Exceptional service in the national interest

SAND2013-8772C

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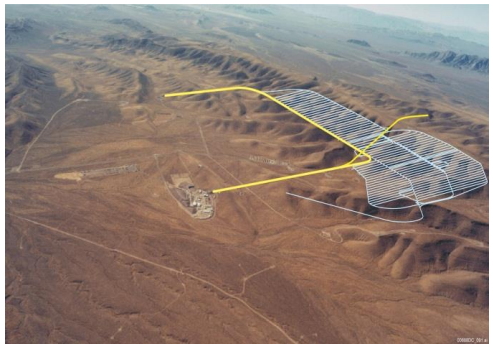

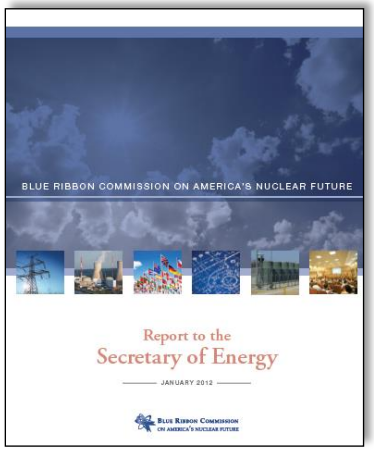

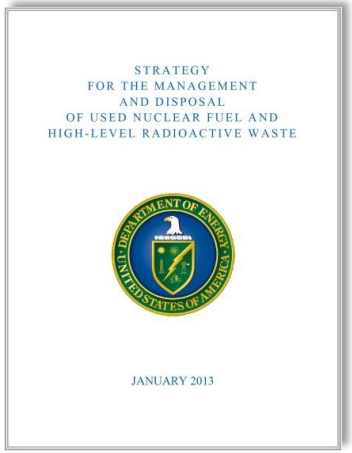

Current Status of Spent Nuclear Fuel Management in the United States

Peter Swift
Sandia National Laboratories

Presentation to ChNE 439/539
University of New Mexico
October 14, 2013

U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

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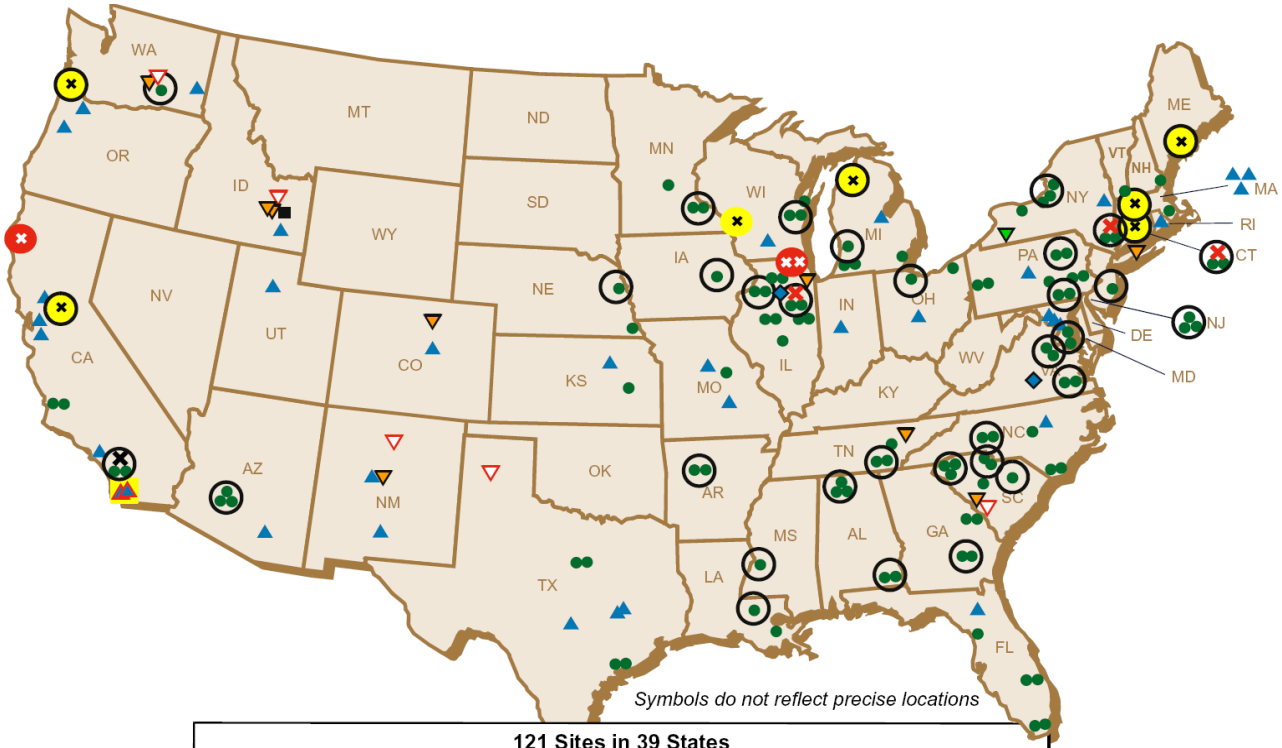
Outline

