Transportation casks are designed to protect spent nuclear fuel during shipment by rail. New cask designs may be needed for transporting some commercial and DOE-managed spent fuel. (Photo: DOE)

Toward a National Transportation Effort

The Nuclear Waste Technical Review Board is examining the technical issues the DOE needs to address in preparing a large program to transport spent fuel and nuclear waste nationwide.

By Daniel G. Ogg

Congress created the U.S. Nuclear Waste Technical Review Board (NWTRB or Board) in the 1987 Nuclear Waste Policy Amendments Act to evaluate the technical and scientific validity of activities undertaken by the secretary of energy to implement the Nuclear Waste Policy Act and to advise Congress and the secretary on technical issues related to nuclear waste management. Among the topics specifically identified for NWTRB evaluation is the transportation of spent nuclear fuel (SNF), both commercial and federally managed, and high-level radioactive waste.

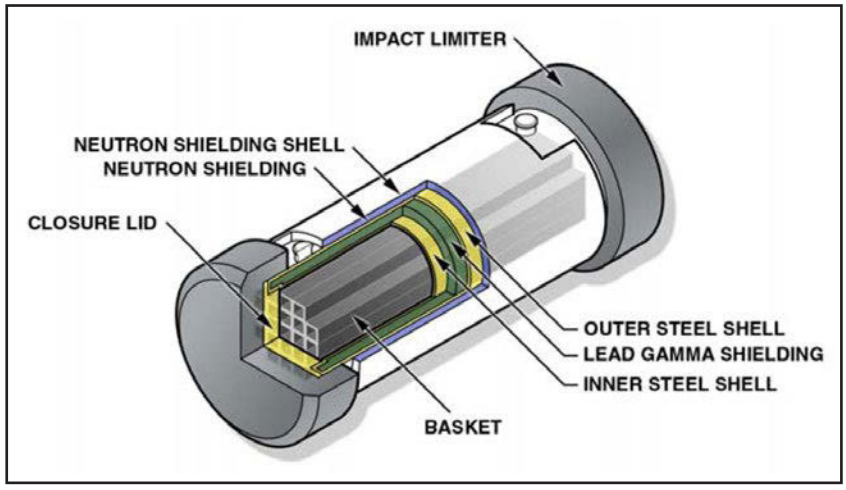
Nuclear waste transportation has been a topic of interest to the Board for many years and has been the subject of NWTRB meetings and associated correspondence. In 2010, the Board published a report evaluating the technical bases for the extended storage and transportation of SNF [1]. Other groups have also evaluated the issues associated with transporting nuclear waste. For example, the National Academies Committee on Transportation of Radioactive Wastes issued a report in 2006 examining the technical and societal aspects of transporting radioactive waste [2].

Most recently, the Board held its 2018 summer meeting on June 13 in Idaho Falls, Idaho. The meeting consisted of a series of invited presentations followed by question-and-answer sessions. This meeting not only helped the Board but also the public to identify and discuss technical and integration issues that will need to be addressed before the Department of Energy can implement a nationwide effort to transport commercial and DOE-managed SNF and HLW.

This article presents some preliminary observations based on past Board activities and on information gathered at the 2018 summer meeting. Additional information has also been obtained during staff-to-staff discussions between NWTRB and DOE staff and in fact-finding meetings held at the DOE's national laboratories.

Technical issues

The technical issues to be addressed in preparing for a large transportation effort span a broad range of topics. These issues include uncertainties or questions about the condition of some wastes, particularly high-burnup commercial SNF that was utilized in a reactor core for longer periods than low-burnup fuel, and some DOE-managed SNF. In other cases, the condition of the commercial SNF is known, but additional packaging, modified cask designs, or modified transportation certificates of compliance will be needed in order to meet the requirements for transportation set by the Nuclear Regulatory Commission. For example, certain SNF that has a relatively high enrichment of uranium-235 (the "initial enrichment" of U-235), but a relatively low burnup, may not meet transportation requirements as packaged without modification to the associated cask designs or certificates of compliance.



A diagram shows the components of a generic rail cask for spent fuel. (Image: NRC)

Other uncertainties are associated with how certain containers that store SNF could be transported. For commercial SNF, some of the welded stainless steel canisters used for SNF storage at commercial nuclear power plant sites were not designed for transportation and are not approved for that purpose by the NRC. Similarly, more than 80 percent (by mass) of DOE-managed SNF has been packaged into storage containers at the DOE's Hanford Site in the state of Washington, but those containers require further structural analyses before the NRC can approve them for off-site transportation. The DOE also must identify an existing transportation cask that can be used for transporting the Hanford SNF or develop a new cask design. Still other types of DOE-managed SNF and HLW have not yet been packaged for transportation. A detailed evaluation of the inventory of DOE-managed SNF and the expected DOE path forward for managing this SNF was published by the Board in 2017 [3].

Addressing the uncertainties associated with the various SNF and HLW types and the containers in which they are stored will be necessary before these wastes can be transported. Furthermore, integrating the DOE waste transportation program with the activities of other federal agencies such as the NRC and the Department of Transportation, as well as with private entities such as the nuclear utilities and rail carriers, will require significant advance planning and coordination.

