

Session III  
of  
LIVING IN A RADIOACTIVE  
WORLD

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# Transportation & Packaging of Radioactive Material & Radioactive Waste

- Radioactive Material
  - Transportation Regulations
  - Packaging Requirements
- Low Level Radioactive Waste
  - What is it?
  - Packaging
  - Transportation & Disposal
- High Level Radioactive Waste
  - What is it?
  - Packaging
  - Transportation & Disposal

# LLW Disposal Facilities Chronology

- September 1962 - 1st Commercial Low Level Radioactive Waste Facility Opens near Beatty, NV
- May 1963 - AEC policy requires Commercial disposal
- By 1971 Five Additional facilities open
- Incident at Beatty, March 1976
- Dec. 22, 1980 - PRESIDENT CARTER SIGNS THE LOW LEVEL WASTE POLICY ACT, creating regional compacts for the disposal of radioactive LLW waste.
- Three of six disposal facilities close after reaching initial design limits.
- Envirocare opens in 1988, licensed for Class A only!
- Beatty closes 31 Dec. 1992.

# Radioactive Material Transportation

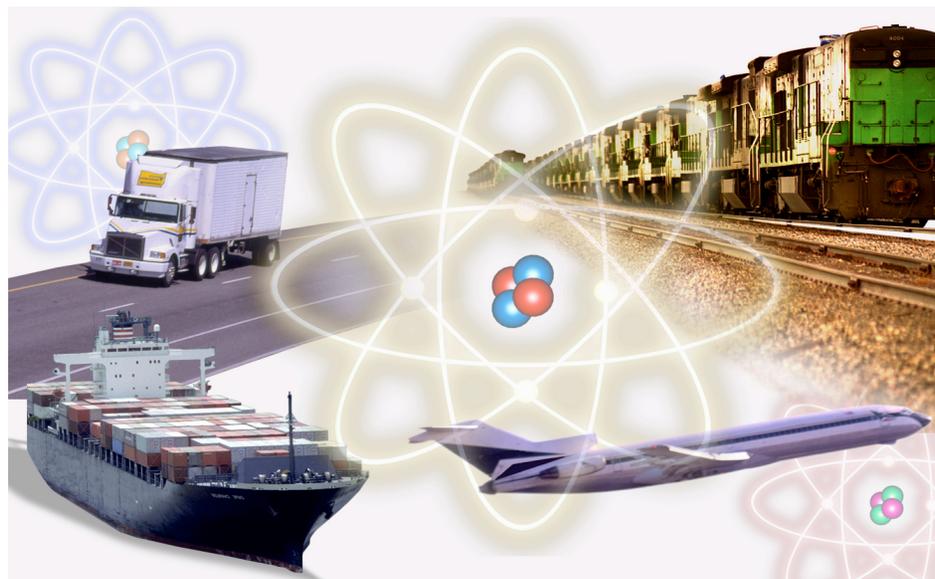
## Utah Issues



- ..... Rail Routes
- Interstate Highways

# Modes of Transport

- **Air**
  - Used for short lived radiopharmaceuticals
- **Rail**
  - Used when materials are very heavy or bulky.
- **Truck**
  - Used for everything else
- **Water**
  - *Not in Utah*



# Who Regulates Radioactive Material Transportation?

- Nuclear Regulatory Commission



- Regulates users of radioactive material (in conjunction with Agreement States) and the design, construction, use and maintenance of shipping packages for more hazardous radioactive material shipments

- U.S. Department of Transportation



- Regulates shippers and carriers of radioactive material and the conditions of transport (such as routing, tie-downs, vehicle requirements, handling and storage)

- State of Utah



- Highway Patrol and Department of Transportation enforce federal highway and motor carrier rules.
- Division of Radiation Control inspects shipments of waste at Envirocare.
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# Statutory Basis of DOT & NRC Packaging and Transport Regulations

- DOT - Dept. of Transportation Act of 1967, P.L. 89-670
- DOT - Transportation Safety Act of 1974, P.L. 93-633
- DOT - Hazardous Materials Transportation Uniform Safety Act of 1990
- NRC - Atomic Energy Act of 1954, P. L. 83-703
- NRC - Energy Reorganization Act 42 U.S.C. 5841

# Main Headings of DOT's 49 CFR “Hazardous Materials Regulations

- 49 CFR 106 Rulemaking Procedures
- 49 CFR 107 Hazardous Material Program Procedures
- 49 CFR 171 General Information, Regulations and Definitions
- 49 CFR 172 Hazardous Materials Tables, Communications & Emergency Response Information Requirements
- 49 CFR 173 Shippers-General Requirements for shipping & Packaging
- 49 CFR 174 Carriage by Rail
- 49 CFR 175 Carriage by Aircraft
- 49 CFR 176 Carriage by Vessel
- 49 CFR 177 Carriage by Public highway
- 49 CFR 178 Shipping Container Specifications

