Lessons Learned from the West Valley Spent Nuclear Fuel Shipment within the United States

Michael J. Tyacke, Traci Anderson

Idaho National Engineering and Environmental Laboratory, P.O. Box 1625, Idaho Falls, Idaho, USA 83415-3135

Abstract

This paper describes the lessons learned from the U.S. Department of Energy (DOE) transportation of 125 DOE-owned commercial spent nuclear fuel (SNF) assemblies by railroad from the West Valley Demonstration Project to the Idaho National Engineering and Environmental Laboratory (INEEL). On July 17, 2003, DOE made the largest single shipment of commercial SNF in the history of the United States. This was a highly visible and political shipment that used two specially designed Type B transportation and storage casks. This paper describes the background and history of the shipment. It discusses the technical challenges for licensing Type B packages for hauling large quantities of SNF, including the unique design features, testing and analysis. This paper also discusses the preshipment planning, preparations, coordination, route evaluation and selection, carrier selection and negotiations, security, inspections, tracking, and interim storage at the INEEL.

Background and History

In 1966, Nuclear Fuels Services (NFS), Inc. began operation of Western New York Nuclear Services Center, the first and only commercial fuel processing facility in the United States (U.S.). The facility is located south of Buffalo, New York on 200 acres of land owned by New York State. NFS operated the facility under a lease with the State of New York from 1966 to 1972. In 1972, NFS halted processing with the intent of upgrading the facility for greater production. After the facility was shut down, the U.S. government enacted stricter environmental laws, which significantly increased the cost for upgrading the facility. For financial reasons, NFS decided not to upgrade the facility and did not renew its lease with New York State when the lease expired in 1980. At that time, there were 750 SNF assemblies stored at the facility.

In 1980, the U.S. Congress passed the West Valley Demonstration Project Act, which directed the U.S. Department of Energy (DOE) to conduct a high-level waste management project at the former processing facility. Between 1983 and 1986, 625 of the SNF assemblies, involving 257 individual cask shipments, were returned to the originating utilities. The remaining 125 of the 750 SNF assemblies belonged to NFS. In 1984, DOE agreed to take title of these assemblies in exchange for NFS providing two large dual-purpose casks for transporting and storing the SNF assemblies.

The Idaho National Engineering and Environmental (INEEL), one of DOE's national laboratories, had a program for developing and testing prototype casks for the dry storage of SNF. Development of a multi-purpose cask system for transport and storage of SNF was added to the program. The INEEL became responsible for managing the procurement, licensing, and ultimately storing of the loaded casks in Idaho.

Several attempts were made in the 1990s to prepare for shipment. However, for technical and political reasons, the shipment was repeatedly delayed. In August 2001, DOE had everything in place to make the shipment. But, in late October 2001, DOE chose to postpone the shipment and focus on efforts at the INEEL to meet legal commitments with the State of Idaho on waste management. Even though the September 11 terrorist attack did not cause the delay in the shipment, sensitivity to the attack would have been a factor in making the shipment.

On July 17, 2003, DOE completed the shipment. The movement of more than 2,300 miles was completed safely, securely, and without incident more than 17 hours ahead of schedule; see Figure 1.

Type B Packages Licensing

The West Valley cask systems are high capacity, first-of-a-kind, specially designed Type B packages for transport and storage casks; see Figure 2. The TN-REG cask (USA/9206/B(U)F) is a cylindrical steel cask designed for shipment of up to 40 pressurized water reactor SNF assemblies. It has an empty weight of 82,100 kg (181,000 lb) and a fully loaded and assembled weight of 105,687 kg (233,000 lb). The TN-BRP cask (USA/9202/B(U)F) is a right circular cylindrical cask designed for shipment of up to 85 boiling water reactor SNF assemblies. It has an empty weight of 81,465 kg (179, 600 lb) and a fully loaded and assembled weight of 101,033 kg (222,739 lb).

Figure 1. Photograph of the loaded West Valley casks parked inside the INEEL secured area.

Initially, DOE intended to self-license the casks as authorized in the 49 Code of Federal Regulations (CFR) for the U.S. Department of Transportation [1]. However, for political and public acceptance reasons DOE decided to have the U.S. Nuclear Regulatory Commission (NRC) license the casks. This decision had a significant impact on the licensing and approval of the casks.

