

*Exceptional service in the national interest*



# Salt Disposal Research, Development, and Demonstration (RD&D)



Federal Ministry  
for Economic Affairs  
and Energy

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.. SAND2013-4207C

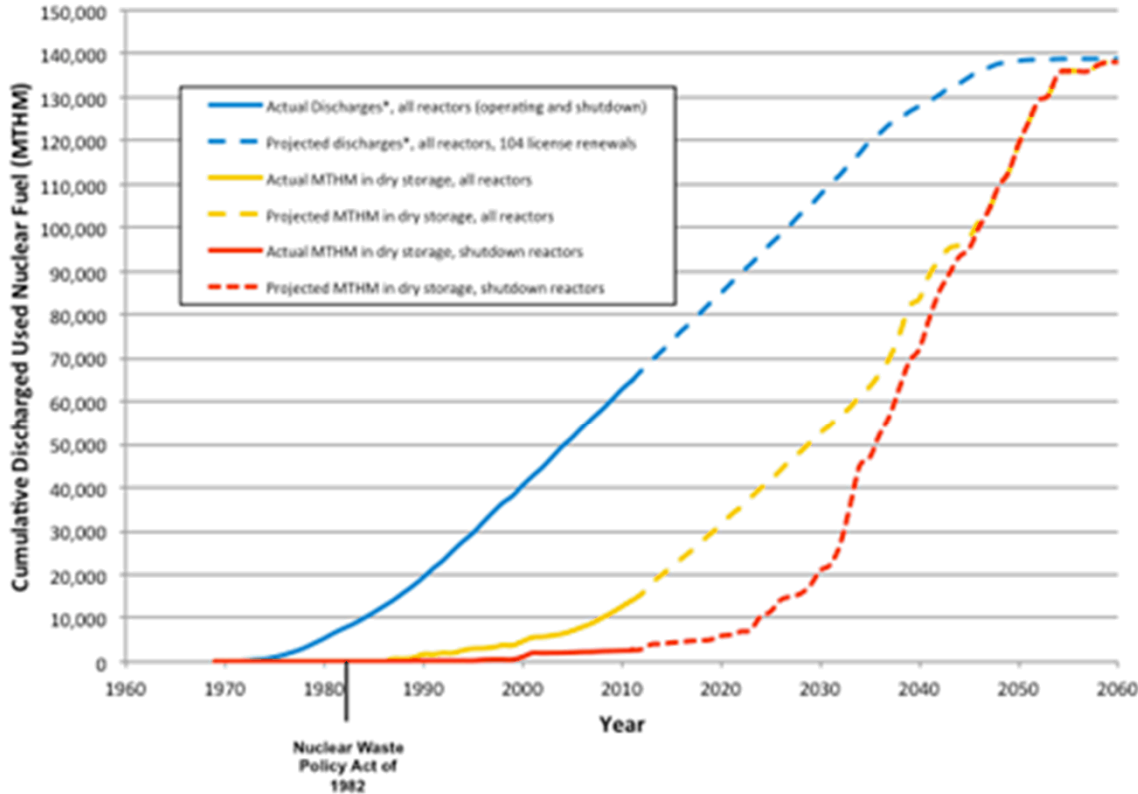
Robert J. MacKinnon  
Sandia National Laboratories

5<sup>th</sup> US/German Workshop on  
Salt Repository Research, Design and Operation

Santa Fe, New Mexico, USA

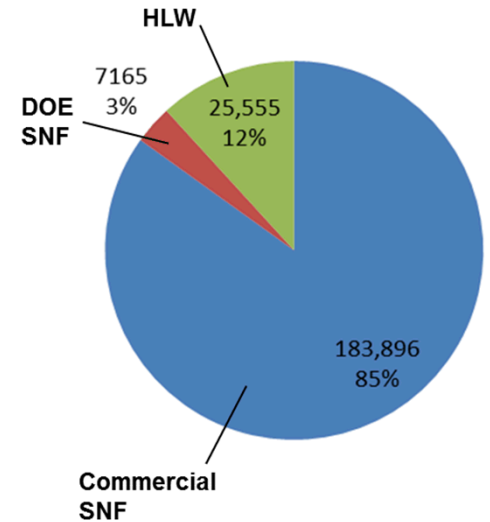
September 7-11, 2014

# Projections of Future SNF and HLW



Source: \*Based on actual discharge data as reported on RW-859s through 12/31/02, and projected discharges, in this case for 104 license renewals

