U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

Extended Dry Storage and Transportation of Spent Nuclear Fuel[1]

Introduction

Spent nuclear fuel (SNF) will be stored at nuclear power plants until a permanent repository or an interim storage facility is available. Because of the uncertainty associated with the timetable for developing such a facility or facilities, how long the SNF will be stored at nuclear plants is not known, but it may be for an extended period. A recent rulemaking by the Nuclear Regulatory Commission (NRC) indicated that SNF can be stored safely at commercial nuclear power plants for up to 60 years beyond the licensed operational lifetime of the plant; the NRC is looking at whether SNF can be stored safely at nuclear reactor sites for even longer periods− up to 300 years.

Following discharge from a nuclear reactor, irradiated or “spent” nuclear fuel continues to generate heat. Initially, the SNF rods are stored at reactor sites in 40-ft deep water-filled pools (wet storage). Before the amount of SNF stored in a pool reaches the pool’s licensed capacity, additional storage capacity must be provided if the nuclear plant is to continue operating. Many nuclear plants have created additional onsite storage by designing and constructing Independent Spent Fuel Storage Installations (ISFSIs). The ISFSIs are secure concrete pads on which metal containers filled with SNF are stored vertically in metal or concrete casks or horizontally in modular dry concrete vaults. Before SNF is removed from a storage pool, it is loaded underwater into a metal container. The container is removed from the pool, drained, dried, and filled with helium gas to minimize potential degradation and increase heat transfer. The containers are then sealed by bolting or welding. The welded canisters are loaded into concrete casks suitable for storage only or for transport and storage.

Challenges

The dry cask storage system includes the canisters, seals, assembly structure and the cask. Identifying and understanding mechanisms that could degrade the SNF or dry storage cask systems over long time periods is important and challenging, as is determining the ability of the SNF to meet transportation requirements after extended dry storage. Following are examples of potential issues to be addressed:

- A primary deterrent to corrosion of the metal components of SNF (cladding) and of the dry storage system (canisters and casks) is the introduction of helium into the casks before they are sealed. However, confirming the presence of helium in welded containers at the storage site currently is not possible, and no requirement exists for periodically inspecting the integrity of the closure welds to ensure that helium has not leaked through cracks created by corrosion.
- Even though most degradation mechanisms are temperature dependent and, over time, the SNF naturally becomes cooler, the degradation that may occur over 100 years is not well understood, especially for “high burnup” (high utilization) spent fuel.

[1] In December 2010, the Board issued an Executive Summary report titled *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*. The Executive Summary is based on a White Paper that represents a review of publicly available information on the subject. The Executive Summary and the White Paper are available on the Board’s website at www.nwtrb.gov. A synopsis of the Executive Summary, including Board findings and recommendations, is provided in this fact sheet.

***Challenges** (cont.)*

- Unless SNF is stored in dual-purpose casks that are licensed for both storage and transport or the current storage casks can be show to be acceptable for transport, SNF must be transferred to a cask suitable for transportation. If that is not possible, the spent fuel canisters must be moved back into the "SNF pool and repackaged into a transportation suitable canister or cask before being moved off the reactor site. Before being transported, it will be necessary to show that for both normal and accident conditions the cask, the canister, and the SNF can meet stringent performance and safety specifications related to transportation regulations.
- There is not sufficient data on fuel degradation mechanisms to predict the condition of the SNF following extended storage and transportation. It therefore may be necessary to open representative casks for inspection in a hot cell to confirm its integrity. (If the SNF canister is considered the disposal waste package, this step may not be necessary.)
- There are inconsistencies among regulations related to dry storage and to transportation of SNF, which need to be addressed. The regulations should be integrated into a consistent technically supported set of regulations that address the safety of spent fuel for storage, transportation, and disposal.

The U.S. Nuclear Waste Technical Review Board is an independent federal agency established in the 1987 amendments to the Nuclear Waste Policy Act (NWPA). The Board evaluates the technical validity of Department of Energy (DOE) activities related to implementing the NWPA and provides objective expert advice on nuclear waste issues to Congress and the Secretary of Energy. The eleven Board members are nominated by the National Academy of Sciences and appointed by the President.

Findings and Recommendations

Technical information available and experience to date indicate that spent SNF can be safely stored in the short term and then transported without significant concern. However, additional information is required to demonstrate with similar high confidence that SNF can be stored in dry-storage facilities for extended periods without affecting the performance of the fuel during very long-term storage and subsequent transportation. The Board recommends that research be conducted on the following issues to improve understanding of factors that may affect the performance of SNF during extended storage and subsequent transportation:

- Changes in fuel cladding properties and fuel-cladding degradation mechanisms, including high-burnup fuels
- Time-dependent conditions that affect aging and degradation processes, such as temperature, material stresses, quantity of residual water, and quantity of helium gas
- Age-related degradation of dry-storage cask systems that may be exposed to a variety of environmental conditions during extended dry storage
- Selective inspection and monitoring of SNF in storage and dry-storage system components to verify the actual conditions and degradation behavior over time, including techniques for ensuring the presence of helium cover gas
- Verification of models used to predict changes in SNF against the results of inspection and monitoring programs