To accommodate the large payload, the cask design incorporated features that had never been licensed. Borated stainless steel (BSS) baskets were used for criticality control; see Figure 2. The NRC had never licensed a Type B cask with BSS basket. Because the BSS was not a codified material, the NRC would not allow DOE to take credit for the materials for use in critically control or providing structural integrity. That decision resulted in the casks being licensed for only half-load shipments. Special inserters were designed and built to be placed inside half of the basket ports to provide criticality control and structural integrity.

Delays in the shipment allowed time for BSS material to become codified. Several technical meetings and destructive examination of representative samples of actual materials from inside the original basket provided the technical basis for the NRC to allow DOE to use the BSS basket for criticality and structure control. The BSS materials were shown to have uniformly distributed boron throughout the material and the structural integrity to meet or exceed the physical properties required for codified BSS materials. By demonstrating the integrity of the material, the NRC agreed to license the casks for a single, full load, one-time-only shipment.

Other design and hardware changes resulted from the NRC licensing. The bolts attaching the impact limiters to the casks had to be enlarged. Special tie rods were installed between the two impact limiters to ensure that the impact limiters did not break loose from the casks during a hypothetical accident; see Figure 3.

Some of the SNF was damaged. There was not enough room in the casks or baskets to accommodate damaged fuel canisters. Specially designed caps were placed at the top and bottom of each fuel assembly basket port to contain any loose material that may result from the transportation or a hypothetical accident.

Lessons learned from the design, fabrication, and licensing of the West Valley casks are to first include the regulator early in the design process. This ensures buy in, at least conceptually, to all design features before beginning fabrication. Using new and exotic materials that have not been codified is risky and can be very costly to qualify. Another lesson learned is to be willing to challenge traditional ways of doing business. The NRC is a rigorous regulator. However, the NRC is willing to listen to and consider different approaches if there is a strong technical basis. It can be costly and time consuming to prove the technical basis.

West Valley SNF Shipment

Preparations for the shipment of the West Valley SNF required comprehensive planning and coordination between the West Valley Demonstration Project (WVDP), INEEL, states, tribes, other federal agencies, and the railroad