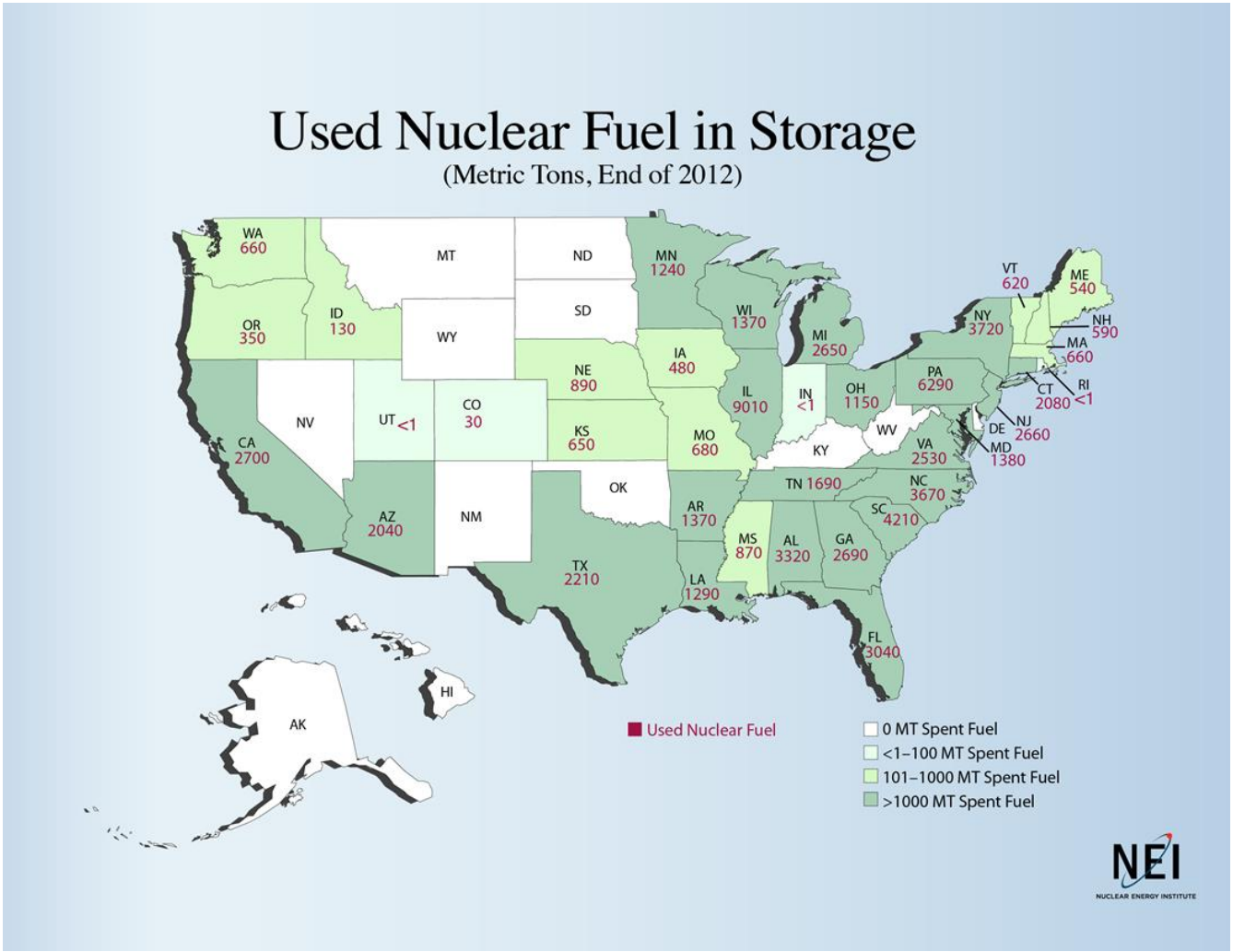
- Where We Are
  - How we got here
  - Constraints on moving forward
- Plans for Moving Forward
  - Recommendations from the Blue Ribbon Commission on America's Nuclear Future and the DOE's Strategy
- Options for Storage and Disposal of Spent Nuclear Fuel (SNF) and High-Level Radioactive Waste (HLW)
- What a Siting and Licensing Process Might Look Like
- DOE's Ongoing R&D Program