## Projected Volumes of SNF and HLW in 2048



Volumes shown in m<sup>3</sup>, assuming constant rate of nuclear power generation

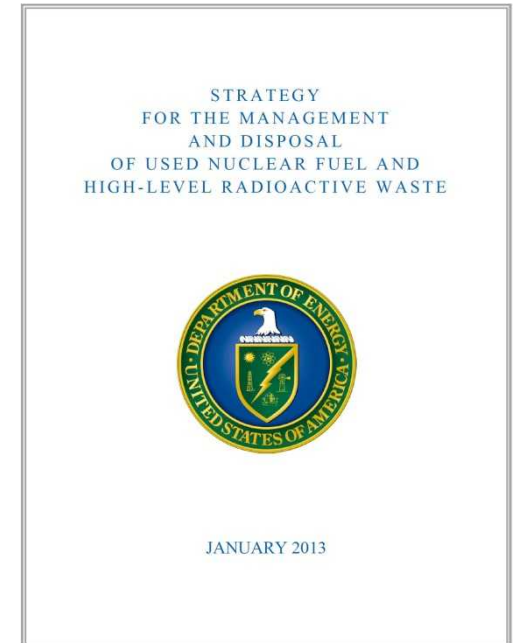
## Historical and Projected Commercial SNF Discharges in the United States

# Summary of the Administration's Strategy for Used Nuclear Fuel and High-Level Radioactive Waste

*Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* issued January 2013.