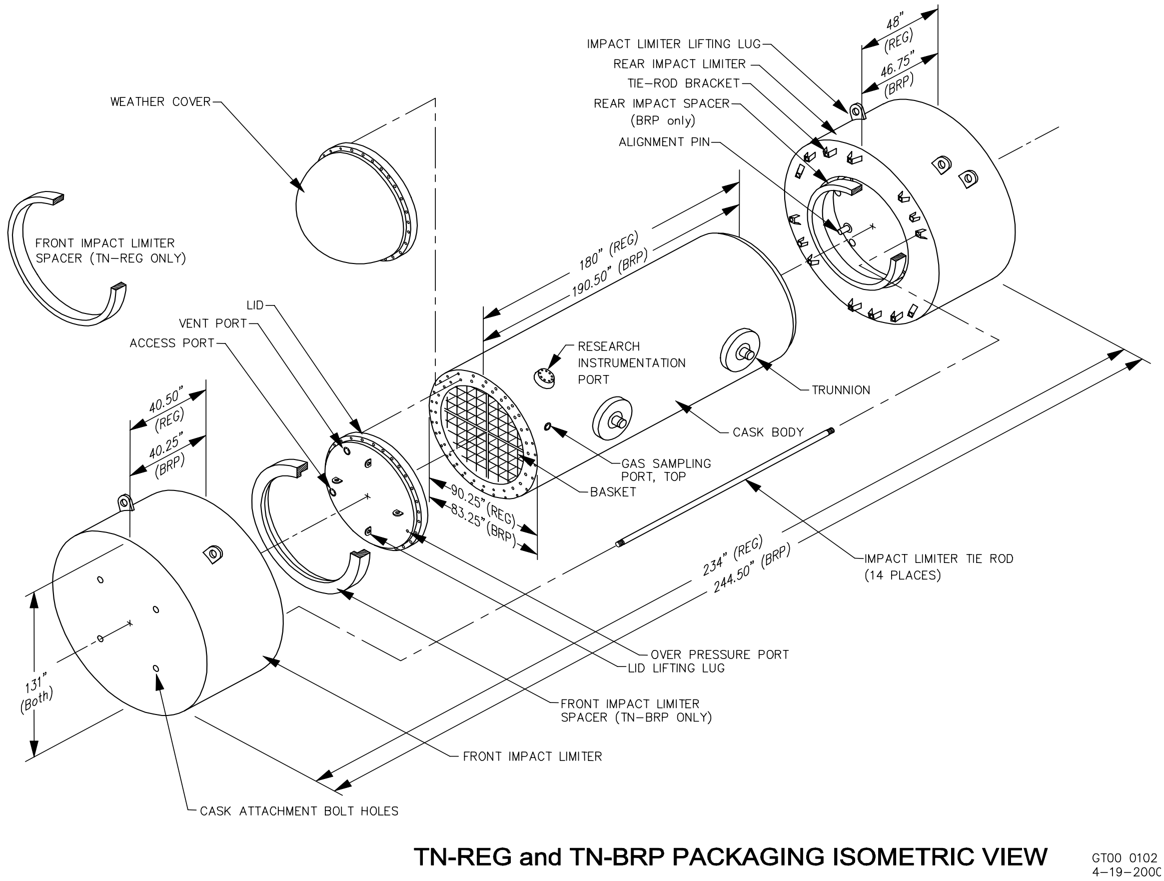

Figure 2. Isometric view of the TN-REG and TN-BRP SNF transport and storage casks.

Figure 3. Photograph of a loaded West Valley cask with the impact limiters and tie rods installed.

carriers. West Valley Nuclear Services Company managed the WVDP under the direction of the DOE West Valley Office. They had the overall management responsibility for the project and were responsible for inspecting and loading the SNF; and sealing, drying and testing the casks. The loaded casks were moved to a safe and secure location within the WVDP complex for temporary storage; see Figure 4. During storage, West Valley Nuclear Services Company performed radiation-monitoring inspections of the casks on a regular basis.

The responsibility for cross-country transport was shared between the INEEL and WVDP. West Valley Nuclear Services Company was responsible for public inquiries and shipment inspections. The INEEL was responsible for the railroad carriers, route evaluation and selection, security, emergency response, and shipper of record.

DOE worked closely with the states, tribes, railroad carriers, and other federal agencies in planning and preparing for the shipment. Shipping planning, information briefings, training courses and communication were coordinated with Council of State Governments–Midwest, Council of State Governments-Eastern Regional Conference, Western Governor's Association and the Shoshone-Bannock Tribes. Additional planning activities were coordinated with security points-of-contact for the states, tribes, carriers, and various federal agencies.

Figure 4. Photograph of the loaded West Valley casks stored within the West Valley Demonstration Project Site.

Route Selection

Selection of the route was undertaken by DOE early in the planning and preparation process. The Oak Ridge National Laboratory (ORNL) was tasked with identifying, evaluating, and prioritizing possible railroad routes from the WVDP to the INEEL. ORNL used the INTERLINE [2] rail routing computer model to identify 28 possible routes; see Figure 5. The routes were then evaluated and ranked based on transit time, distance, population, interchange, number of carriers, and track usage. DOE had additional restrictions that were factored into the route selection, such as limited route options within New York State, which did not compromise the ranking of the routes. Once a preliminary preferred route was identified, DOE made contact with the affected railroad carriers, states, and tribes.

Four carriers, eleven states, and two tribes were identified as being affected by the route. The railroad carriers were: Buffalo and Pittsburgh Railroad (BPRR), Northfolk Southern (NS) Railway, CSX Transportation (CSXT), and Union Pacific Railroad (UPRR). The states were: New York, Pennsylvania, Ohio, Indiana, Illinois, Missouri, Kansas, Nebraska, Colorado, Wyoming, and Idaho. The Shoshone-Bannock Tribes of Fort Hall, Idaho, were affected. Before finalizing the route, the carriers, states, and tribes confirmed that the proposed route was acceptable.