Spent Nuclear Fuel and High-Level Radioactive Waste in the United States



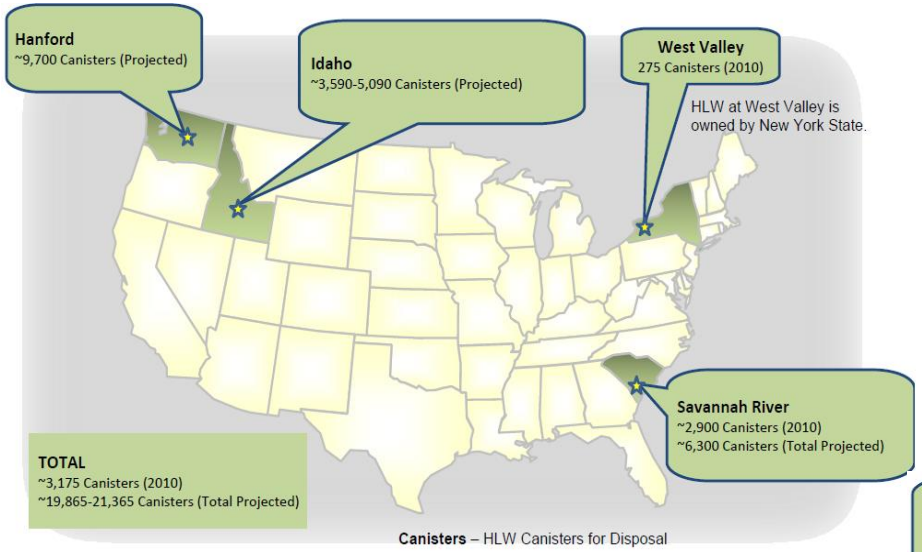
As of January 2008

Where Commercial SNF is Stored Today



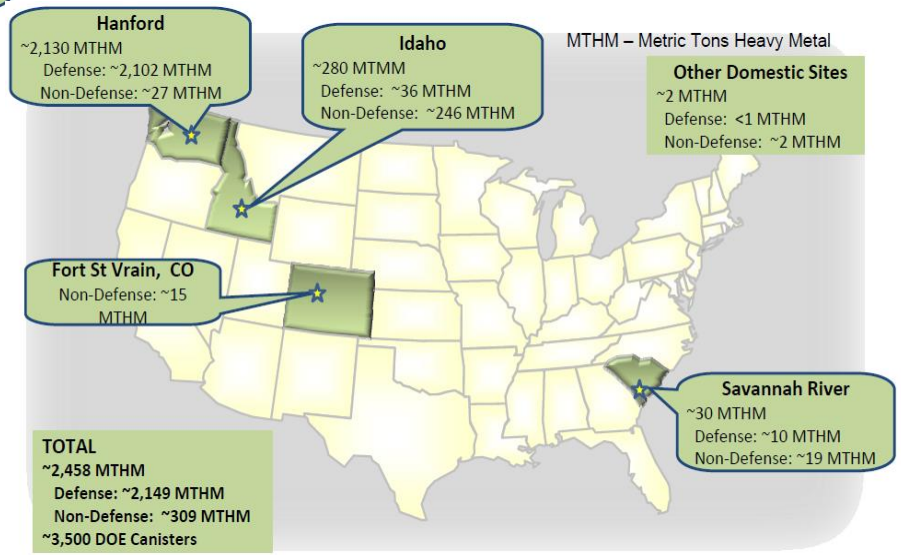
http://www.nei.org/resourcesandstats/documentlibrary/nuclearwastedisposal/graphicsandcharts/used-nuclear-fuel-storage-map/

Where DOE-Managed SNF and High-Level Radioactive Waste (HLW) is Stored Today



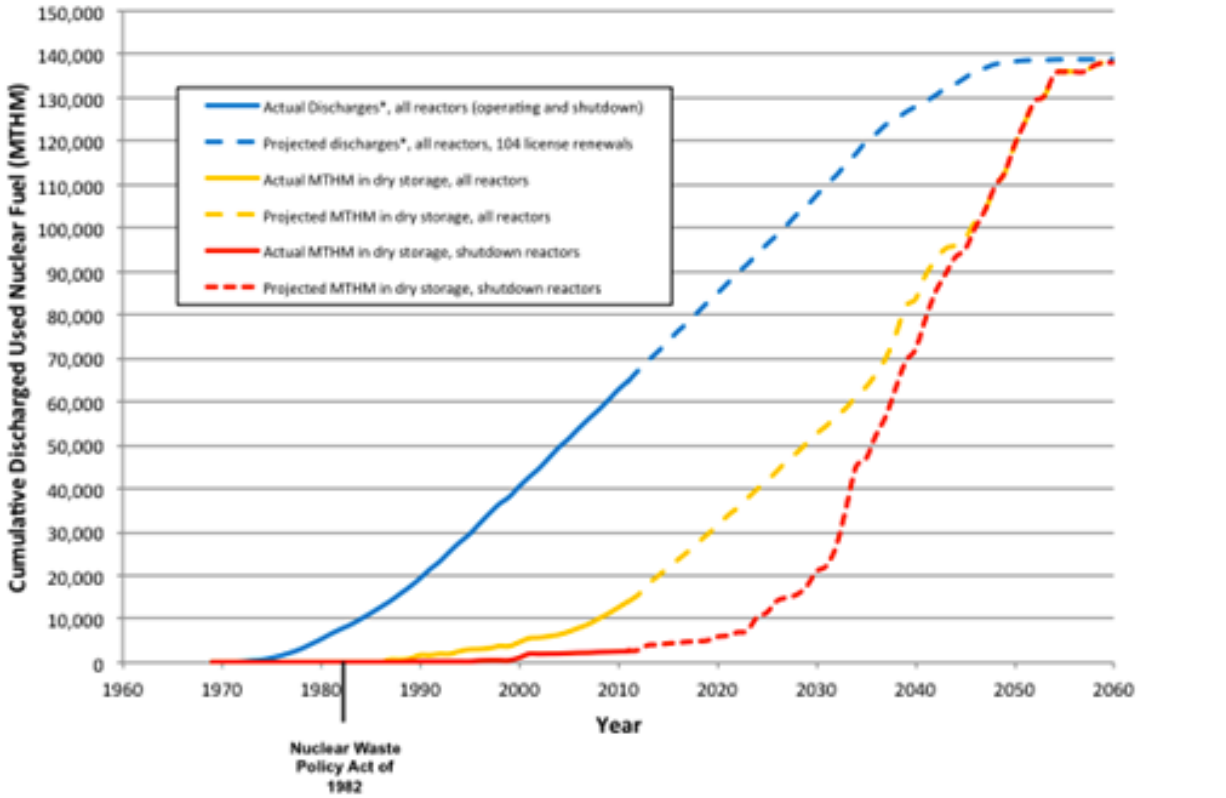
DOE-Owned HLW
~20,000 total canisters
(projected)

