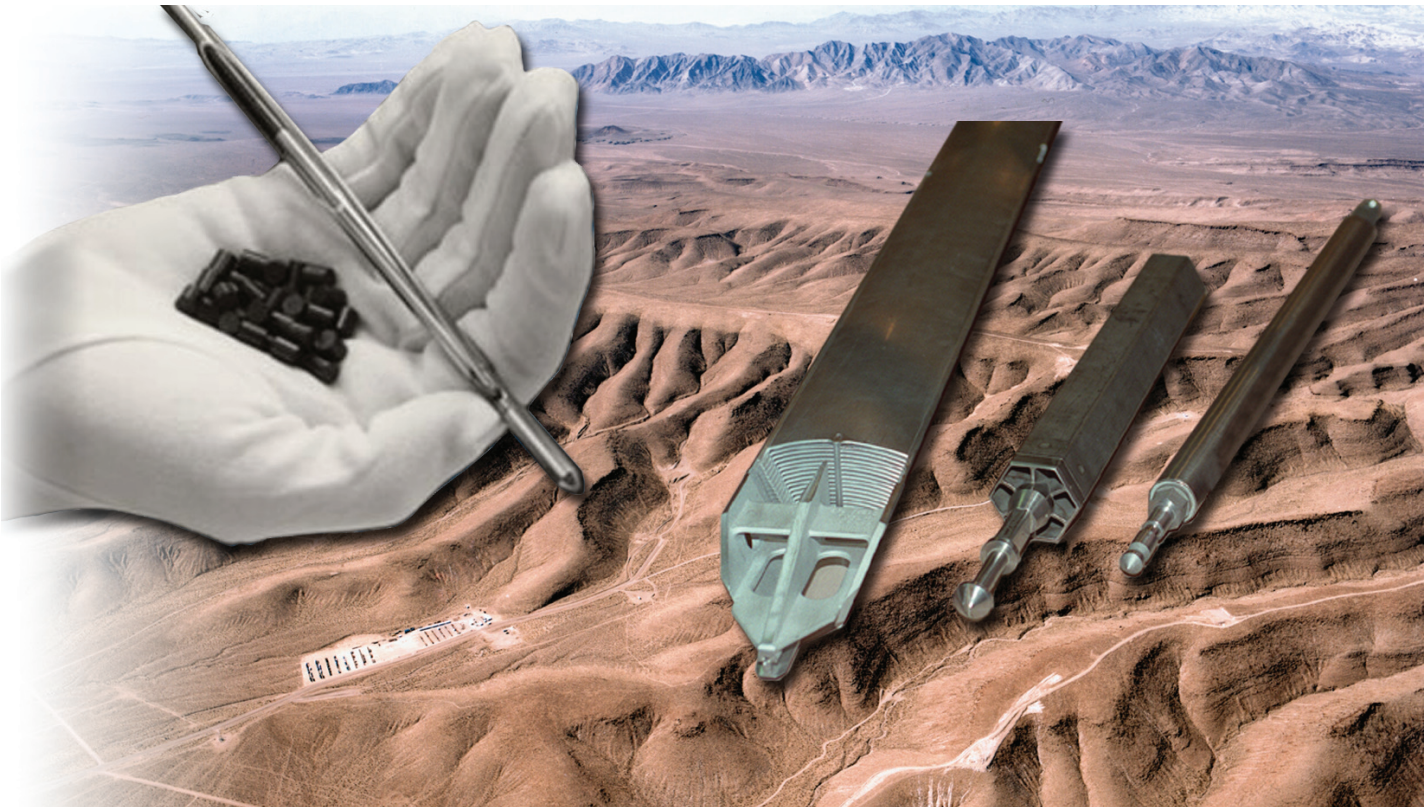

Spent Nuclear Fuel and High Level Waste Analysis

Providing enhanced understanding of material and energy interactions through chemical and engineering analysis, and detailed computational modeling that assists in managing spent nuclear fuel and other materials during storage and disposal.

Overview

Radioactive waste site remediation and nuclear facility decommissioning often require spent nuclear fuel (SNF), radioactive materials, and waste to be processed and packaged for storage or final disposition. The remediation process can be made more effective by analysis of the material behavior in the storage or disposition environment.

Chemical, engineering, and computational modeling analysis provide evaluation of a set of given materials (e.g., SNF or high-level waste [HLW]) physical/chemical interaction with the surrounding environment. This analysis can be used to help evaluate material management and disposition options, identify areas where more detailed data may be required, or demonstrate how well package and treatment options meet requirements.

