U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

SYNOPSIS OF BOARD REPORT

Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel

The U.S. Nuclear Waste Technical Review Board has reviewed the technical and scientific validity of the U.S. Department of Energy (DOE) activities related to the management and disposal of DOE spent nuclear fuel (SNF)[1] and, in December 2017, published a report titled *Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel*. DOE SNF, totaling approximately 2,500 metric tons of heavy metal (MTHM),[2] resulted mostly (85% by mass) from defense-related activities (primarily weapons plutonium production reactors and naval propulsion reactors). It also includes SNF from DOE's research and development activities, commercial SNF that DOE took title to for testing and examination, and SNF from some decommissioned commercial nuclear facilities. More than 99% by mass of the SNF is stored at four locations: the Hanford Site in Washington State, the Idaho National Laboratory in Idaho, the Savanah River Site in South Carolina, and the Fort St. Vrain Independent Spent Fuel Storage Installation in Colorado. DOE's SNF inventory is diverse, consisting of more than 250 types of SNF with differing physical and chemical properties.

DOE is responsible for packaging, storing, transporting, and eventually disposing of its SNF. Although disposal of DOE SNF and high-level radioactive waste in a deep geologic repository remains the ultimate objective of the DOE nuclear waste management program, there is significant uncertainty about when such a repository will be available in the United States. Therefore, DOE SNF will need to be stored for decades longer than originally planned. Until disposal occurs, it is essential to manage SNF in a manner that will not impede its eventual disposal. It is also important to improve understanding of processes related to packaging and storing DOE SNF that could affect future transportation and disposal activities.

The Board report examines the technical issues related to DOE SNF packaging and storage that might affect continued storage, transport, and final disposal of SNF. The report records the quantities and characteristics of DOE SNF at each of the four storage sites and analyzes DOE's packaging and storage activities and plans related to the management and disposal of its SNF.

Three main issue areas are highlighted in the report. First, the report identifies issues related to managing the aging of DOE SNF and the facilities in which it is stored. With time, SNF, as well as the containers used to store it and the components of the storage facilities *(e.g.*, concrete in an SNF storage pool or cask), can degrade. The effects of degradation can be mitigated through "aging management" programs designed to support the safe storage of SNF for extended periods

[1] SNF is nuclear fuel that has been discharged from a nuclear reactor following irradiation.

[2] Metric ton of heavy metal is a commonly used measure of the mass of nuclear fuel. Heavy metal refers to elements with an atomic number greater than 89 (*e.g.*, thorium, uranium, and plutonium) in the fuel. The masses of other constituents of the fuel, such as cladding, alloy materials, and structural materials (and fission products in spent nuclear fuel), are not included in this measure. A metric ton is 1,000 kilograms, which is equal to about 2,200 pounds.

of time. The aging issues the report considers include (i) the need for the DOE SNF to be stored for multiple decades; (ii) the degradation rates during storage of different fuel materials (*e.g.*, uranium metal and uranium oxide), cladding materials (*e.g.* zirconium alloy and stainless steel), and SNF storage container materials (*e.g.*, aluminum, carbon steel, and stainless steel); (iii) the different environmental conditions at different DOE SNF storage facilities; (iv) the need for equipment and strategies to measure and monitor the conditions of the SNF inside canisters, the external surfaces of canisters, and other components of the storage systems whose degradation could impact fuel conditions; and (v) the adequacy of aging management programs for DOE SNF storage facilities.

Second, the report discusses issues related to packaging of stored non-naval DOE SNF into standardized canisters.[3] These issues include (i) processes that may occur during drying of SNF canisters and during storage (*e.g.*, flammable gas generation due to canister corrosion and radiolytic decomposition of water); (ii) research and development activities needed to complete the development of the standardized canister system, including remote welding techniques and advanced neutron absorbers; and (iii) research and development activities needed to support the design and operation of a facility to package DOE SNF into standardized canisters that may be required for transportation or disposal.

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.

Third, since 2010, DOE's disposal research and development activities have focused on a range of geologic disposal options, including repositories in granite, clay/shale, and salt environments, as well as disposal in deep boreholes. Because DOE SNF varies widely in its physical and chemical characteristics, it will degrade differently in different disposal environments. The Board report discusses issues that would affect disposal of DOE SNF if DOE continues to evaluate a range of disposal options and repository environments. These issues include (i) the characteristics of DOE SNF and its packaging, and (ii) the degradation processes and rates for DOE SNF and its packaging, and the factors that affect them in different disposal environments (*e.g.*, host rock types and saturated versus unsaturated conditions) and different disposal options (*e.g.*, a commingled repository containing commercial SNF, DOE high-level waste, and DOE SNF, or a separate repository containing some DOE high-level waste and DOE SNF).

The Board report presents principal findings and recommendations on six main areas related to managing and disposing of DOE SNF: (i) aging management, (ii) measuring and monitoring conditions during storage, (iii) SNF drying procedures, (iv) development of packaging facilities, (v) waste acceptance system requirements, and (vi) SNF disposal research efforts.

[3] The Board adopted DOE's nomenclature for this canister, although it should be noted that this term refers to a set of canisters of different dimensions, rather than canisters of a single design. The DOE standardized canister is a canister system that consists of four cylindrical stainless steel canisters with two different diameters [18 in (46 cm) and 24 in (61 cm)] and two different lengths [10 ft (3.0 m) and 15 ft (4.6 m)]. These four sizes, together with eight internal basket designs, can accommodate all of the DOE SNF types intended for packaging in these canisters.