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DOE/NE Used Fuel Disposition Program Overview

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Outline

- **The Office of Used Nuclear Fuel Disposition R & D**
  - Who we are
  - Our mission and goals
- **Storage and Transportation Activities**
  - Storage R & D (Ken Sorenson)
  - Storage activities to evaluate integrating consolidate storage and standardizing dry cask storage
  - Transportation R & D (Paul McConnell)
- **Disposal R&D**

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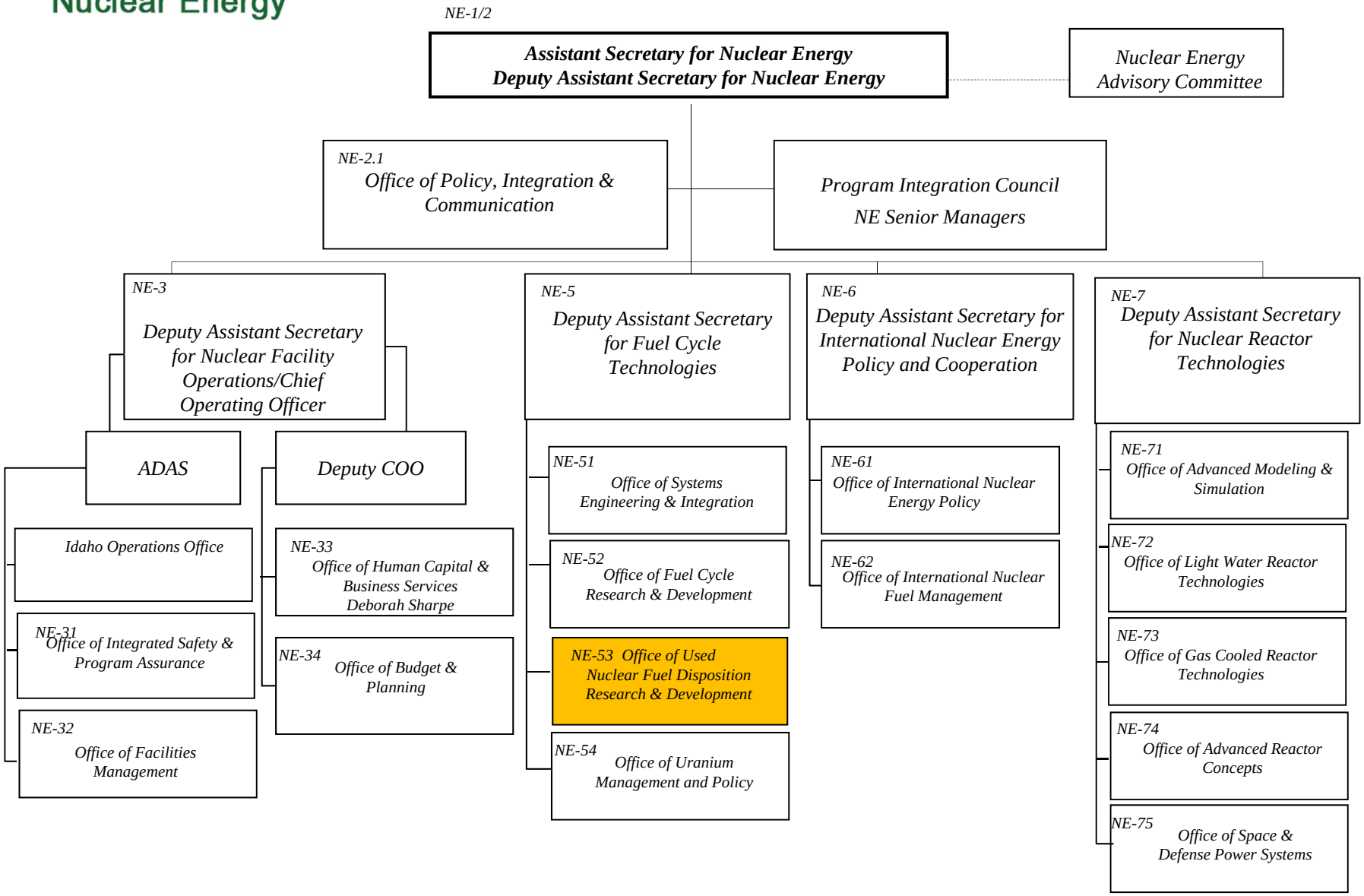