# Radiation Exposure Limits for Transporting Radioactive Materials

- On packages shipped as non-exclusive use (173-441 (a))
  - At any point on surface - 200 mrem/hr
  - At one meter from package surface-10 mrem/hr
- On packages & vehicles shipped as exclusive use (173.441 (b) & 10 CFR71.47)
  - At any point on package surface-200 mrem/hr, except for a closed transport vehicle only-1000 mrem/hr
  - At two meters (6.6 ft.) from lateral surfaces of vehicle-10 mrem/hr
  - At all external surfaces of vehicle-200 mrem/hr
  - In occupied area of vehicle-2 mrem/hr
- [Note: the radiation level at one meter from the surface of a package is

# Types of Shipments

- Radioactive Materials
  - Medical and Research sources
  - Consumer Products
  - Industrial Sources
  - Uranium Ores/Alternate Feed Materials
- Radioactive Waste
  - Spent Reactor Fuel
  - Transuranic Waste
  - Low Level Waste
  - Uranium Mill Tailings

# Who Ships Radioactive Materials?

- Radioactive Material (RAM) Licensees
  - Radiopharmaceuticals
  - Portable and Fixed Gauges
  - Industrial Radiographers
- Nuclear Power, DOE sites, RAM licensees, Other
  - Low Level Waste
  - NORM/NARM
  - Mixed Waste
  - Uranium Mill Tailings/Alternate Feed Materials
- DOE Waste Isolation Pilot Plant
  - Transuranic waste
- Foreign Research Reactor Spent Fuel
- DOE Office of Civilian Radioactive Waste
  - Commercial Spent Fuel

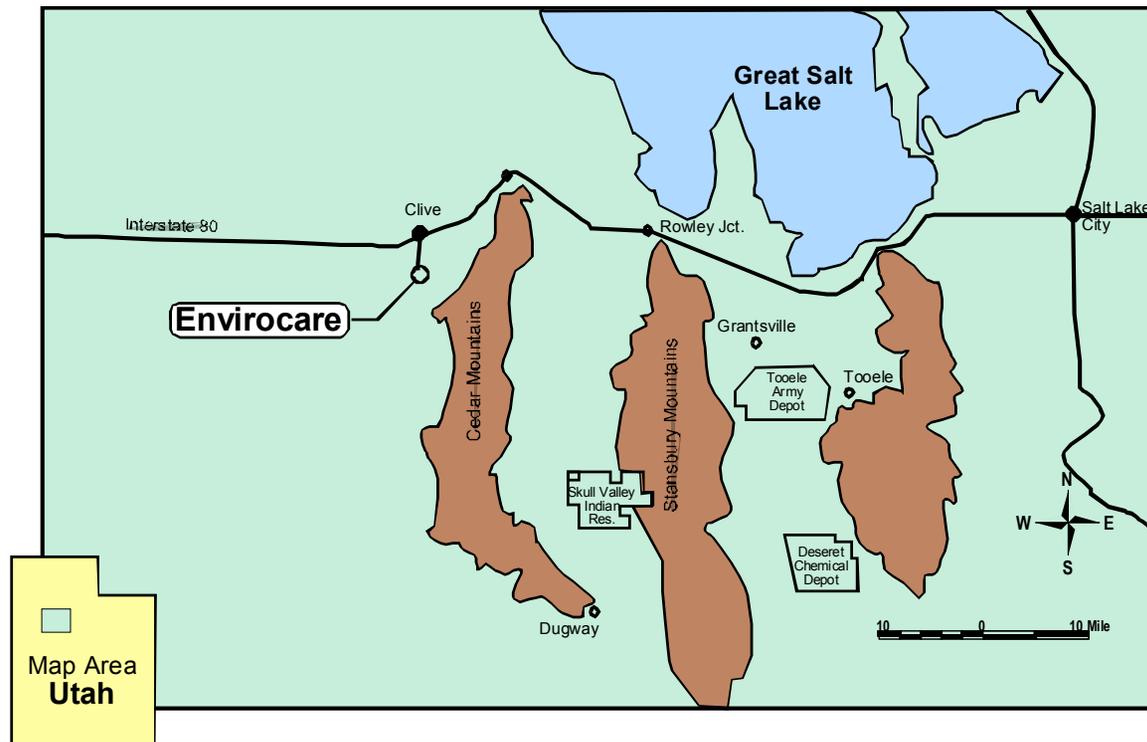
# Radioactive Material Shipments

Shipments made to or from Utah Licensees

- 201 Licenses
- 2 Radiopharmacies
  - Incoming packages 2340/yr or . 45 /wk
  - Outgoing to hospitals 15,600/yr or . 300 /wk
- 6 Universities with licenses
  - 2300 packages/yr or .45/wk
- 10 Radiographers
- 77 Portable Gauge Licenses
- 108 Other licenses