NSNFP Solutions

NSNFP provides detailed analysis and advanced state-of-the-art computer modeling capabilities to evaluate behaviors, such as chemical reaction and material release, for various waste forms. National Spent Nuclear Fuel Program (NSNFP) computational tools can model energy and mass transfer for highly complex geometries and systems. NSNFP capabilities include:

- Ability to perform geochemical, total system performance assessment and general chemical system analysis
- State-of-the-art advanced software to simulate a wide range of material, thermal, and transport behaviors
- Advanced computer systems to support complex analysis
- Analysis and software controls compliant with both NQA-1 and RW-0333P quality programs.

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Science

Idaho National Laboratory

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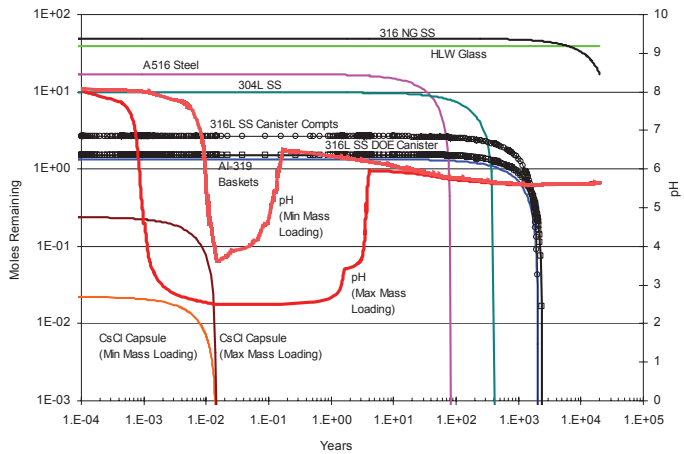


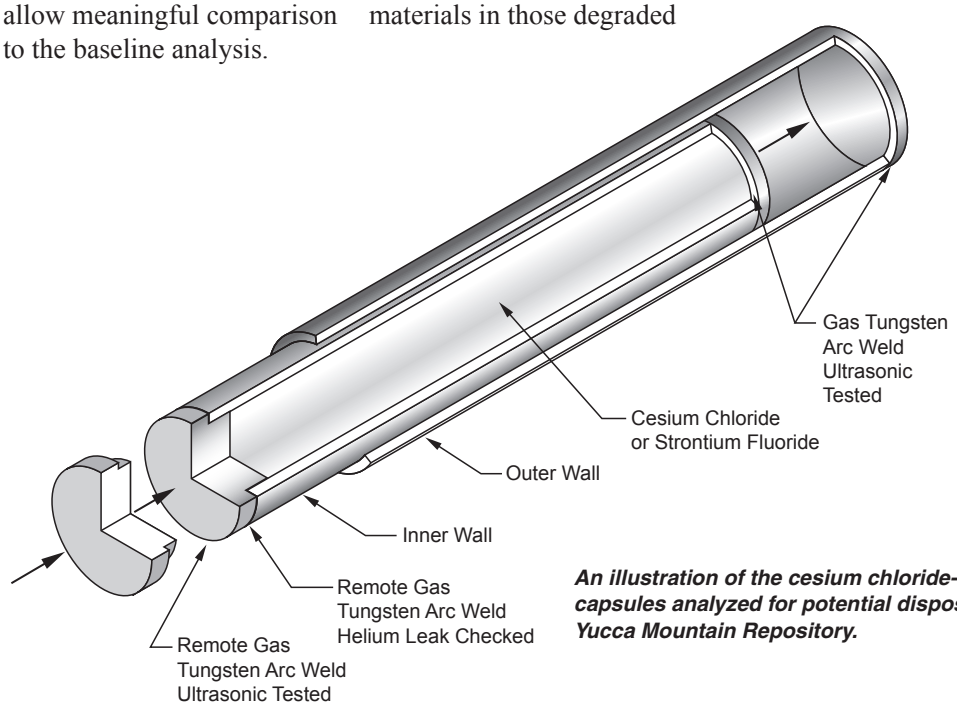
An example output from the geochemical analysis of Hanford cesium chloride-bearing capsules. Note the geologic time-scale tracking changes in variables important to the analysis.

Geochemical Analysis

Geochemical analysis calculates in-package solution chemistry as waste package materials and contents interact with infiltrating groundwater during a defined period. Calculations could include HLW glass that provides a waste package configuration similar to the repository baseline, to allow meaningful comparison to the baseline analysis.

Total System Performance Assessment

The Yucca Mountain project (YMP) has developed detailed computer simulations of repository behaviors such as water infiltration, degradation of waste packages in the national repository, and subsequent transport of radionuclides released from materials in those degraded waste packages. Analysis using these models is known as a Total System Performance Analysis (TSPA). A more detailed discussion of the TSPA may be found in the TSPA fact sheet. The NSNFP uses these models to simulate placement of different materials in a future repository (one planned to open after YMP) to assist with program evaluations of materials that do not have a disposition path. These analyses define an analysis case, usually defining a packaging configuration and the physical/chemical properties of materials in the package. This case is then used to perform the analysis, with results indicating general acceptability of the form or a need for further data definition and analysis. These analyses are scoping for program decision assistance only, and do not replace required analysis by



An illustration of the cesium chloride-bearing capsules analyzed for potential disposal in the Yucca Mountain Repository.