## The Strategy outlines a 10-year program:

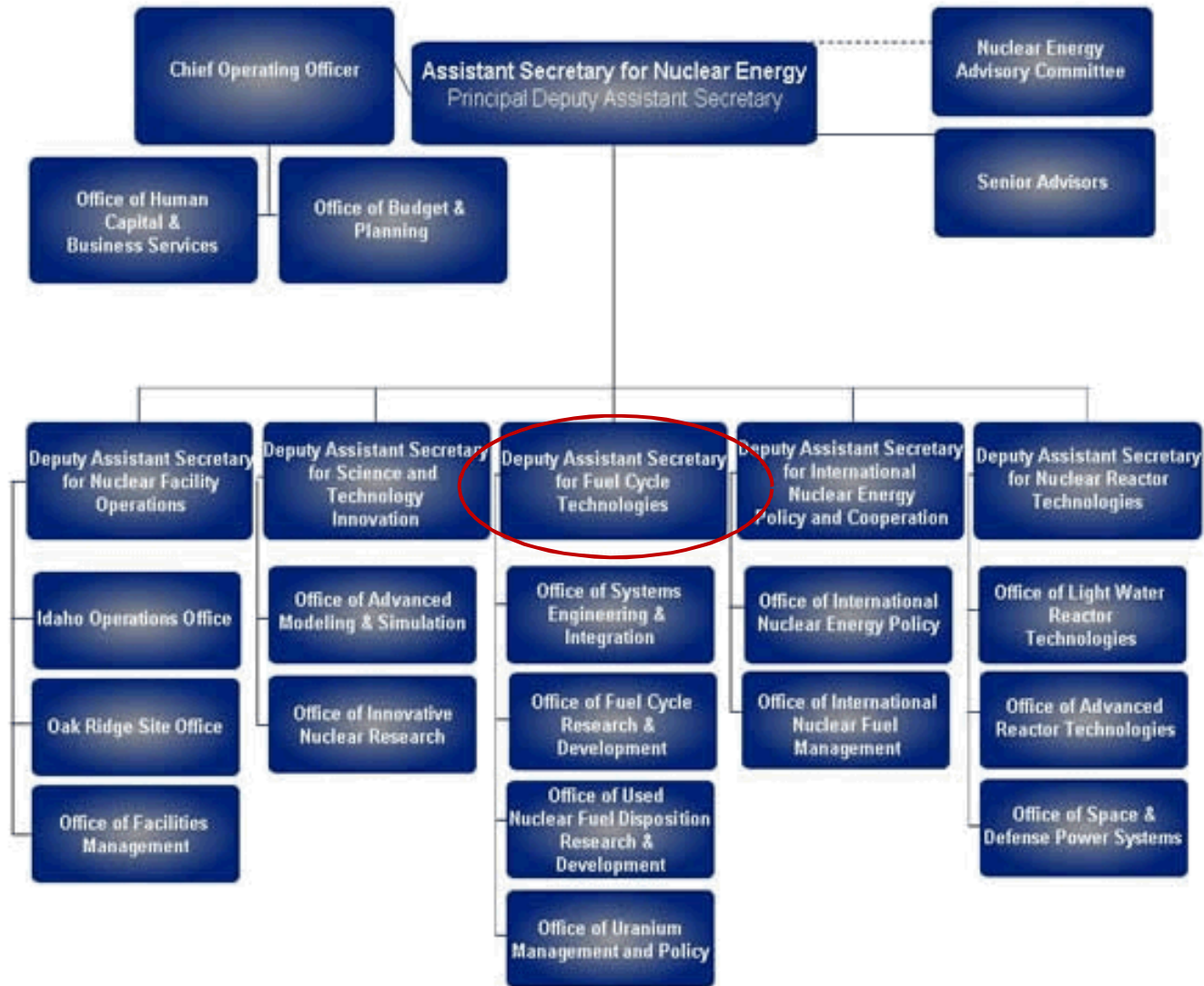
- Site, design, license, construct and begin operation of a pilot interim storage facility (operating 2021)
- Advance toward siting and licensing of a larger interim storage facility (operating 2025)
- Make demonstrable progress on siting and characterization for geologic disposal (sited 2026, operating 2048)