# Radioactive Waste Shipments to Envirocare

- Shipments Began 1988
- Shipment Activity
  - 11,115/yr or 213 rail cars/wk
  - 1,873/yr or 36 trucks/wk



# Waste Isolation Pilot Project

## Transuranic Shipments from USDOE sites

- WIPP facility near Carlsbad, NM
- Shipments began March 1999
- 35 year duration
- 578 thru Utah to date
- 14-20 shipments/wk
- Currently all by truck
- Northern Interstate System
- Training ongoing since 1988
- 3 Emergency Response Exercises  
(Morgan 93, South Weber 95, Tremonton 99)



# Foreign Research Reactor Spent Fuel

## Spent Fuel from Overseas

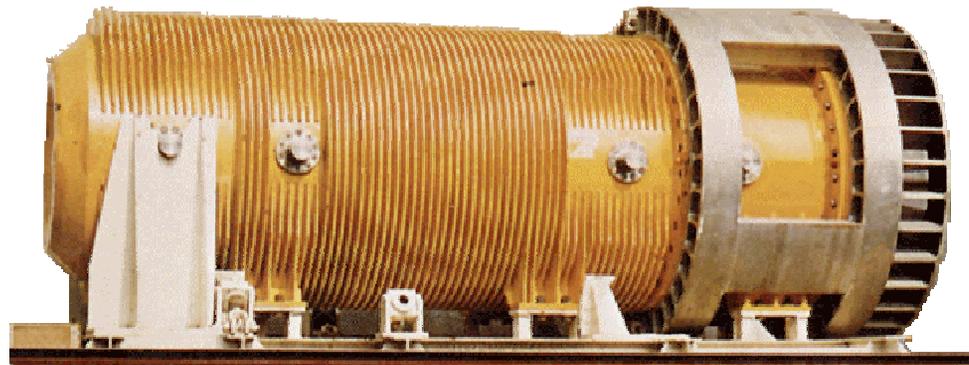
- Shipments began July 1998
- 13 year duration
- 1 train from California (3 casks)
- 3 shipments by truck from South Carolina (9 Casks)
- Training for Utah emergency responders in 1997
- Emergency Response Exercise in Cache County 1997



# Spent Fuel Shipments

## Office of Civilian Radioactive Waste Management

- Shipments to Yucca Mountain
- 30 year duration
- 175 shipments/year or 3-4 per week
- All shipments by interstate highways and rail lines
- Training required by National Waste Policy Act of 1987
- Regional Group (WGA) involvement likely



# Types: Excepted Packaging

Materials with extremely low levels of radioactivity



# Industrial Packaging

Used for Low Specific Activity Shipments (LSA)  
or Surface Contaminated Objects (SCO)



# Type A Packaging

Designed to withstand normal transport  
and minor mishap conditions



# PACKAGE TESTING REQUIREMENTS

## **Type A Tests**

Type A Packages must be able to withstand a series of tests that simulate normal transport conditions. These tests include:

**Type A Packaging** is used to transport small quantities of radioactive material with higher concentrations of radioactivity than those shipped in industrial packagings. They are typically constructed of steel, wood, or fiberboard, and have an inner containment vessel made of glass, plastic, or metal surrounded with packing material made of polyethylene, rubber, or vermiculite. Examples of material typically shipped in Type A Packages include nuclear medicines (radiopharmaceuticals), radioactive waste, and radioactive sources used in industrial applications. Type A packaging and its radioactive contents must meet standard testing requirements designed to ensure that the package retains its containment integrity and shielding under normal transport conditions. Requirements for Type A packaging are addressed in 49 CFR 173.412.

Type A Packages must withstand moderate degrees of heat, cold, reduced air pressure, vibration, impact, water spray, drop, penetration, and stacking tests. Type A Packages are not, however, designed to withstand the forces of an accident. The consequences of a release of the material in one of these packages would not be significant since the quantity of material in this package is so limited. Type A packagings are only used to transport non life-endangering amounts of radioactive material.