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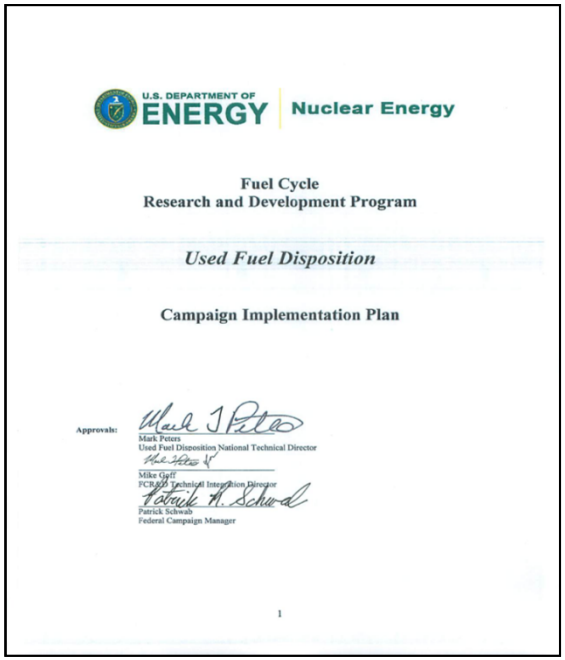
UFD Mission

The MISSION of the Used Fuel Disposition Campaign is 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.

Used Fuel Disposition Campaign
Implementation Plan
March 29, 2010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Fuel Cycle
Research and Development Program

Used Fuel Disposition

Campaign Implementation Plan

Approvals:

Mark Peters
Used Fuel Disposition National Technical Director

Mike Orff
FCR&D Technical Integration Director

Patrick Schwab
Federal Campaign Manager

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UFD Work Scope is Evolving

- **"DOE's Office of Used Nuclear Fuel Disposition Research and Development … objectives … to identify alternatives and conduct R&D on transportation, storage, and disposal options for SNF … should be continued" (BRC, January 2012, pg 69)**
- **BRC urges near-term actions that can be initiated without a new organization in place**
- **FY 2012 Appropriations Increased Funding for UFD**
  - $10,000,000 is for development and licensing of standardized transportation, aging, and disposition canisters and casks.
  - the Department should build upon its current knowledge base to fully understand all repository media and storage options and their comparative advantages
  - $3,000,000 on development of models for potential partnerships to manage spent nuclear fuel and high level waste
  - $7,000,000 on characterization of potential geologic repository media.
  - $10,000,000 to expand the Department's capabilities for assessing issues related to the aging and safety of storing spent nuclear fuel.
- **"Congress has asked the Department to develop a strategy for managing used nuclear fuel and other nuclear waste within six months of the completion of the Commission's report, and I look forward to working to do so. In the meantime, we will work in parallel to begin implementing the new strategy." (Secretary Chu, January 26, 2012)**

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Used Fuel Disposition Campaign Participants

- **Nine National Laboratories**
  - SNL, INL, LLNL, SRNL, LANL, PNL, ANL, LBNL, ORNL
- **University Programs**
  - 2010: one NEUP grant relevant to used fuel storage
  - 2011: two NEUP grants relevant to storage, one relevant to disposal; integrated research project in storage R&D
- **Industry (Advisory and Assistance Contracts)**
  - Areva, Shaw/Westinghouse, GE Hitachi, EnergySolutions, Enercon, CH2M Hill
- **EPRI**
  - Extended Storage Collaboration Program (ESCP) (with NRC and international groups)
- **International activities**
  - Bilateral agreements on disposal R&D
  - IAEA working groups in storage and transportation
  - Significant effort proposed in FY12 to increase US presence in underground research laboratories in Europe

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UFD Storage and Transportation Activities

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UFD Storage and Transportation Objectives

- **UFD Storage and Transportation objectives roll up to three points:**
  - Develop the technical basis for extended storage of used nuclear fuel
  - Develop the technical basis for fuel retrievability and transportation after extended storage
  - Develop the technical basis for transportation of high burnup used nuclear fuel
- **Storage R&D to be covered in follow-on talk (Ken Sorenson)**
- **Transportation R&D to be covered in follow-on talk (Paul McConnell)**
- **BRC has recommended near term non-R&D activities that should be initiated in the near term**

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BRC Storage Near Term Actions

