Standardized SNF canister survives puncture drop test (40' onto 6' diameter post)

Pre-Closure Safety Analysis

The Nuclear Regulatory Commission requires the U.S. Department of Energy (DOE) to evaluate off-normal event sequences to ensure that people and the environment are adequately protected during repository pre-closure operations.

Overview

The National Spent Nuclear Fuel Program supports repository design basis events analysis by demonstrating that DOE-owned spent nuclear fuel (SNF) does not adversely affect repository safety. Pre-closure safety analysis is used in the national repository design and licensing to establish administrative and operational controls to ensure safety during fuel receipt and handling.

Hazard analysis has been performed to identify events that could potentially result in an unplanned release of radioactive material from DOE SNF. Probability trees have been developed to calculate the frequency of these events. Engineers identified the worst credible events (i.e., design basis events) and calculated potential consequences. Using these analyses, design requirements and other controls have been developed to prevent the event and/or to reduce the consequences to acceptable levels.

INL Solutions

Fuel Grouping

- DOE currently manages more than 250 SNF types. These fuels were grouped to simplify the pre-closure safety analysis. By segregating these SNFs into six groups, which will respond similarly to design basis event conditions, the required analyses are significantly reduced, yet the results still thoroughly and defensibly bound all potential radiological consequences from handling DOE SNF.

Standardized Canister

- The standardized canister has been developed to minimize handling, storage and transportation equipment and the associated analyses and

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requirements. The standardized canister provides an additional safety barrier that has been demonstrated to maintain confinement under all credible accident conditions that could be encountered during interim storage and repository operations. As a result, the costs, personnel exposure and waste generation associated with characterization to verify radiological and mechanical properties of DOE SNFs can be avoided.

Radionuclide Inventory Estimates

- DOE SNFs come from a wide range of reactor types (such as light and heavy water-moderated reactors, graphite-moderated reactors, breeder reactors) with various fuel compounds, cladding materials and enrichments. Many of these reactors had unique operational characteristics and design features such as core configuration, fuel element and assembly geometry, reflector and coolant materials, and neutron spatial and spectral properties. Although these fuels have been safely handled and stored for many years at DOE storage facilities, historical data, such as fuel fabrication, operations, and storage records are incomplete or questionable for many of these fuels. Fuel-specific radionuclide inventory calculations would require a substantial computational effort with results that would inherit the uncertainty of the inputs.
- As an alternative, a methodology was developed for using available information to conservatively estimate the radionuclide inventories. The methodology is based on the application of similarity principles to bin fuels into groups that can employ pre-calculated ORIGEN outputs, scaled to account for burnup, to model the generation of radionuclides. This methodology can be employed to conservatively estimate radionuclide inventories and the associated source term, decay heat and photon emission rate for a broad range of SNF.

Benefits

An understanding of accident scenarios (including natural events) ensures safety by establishing design requirements that adequately prevent and/or mitigate the consequences of potential accidents. Understanding the potential accident scenarios enables safety to be properly addressed by design licensing, and operational requirments. and contingency planning that affect those scenarios.

Based on facility and canister design, analyses for the proposed Monitored Geological Repository at Yucca Mountain have demonstrated that an unplanned radiological release from DOE SNF is not a credible event. Using conservative assumptions, consequence calculations have also demonstrated that radiological doses would be acceptable even during the extremely unlikely event of a canister breach.

Standardized SNF canister survives corner drop (30" onto unyielding surface)

For more information

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