U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

SYNOPSIS OF BOARD REPORT

Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel

Introduction

The Nuclear Waste Technical Review Board reviewed technical information related to the storage and transportation of commercial spent nuclear fuel (SNF) and, in December 2010, published the report *Evaluation of the Technical Basis for Extended Dry Storage and Transportation of Used Nuclear Fuel*. Commercial 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 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 be highly radioactive and to generate heat. Initially, the SNF is stored at reactor sites in 40-ft deep water-filled pools (wet storage) for shielding and cooling. 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 where SNF is stored dry in systems that provide shielding against radiation and allow for cooling to remove the heat generated by the SNF. Before SNF is removed from a storage pool, it is loaded underwater into a bare metal or shielded 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 container is then sealed by bolting or welding. Some containers were designed for storage only and others were designed for both storage and transportation. A system including the welded or bolted SNF container and the necessary shielding is called a *dry cask storage system*.

Typical ISFSI (photo by permission: NAC International)

Challenges

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

- A primary deterrent to degradation of the metal components of SNF (cladding) and of the dry cask storage system is the introduction of helium into SNF containers before they are sealed. However, confirming that helium has not leaked from welded containers during extended storage 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, SNF naturally becomes cooler, the degradation that may occur over long time periods is not well understood, especially for "high burnup"[1] spent fuel.
- Unless SNF is stored in a dual-purpose container that is licensed for both storage and transport or the current storage container can be shown to be acceptable for transport, the SNF must be transferred to a container licensed for transportation. If the transfer is not possible at the ISFSI, the SNF container must be moved back into the SNF pool to complete the transfer before the SNF can be transported off site. Before being transported, it will be necessary to show that for both normal and accident conditions, the container 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 SNF following extended storage and transportation. It therefore may be necessary to open representative containers for inspection in a hot cell to confirm integrity of the SNF.

Findings and Recommendations

Technical information available and experience to date indicate that SNF can be safely stored in the short term and then transported in accordance with regulatory requirements. 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 while in storage and during 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 those for high-burnup SNF
- Time-dependent conditions that affect SNF degradation processes, such as temperature, material stresses, quantity of residual water, and potential leakage of helium from SNF containers
- Age-related degradation of dry cask storage systems that may be exposed to a variety of environmental conditions during extended dry storage
- Inspection and monitoring of SNF and dry cask storage system components to verify the actual conditions and degradation behavior over time, including techniques for ensuring the presence of helium
- Verification of models used to predict changes in SNF performance against the results of inspection and monitoring programs

The U.S. Nuclear Waste Technical Review Board is an independent federal agency established in the 1987 Nuclear Waste Policy Amendments Act.

The Board evaluates the technical and scientific validity of U.S. Department of Energy activities related to implementing the Nuclear Waste Policy Act. The Board also provides objective expert advice on nuclear waste management and disposal issues to Congress and the Secretary of Energy.

The Board's eleven members are nominated by the National Academy of Sciences and are appointed by the President.

[1] Burnup is the amount of energy produced per unit mass of the fuel. Typical units for burnup of commercial SNF are gigawatt-days per metric ton of uranium originally contained in the fuel (GWd/MTU). In the U.S., SNF with a burnup greater than 45 GWd/MTU is considered high-burnup SNF.