- **Perform systems analysis and design studies needed to develop conceptual design for initial storage facility.**
- **Prepare to respond to requests for information from communities, states, or tribes that might be interested in learning more about hosting a consolidated storage facility.**
- **Work with nuclear utilities, the nuclear industry, and other stakeholders to promote the better integration of storage into the waste management system, including standardization of dry cask storage systems.**
  - development of the systems analyses needed to provide quantitative estimates of the system benefits of utility actions such as the use of standardized storage systems
  - support the provision of incentives to utilities to undertake actions such as using standardized storage
- **Fund a National Academy of Science independent investigation of the events at Fukushima and their implications for storage sites in the United States.**
- **With NRC and industry, continue a vigorous research and regulatory oversight effort in areas such as spent fuel and storage system degradation.**

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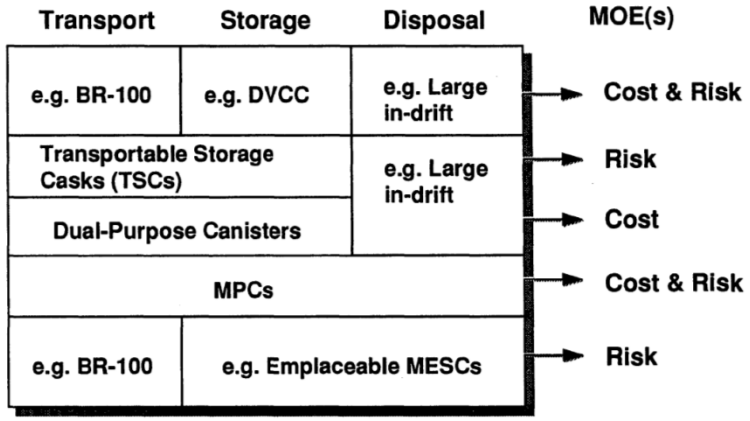
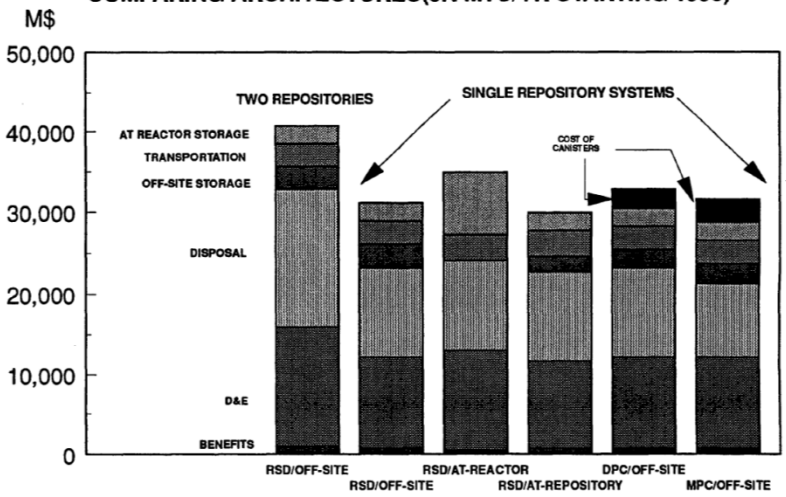
UNF Management System Architecture Evaluation – Past Work

- **In the 1990s the U.S. DOE completed a number of systems analyses investigating consolidated interim storage as part of the waste management solution**
- **These analyses are "dated" and conditions have changed**
  - Utility evolution and progress loading dry storage systems
  - Consideration of different geologic disposal environments
- **Need to update back-end system architecture studies**
- **Need to update tools for evaluating the back-end of the fuel cycle**



DVCC - Dry Vertical Concrete Cask
MESC - Multiple Element Storage Canister

COMPARING ARCHITECTURES(3K MTU/YR STARTING 1998)



System Architecture Study, July 26, 1994.

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System Architecture Evaluation – Current Work

- Evaluate an integrated approach to transportation, storage, and disposal in the waste management system with an emphasis of providing flexibility to respond to unknown situations and developments
- Evaluate the implications of the current strategy for on-site storage of used nuclear fuel in large dry storage systems on the subsequent direct disposal of the stored used nuclear fuel in salt, clay/shale, and crystalline mined geologic repositories and in deep boreholes
- Alternative strategies and approaches for managing the used nuclear fuel will be identified and evaluated to identify potential benefits in cost and flexibility
- Factors including emplacement capability, thermal constraints, the need for re-packaging techniques, storage alternatives, transportation, impacts on utility operations, etc. will be considered
- Measures for flexibility and rough order of magnitude cost factors associated with each alternative included in the evaluation

