NPRI 442
Transporting Radioactive Wastes
Rich Holm
Low level Waste

- Typically shipped in drums or 4’x4’x6’ boxes

Minimal special controls on shipping – may be changing
LLW stacked at disposal site
Major RAM ShippingRegs

• 49 CFR ---- DOT Federal Transportation regs

• IATA – International Air Transport Association

• 10 CFR 71 – NRC -transport of RAM
Shipping Documentation

• **Classification** – Class 7 is radioactive
• **Hazardous substance** – (RQ) exceeds reportable quantity of isotope(s) 49 CFR 172.101 Appendix A
• **Proper Shipping Name** – special form or normal form, fissile, etc. and type of packaging
• **UN classification**
Radioactive White I Label: Nearly no radiation. The maximum allowable radioactivity is 0.5 millirem/hr on the package surface.

Radioactive White II Label: Low radiation levels. The maximum allowable radioactivity is 50 millirem /hr on the package surface, and one millirem /hr at three feet from the package.

Radioactive White III Label: Higher levels of radiation. Maximum allowable radioactivity is 200 millirem /hr on the package surface, and 10 millirem /hr at three feet from the package. Required for fissile Class III materials or large quantity shipments of any radiation level.

Radioactive Shipping Placard: Vehicles carrying packages with Yellow III labels must have a radioactive placard on both sides and both ends of the vehicle. TI > 10 is exclusive use vehicle (TI = transport index = dose in mr/her at 1 m)
Labeling Example
**Type A Packagings** are designed to survive normal transportation, handling, and **minor accidents**. They are used for the transportation of limited quantities of radioactive material (RAM) that would not result in significant health effects if they were released.

Type B packagings are certified as Type A on the basis of performance requirements, which means it must survive certain tests.

Type A packagings may be cardboard boxes, wooden crates, or drums. The shipper and carrier must have documentation of the certification of the packages being transported.

**Type B Packagings** must be able to survive severe accidents. They are used for the transportation of large quantities of radioactive material. A Type B packaging may be a metal drum or a huge, massive shielded transport container. Type B packagings must meet severe accident performance standards that are considerably more rigorous than those required for Type A packages.

Type B packagings either have a **Certificate Of Compliance (COC)** by the **Nuclear Regulatory Commission (NRC)** or **Certificate of Competent Authority (COCA)** by the **Department of Transportation (DOT)**.
Special Form Capsule is used for sources where possible to reduce the shipping requirements if the source material exceeds the Table A value (i.e. must be shipped in a Type B package – much more involved and expensive.)

NOTE: A spent fuel cask is a Type B package.

A special form capsule is designed such that an encapsulated source will be contained within the capsule for any type of accident short of the complete destruction of the capsule.

Use of the special form capsules at Illinois for the shipment of 4 RaBe sources changed the shipping costs from ~$35,000 (Type B cask) to ~$5,000.
<table>
<thead>
<tr>
<th>No. of units and Container type</th>
<th>HM</th>
<th>BASIC DESCRIPTION</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 DM</td>
<td>X</td>
<td>Ra, Radioactive Material, Type A Package, Special Form, Class 7, 1 1/302. Instructions provided to CRFWS DOT NAFRC 2164 included in the drivers instruction booklet.</td>
<td></td>
</tr>
</tbody>
</table>

**Exclusive Use Shipment**

| SN121275 Ra-226, solid oxide, 19.1 Gbq, Radioactive Yellow III, T1-10.9 | 225 KG |

**Placarding Required**

**24 Hour Emergency Contact:** Rich Hall 317-621-6099. This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.
TYPICAL SPENT FUEL TRANSPORTATION CASKS

Generic Truck Cask

- **Typical Specifications**
- Gross Weight (including fuel): 50,000 pounds (25 tons)
- Cask Diameter: 4 feet
- Overall Diameter (including Impact Limiters): 6 feet
- Overall Length (including Impact Limiters): 20 feet
- Capacity: Up to 4 PWR or 9 BWR fuel assemblies
Generic Rail Cask for Spent Fuel

- **Typical Specifications**
- Gross Weight (including fuel): 250,000 pounds (125 tons)
- Cask Diameter: 8 feet
- Overall Diameter (including Impact Limiters): 11 feet
- Overall Length (including Impact Limiters): 25 feet
- Capacity: Up to 26 PWR or 61 BWR fuel assemblies
All spent nuclear fuel cask designs must be certified by the NRC, and must safely contain radioactive contents under hypothetical accident conditions that simulate the conditions of severe accidents. These conditions must be evaluated in sequence, on the same cask design:
- a 30-foot free fall onto an unyielding surface, landing on the cask’s weakest point, which would be equivalent to a crash at 120 miles per hour into a concrete bridge abutment;
- a puncture test, during which the container must fall 40 inches onto a steel rod six inches in diameter;
- a 30-minute exposure to fire at 1,475 degrees Fahrenheit that engulfs the entire container; and
- submergence of the same container under three feet of water.

