Transportation of High-Level Radioactive Waste and Spent Nuclear Fuel in the Northeast

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Transporting Radioactive Waste

- NATIONAL/INTERNATIONAL
 - Past and Present Shipments
- Shipments in New England
- Planning for Commercial Spent Nuclear Fuel Shipments

NATIONAL/INTERNATIONAL SHIPMENTS

- The U.S. nuclear energy industry has completed more than 3,000 shipments of spent nuclear fuel over the past 40 years (Lanthrum NWTRB 6/13/18)
- Internationally, there have been more than 7,000 shipments of used fuel (over 80,000 metric tons) over many millions of kilometers by land and sea. (Lanthrum NWTRB 6/13/18)
- The U.S government has accepted up to 22,700 spent fuel assemblies from research reactors from 41 countries around the world and transporting them for interim storage at DOE facilities in South Carolina and Idaho.
- The majority of spent nuclear fuel and high-level waste shipped routinely from research and defense/naval facilities throughout the U.S. is sent to Idaho, South Carolina and Washington for storage.

Safety

- Although there have been accidents, none of those shipments have ever released any of their radioactive cargo, and there have been no injuries, fatalities, or environmental damage as a result of the spent nuclear fuel being shipped. (Lanthrum NWTRB 6/13/18)
- The accident risk associated with spent fuel shipments is more than three orders of magnitude less than for some other common of hazardous materials. (Lanthrum NWTRB 6/13/18)

Past and Present Transportation

 Department of Energy Office of Environmental Management (DOE-EM)

 National Nuclear Security Administration (NNSA)

Waste Isolation Pilot Plant, NM



WIPP





WIPP Facts

- First shipment of waste in March 1999.
- As of 2018 WIPP received 12,160 shipments. Sometimes as many as 35 per week.
- Loaded WIPP shipments traveled 14.5 million miles.
- Several minor accidents but no release of radioactive material.

WIPP Shipment



Repatriation of Nuclear Fuel



Shipping Solid and Liquid Highly Enriched Uranium (HEU > 20% U-235)



Shipping Cask for Solid and Liquid EU



Shipping Cask for EU





Naval Spent Fuel Type B Shipping Containers

- Models M-140 and M-290:
 - Type B NRC/DOE Certified
 - At least 10" thick solid stainless steel
 - 350,000 and 520,000 pounds (loaded), respectively
- Thick, solid steel typically results in radiation levels much lower than the safe maximum DOT limits:

	DOT Limit	Naval Container	Typical Chest X-Ray
On contact	200 mR/hr	1 to 5 mR/hr	10 mR
At 2 meters	10 mR/hr	.1 to .5 mR/hr	

Everyday life exposure to radiation:
~300 mr/yr – soil, rocks, cosmic rays, radon





Transportation of SNF in New England

- Prior Shipments of SNF
- Shipping of large radioactive components during decommissioning

YANKEE ATOMIC HISTORICAL SPENT NUCLEAR FUEL ASSEMBLY SHIPMENTS

- A total of 51 shipments involving 333 spent fuel assemblies occurred in the 1960's and 1970's. There were 316 assemblies shipped in 34 rail shipments and 17 assemblies shipped by truck.
- The 34 rail shipments occurred between July 26, 1965 and May 26, 1971 and went to West Valley, NY for reprocessing. The rail shipments occurred during a 6year period with approximately 1 shipment every 2 months.
- There were 8-10 assemblies per rail shipment using the Westinghouse ELC-102 rail cask (the cask weighed 73 tons fully loaded and was 13 ft long; 5 ³/₄ ft diameter).

CONNECTICUT YANKEE HISTORICAL SPENT NUCLEAR FUEL ASSEMBLY SHIPMENTS

- A total of 83 truck shipments involving 83 spent fuel assemblies occurred in the 1970's and 1980.
- 80 shipments were made between January 13, 1972 to August 8, 1974 to Morris, Illinois and 3 shipments occurred between April 27, 1980 and May 12, 1980 that went to Battelle Columbus, Ohio for study (two later sent to Morris facility in a NLI-1/2 Truck Cask).
- The 1972-1974 shipments used the GE IF–200 single assembly truck cask (the cask weighed 25 tons and was 13 ft by 3.5 ft).
- There were an average of 2.5 shipments per month over the 30-month period.

Large Radioactive Components Shipped During Decommissioning







YANKEE ROWE REACTOR PRESSURE VESSEL TRANSPORT- 1997

Package Specifications

28 feet long x 13.5 feet in diameter 365 tons including saddle and tie-downs RPV filled with low density grout RPV encased inside container with grout

First-Of-A-Kind shipment of a very heavy, radioactive RPV by rail over 1,000 miles from MA to SC

Successful negotiation with 5 railroads: Guilford (old B&M), Canadian Pacific, Conrail, Norfolk Southern, and CSX











MAINE YANKEE REACTOR PRESSURE VESSEL TRANSPORT – 2003

MY RPV package included the RPV, its three-inch thick steel shipping container, and the transport cradle holding it and weighed about **1175 tons**.

It was approximately **35 feet long** and **19 feet** in diameter.

The RPV package was welded to the transport cradle.

The package met the U.S. Department of Transportation radiological shipping requirements of <200 mR/hr on contact and <10 mR/hour at 2 meters.

The actual dose at 2 meters was approximately 1 mR/hour. All radioactive components included in the package were Class C or less in accordance with federal regulations.