DOE-Owned SNF
~2,458 Metric
Tons



Source: Marcinowski, F., "Overview of DOE's Spent Nuclear Fuel and High-Level Waste," presentation to the Blue Ribbon Commission on America's Nuclear Future, March 25, 2010, Washington DC.

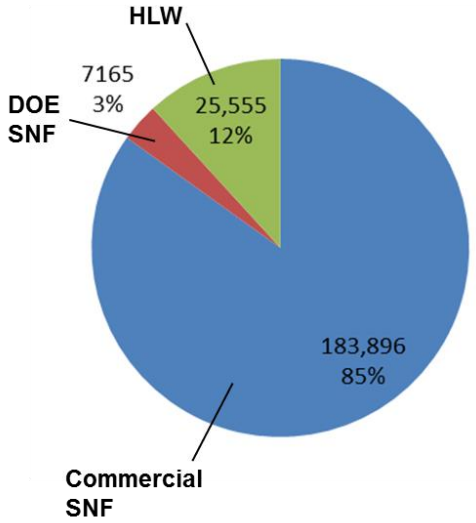
Projections of Future SNF and HLW



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

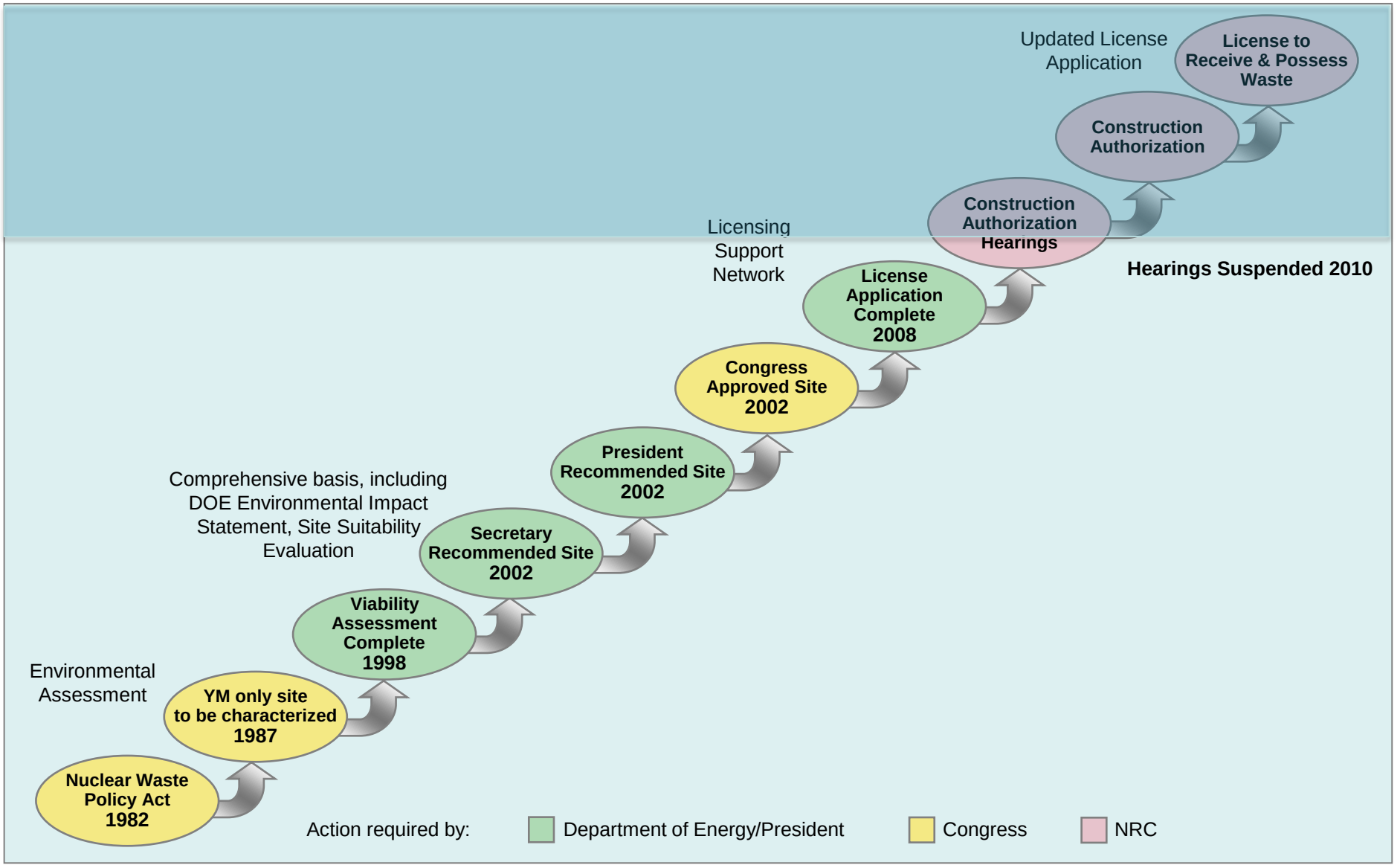
Historical and Projected Commercial SNF Discharges in the United States