# Disposal R&D within the DOE

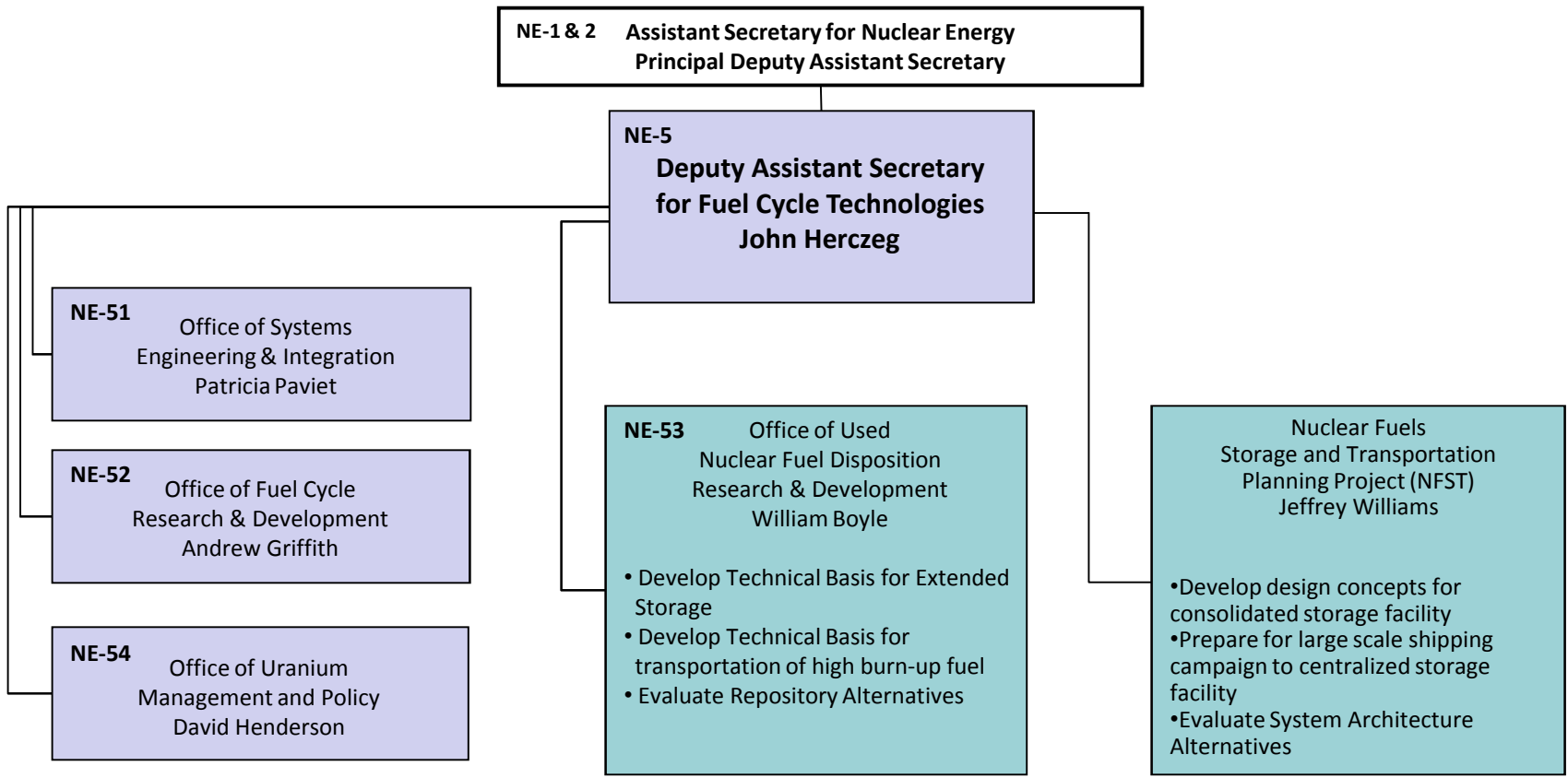
- **The Nuclear Waste Policy Act and Congressional Appropriations preclude site-specific repository investigations**
- **All disposal research must be generic at this stage**
- **What can generic R&D accomplish?**
  - Provide a sound technical basis for the assertion that the US has multiple viable disposal options that will be available when national policy is ready
  - Identify and research the generic sources of uncertainty that will challenge the viability of disposal concepts
  - Increase confidence in the robustness of generic disposal concepts to reduce the impact of unavoidable site-specific complexity
  - Develop the science and engineering tools required to address the goals above, through collaborations within NE and DOE, and with universities, industry, and international programs

# DOE Office of Nuclear Energy Organization Chart



Source: <http://energy.gov/ne/organization>

# DOE Office of Nuclear Energy Office of Fuel Cycle Technologies (NE-5)



- Develop Technical Basis for Extended Storage
- Develop Technical Basis for transportation of high burn-up fuel
- Evaluate Repository Alternatives

- Develop design concepts for consolidated storage facility
- Prepare for large scale shipping campaign to centralized storage facility
- Evaluate System Architecture Alternatives