# PACKAGE TESTING REQUIREMENTS

## Type A Tests



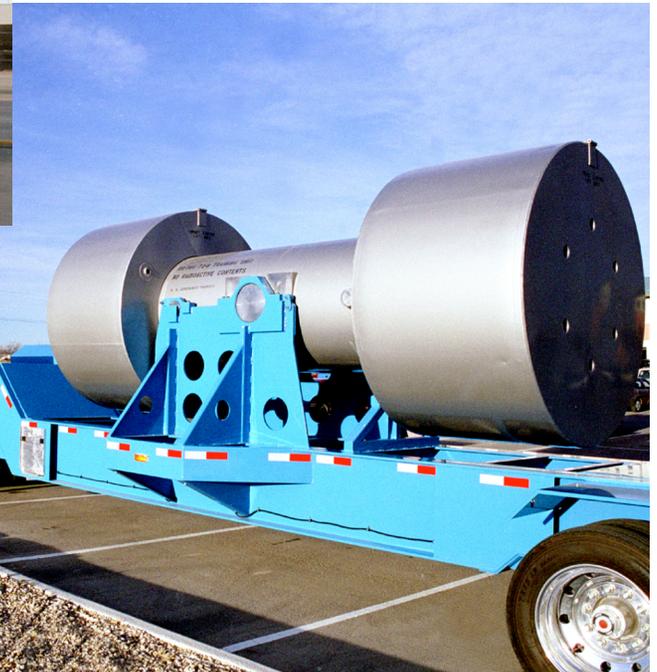
Water spray for 1 hour to simulate rainfall of 2 inches per hour.