Projected Volumes of SNF and HLW in 2048



Volumes shown in m^3, assuming constant rate of nuclear power generation

A Short History of Yucca Mountain



The U.S. Repository Program Today

- "Yucca Mountain is not a workable option" (DOE licensing motion, March 3, 2010)
  - "the Secretary's judgment here is not that Yucca Mountain is unsafe or that there are flaws in the LA, but rather that it is not a workable option and that alternatives will better serve the public interest." (DOE filing to NRC Licensing Board, May 27, 2010, footnote 102)
- The Nuclear Waste Policy Act remains in effect and Yucca Mountain remains the only legally available option
- Yucca Mountain license hearings remain suspended pending court action
  - August 13, 2013 ruling by the US Court of Appeals for the District of Columbia directs NRC to use available funds ($11M) to resume licensing process
- All current DOE activities related to disposal of spent nuclear fuel and high-level radioactive waste have moved to the DOE Office of Nuclear Energy and are limited to generic R&D
- The Waste Isolation Pilot Plant (WIPP) is in operation for transuranic waste, managed by the DOE Office of Environmental Management

Constraints Posed by the Nuclear Waste Policy Act on Interim Storage Options

- NWPA Section 145(b): "The Secretary may not select a site [for a monitored retrievable storage facility] … until the Secretary recommends to the President the approval of a site for development as a repository…"

- NWPA Section 148(d)(1): "construction of such facility [MRS] may not begin until the Commission has issued a license for the construction of a repository …"

- NWPA Section 148(d)(3): the quantity of spent nuclear fuel or high-level radioactive waste at the site of such facility [MRS] at any one time may not exceed 10,000 metric tons of heavy metal until a repository under this Act first accepts … waste"

Constraints Posed by the Nuclear Waste Policy Act on Repository Siting Options

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- NWPA Section 113(a): "The Secretary [of the DOE] shall carry out … site characterization activities at the Yucca Mountain site."
- NWPA Section 114(b): "If the President recommends to the Congress the Yucca Mountain site … and the site designation is permitted to take effect … the Secretary shall submit to the Commission an application for a construction authorization …"
- NWPA Section 160(a)(2): "The Secretary shall terminate all site specific activities (other than reclamation activities) at all candidate sites, other than the Yucca Mountain site, within 90 days…"
- NWPA Section 161(a): "The Secretary may not conduct site-specific activities with respect to a second repository unless Congress has specifically authorized and appropriated funds for such activities."

Plans for Moving Forward:

