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Technical Issues That Need to be Addressed in Preparing a Large Program to Transport Spent Nuclear Fuel and High-level Radioactive Waste

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ABSTRACT

Spent nuclear fuel (SNF) and high-level radioactive waste (HLW) transportation has been a topic of interest to the U.S. Nuclear Waste Technical Review Board (Board) for many years and has been the subject of several Board meetings and associated reports and correspondence. The Board held its Summer 2018 Board Meeting in Idaho Falls, Idaho, on the topic of technical and integration issues that will need to be addressed in preparing a nationwide effort to transport SNF and HLW. Based on the presentations at the meeting and previous interactions with the DOE, the Board made several observations that included, among others: 1) the Department of Energy's preliminary evaluations of removing SNF from shutdown sites have generated valuable information and are important to continue; 2) the Waste Isolation Pilot Plant transportation approach represents a useful model and provides relevant lessons for the development of a nationwide transportation program for SNF and HLW; 3) given the need for new cask and canister designs, the Board observes that the lead times for licensing and procurement of new types of casks and canisters may be greater than 10 years and therefore, considerable advanced coordination with the Nuclear Regulatory Commission will be required; and 4) the advances made by DOE in developing system analysis and planning tools are to be commended.

INTRODUCTION

Congress created the U.S. Nuclear Waste Technical Review Board (Board) in the 1987 Nuclear Waste Policy Amendments Act (NWPAA) (Public Law 100-203) 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 Board evaluation is the transportation of spent nuclear fuel (SNF) and high-level radioactive waste (HLW).

SNF and HLW transportation has been a topic of interest to the Board for many years and has been the subject of Board meetings and associated reports and correspondence. In 2010, the

[1] Note: The views expressed do not represent those of the U.S. Nuclear Waste Technical Review Board or the United States Government

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 SNF and HLW. For example, the National Academy of Sciences Committee on Transportation of Radioactive Wastes issued a report in 2006 examining the technical and societal aspects of transporting radioactive wastes [2].

More recently, the Board held its Summer 2018 Board Meeting on June 13, 2018, in Idaho Falls, Idaho, which 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 as the Department of Energy (DOE) works to prepare a nationwide effort to transport SNF and HLW.

This paper presents preliminary observations based upon past Board activities and on information gathered at the Summer 2018 Board Meeting. Additional information has also been obtained during staff-to-staff discussions with DOE staff and in fact-finding meetings at DOE's national laboratories.

DESCRIPTION

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 including, for example, DOE-managed SNF. In some cases of commercial SNF, the condition of the SNF is known, but the characteristics of the SNF are such that the SNF does not currently meet the requirements for transportation set by the Nuclear Regulatory Commission (NRC). For example, certain SNF that has a relatively high enrichment of uranium-235 [the "initial loading" of uranium-235], but a relatively low burnup [i.e., used in the reactor for a relatively short period of time], may require special packaging or other measures in order to meet the NRC's transportation requirements.

Other uncertainties are associated with the containers that store SNF. 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 DOE's Hanford site in Washington State, and these containers will require further structural analyses before the NRC can approve them for off-site transportation. DOE also must develop a new transportation overpack for the Hanford SNF containers, unless an existing overpack is chosen. Still other types 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 these uncertainties in how to transport the various SNF and HLW types will be necessary as DOE prepares the materials for transportation. DOE will have to ensure that all SNF and HLW is packaged in a manner that meets the requirements set by the NRC for transporting these wastes. Furthermore, developing an integrated transportation program that

meets the regulatory requirements of other Federal agencies, such as the NRC and the Department of Transportation, will require significant advanced planning and coordination. DOE's coordination efforts will also have to include private entities such as the nuclear utilities and rail carriers, which will be involved in implementing the program.

Staff Meetings and Fact-Finding Meetings

The Board staff meets 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 transportation and disposal was transferred to DOE-NE. One significant part of the DOE-NE effort is developing a suite of system analysis tools that can be used to help design a nationwide waste management system, including nuclear waste transportation. The five key analysis tools being developed by 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 NGSAM. The Board found this tool to be relatively mature, with the capability to run simulations of alternative configurations for an integrated waste management system. This capability allows 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 central component of the DOE suite of system analysis tools 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 the 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. However, also like NGSAM, UNF-ST&DARDS and the Unified Database include 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 notable challenge for UNF-ST&DARDS and its Unified Database is the lack of detailed technical

information for many types of commercial SNF that is needed to complete properly-detailed criticality, thermal, and shielding analyses. 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 loaded and its specific location in the cask system. DOE-NE recognizes this issue and is working with nuclear utilities and SNF cask vendors to obtain the detailed information.

The Summer 2018 Board Meeting

The Summer 2018 Board Meeting included presentations and discussions on technical and integration issues that will need to be addressed by DOE in developing a nationwide effort to transport SNF and HLW. The Board heard presentations from past and present transportation system managers at DOE and 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.

CONCLUSIONS

Based on the presentations at the Summer 2018 Board Meeting, previous Board meetings and reports, and interactions with DOE, the following preliminary observations are made:

- DOE's preliminary evaluations of removing spent nuclear fuel from shutdown sites, which involved working with site personnel, utilities, and local stakeholders, have generated valuable information and are important to continue. As these studies have shown, advanced planning and coordination will be required to refurbish or re-establish the capabilities to handle and load SNF containers, re-constitute 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 Office of Nuclear Energy to evaluate options for a nationwide transportation program is not yet integrated with activities of the DOE Office of Environmental Management (DOE-EM). Furthermore, the current transportation evaluation effort does not take into account the SNF and HLW materials and packages that are managed by DOE-EM.

- 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, all transuranic waste is transported to WIPP by road, while transportation of commercial SNF is expected to by 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 for SNF and HLW.

- DOE will need to develop new, or modify existing, designs for casks and canisters to transport DOE-managed SNF and HLW. Additional types of new casks and canisters may be required for the transport of some commercial SNF. Furthermore, several past

efforts to plan SNF transportation have noted advantages to developing a waste management program based on new standardized cask and canisters designs. Given the need for new cask and canister designs, the Board notes that the lead times for licensing and procurement of any new types of casks and canisters may be greater than ten years and therefore, considerable advanced coordination with the NRC will be required.

- The advances made by 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 DOE gains access to the detailed technical information necessary to conduct realistic system analyses.

As part of its ongoing evaluation of the transportation topic, the Board is also planning future review activities and is developing a report on the technical and integration issues that will need to be addressed before DOE can implement a nationwide effort to transport nuclear wastes. The report, which the Board expects to issue later this year, will reflect the Board's plans for future reviews as well as the information presented and discussed at the Summer 2018 Board Meeting.

REFERENCES

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