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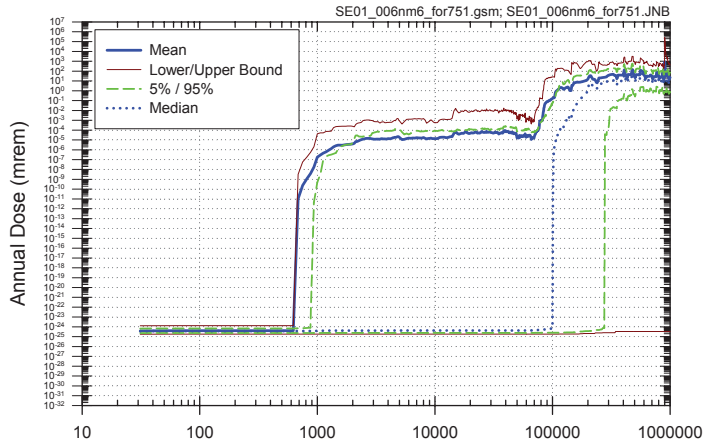

An example TSPA output, for potential disposal of the cesium chloride-bearing capsules to the repository, showing annual dose from released capsule materials.

YMP for repository placement of material. This type of TSPA analysis has been performed for Hanford cesium and strontium-bearing waste capsules as well as INL high-level waste calcine. Both cases demonstrated that further treatment of these materials before disposal may not be required, which is different from what was previously believed. This may result in significant program savings.

General Chemical Analysis

General chemical analysis uses chemical and physical characteristics of materials and packages to evaluate behavior in various scenarios. This modeling simulates the chemical and physical phenomena affecting materials in a storage/disposition package and the surrounding storage environment. Outputs include energy and material consumption/release for the package materials. This is different from the geochemical analysis because the surrounding environment may be a building, storage basin, or a container. It is based on near-term calendar time rather than geologic time. Examples of this type of analysis are:

- NSNFP previously evaluated the chemical reactivity of uranium hydride bearing N-reactor SNF in the repository, and demonstrated a negligible impact to repository facilities from incidents involving this SNF.

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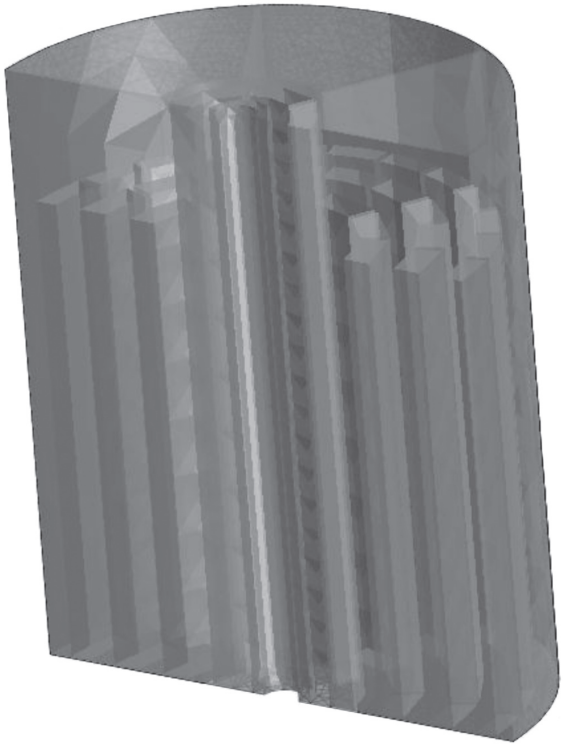

Hanford N-Reactor scrap was modeled as slabs of material to evaluate the chemical reactivity potential of the Multi-Canister Overpack.

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- NSNFP is currently performing an evaluation of metallic sodium-bearing FERMI-1 blanket potential disposal in repository to determine if sodium presents a significant reaction hazard.

Benefits

NSNFP has comprehensive experience across the entire nuclear fuel cycle. The analysis modeling capabilities at NSNFP draw on this experience to address specific needs of the nuclear fuel cycle. Cost reduction, process optimization, cost- effective alternatives, and evaluation are some of the many benefits provided.

For more information

Technical Contact:

Steven Wahnschaffe
(208) 526-3219
fax: (208) 526-4902
Steven.Wahnschaffe@inl.gov

Management Contact:

Sandra Birk
Manager, Nuclear Materials Disposition and Engineering
(208) 526-1866
Sandra.Birk@inl.gov

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