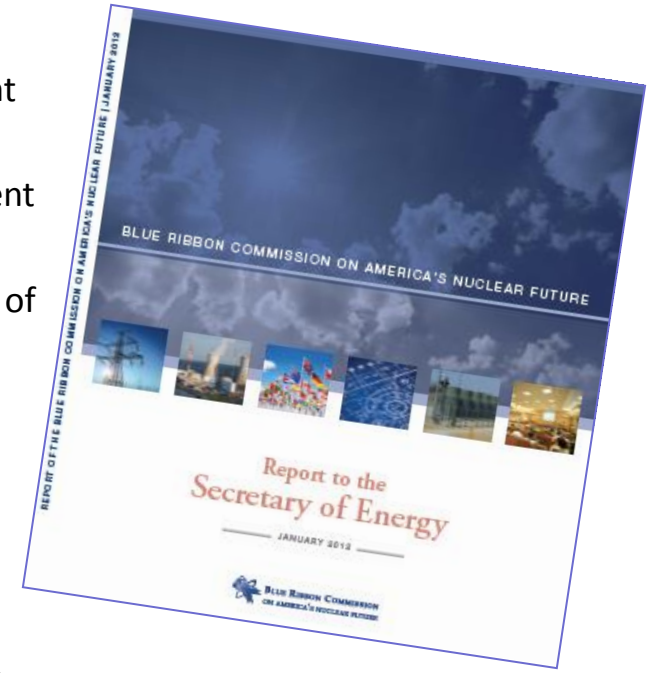
Recommendations of the Blue Ribbon Commission on America's Nuclear Future and the DOE's Strategy

Blue Ribbon Commission on America's Nuclear Future

Sandia National Laboratories

Recommendations Issued January 2012

1. A new, consent-based approach to siting future nuclear waste management facilities.
2. A new organization dedicated solely to implementing the waste management program and empowered with the authority and resources to succeed.
3. Access to the funds nuclear utility ratepayers are providing for the purpose of nuclear waste management.
4. Prompt efforts to develop one or more geologic disposal facilities.
5. Prompt efforts to develop one or more consolidated storage facilities.
6. Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available.
7. Support for continued U.S. innovation in nuclear energy technology and for workforce development.
8. Active U.S. leadership in international efforts to address safety, waste management, non-proliferation, and security concerns.



Former Secretary of Energy Dr. Steven Chu Statement on the BRC Recommendations

January 2012

The Department recognizes that the BRC Report represents "*a critical step toward finding a sustainable approach to disposing used nuclear fuel and nuclear waste".*

The Department acknowledges that *"the specifics of a new strategy for managing our nation's used nuclear fuel will need to be addressed in partnership with Congress".*

The Department *"will work in parallel to begin implementing the new strategy"* by taking sensible steps toward the implementation of near-term recommendations.

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

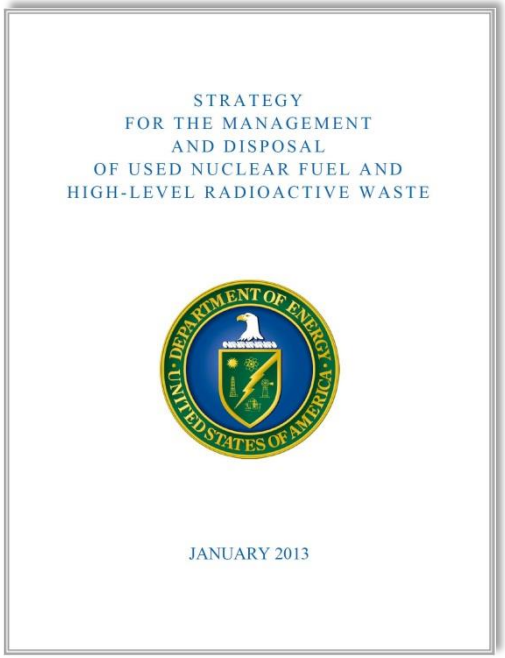
Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste issued January 2013.

The Strategy is:

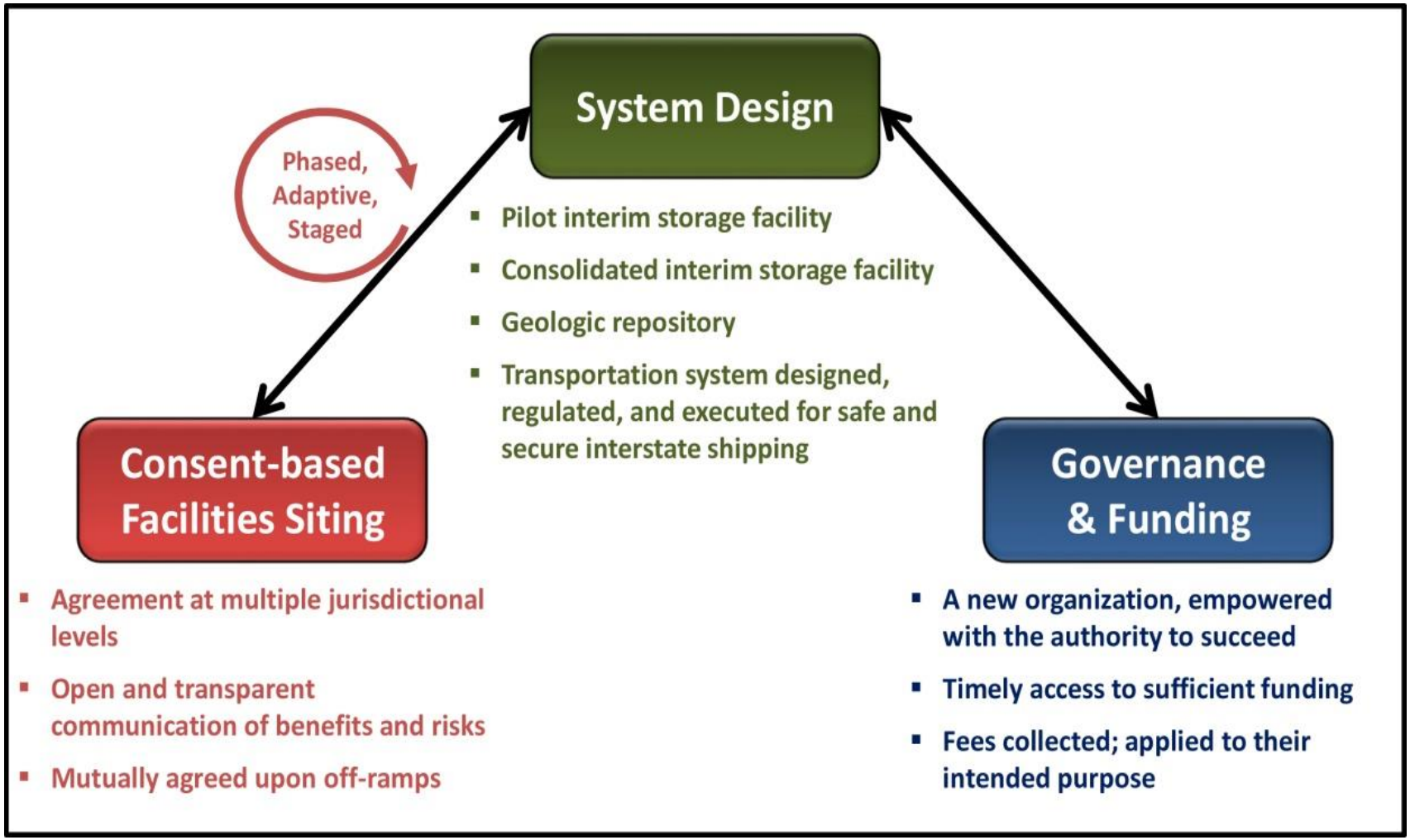
- A statement of Administration policy regarding the importance of addressing the disposition of used nuclear fuel (UNF) and high-level radioactive waste (HLW)
- The Response to the final report and recommendations made by the *Blue Ribbon Commission on America's Nuclear Future*
- The initial basis for discussions among the Administration, Congress and other stakeholders

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 geologic repository sites (sited 2026, operating 2048)



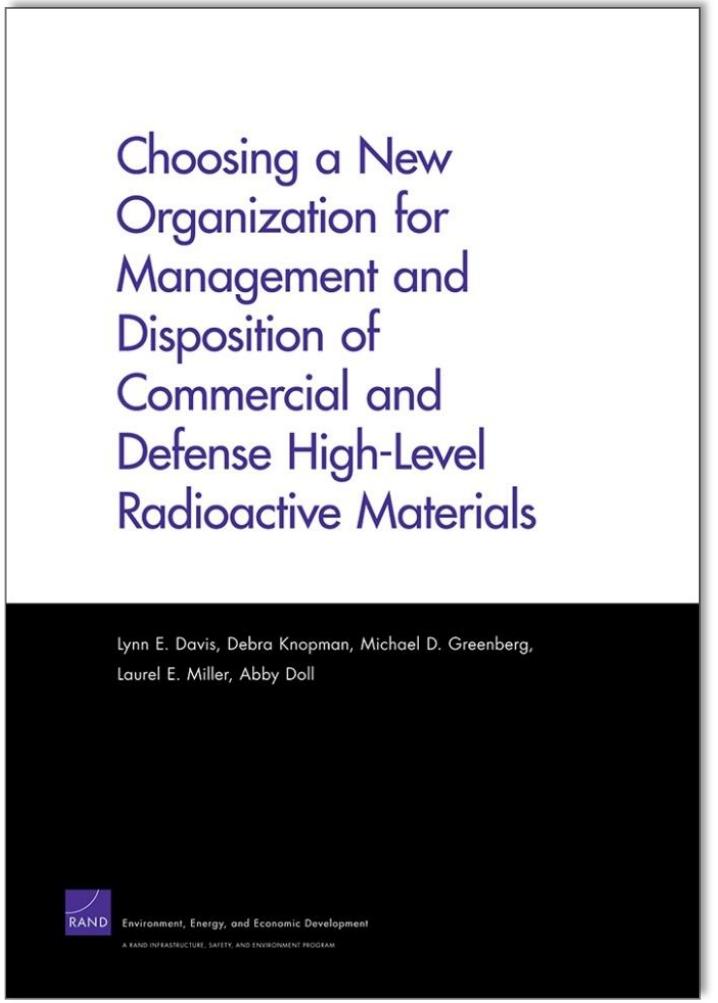
Key Elements of the DOE Strategy



Implementation:
Consent-based Process and New Organization

- Consent-based process
  - Host jurisdictions to be recognized as partners
  - Consent required at multiple levels
  - Public trust and confidence necessary for success
  - Defining process and terms is critical initial step