Free drop test onto a flat, hard surface. This test is conducted

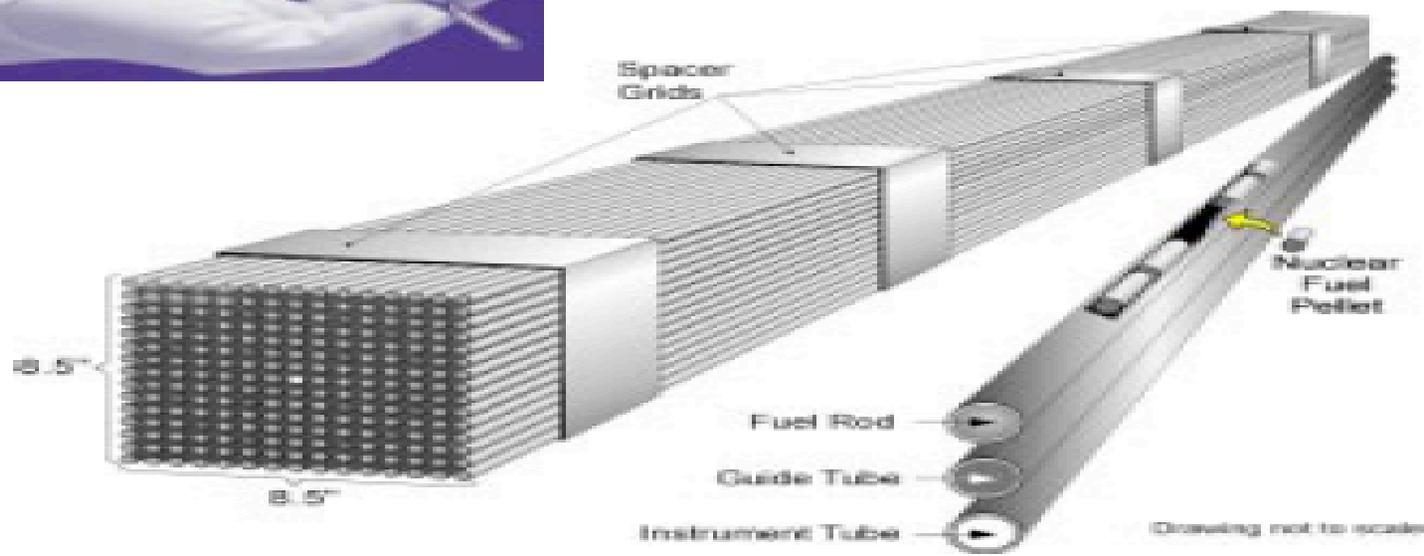
# Type B Packaging

Designed to withstand normal transport  
and severe accident conditions

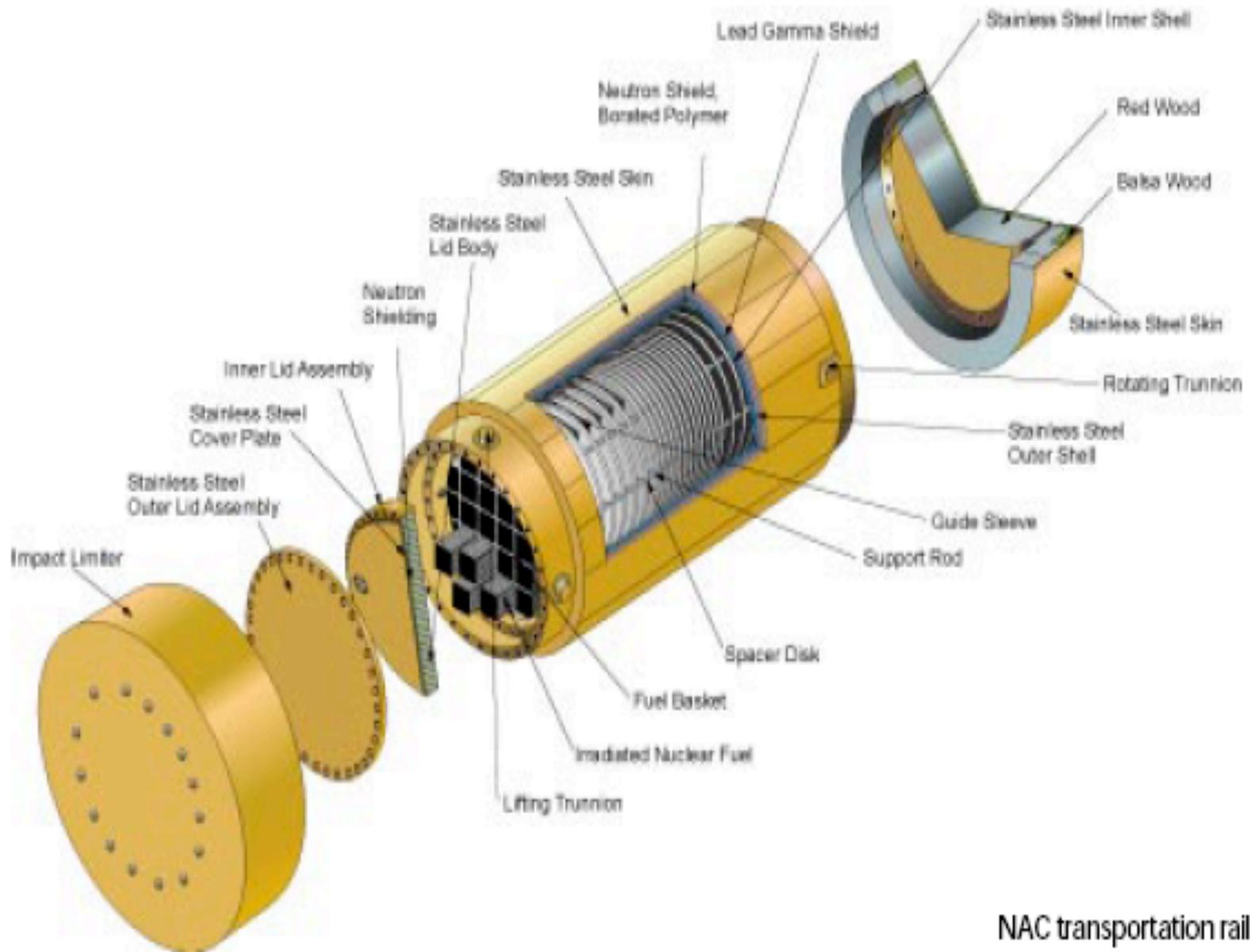


# What is spent nuclear fuel?

- “Spent nuclear fuel” is a collection of solid ceramic pellets. Each pellet is approximately the size of a pencil eraser, and is secured inside an assembly of strong, multi-layer metal tubes. These pellets, tubes, and assemblies are specifically manufactured to contain radioactive materials both during use in a reactor and during long-term storage. **Spent nuclear fuel is not a liquid or a gas, and will not pour or evaporate.**
- Spent nuclear fuel does not burn. In fact, it is not flammable; **it cannot burn, even if it is engulfed in fire.** Nuclear fuel generates heat when it is subject to certain conditions in a nuclear reactor; the heat from the fuel is used to create steam, which passes through a turbine and turns a