To achieve certification, a cask must prevent harmful release of radioactive material even when subjected to each of these tests.

How is cask safety verified?
The NRC and the DOE both maintain state-of-the-art capabilities to evaluate cask strength. The NRC evaluates cask designs as part of the certification process, and the Department’s labs—the so-called “national labs”—have been called upon in the past to conduct a variety of cask tests.
• The NRC regularly updates its cask safety evaluations. The NRC reviews real-life transportation accidents to verify that cask designs will continue to perform safely and securely during transport. For example:
  - As a result of the Howard Street Tunnel accident in Baltimore, Maryland (which did not involve radioactive materials), studies were done by the NRC to determine the potential effects of such an accident if it involved a spent fuel shipping container. As a result of these studies an NRC staffer concluded that the spent fuel would not have been damaged in a similar accident scenario. (Nuclear Fuel, 11/12/01)
  • Live-action tests. Extensive studies and tests have been conducted. Examples are:
    - Sandia Crash Tests. Sandia National Laboratories in New Mexico subjected casks to real-life accidents to see what would happen. They included:
      (1) A flatbed truck loaded with a full-scale cask was smashed into a 700-ton concrete wall at 80 miles an hour.
      (2) A cask was broad-sided by a rocketpropelled 120-ton rail locomotive traveling 80 miles per
hour, and
(3) A transportation container was dropped 2000 feet onto soil as hard as concrete, and was traveling 235 miles an hour at impact.

In all of these cases the containers survived their tests intact.
- Operation “Smash Hit.” On July 17, 1984, the Central Electricity Generating Board of Great Britain conducted a live television demonstration of spent fuel cask integrity. In front of 2,000 spectators, CEGB rammed an unmanned locomotive at 100 mph into a MAGNOX spent fuel cask. The cask survived the test with superficial damage, meeting the stringent containment standards. Although the cask was of British design, essentially the same international design standards for strength are used in both the U.K. and the U.S.
British rail test
Unstoppable force meets immovable object
Drop Test
Routing. The DOT has established a process that must be used for evaluating potential highway routes, and the NRC would approve all routes and security plans. States and tribes will work with the DOT, the DOE and the NRC to identify preferred shipping routes; all states and tribes can—and some states already have—designated their “preferred” highway routes.

Security. Armed escorts are required through heavily populated metropolitan areas and, at the discretion of the Governor of a state, through the entire state. All shipments are accompanied by escorts 24-hours a day.

Tracking. The Governor of each state is notified in advance of spent fuel shipments. Federal officials track these shipments around the clock through a satellite-based tracking system. In addition to continuous tracking by satellite, these shipments are required to have an escort report in to the central transportation command facility every two hours to ensure there are no problems.

Coordination with States. Specific timing and routes of shipments are kept classified for security reasons. However, those with a need-to-know (such as state or tribal representatives, law enforcement and emergency response officials, and inspectors) are informed of spent fuel shipments as they are being transported. All shipments are closely coordinated with local and federal law enforcement agencies.
Not everything goes by truck or rail

*Maine Yankee steam generators on barge*
Fuel shipping at U of I

- 203 TRIGA elements – to be loaded in:
  - Three NAC-LWT casks
  - One 6M drum (2 training elements)
- 4 Fuel Follower Control Rods to cut
- 14 failed aluminum elements to go in sealed cans
Bought a 5000 gallon poly tank, cut the top off and put it in the bay to cut the FFCRs – didn’t want to risk contaminating my clean pools.
Majority of the fuel was in the BST in racks – positions had been optimized for loading the fuel baskets per the loadout sheets
Preloaded fuel baskets
Loading basket into inner shield
Inner shield going into ITS
ITS and DTS in position
Transferring fuel from the ITS to the DTS
DTS mating to LWT
Cask supported by crane, removing the lockdown chains
Lifting the cask to the trailer
Cask lowering into cradle
Rocking down into place
Final degassing and drying of Shipping Cask.

The casks are vacuum dried
Shipping cask inside shipping container
Crushable end bells for another cask at left
Hitting the Road

Note the trailing vehicles – State :Police in front and back, IDNS behind.
B25 containers
Loading activated graphite
Your Prof at work labeling
Loading a Sealand
Reflector/core assembly
Sealand & 2 B25s
Loading concrete rubble bags

Shipped
Activated/contaminated Pb in boxes
Lazy susan mockup
Lazy susan evolution
Lazy susan move to container
(video)
Loading LS container in cask
Lid on cask