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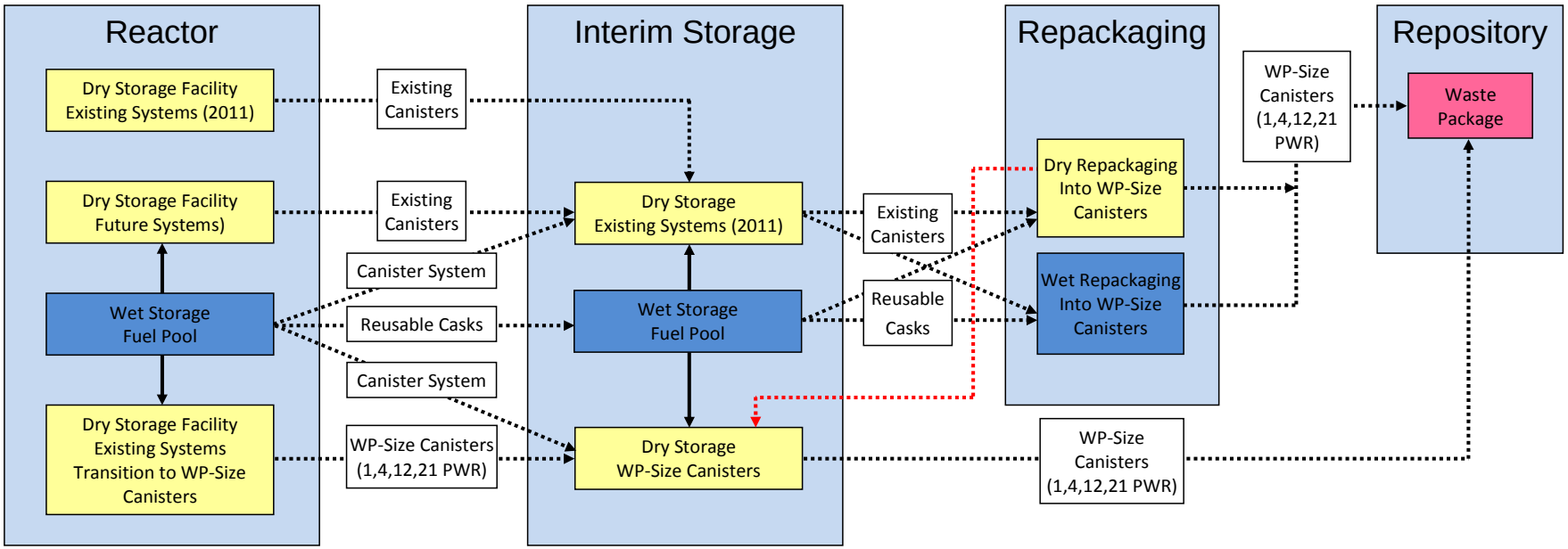
Architecture Study will Utilize Logistic Simulation Tools

- **Transportation-Storage-Disposal Logistics Model (FY12)**
  - **Combine features of existing codes CALVIN & TSM (OCRWM) and TOM (ORNL)**
  - **Support system engineering and resource estimation scenarios**



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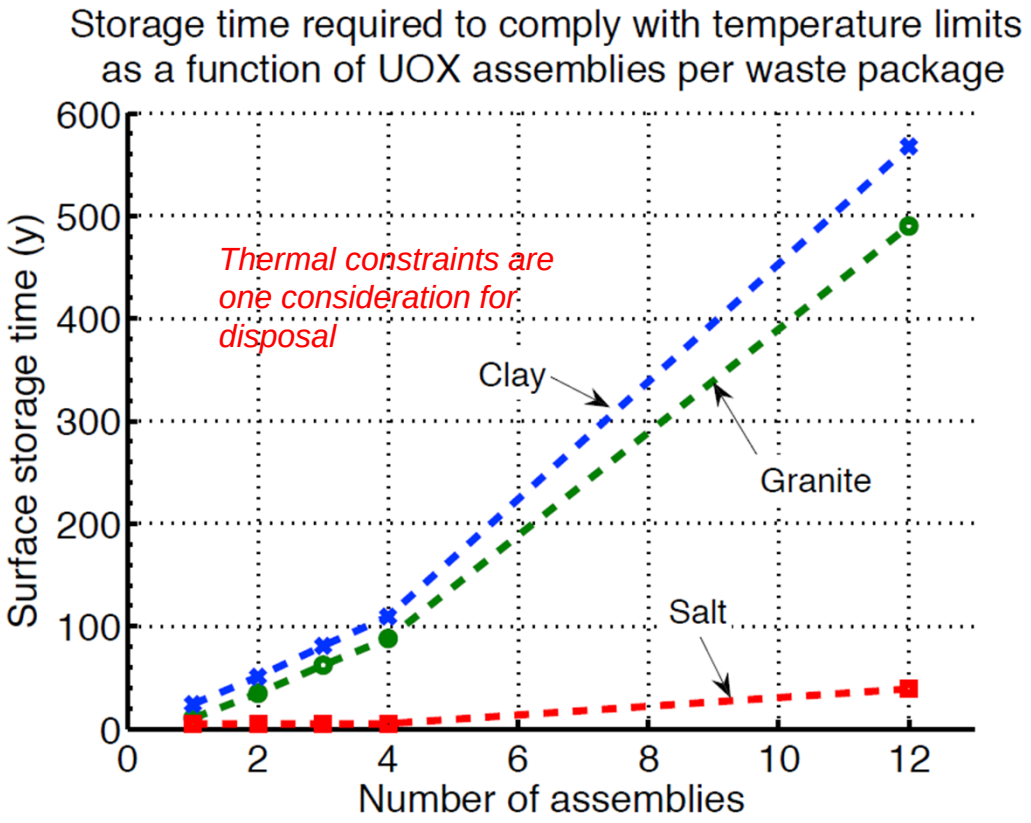
An Example of Possible Thermal Constraints on Geologic Disposal

