U.S. DEPARTMENT OF ENERGY | Nuclear Energy

Nuclear Energy University Programs
Fiscal Year 2022
Annual Planning Webinar

# Spent Fuel and Waste Disposition

## FC - 4.1 Disposal Research

## FC - 4.2 and 4.3 Storage & Transportation


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# Spent Fuel Disposition Overview

## ❖ DOE Office of Nuclear Energy Mission

- Advance nuclear power as a resource capable of meeting the nation's energy, environmental, and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development, and demonstration as appropriate

## ❖ Spent Fuel and Waste Disposition Mission

- Identify alternatives and conduct scientific research and technology development to enable storage, transportation and disposal of spent nuclear fuel and wastes generated by existing and future nuclear fuel cycles

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# Spent Fuel Disposition Campaign R&D Participants

Pacific Northwest NATIONAL LABORATORY

SRNL SAVANNAH RIVER NATIONAL LABORATORY

Los Alamos NATIONAL LABORATORY

Sandia National Laboratories

Argonne NATIONAL LABORATORY

Science in the National Interest
Lawrence Livermore National Laboratory
Department of Energy University of California
Lawrence Livermore National Laboratory ensures national security and applies science and technology to important problems of our time.

ornl OAK RIDGE NATIONAL LABORATORY

INL Idaho National Laboratory

BERKELEY LAB

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# Spent Fuel Disposition Grand Challenge

- The *Grand Challenge* for the Spent Fuel and Waste Campaign is to provide a sound technical basis for the safety and security of long-term storage, transportation, and disposal of spent nuclear fuel and wastes from the nuclear energy enterprise
- Importance: Supports the establishment of SNF management and disposition pathways

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# Spent Fuel Disposition Research Needs

## ❖ Disposal

- Provide a sound technical basis for assurance that the US has multiple viable disposal options available when national policy is ready
- Identify and research generic sources of uncertainty that challenge the viability of disposal concepts
- Increase confidence in robustness of generic disposal concepts to reduce the impact of site-specific complexity
- Develop the science and engineering tools required to address the needs above

## ❖ Storage & Transportation

Develop the technical bases:

- To demonstrate spent fuel integrity for extended storage periods
- For fuel retrievability and transportation after extended storage
- For transportation of high burnup fuel

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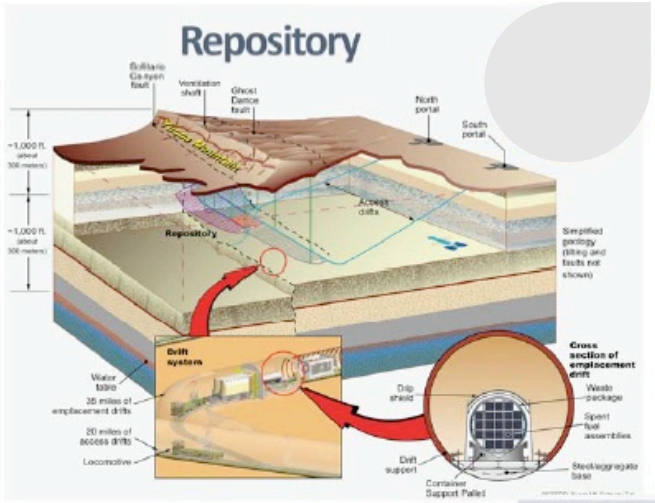
# NEUP R&D Work Scope Description: Spent Fuel Disposition FC-4.1: Disposal




## Generic Geologies

- clay/shale
- salt
- crystalline rock
- alluvial media

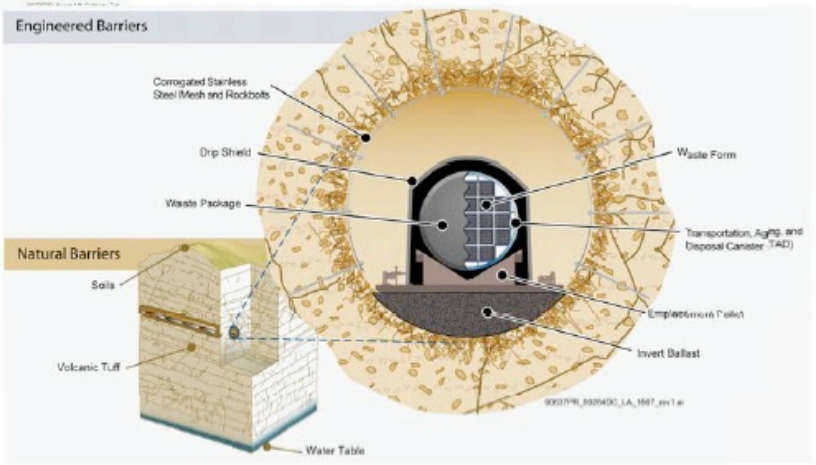
## Barriers for Waste Isolation

Natural Barriers:

- Saturated or Unsaturated
- Reducing or Oxidizing

Engineered Barriers:

- Backfill
- Container, Overpack, etc.
- Waste Form (glass, ceramic)



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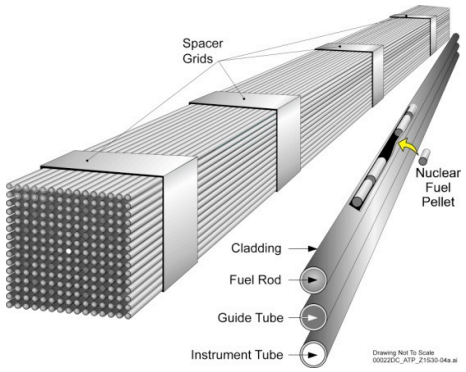
# FC-4.2 Storage & Transportation Storage System Components

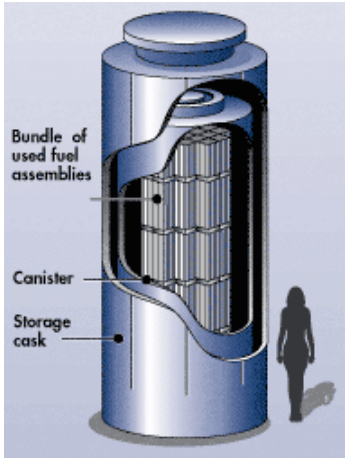
## I. Fuel

- Fuel/Pellet
- Cladding
- Assembly hardware




## II. Cask

- Internals (baskets, neutron poisons)
- Container (canister, welds, seals, bolts)
- Overpack/Storage module




## III. ISFSI

- Pad
- Rebar
- Physical Protection

## IV. Monitoring Systems

- Remote inspection
- In-package sensors
- Security

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# Spent Fuel & Waste Disposition FC-4 Focus Areas for University Research Proposals

- **Program Supporting R&D proposals are being solicited in the Spent Fuel Disposition Areas:**
  - **FC-4.1 Disposal**
  - **FC-4.2 Earthquake Response**
  - **FC-4.3 Particulate Deposition**

**(University-led up to $800,000 for 3 years)**

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# Spent Fuel Disposition
# FC-4.1 Disposal

**Develop new and improved concepts, data, and models to demonstrate total system performance of the permanent disposal of spent nuclear fuel and high-level radioactive waste. This should apply to a variety of generic deep geologic repository concepts in clay/shale, salt, crystalline rock, and alluvial media. The research should include one of the following strategies:**

- **Barrier material development and experimenting/testing/investigating/characterizing methods advancement**
- **Data quality improvement and model enhancement focusing on sensitivity analysis, uncertainty quantification, reducing uncertainties**

**The research should address one or more of the following interest areas:**

- **Improved understanding of waste package failure modes**
- **Improved data and understanding of aqueous speciation and geochemistry of radionuclides**
- **Improved understanding and new concepts for engineered and natural barrier systems**
- **New concepts or approaches for alleviating post-closure criticality concerns**

# Spent Fuel Disposition Storage & Transportation

## FC-4.2: Earthquake Response of Spent Nuclear Fuel in Dry Storage Facilities

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**DOE is evaluating the seismic loads that Spent Nuclear Fuel (SNF) assemblies might be subjected to during extended storage and transportation by applying simulated earthquake loads to a full-scale mock-up of a dry storage canister containing surrogate and dummy SNF assemblies on a shake table. Research proposals are sought for developing innovative techniques to analyze the stresses and strains on all structural components of the SNF assembles, based on the data collected during the empirical tests. Universities must develop (or adapt) innovative approaches for computational modeling and simulation, analyzing large volumes of empirical data, developing novel transfer functions for sliding and rocking, validating high-fidelity computational models, identifying risk and mitigation, as well as recommend additional empirical tests and future work.**

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# Spent Fuel Disposition Storage & Transportation

## FC-4.3: Experimental Validation of Particulate Deposition Mechanisms on Dry Storage Canisters

**DOE is evaluating the susceptibility of Spent Nuclear Fuel dry storage canisters to stress corrosion cracking induced by chlorine salts precipitated in marine environments. To support this study, research proposals are sought for designing and performing laboratory- and small-scale experimental analyses and interpretation of ten of the most likely particulate deposition and resuspension mechanisms under relevant conditions: aerosol droplet evaporation, Brownian Diffusion, Aerodynamic Deposition, Gravitational Settling, Thermophoresis Turbophoresis, Saffman Lift, Diffusiophoresis, Stefan Flow, and Electrophoresis. The tests should look at the separate as well as combined effects of these mechanisms and assess the relative importance of each under the different conditions.**

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# Questions?


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