Typical nuclear fuel assembly design



NAC transportation rail cask

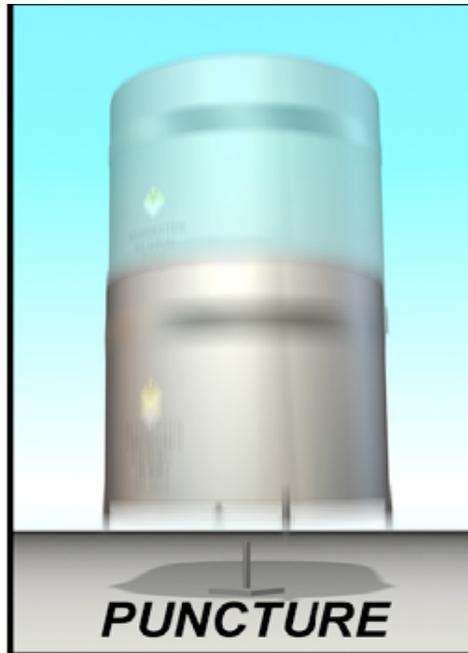
# PACKAGE TESTING REQUIREMENTS

- **Type B Tests**
- In addition to the requirements for Type A Packages, the Nuclear
- Regulatory Commission (NRC) requires that Type B Packages be
- able to withstand a series of tests that simulate severe accident
- conditions. These tests are conducted sequentially and include:

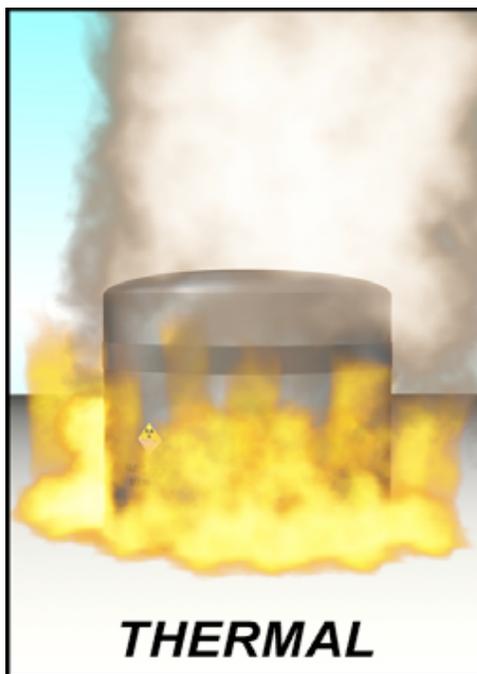
- **Type B Packaging** is designed to transport material with the highest
- levels of radioactivity. As illustrated in the photos below, Type B
- packagings range from small hand-held radiography cameras to
- heavily shielded steel casks that weigh up to 125 tons. Examples of
- material transported in **Type B packagings include spent nuclear**
- **fuel, high-level radioactive waste, and high concentrations of other**
- **radioactive material such as cesium and cobalt.** These package
- designs must withstand all Type A tests, and a series of tests that
- simulate severe or “worst-case” accident conditions. Accident
- conditions are simulated by performance testing and engineering
- analysis. Life-endangering amounts of radioactive material are
- required to be transported in Type B Packages. Requirements for
- Type B packaging are addressed in 49 CFR 173.411. 49 CFR 173.413
- and 10 CFR 71.



A 30-foot free drop onto a flat, essentially unyielding 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 its most vulnerable spot.