- **Potential geologic disposal media have thermal constraints that could limit waste package size and require lengthy decay storage**

- **This will have system-level impacts**
  - Large storage canisters may not be "disposable" without different disposal concepts
    - *Need to analyze "what it would take"*
  - Potential need to re-package
    - *When, where, how*



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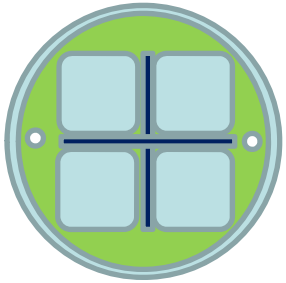
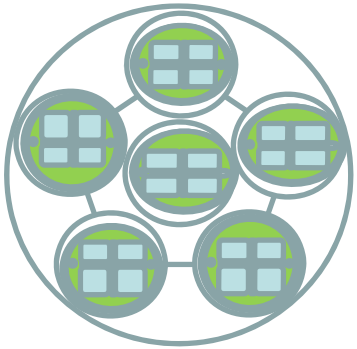
Integrated Canister-in-Canister Concept

Flexible Integrated Modular Nuclear Fuel Storage, Transportation, and Disposal Canister System (FIRST)

- Multi-modal use and flexibility in all operations while working within existing utility framework
- Unique design features to accommodate future, current, and past proposed disposal concepts
- Allows direct disposal (similar to YMP TAD concept)
- Many secondary benefits
  - *Including improved characteristics to accommodate extended storage*
- Repackaging could be done at a consolidated interim storage facility

Small canister provides flexible disposal options





Small canisters in larger canister for storage and transportation

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Effort Initiated in FY12 in UFDC to Evaluate Integrated Canister Concept

- **Multiple national laboratories involved, led by ORNL**
- **FY12 activities**
  - Develop drawings for design iterations
  - Evaluate operational aspects
    - *Design and operational options will be explored to minimize impact on current cask loading processes, durations and cost*
      - Welding versus bolting lids
      - Drying process
  - Perform initial evaluations to demonstrate compliance and, where applicable, benefits relative to criticality, shielding, thermal, confinement, and structural requirements
  - Develop cost basis analysis
- **The concept is not proposed as "the solution": it's input to the decision-making process**

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Direct Disposal of Large Dual Purpose Canisters (DPCs)

- **Direct disposal of DPCs is attractive from the storage and transportation perspective, but…**
- **Direct disposal of 24-37 PWR-assembly DPCs is currently beyond the domestic and international experience base**
  - DPCs are much larger than the 4 PWR-assembly waste package designs under consideration by mature repository programs in saturated geologic media
  - DPCs are larger than the 21 PWR-assembly waste package designs proposed for repositories in unsaturated geologic media
- **Larger size means either substantially higher temperatures or much longer surface storage coupled with alternative repository designs (e.g., open-drift emplacement in unsaturated media)**
  - See following presentation on thermal load management analyses
- **Direct disposal of DPCs represents a potentially significant engineering and scientific challenge**

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Work Needed to Support Direct Disposal of DPCs