There were several lessons learned from the route selection process. First, there must be clearly defined route selection criteria, e.g., distance, population, interchanges, carriers, and class of track. Second, the use of an analytical tool, like INTERLINE, ensures that the route selected, ranking and selection use the appropriate criteria and are not biased. Third, every effort should be made not to change the route unless there is a strong technical justification. Fourth, the carriers, states, and tribes should be included early in the planning process to ensure that all pertinent factors are considered. Finally, the lack of flexibility in the railroad system makes it difficult to identify

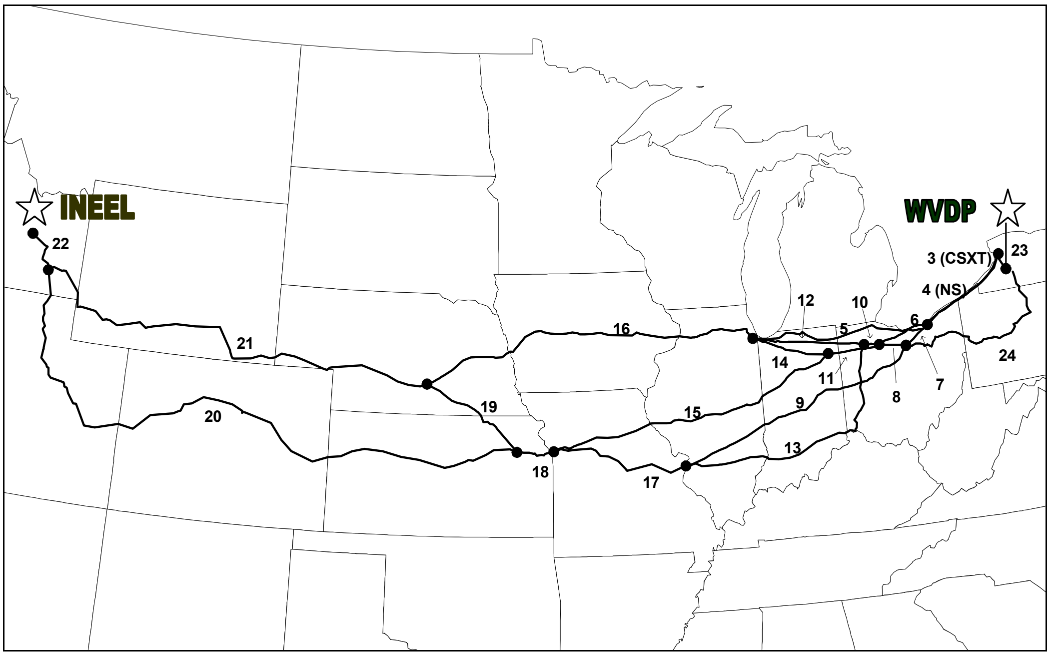

Figure 5. Map showing the sections of railroad route that were used for evaluation and identifying a preferred route.

specific alternate routes for cross-country rail shipments. The railroad carriers need flexibility to choose and use alternate routes. Close coordination between the carriers, states, and tribes is needed to ensure alternate routes can be used safely and securely.

Carrier Selection and Negotiations

The railroad carriers played an integral role in the successful completion of the West Valley SNF shipment. Contracts were established with the four carriers. Negotiating those contracts was complicated and time-consuming. Negotiations began as soon as the railroad carriers were identified and took nearly 2 years to negotiate for the 2001 shipment attempt and an additional 6 months to renegotiate the contracts for the 2003 actual shipment.

Lessons learned from selecting and negotiating with the railroad carriers included beginning discussions with the carriers as early as possible and understanding the uniqueness of the railroad system, operations, and limitations. Other lessons learned included 1) minimizing the number of requirements imposed on the railroad carriers and their personnel, 2) minimizing the number of en route inspections and only use railroad trained Federal Railroad Administration (FRA) certified inspectors, and 3) setting a firm shipping date that allows adequate time for the carriers to coordinate the shipment and maintain that shipping date. This will make negotiations for transporting the materials much easier.

Liability will be the most complicated issue to resolve in negotiating an agreement with the railroad carriers. An equitable adjustment clause was provided in the contract to supplement the nuclear accident coverage provided by Price-Anderson. The equitable adjustment clause covered nonnuclear impacts on the carriers in the event of an accident.