**R&D Focus** ← → **Implements Strategy for Storage and Transportation**

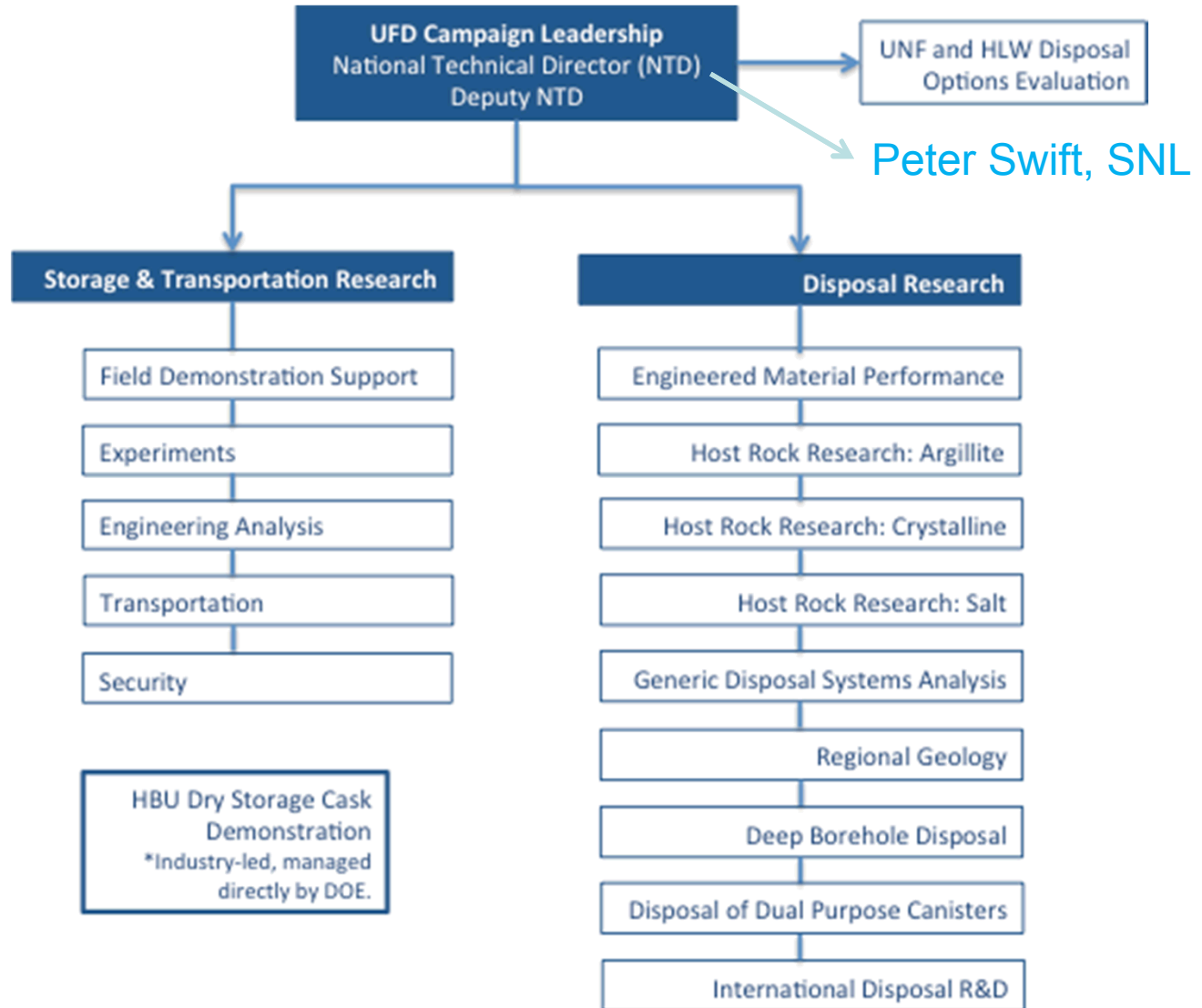
# DOE's R&D Program for Used Nuclear Fuel Disposition

*Nine national laboratories participate in the DOE Office of Nuclear Energy's "Used Fuel Disposition Campaign" (UFDC)*

**Campaign Mission:** to identify alternatives and conduct scientific research and technology development to enable storage, transportation and disposal of used nuclear fuel and wastes generated by existing and future nuclear fuel cycles



