste"

- Spent fuel (SNF)
- High level waste (HLW)
- Transuranic waste (TRU)
- Low-level waste (LLW)
- Mixed low-level waste
- Reactor components
- Uranium mill tailings





128 sites in 39 states

Cargo Waste Forms & Package Designs





The Transportation Challenge

- Spatial diversity of shipping origins
- Many waste forms
- Varying volumes to be shipped
- Uncertainties
 - Where to ship?
 - When to ship?





Topics of Interest

- Transportation system infrastructure
- Radioactive shipment regulators
- Responsibilities of shippers & carriers
- Mode selection
- Routing
- Operational issues
- Institutional considerations
- Experience to date
- Risk perception



Transportation System Infrastructure

- Transportation networks
- Rolling stock
- Transportation casks
- Loading/unloading facilities
 - Wet/dry storage handling
 - Crane capacity
- Maintenance facilities







Radioactive Materials Transport Regulators

U.S. Department of Transportation

- Training
- Packaging
- Labeling/placarding
- Shipping papers
- Loading/unloading

Nuclear Regulatory Commission

- Package design & performance
- Safeguards & security
- **Others** (USPS, OSHA, EPA, IAEA, IMO, ICAO)



Responsibilities of Shippers & Carriers

Shipper

- Classifies & packages radioactive materials
- Marks & labels packages
- Completes & signs shipping papers
- Selects carrier

Carrier

- Reviews shipping papers
- Placards vehicle
- Stows & secures package
- Complies with driver training and routing requirements
- Follows vehicle safety requirements
- Reports incident (if one occurs)



Mode Selection

Rail

- Regular train
- Dedicated train

Truck

- Legal weight
- Overweight
- Heavy haul
- Barge
- Intermodal



Factors Affecting Mode Selection

- Container size & weight
- Characteristics & composition of radioactive contents
- Shipping distance
- Availability of transportation facilities & infrastructure





Routing

Highway (DOT HRCQ Routing Regulations)

- Vehicles operate over preferred routes
 - Interstate highway system, including bypasses or beltways
 - A state or tribe may designate alternative routes
- Alternative route selection based on multiple criteria
 - Travel time
 - Accident rate
 - Population density & special events
 - Temporal considerations (time of day, day of week, season)
 - Continuity of operations

<u>Rail</u>

- There are no federal rail routing regulations
- Standard rail industry practices
 - Minimize time, distance, number of carriers, interchange points
 - Maximize use of best track



Operational Issues

- Permits and fees
- Advance notification
- Inspections
- Security
 - Accessibility
 - Vulnerability
- Tracking & communications
- Safe parking
- Contingencies
- Emergency response
 - First response
 - Qualified response
- Recovery & cleanup



Institutional Considerations

- Transportation organization and culture
- Management processes
- Stakeholder identification & interactions
- Issue resolution







Experience to Date

- Roughly 3,000 shipments in the U.S. during the past 30 years
- 738 Navy container shipments, over 1 million miles since 1957
- Average 650 shipments per year in France and Britain
- There has never been a release of radioactive material harmful to the public or the environment



Perceived Relative Risks of Energy Sources

Considering the risks of normal operations and potential accidents, how do you rate the risks to society and the environment from these sources of energy?



Perceived Risks vs. Benefits of Nuclear Energy

How do you rate the overall balance of risks and benefits of nuclear energy in the US?



Thank You



Questions?