Staff meetings and fact-finding meetings

Board staff members meet with representatives of the DOE Office of Nuclear Energy (DOE-NE) on a periodic basis. When the DOE Office of Civilian Radioactive Waste Management ceased operations in 2010, responsibility for directing and implementing DOE activities related to nuclear waste management and disposal was transferred to the DOE-NE. One significant part of the DOE-NE effort is developing system analysis tools that can be used to help design a nationwide waste management system, including transportation. The five key analysis tools being developed by the DOE-NE are:

- ESA: Execution Strategy Analysis
- MOEF: Multi-Objective Evaluation Framework
- NGSAM: Next Generation System Analysis Model
- START: Stakeholder Tool for Assessing Radioactive Transportation
- UNF-ST&DARDS: Used Nuclear Fuel Storage, Transportation & Disposal Analysis Resource and Data System

In December 2017, a team of Board members and staff members visited Argonne National Laboratory to discuss the development of the NGSAM tool. The Board found this tool to be relatively mature with the capability to run simulations of alternative waste management system configurations. This capability allows the DOE-NE to assess many parameters associated with each waste management system configuration. Examples of these parameters include equipment requirements, personnel requirements, cost, and schedule. Of note is that, while NGSAM has been demonstrated for systems including commercial SNF, it has not yet been applied to waste management system configurations that include DOE-managed SNF and HLW.

In May 2018, the same Board team visited Oak Ridge National Laboratory to review the status of the UNF-ST&DARDS tool. This tool can be considered the starting point of the DOE system analyses, because it contains the underlying database of nuclear waste information. Currently, this unified database is populated with data on commercial reactor spent fuel pools, SNF discharged from the reactors, dry cask storage systems for SNF, and the independent spent fuel storage installations where the SNF is stored at or near nuclear power plant sites.

Like NGSAM, the Board found UNF-ST&DARDS to be mature, particularly the embedded modules for conducting shielding, thermal, structural, and criticality safety analyses. Like NGSAM, however, UNF-ST&DARDS and its unified database includes information for commercial SNF only. To be fully applicable to a nationwide waste management system, information on DOE-managed SNF and HLW will need to be added. One other current shortfall in UNF-ST&DARDS is the lack of detailed technical information for many types of commercial SNF. Such technical information is needed to complete detailed criticality, thermal, and shielding analyses necessary to demonstrate compliance with the NRC transportation requirements.

For example, a key piece of needed technical information for many SNF cask systems is a spatially specific loading map showing the characteristics of each SNF assembly that has been loaded and its specific location in the cask system. The DOE-NE recognizes this issue and is working with nuclear utilities and SNF cask vendors to obtain the detailed information.

The Board's 2018 summer meeting

The Board's 2018 summer meeting included presentations and discussions on technical and integration issues that will need

to be addressed before the DOE can implement a nationwide effort to transport commercial and DOE-managed SNF and HLW. The Board heard presentations from past and present transportation system managers at the DOE, along with DOE staff members involved in current activities related to transportation planning. The Board also heard from representatives of the nuclear industry, including domestic companies and one utility in Switzerland, as well as from representatives of stakeholder groups and the NRC.

Based on the presentations at the meeting and previous interactions with the DOE, the Board has made the following preliminary observations:

- The DOE's preliminary evaluations of removing SNF from shutdown sites, involving working with site personnel, utilities, and local stakeholders, have generated valuable information and are important to continue. As these studies have shown, advance planning and coordination will be required to refurbish or re-establish the capabilities to handle and load SNF containers, reconstitute needed site infrastructure (e.g., electrical power, radiological controls), and rebuild the roadways and/or rail lines necessary to support SNF transportation.
- The current effort by the DOE-NE to research and access a nationwide transportation program does not appear to be well integrated with activities of the DOE's Office of Environmental Management. Furthermore, the current effort does not include sufficient consideration of the SNF and HLW materials and packages that are managed by the Office of Environmental Management.
- The Waste Isolation Pilot Plant (WIPP) transportation approach represents a useful model and provides relevant lessons for the development of a nationwide transportation program for SNF and HLW. However, transuranic waste is transported to WIPP by road, while transportation of commercial SNF is expected to be mostly by rail, so the differences between highway and rail transport will need to be considered in applying WIPP experience in developing the transportation program in support of the nuclear waste disposal program.
- The DOE will need to develop designs for new casks and canisters for transporting DOE-managed SNF and HLW. Additional types of new casks and canisters may be required for the transport of some commercial SNF. Furthermore, some of the presenters at the meeting noted advantages to developing a waste management program based on new standardized cask and canister designs. Given the need for new cask and canister designs, several meeting presenters noted that the lead times for licensing and procurement of any new types of casks and canisters may be greater than 10 years, and therefore considerable advance coordination with the NRC will be required.
- The advances made by the DOE-NE in developing the system analysis and planning tools are to be commended. These tools will be a major asset in designing the transportation program, particularly as development of the tools is continued and as the DOE gains access to the detailed technical information necessary to conduct the necessary system analyses.

To document its evaluation of the transportation topic, the Board is developing a report on the technical and integration issues that will need to be addressed before the DOE can implement a nationwide effort to transport nuclear wastes. The report, which the Board expects to issue in 2019 (www.nwtrb.gov), will reflect information gathered by the Board in interactions with the DOE and the national laboratories. It will also reflect the information presented and discussed at the Board's 2018 summer meeting. The Board expects to conduct additional reviews related to nuclear waste transportation that will depend, in part, on the transportation-related activities of the DOE.

References

1. U.S. Nuclear Waste Technical Review Board, *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*, Arlington, VA, NWTRB (2010).
2. Committee on Transportation of Radioactive Waste, *Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States*, Washington, DC, National Academies Press (2006).
3. U.S. Nuclear Waste Technical Review Board, *Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel*, Arlington, VA, NWTRB (2017). ■

Daniel Ogg is a member of the senior professional staff at the Nuclear Waste Technical Review Board.

This article is based on a paper presented at the 2018 American Nuclear Society Winter Meeting & Expo, held Nov. 11-15 in Orlando, Fla.