Management and Disposal of U.S. Department of Energy (DOE) Spent Nuclear Fuel (SNF)

Presented to:
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- Examines technical issues related to DOE SNF packaging and storage that might affect continued storage, transportation, and disposal
- Records quantities and characteristics of DOE SNF
  - Hanford, Idaho National Laboratory (INL), Savannah River Site, and Fort St. Vrain
  - 250 types of fuel
- Analyzes DOE’s packaging and storage activities and plans for management and disposal
Issues Identified

• Managing the aging of DOE SNF and the facilities in which it is stored

• Packaging of stored non-naval DOE SNF into DOE standardized canisters, a type of multi-purpose (storage, transportation, and disposal) canister system

• The need for disposal-related research on DOE SNF degradation processes IF DOE’s generic repository research continues
Aging Management

• DOE SNF will be stored decades longer than expected
  – Some DOE SNF is already in multi-purpose canisters
  – Plans for packaging remaining SNF in multi-purpose canisters
  – DOE SNF is more degraded than commercial SNF

• Wide diversity of fuel types and storage conditions affects aging management efforts
  – Fuel compound (e.g., U metal, U dioxide, Th-U dioxide, Th-U carbide, mixed oxide, and U-aluminum)
  – Cladding composition (e.g., none, stainless steel, zirconium alloy, and aluminum) and condition (good-fair-poor-none)
  – Enrichment of U-235 varies widely (0.2-93%)
  – Storage (wet and a variety dry storage configurations)
  – Storage materials (e.g., aluminum, carbon steel, and stainless steel)
Aging Management

• It is essential to manage SNF in a manner that will not impede its eventual disposal

• It is important to improve understanding of processes related to packaging and storing DOE SNF that could affect future transportation and disposal activities
Aging Management Recommendation

• **Board Finding:** DOE’s aging management programs are not fully implemented.
  – Assessments missing for some facilities and incomplete implementation at other facilities

• **Recommendation:** The Board recommends that DOE develop and fully implement programs to manage degradation of SNF, the materials that contain SNF, and SNF facilities for additional multiple decades of storage operations at all storage facilities.
Aging Management (continued)

• These programs should take into account the following important considerations:
  – the diversity of degraded DOE SNF, storage facility construction materials, and storage systems that differ from those used commercially;
  – the potential for additional multiple decades of storage operations;
  – the requirements that may have to be met to manage degradation of multi-purpose canisters—and any other canisters that may be used—after multiple decades of storage until final disposal occurs;
  – the impact of potential future missions in existing storage facilities when assessing what aging management activities may be needed at each facility; and
  – lessons learned from similar programs developed for commercial nuclear reactors and commercial SNF dry storage facilities.
U.S. DOE Packaging Approach

- Multi-purpose canisters (storage, transportation, and disposal)
  - 3 different systems developed for different DOE SNF
- Multi-canister overpack (MCO)
  - Used only at Hanford
  - SNF from Pu-production reactors stored wet for decades
  - Packaging completed
  - 15 of 394 monitored for pressure, temperature, and gaseous constituents
DOE Packaging (continued)

• Naval canister
  – Used at INL for naval SNF
  – Packaging ongoing (>100 of 400 completed)
  – 2 sizes with 3 different packaging methods

Naval Long SNF Canister
Height (Nominal): 210.5 in

Naval Short SNF Canister
Height (Nominal): 185.5 in

Naval SNF Canisters Outer Diameter (Nominal): 66.5 in

• DOE standardized canister

  – Development stopped before deployment
  – For all remaining non-naval DOE SNF (~3,500 packages)
  – 2 heights (10 and 15 feet)
  – 2 diameters (18 and 24 inches)
  – Advanced neutron absorbers
  – 8 basket arrangements

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Aluminum fuels basket (DOE 2009)
Measuring and Monitoring Recommendation

• **Board Finding**: Measuring and monitoring conditions of the SNF during dry storage is important.
  – The ability to measure and monitor conditions of the SNF in the storage facility during future dry storage (e.g., monitoring gas composition in a multi-purpose canister like that being done for the MCOs) is important to the design, development, and deployment of new DOE storage systems.

• **Recommendation**: The Board recommends that DOE include the capability for measuring and monitoring the conditions of the SNF in new DOE storage systems, such as the DOE standardized canister, and in new packaging and storage facilities to aid in establishing the condition of the SNF during subsequent operations and its acceptability for those operations.
Drying Recommendation

• **Board Finding:** An improved technical basis is needed for proposed drying procedures for DOE SNF before packaging it in multi-purpose canisters.

• **Recommendation:** The Board recommends that DOE conduct research and development activities to confirm that reactions between DOE SNF and any water remaining in any multi-purpose canister do not cause cumulative conditions inside the canister (e.g., combustibility, pressurization, or corrosion) to exceed either the design specifications or applicable regulatory operational requirements. The period of interest extends over the duration of canister use, including the time spent in storage, in transportation, and at a repository, until DOE closes the repository.