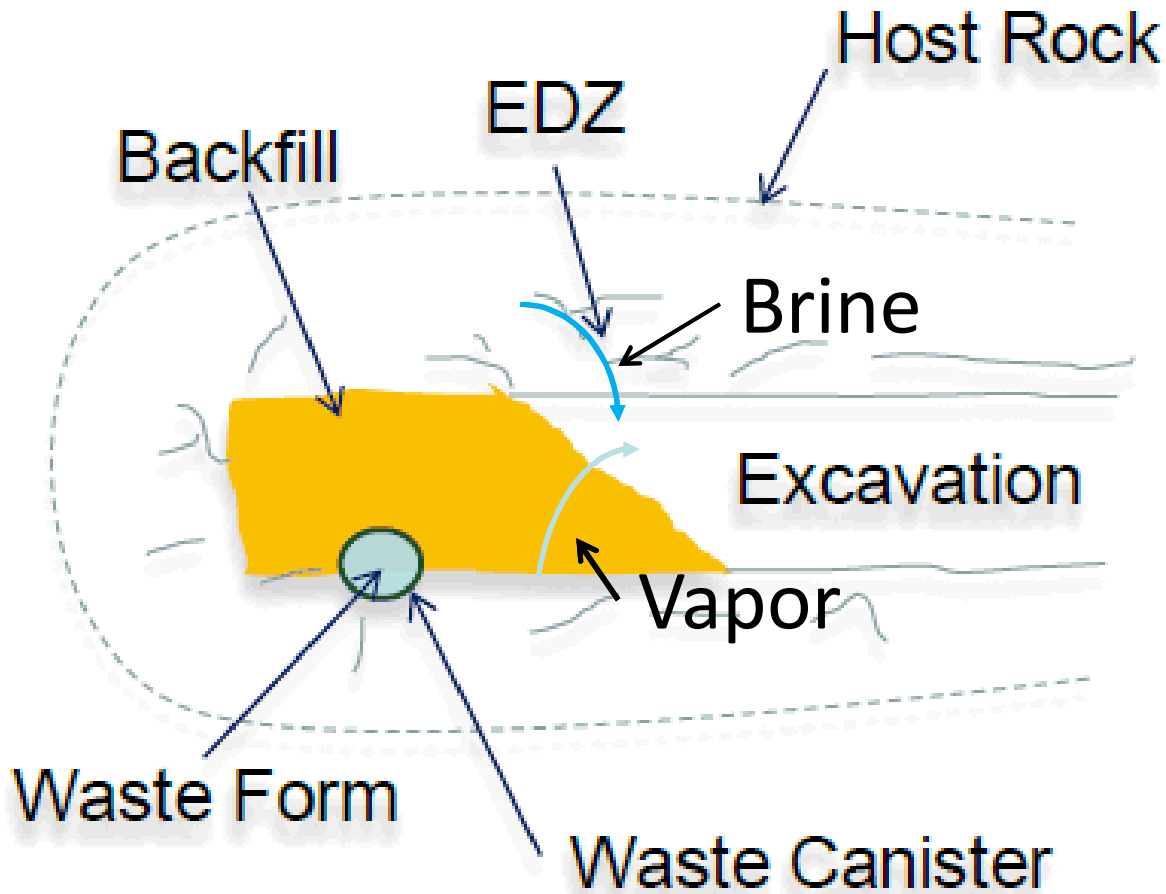
# Campaign Structure



# UFD R&D Campaign 2009-Present

- FY09 Planning meeting at Argonne National Laboratory, June 2009
- FY10 R&D funding at \$7.1 M
  - Disposal R&D, modest level of effort on Storage R&D, no Transportation R&D
- FY11 R&D funding at \$23.8 M
  - Nine national laboratories participating in UFD
  - Significant R&D program in Storage, including Transportation
  - Disposal R&D not site specific
- FY12 R&D budget baseline at \$22.8 M, end-of-year actual ~\$37 M (Salt R&D - \$4.5 Mill)
  - Some elements of FY12 work scope not established until fourth quarter
- FY13 R&D \$23.5 M (Salt R&D - \$2.06 Mill)
  - Nuclear Fuel Storage and Transportation Planning Project initiated
  - Storage demonstration R&D initiated external to UFD R&D campaign
- FY14 R&D end-of-year baseline at \$22.5 M (Salt R&D - \$2.25 Mill)
  - Significant redirection of scope within campaign in initial planning
    - Storage and transportation at 54% of budget
    - Disposal research at 37% of budget
    - Management and integration at 8%
  - Work through February 2014 limited to annual total of \$15.4 M
- FY15 Salt R&D projected to be \$1.25 Mill (\$750K lab, \$500K Field)

# Schematic of Features of a Backfilled Repository Room



Many of these activities are documented in technical reports and will be discussed in this 5<sup>th</sup> US/German Workshop

## EXISTING SALT DATA COMPILATION AND ASSESSMENT

### THERMAL, MECHANICAL, HYDROLOGIC, AND CHEMICAL LABORATORY STUDIES RELATED TO SALT

- *Hot Granular Salt Consolidation, Constitutive Model and Micromechanics*
- *Thermal Conductivity as a Function of Porosity and Temperature*
- *Laboratory Thermomechanical Testing*
- *Brine Migration Experimental Studies*
- *Material Interactions In Heated Salt*
- *Thermodynamic Properties of Brines, Minerals and Corrosion Products In High Temperature Systems*
- *Radionuclide Solubility Measurements*

### MODELING STUDIES RELATED TO SALT

- *Safety Framework Development*
- *Total System Performance Assessment (TSPA) Model Development*
- *Generic Salt Repository Benchmarking*
