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Exceptional service in the national interest

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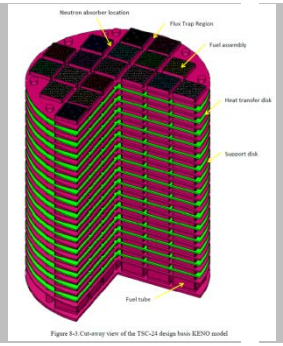

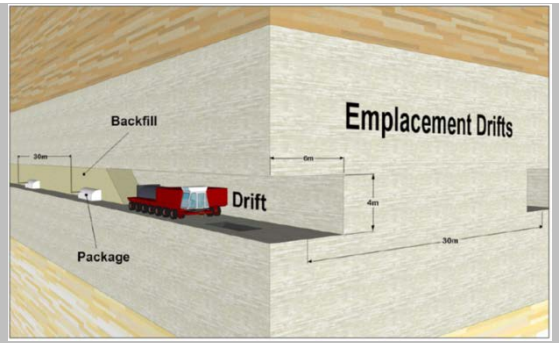

Nuclear Waste and Fuel Cycle Activities

Visit of Dr. Jean-Yves LE DEAUT and Colleagues
March 13, 2015

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Nuclear Waste Classification in the U.S.

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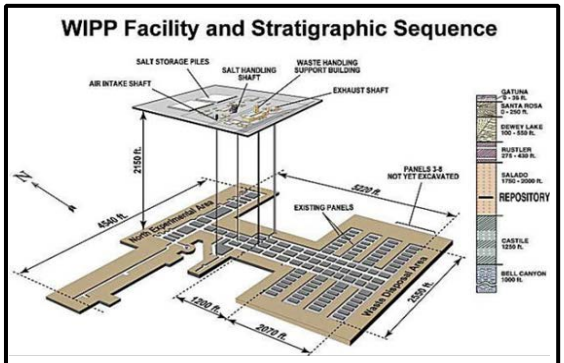
High-Level Waste (HLW) and Spent Nuclear Fuel (SNF)