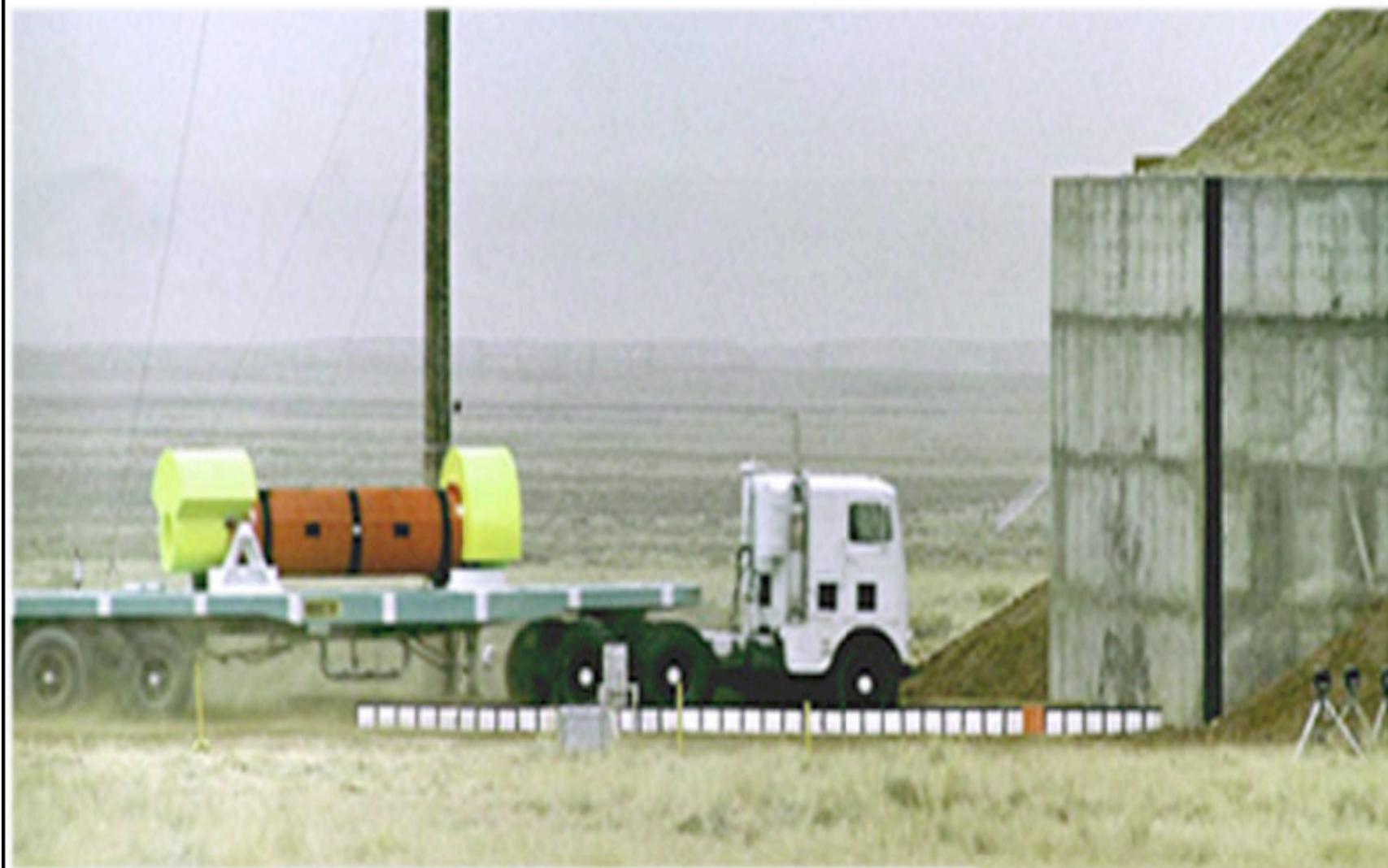
Exposure of the entire  
package to 1475°F for  
30 minutes.



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

# Demonstration of a Type B Package Test

To demonstrate that Type B Packages can withstand a severe accident, a tractor-trailer (below) carrying a Type B Package prototype was crashed into a massive concrete wall at 84 miles per hour. The package was slightly dented, but it did not release its simulated radioactive material.









# International Shipping Activity

- IAEA (International Atomic Energy Agency) estimates 18-38 Million packages of radioactive materials are shipped each year worldwide.

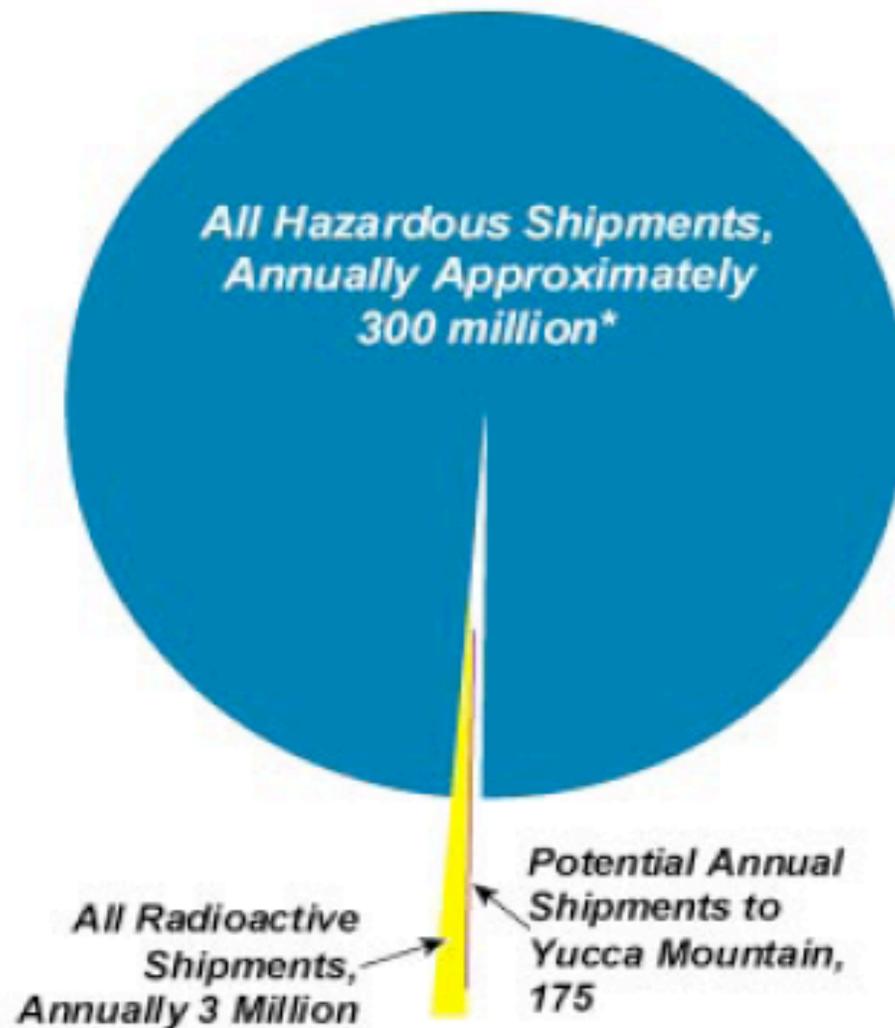
# History of Transporting Radioactive Material