Finally, for large shipping campaigns, DOE should consider owning or long-term leasing the railroad equipment. Owning or long-term leasing of equipment allows DOE better control over delivery, use, maintenance, and inspection of the equipment.

Security

Security has always been an integral part of SNF shipments in the U.S. However, since the September 11, 2001, terrorist attack, it has become even more important. Protecting key information is an important security measure. Key information should be provided to only those with a “need to know.” Information that could be used by adversaries to disrupt the shipment and response to an event includes the schedule, route, detailed packaging and content information, communications, security measures, emergency response procedures, and other information.

Security should perform threat assessments and establish an integral system that draws security information from key federal, state, tribal, local, and carrier sources. It is necessary to clearly understand the roles, responsibilities and limitations of the armed escorts. Coordinating multi-security forces, e.g., state, tribes, carriers, and federal, was complicated. DOE considered having federal officers escort the shipment. The federal officers are trained for railroad operations and have jurisdiction over the railroad lines and throughout the various state and tribal jurisdictions.

Finally, DOE worked with the carriers to block information about the shipment from their internet tracking system. This was necessary because there are people that track all activities on the railroad as a hobby and have an excellent communication network through the internet. They are especially interested in unusual operations and equipment that is not normally seen in their area.

Inspections

Inspections were important for demonstrating to DOE, the carriers, FRA, states, and tribes that the shipment could and was done safely and in compliance with the regulations. The inspections were done in three phases, e.g., preshipment, en route, and postshipment.

The preshipment inspections involved the FRA inspecting over 2,300 miles of primary route tracks and the associated equipment before the shipment. FRA also performed mechanical inspections of the rolling stock prior to delivery to the WVDP and prior to the shipment from the site. West Valley Nuclear Services Company and the State of New York (state of origin) performed radiological (radiation and surface contamination) inspections of the shipping casks at the WVDP Site. Information from these inspections was provided to other states, tribes, carriers, and federal agencies as appropriate.

It is important to standardize the preshipment radiological inspection, conduct it sufficiently in advance of the shipment to allow distribution to all involved parties, and to use it as the cornerstone of the confirmatory inspections. Acceptance by all involved parties of the survey results performed during inspections is a first step in developing a process whereby redundant en route radiological inspections during routine shipping operations can be streamlined or eliminated.

Multiple preshipment mechanical inspections (including at the point of origin) of the rolling stock are recommended for single or first-of-a-series shipments by railroad. Identifying a mechanical problem at the time of the shipment or during the shipment could have significant impact on the shipment, public/stakeholder confidence in the shipment, schedule, and cost. Sharing the results of those inspections with interested parties who have a “need-to-know” can provide confidence in the planning and safety of the shipment and reduce the need for en route inspections.

At various locations along the route, the FRA and the carriers performed the en route mechanical inspections of the rolling stock. The carriers, states, and DOE also performed radiological inspections of the shipping casks at predetermined locations along the route; see Figure 6.

En route inspections were made near New Castle, Pennsylvania; Peru, Indiana; and Cheyenne, Wyoming. There is a false sense of security in assuming en route inspections ensure the safety of the shipment. The railroads operate very efficiently, using well-coordinated schedules. Delaying or imposing restrictions on a shipment can negatively affect all the other shipments on the route. Stopping the shipment for an extended period increases security risks. And, the more people around accessing the railroad yards, the greater the chance someone will get hurt, especially if nonrail or non-FRA personnel are involved in the inspections. Eliminating the need for prearranged en route stops of railroad shipments for radiological inspections would benefit in expediting shipments and reducing the costs of the shipper and the impacted states and tribes. Reducing transit time and movement complexity will also enhance security.

Figure 6. Photograph of en route radiological inspection of a railcar and cask.

The FRA has developed a plan for ensuring the safety of high-level waste and SNF [3]. FRA needs enough time to perform track inspections so that the carriers can correct deficiencies and the FRA can reinspect. For multiple SNF shipment rail campaigns, the involved parties and agencies should work together to establish an approach to review and adjust the inspection plan as the number of shipments increases to ensure safety while still identifying redundancy and ways to streamline the process.