- **Engineering and design work related to handling and emplacement of larger, heavier packages**
  - Ramps vs. shafts
  - Cranes, hoists, transport/haulage mechanisms
  - Hazard and risk assessments to identify safety and regulatory issues
- **High temperature materials R&D**
  - Both engineered and natural materials
- **High temperature geochemistry R&D**
- **Development of coupled T-H-C-M models valid at elevated temperatures**
- **Re-evaluation of approaches for criticality evaluation in performance assessments**
- **Iterative integrated performance assessments and performance allocation to support design evolution**

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UFD Disposal Activities

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Role of Disposal R&D after Yucca Mountain

- **The Disposal R&D Program is not starting over**
  - There is an international consensus that deep geologic disposal is a robust and necessary solution for permanent isolation of high-level radioactive waste and used nuclear fuel
  - Internationally, mature safety assessments indicate that granite and clay sites are viable
  - DOE concluded in 2008 that the technical basis for Yucca Mountain was sufficient to submit a license application
- **We have an opportunity to rethink disposal concepts: nearly all options are back on the table**
- **We are limited to generic disposal concepts**
  - No site specific investigations
- **Goals of disposal R&D at this stage**
  - 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

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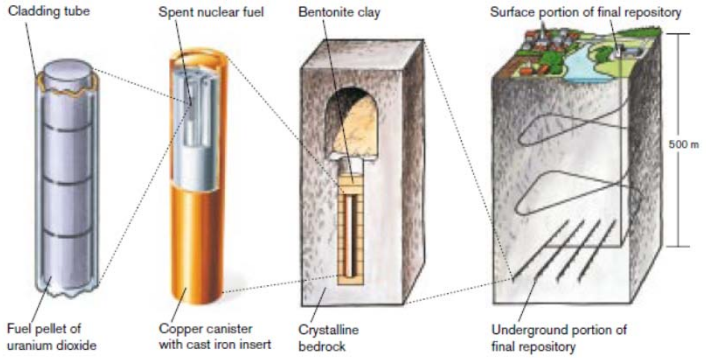
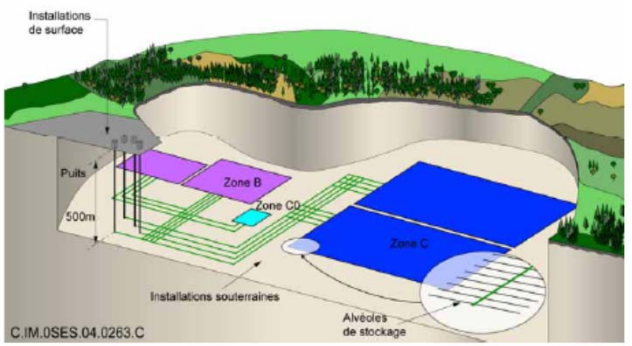
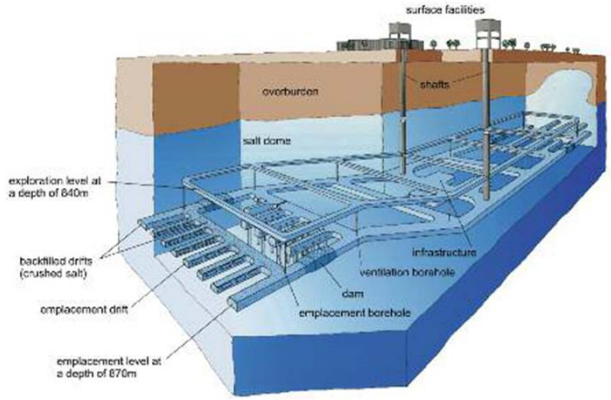
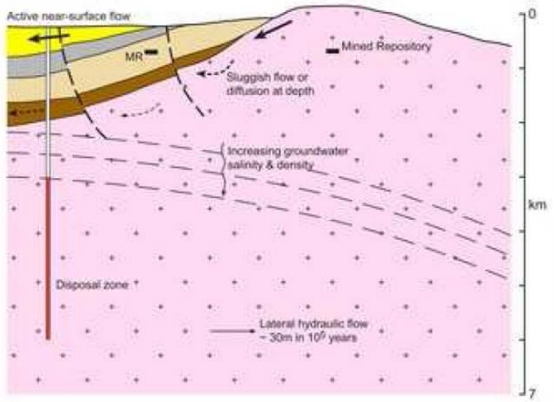
Disposal Options Included for R&D

- **Disposal R&D is focusing on four basic disposal options**
  - Three mined repository options (granitic rocks, clay/shale, and salt)
  - One geologic disposal alternative: deep boreholes in crystalline rocks