Defense HLW and SNF

Commercial SNF and HLW

Transuranic (TRU) waste

Defense, contaminated mainly with Am & Pu

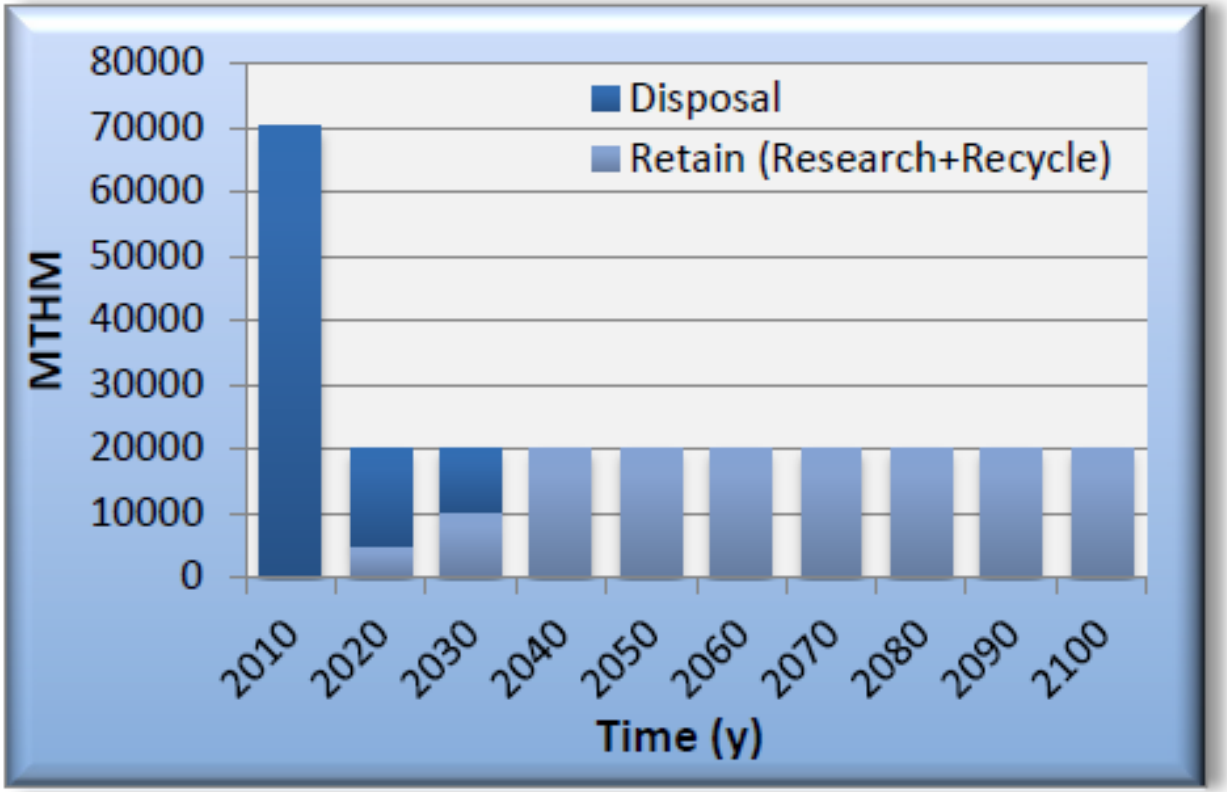


Low-Level Waste (LLW)

Defense

Commercial

How much used reactor fuel is needed to initiate a future, fully closed fuel cycle?



→ Disposal of 98% of current inventory: No adverse impact on deployment of future alternative fuel cycles

Source: Wagner et al. 2012. Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy. FCRD-FCT-2012-000232. U.S. Department of Energy, Office of Used Nuclear Fuel Disposition.

Yucca Mountain, Nevada USA

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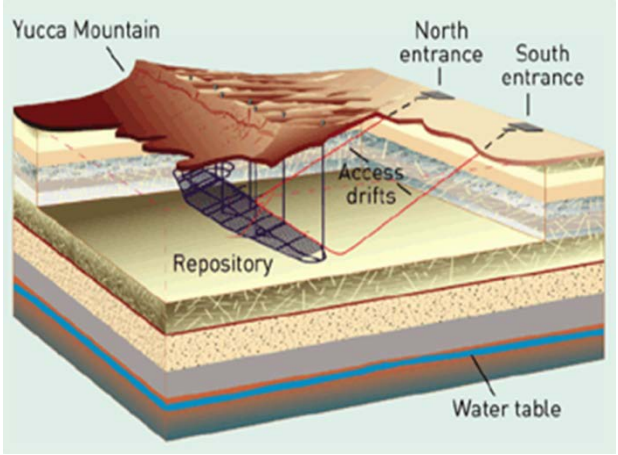
- Sparsely populated, arid desert
- Deep water table, closed groundwater basin
- Unsaturated, volcanic tuff (11.5 to 14 Myr age)
- License application completed in 2008, with Sandia serving as Lead Laboratory
- "Yucca Mountain is not a workable option" (DOE licensing motion to withdraw, March 3, 2010)
- Congress has not appropriated funds for Yucca Mountain since 2010
- License hearings remain suspended
- The Nuclear Waste Policy Act remains in effect and precludes site-specific work elsewhere without Congressional authorization