CONNECTICUT YANKEE REACTOR PRESSURE VESSEL TRANSPORT -2003

Reactor Pressure Vessel 383 tons

Low density concrete inside RPV 146 tons and between walls of RPV and shipping container

Steel shipping container 191 tons

Shipping cradle and tie down equipment 100 tons

Total RPV package weight = 820 tons

Length of RPV package = **35 feet** Diameter of RPV package = **18 feet**



Future Shipments of Commercial Spent Nuclear Fuel

Future Yankee Rowe; Maine Yankee; Connecticut Yankee SNF Shipments Will Use a NAC International Transport Cask

NAC Dual-Purpose Canister System Schematic



NAC Transportation Cask For Multipurpose Canister (MPC)



FIGURE 2-12: NAC-STC PACKAGE (<u>https://curie.ornl.gov/content/initial-site-specific-deinventory-report-maine-yankee</u>)



Northeast Task Force

- Created in 1995
- Representatives from 10 Northeast States from Maine to Delaware
- Funded by DOE Cooperative Grants
- Managed by the Council of State Governments/Eastern Regional Conference located in Manhattan, NY

Task Force Activities

- Develop and Coordinate transportation policy with the DOE, State Regional Groups, and Tribes
- Receive updates on WIPP, foreign, and commercial spent nuclear fuel shipments

Northeast Task Force

- Hold at least 2 regional group meetings per year
 - One meeting held concurrently at the National Transportation Stakeholders Forum (NTSF) annual meeting
- 2017 NTSF annual meeting held in Pittsburg
- 2018 NTSF annual meeting held in Omaha
- 2019 NTSF annual meeting will be held in Alexandria, Virginia June 10-13

NWPA Section 180(c) Mandate

"The Secretary shall provide technical assistance and funds to States for training for public safety officials of appropriate units of local government and Indian tribes through whose jurisdiction the Secretary plans to transport spent nuclear fuel or high-level radioactive waste [to an NWPA-authorized facility].

•The training shall cover procedures for safe routine transportation of these materials and procedures for dealing with emergency response situations.

•Covers all modes of transport including rail, highway, and barge

SNF Stored in the US

Credit: Nuclear Regulatory Commission



Permanently & Announced Shutdown Nuclear Plant Sites

Credit: Decommissioning Plant Coalition



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DOE-Office of Nuclear Energy (DOE-NE) has been gathering data from sites as they shut down

• Preliminary Evaluations of Removing Used Nuclear Fuel from Shutdown Sites [DOE Bickford 6/13/18 presentation]:

•Includes input from site personnel, local Tribes/states, DOT, and other stakeholders

•These reports are a first look at how an integrating contractor could recommend going about removing SNF and GTCC waste from these sites

• The reports represent one contractor's perspective and do not represent DOE's plans

 No "showstopper" technical issues identified among the six sites studied

Shutdown Sites – De-Inventory Reports



Initial Site-Specific De-Inventory Report for Maine Yankee

RPT-3016127-002

Prepared by: AREVA Federal Services LLC

March 21, 2017

Initial Site-Specific De-inventory Report for Connecticut Yankee

RPT - 3014538-002

Prepared by: AREVA Federal Services LLC

May 5, 2017

Oyster Creek Nuclear Generating Station

Oyster Creek ceased operations on September 17, 2018

Site-Specific De-Inventory Report Planned for May 2019

Spent Fuel will be primarily transported by rail

Spent Fuel Transportation Casks (1 of 2)





Spent Fuel Transportation Casks (2 of 2)

Nuclear Energy



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The Complete Spent Fuel Train



- Two locomotives
- Buffer railcar
- One or more Atlas railcar(s)
- Buffer railcar
- Rail Escort Vehicle



Atlas Preliminary Design: Attachment System

Cradle Attachment Pin Blocks



End Stop Attachment Pin Blocks



Atlas Preliminary Design: Heaviest Load



Total Load: Approximately 480,000 lbs. Center of Gravity: 96.08 inches above the top of the rail



Fabrication Photos Welding Atlas in June 2018





Fabrication Photos Atlas in September 2018



Fabrication Photos Buffer Car in September 2018





Fabrication Photos Rail Escort Vehicle in October 2018





Path Forward

- Ship Atlas and Two Buffer Railcars to the Testing Facility in Colorado
- Perform Phase 4, Single-Car Testing
- Fabricate DOE's Rail Escort Vehicle
- Perform Phase 5, Multiple-Car Testing
- Conditional Approval from AAR



Summary

- DOE is making steady progress on Atlas, Buffer and Escort Railcars.
 - Fabrication of prototype Atlas and Buffer Railcars is complete.
 - DOE and Navy have agreed on fabrication of DOE's Rail Escort Vehicle.
 - DOE awarded a contract for the single-car and multiple-car testing program.
- Conditional Approval from AAR is expected in 2022.



Two private companies are pursuing siting and building Consolidated Interim Storage Facilities

Interim Storage Partners, LLC in Andrews County, Texas

- -- NRC application submitted April 28, 2016
- -- Store 40,000 metric tons heavy metal

◆Holtec International, Lea County, New Mexico

- -- NRC application submitted March 31, 2017
- -- Initial application for 8,680 metric tons heavy metal

Artist Rendering of Proposed WCS Consolidated Interim Storage Facility (CISF) Source: Waste Control Specialists



Artist Rendering of Proposed Holtec Consolidated Interim Storage Facility (CISF) Source: Holtec



Consolidated Interim Storage Sites

Priority for Shutdown Sites NRC Review may be completed by 2020-2021

State's need 3 to 5 years to train emergency responders Emergency Response is diminishing as power plants shut down

Questions?