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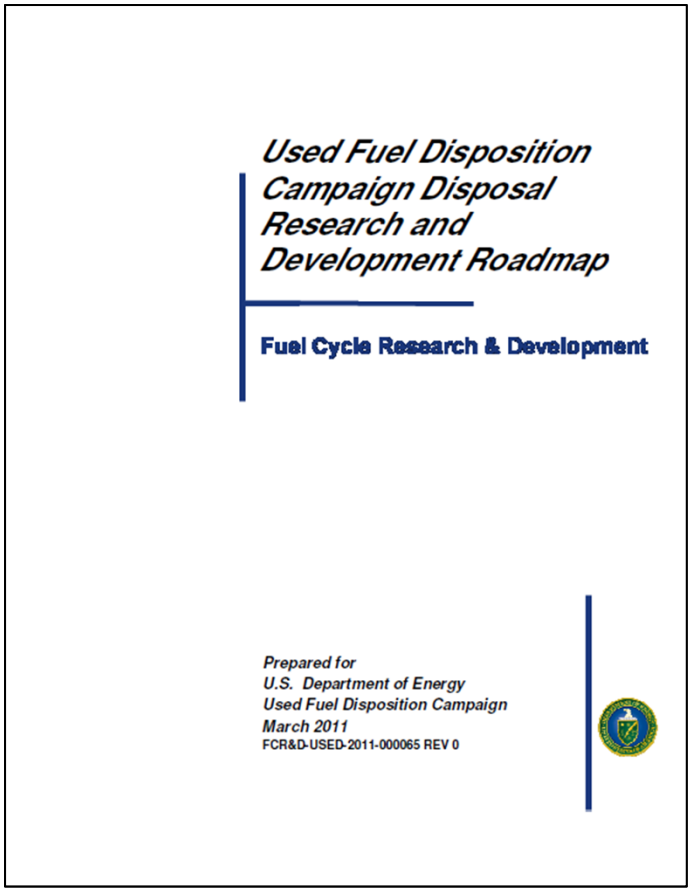
The Disposal R&D Roadmap



- ***Used Fuel Disposition Campaign Disposal Research and Development Roadmap***
  - "an initial evaluation of prioritization of R&D opportunities that could be pursued by the campaign"
  - Completed March 2011
  - Used to inform prioritization decisions for disposal research in FY12 and beyond
- **Planned for update Sept. 2012**

http://www.ne.doe.gov/FuelCycle/neFuelCycle_UsedNuclearFuelDispositionReports.html

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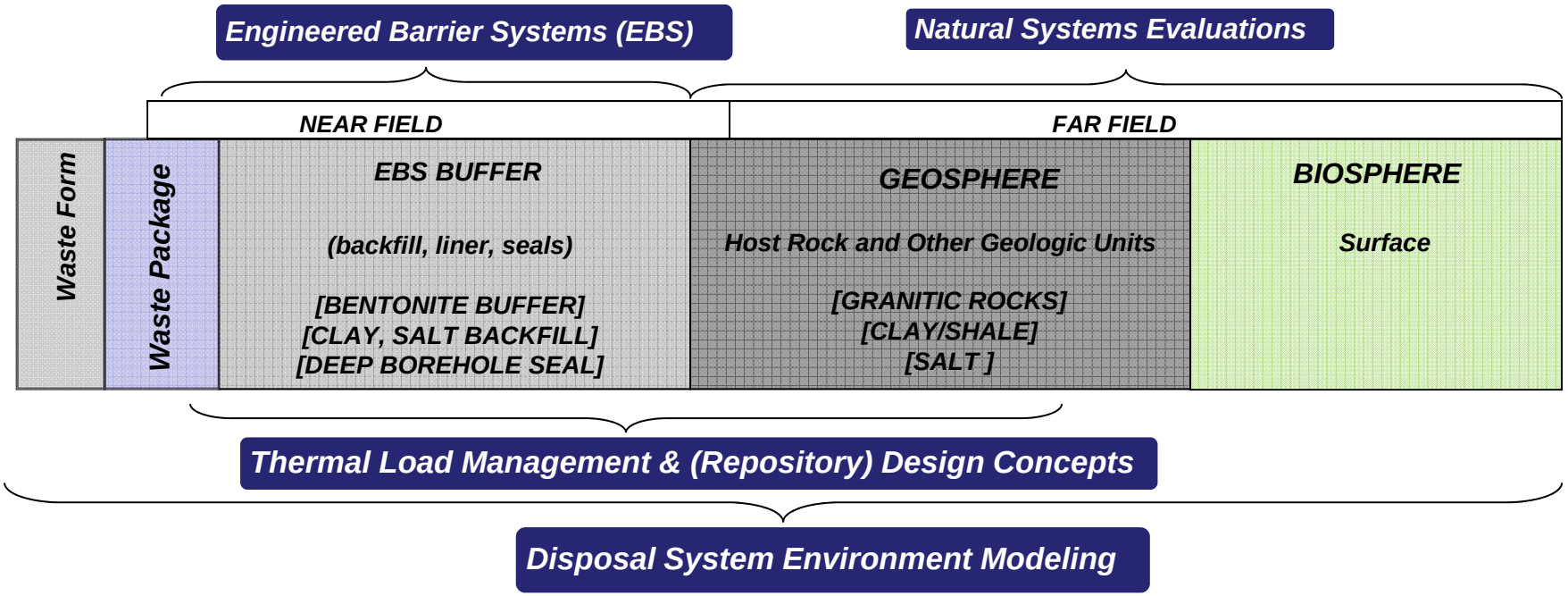
UFD Disposal Research Activities