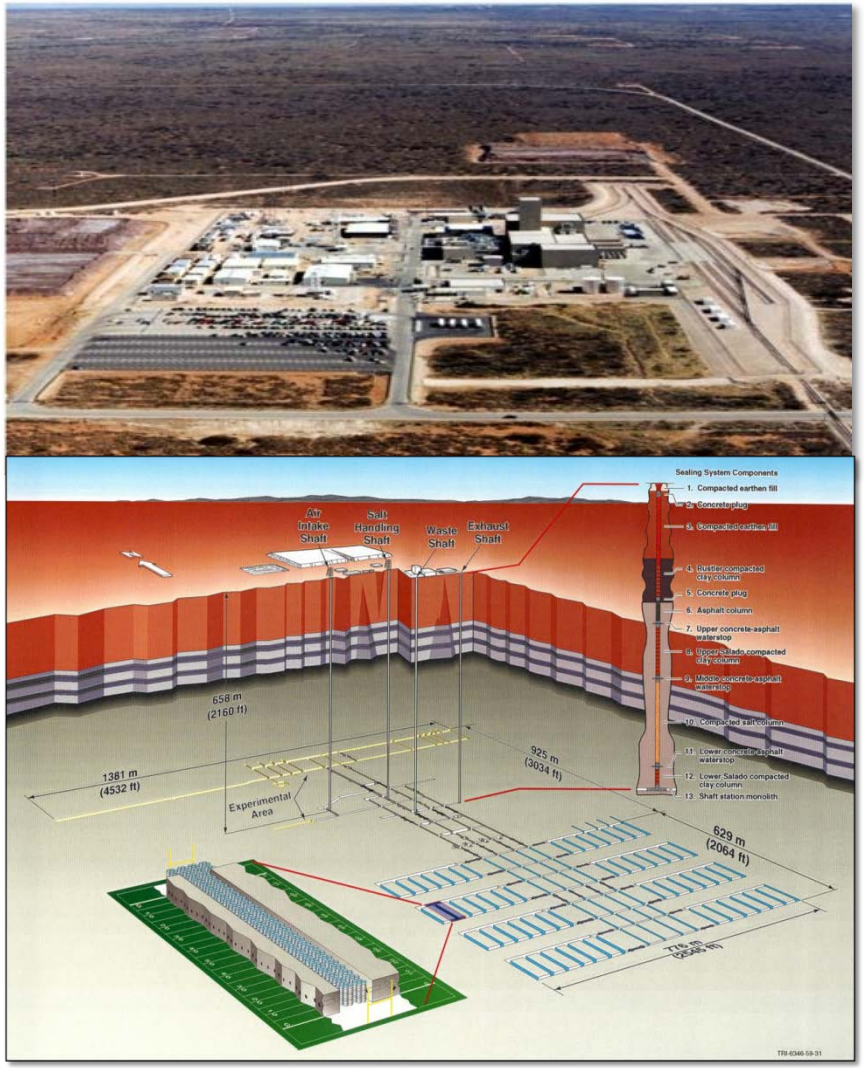


"…the Secretary's judgment here is <u>not that Yucca Mountain is unsafe or that there are flaws in the LA</u> [license application], but rather that it is not a workable option and that alternatives will better serve the public interest." (DOE filing to Nuclear Regulatory Commission Licensing Board, May 27, 2010, footnote 102)