- *Thermomechanical-Hydrological and Chemical (TMHC) Model Development/Brine Migration*

### INTERNATIONAL COLLABORATION

# Salt RD&D Deliverables

- Summary Results for Brine Migration Modeling Performed by LANL, LBNL and SNL for the Used Fuel Disposition Program (9/25/2014) – SNL, LBNL, LANL
- Salt R&D Brine migration experimental studies in salt 2014 (08/24/2014) - LANL
- Report on Modeling Coupled THMC Processes and Brine Migration in Salt at High Temperatures (9/13/2014) - LBNL
- Analysis of Data from Salt Reconsolidation Experiments at Sandia National Laboratories in FY12 and FY13 (3/13/2014) - SNL
- Thermal Conductivity of Salt as a Function of Porosity (3/12/2014) - SNL
- Modified Test Plan For Salt Reconsolidation Experiments at Sandia National Laboratories (6/26/2014) - SNL
- Thermomechanical Testing of Intact Salt Results for FY14 (6/16/2014) - SNL
- Thermodynamics of Brines, Minerals and Corrosion Products at High Temperatures: FY14 Results (9/30/2014 ) - SNL
- Results from the US-German Benchmark Initiative for FY14 (9/30/2014 ) - SNL
- Results from The 4th US German Workshop on Salt (12/23/2013) - SNL

## General Objectives

- *Develop technology and methodology for rock characterization and testing*
- *Better understand, model and test relevant processes*
- *Better understand various components of engineering barrier system*
- *Provide quantitative data for safety assessment calculations*
- *Test and optimize full-size repository components and operating procedures (demonstration)*
- *Optimize repository construction techniques*
- *Training and benchmarking*
- *Promote international co-operation*
- *Build confidence in scientific and technical community*
- *Contribute to public trust and confidence*

After IAEA-TECDOC-1243, 2001

## Upcoming Deliverables

- *Framework for Underground Research—important protocol for URL activity evaluation*
- *Draft report--Test Plan for Mechanical and Hydrological Behavior of the Near-field Host Rock Surrounding Excavations*
- *Draft report--Test Plan for Phased Large-Scale Thermal Testing*

# Questions?