SUPPORT, ANALYSIS & EXPERIMENTAL ACTIVITIES

Engineered Materials Performance	(corrosion, degradation studies)
Features, Events & Processes	(how R&D is organized and prioritized)
Low Level Waste Disposition Issues	(part of total nuclear waste consideration)
Inventory Projections	(LLW/HLW, used fuel, open → closed fuel cycles)

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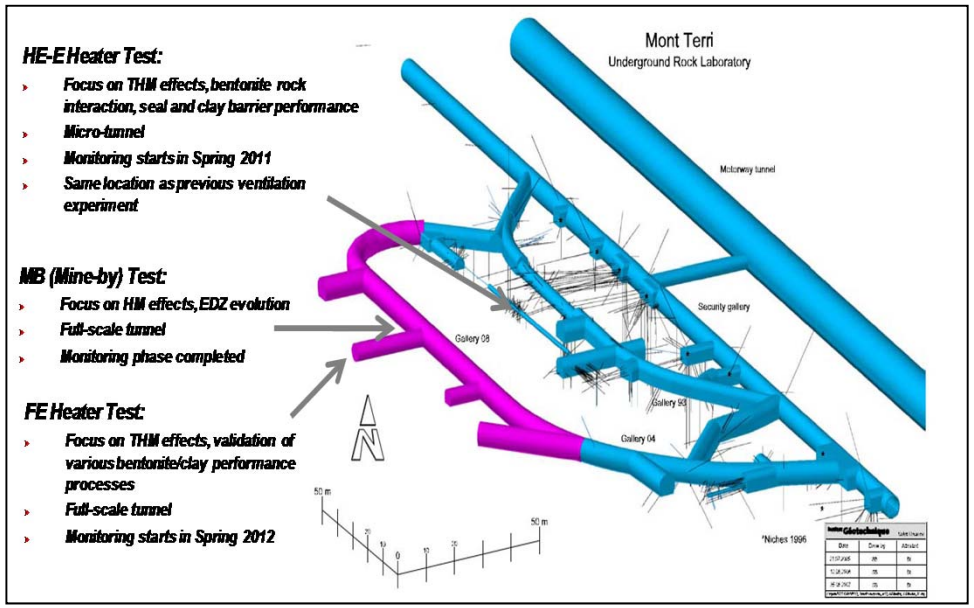
International Disposal Activities

Primary new goal for Disposal R&D in FY12: Establish formal collaborative R&D arrangements with three ongoing European programs

Major current or soon-to-be started experiments



Mont Terri: International underground research laboratory (URL) in clay in Switzerland

Joining the URL will give DOE access to data from all Mont Terri R&D, also the opportunity to conduct new experiments

Colloid Formation and Migration Project

Colloid research at Grimsel granite URL in Switzerland

DECOVALEX: (Development of Coupled Models and their Validation against Experiments)

DOE has participated in the past, new phase of project begins Spring 2012

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Summary

- **NE's Office of Used Nuclear Fuel Disposition is conducting R&D that will build a foundation to support any potential new U. S. waste management organization**
  - Storage and Transportation
  - Disposal
- **Near-term direction advocated by the BRC aligns, however, with NE FY 2012 programming and planning.**
- **The Administration Position on the BRC recommendations has not been established**