Waste Isolation Pilot Plant (WIPP), New Mexico, USA

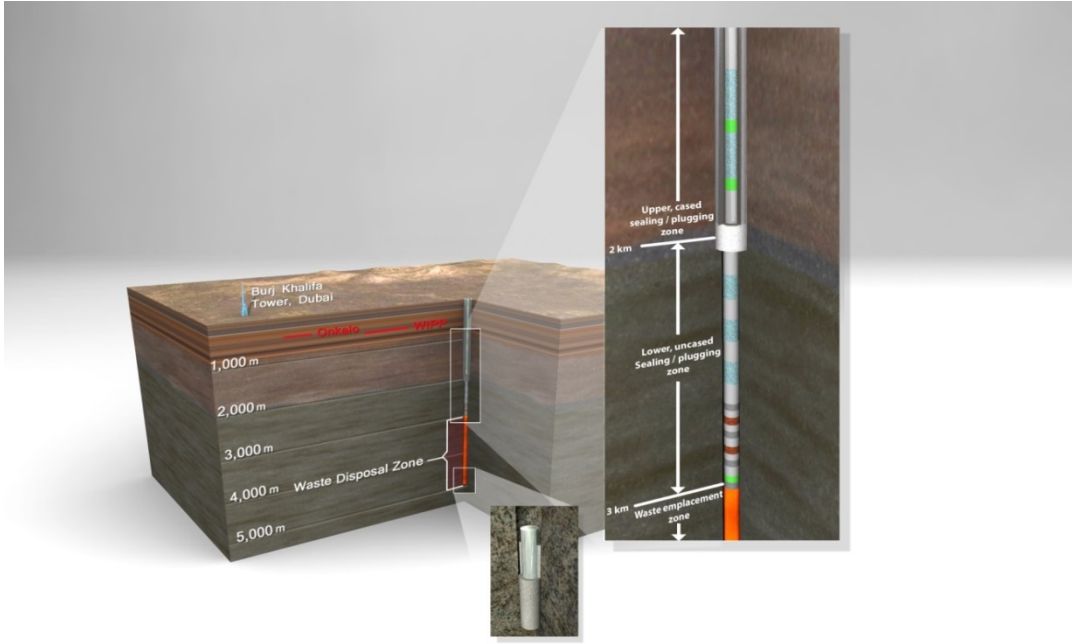
Sandia National Laboratories

- Shafts descend 600 m
- Operated for R&D 1986–1996
- License application in 1996
- TRU waste disposal began in 1999
- Sandia has performed or directed research and licensing analysis, and serves as official Scientific Advisor (since 1975)
- 14 million miles safe waste transport
- Current status:
  - Accidental radiological release 14 February, 2014
  - Decontamination and system improvements underway
  - Current plan to resume disposal operations in ~12 months



More information: www.wipp.energy.gov

Deep Borehole Disposal Concept



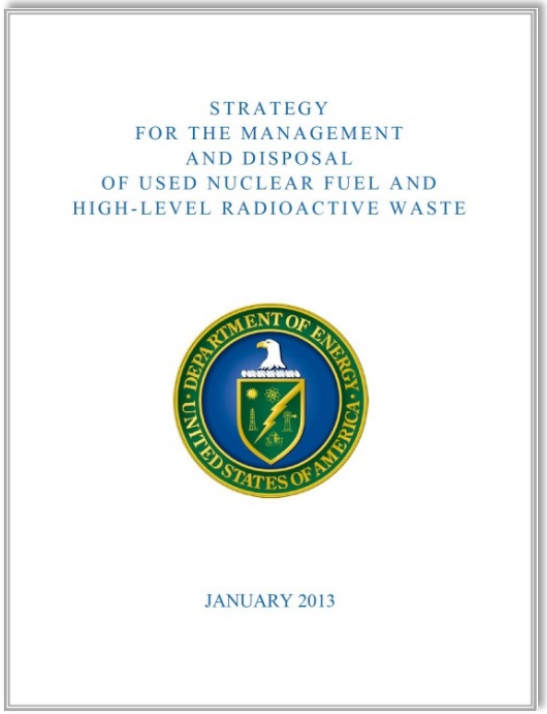
- Waste disposal in boreholes in basement rock (granite) at up to 5,000 m depth
- Very old, saline, immobile groundwater
- Borehole diameter 25 to 45 cm
- Up to 400 steel waste canisters for HLW, possibly SNF
- Boreholes would be sealed with clay, cement, concrete
- Sandia leads an ongoing field demonstration project, with drilling planned to begin in 2016

Summary of U.S. Strategy for SNF and HLW

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 of work that:

- **Sites, designs, licenses, constructs and begins operations of a pilot interim storage facility (operating 2021)**
- **Advances toward the siting and licensing of a larger interim storage facility (operating 2025)**
- **Makes demonstrable progress on the siting and characterization of repository sites (repository sited 2026, licensed 2042, operating 2048)**