- In the 50- year history of transporting radioactive material,
- there has never been a release from a Type B Package.
- In addition, there has never been an injury or death resulting from the release of radioactive material in a transportation incident.

# Shipments of Spent Reactor Fuel

- Our national experience (to date):
- 30 years;
- 2,700 shipments;
- 1.6 million miles;
- No harmful release of radiation

## ***A Comparison of Annual Shipments:***



\* Based on U.S. Department of Transportation Office of Hazardous Materials Safety Estimate. "Hazardous" shipments include materials such as explosives, flammable gases, solids and liquids, and poison gas.

# USA record VS Europe

Our safety record is comparable to that in Europe, where spent nuclear fuel has been transported extensively. Over the last 25 years, more than 70,000 metric tons of spent nuclear fuel (an amount roughly equal to what the Nuclear Waste Policy Act authorizes for Yucca Mountain) has been shipped. France and Britain together average 650 shipments per year, considerably more than 175 average annual shipments contemplated for the Yucca Mountain Project. While some of the shipments in Europe travel a shorter distance than some of the shipments to Yucca Mountain would travel, it's worth noting that these shipments travel across countries that are much more densely populated than the United States.

# WIPP Experience

- The Waste Isolation Pilot Plant, or WIPP, is the nation's first facility licensed to safely and permanently dispose of radioactive waste associated with the production of nuclear weapons. In the last 3 years WIPP has received nearly 700 shipments and logged 1.5 million safe transportation miles.

# Shipments to Yucca Mtn., NV

Should a repository be licensed at Yucca Mountain, the Department of Energy (DOE) projects that it would conduct approximately 4,300 shipments over a 24-year period. That's an average of about 175 shipments of spent nuclear fuel per year, a relatively small amount compared with the approximately 300 million annual shipments of hazardous materials<sup>1</sup>—explosives, chemicals, flammable liquids, corrosive materials, and other types of radioactive materials—that are currently transported around the country every day.

# **Assessing Potential Exposure from Truck Transport of Low-level Radioactive Waste to the Nevada Test Site**

prepared by

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# PIC Array



# Summary Results of the 1012 Truck Measurement Program

The absolute number of trucks per increment of exposure measured at the PIC array.

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Exposure Range:	Number of Trucks
<10 $\mu\text{R/hr}$	794 trucks
11-100 $\mu\text{R/hr}$	109 trucks
101-500 $\mu\text{R/hr}$	37 trucks
501-1,000 $\mu\text{R/hr}$	18 trucks
1,001-5,000 $\mu\text{R/hr}$	49 trucks
5,001-10,000 $\mu\text{R/hr}$	4 trucks
>10,000 $\mu\text{R/hr}$	1 truck

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# Summary of Results

- In the vast majority of cases (79 percent) measured in this study, the degree of exposure is approximately 2.5  $\mu\text{R/hr}$  (0.0025 mrem/h) or 0.025 percent of the DOT standard for the public.
- Even when cumulative exposures are calculated for short exposures of time (for example, Scenario 1), the results are still a small percentage of DOT standards.
- Only 5.3 percent of the trucks measured in this study had external readings exceeding 10 percent of the DOT standard (1 mrem/h @ 2 m).



# Emergency Response

- Local Responders First on scene
- Coordination begins here
- Responsibilities
  - Rescue Injured
  - Extinguish Fires
  - Provide First Aid/CPR
  - Isolate Area
  - Make Notifications to those with assets
    - Shipper
    - UHP, DEQ, DES, Federal Agencies
    -