Idaho State Police inspectors and INEEL radiological technicians performed a postshipment inspection once the shipment was safely secured within the INEEL. The tribes were invited to participate in this inspection, but were not available. Results from that inspection showed that the shipment had not changed en route. INEEL inspectors also performed physical inspection of the casks, tiedowns, and railcars once the loaded railcars were parked within the Idaho Nuclear Technology and Engineering Center (INTEC) fenced area. Again there were no abnormalities found from that inspection. Results from these inspections were shared with the states, tribes, and other federal agencies.

Tracking

The West Valley shipment was tracked by three methods, e.g., Transportation, Tracking, and Communications System (TRANSCOM) satellite tracking system; rail carrier's dispatch tracking system; and the West Valley Project Status Center using cell phones between the Center and DOE representatives on the train.

TRANSCOM was the formal tracking system used by the states, tribes; and others with a "need-to-know" to monitor the shipment. The TRANSCOM Communications Center and ;Program developed a TRANSCOM Plan. The plan contained shipment-specific, emergency preparedness communications and a contingency plan for addressing loss of communications with TRANSCOM end users.

The dispatch centers for each rail carrier tracked the shipment and coordinated it with other freight shipments in the same manner as all other shipments. The centers play a critical role in ensuring that the entire rail system runs smoothly and safely. It would be inappropriate and potentially unsafe to ask the dispatch centers to perform functions above and beyond their routine operations.

The DOE representatives on the train provided up to the minute status of the train and surrounds situation. The representatives not only provided real time communications for the status of the shipment, but they also provided other critical functions. They operated the on-board TRANSCOM system. They performed confirmatory radiological surveys during the en route inspections. The DOE representatives were also available to provide first responder and technical assistance, if needed. The use of a 24-hour status center and representatives on the train is critical to ensuring that the shipment is functioning as planned and that deviations from the plans can be dealt with appropriately and in a timely manner.

Interim Storage at the INEEL

The loaded West Valley casks were placed in interim storage within the fenced area of INTEC; see Figure 7. Radiological and physical inspections were conducted to verify that the condition of shipment had not changed in transit. Gas samples were taken from the casks to verify that there was no gas pressure buildup in the casks. These gas samples also provided a baseline for future sampling. The casks will be stored horizontally on the railcars until an alternate disposition is identified.

Conclusions

The West Valley SNF shipment from the WVDP to the INEEL was a successfully coordinated team effort. It is recommended that future cross-country SNF shipments by railroad establish a *systemwide approach* to coordinating activities with railroads, states, and tribes, and the FRA. Areas with the greatest potential for increasing efficiency, ensuring quality performance, and reducing costs are:

- The regulator needs to be included early in the planning and design process, especially if unproven exotic materials and untested designs are proposed.
- Route selection needs to be clearly defined and nonbiased. Selection of the final routes need to be closely coordinated with the carriers, states, and tribes.

- An accepted contracting system with the railroads should be established.

Figure 7. Arial photograph of INTEC, the final storage location of the West Valley casks.

- Standard guidelines for protecting critical information and dissemination of information to those with a “need-to-know” is critical for security.
- A process for establishing and maintaining schedules is vital.
- National protocols are needed to standardize radiological inspections, limit en route inspections, and eliminate en route inspections by non-FRA-certified personnel.
- Larger shipping campaigns need the ability to periodically review all procedures and processes, look for efficiencies and improvements, and eliminate those no longer needed.
- A plan to identify roles, responsibilities, and contingencies is needed for TRANSCOM use.
- The use of a DOE 24-hour status center and representatives on the train is critical to ensuring that the shipment is functioning as planned and that deviations from the plans are dealt with appropriately and timely.

References

[1] 49 CFR Part 107, Subpart E, “Designation of Approval and Certification Agencies.”

[2] Oak Ridge National Laboratory, *Interline Routing Model*, Revision 0, March 1993.

[3] Federal Railroad Administration, *Safety Compliance Oversight Plan for Rail Transportation of High-Level Radioactive Waste and Spent Nuclear Fuel, Ensuring the Safe, Routine Rail Transportation of Foreign Research Reactor Spent Nuclear Fuel*, June 1998.