Integration of Storage-Transportation-Disposal

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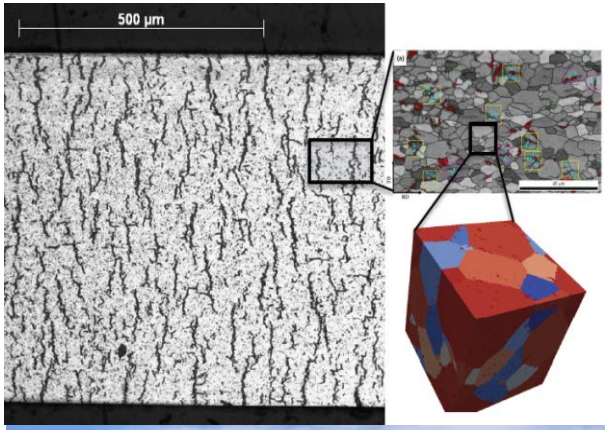
- **Sandia provides technical leadership for a DOE-sponsored multi-laboratory R&D program on storage, transportation, and disposal of SNF and HLW**
- **Establish Waste Pathways to Disposition for Waste Forms**
  - **Commercial spent fuel (140,000 MT in the U.S. by mid-century)**
  - **Defense SNF and HLW types**
- **Cross-Cutting Technical Feasibility Questions, for example:**
  - **Can all waste forms be transported 100 years in the future?**
  - **How can centralized storage be used?**
  - **What are the technical requirements for geologic disposal of waste forms?**
  - **How should waste forms be packaged for disposal?**
- **Repository Science**
  - **Sandia contributions: Yucca Mountain, WIPP, deep borehole, other disposal programs, and ongoing R&D**

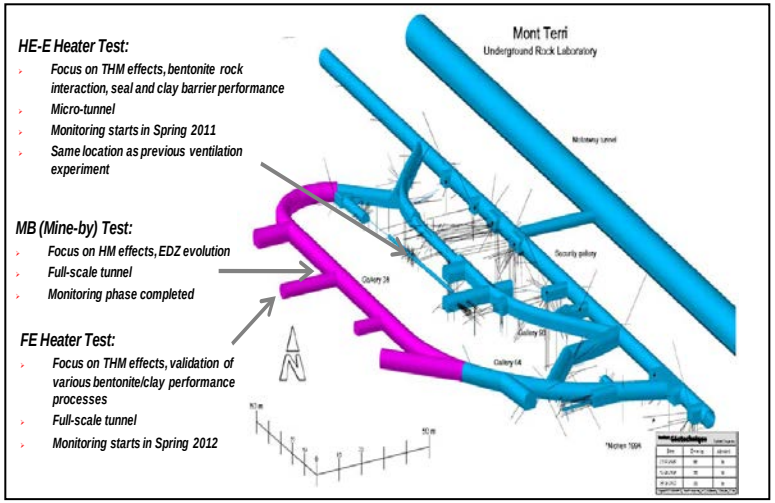
R&D for Storage and Transportation

- Prepare for extended spent fuel storage (up to 100 years?)
- Prepare for large-scale transport of SNF/HLW
- Sandia has a leadership role in:
  - Experiments
    - Fuel cladding testing
    - Storage canister corrosion investigations
  - Analysis
    - Simulation of hydride behavior and cracking
  - Transportation
    - Fuel shock and vibration
  - Field Demonstration
    - Test canister, high-burnup spent fuel



Disposal R&D International Collaboration

Sandia has a leadership role in formal, collaborative R&D arrangements with ongoing programs in Europe and Asia



- **Mont Terri**: Underground research laboratory in clay (Swisstopo, Switzerland)
- **Grimsel**: Colloid Formation and Migration Project in granite (NAGRA, Switzerland)
- **KAERI** Underground Research Tunnel: Borehole Geophysics (South Korea)
- **SKB**: Task Forces on Groundwater Flow and Engineered Barriers at Äspö Hard Rock Laboratory (Sweden)
- **BMWi**: Data exchange for salt repositories at Gorleben and WIPP (Germany)
- **ANDRA**: Natural and Engineered Barriers in clay and shale (France)
- **DECOVALEX**: (Development of Coupled Models and their Validation against Experiments)