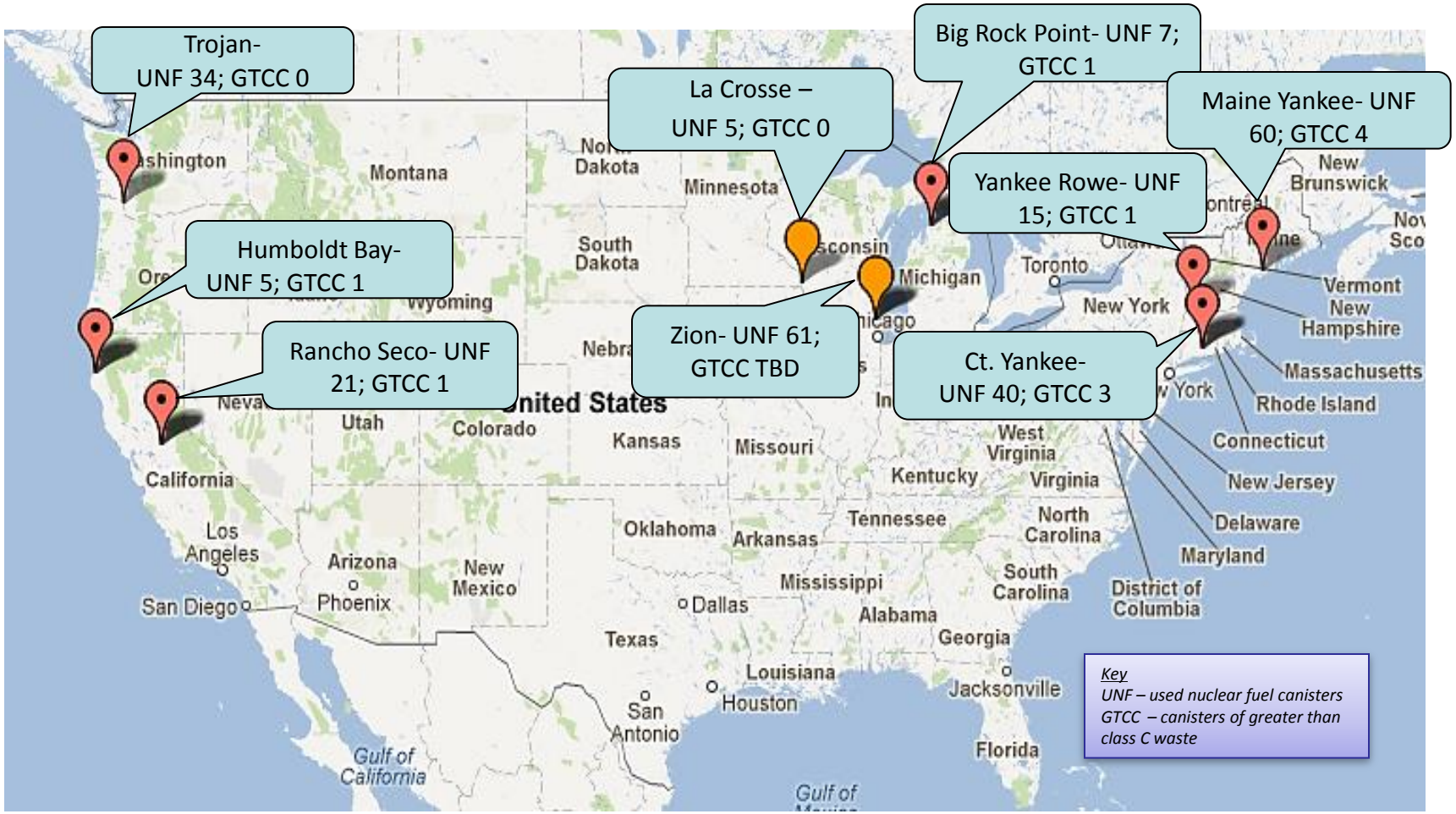
- New Organization
  - Multiple workable models
  - RAND study looked at independent government agency and government corporation models
  - Critical attributes: accountable, autonomous, mission-oriented, stable
  - No specific model endorsed at this time



Implementation: Interim Storage Facilities

- Facilities sited using consent-based process and licensed by the Nuclear Regulatory Commission
- Pilot-scale interim storage facility
  - Focused on servicing shutdown reactors
  - Operational in 2021
- Consolidated interim storage facility
  - Larger capacity to provide system flexibility
  - Operational in 2025
- Facilities could service environmental cleanup and defense sites

Stranded Spent Fuel at Shutdown Reactor Sites



Implementation: Geologic Disposal and Transportation

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- Geologic Repository
  - Sited using consent-based process by 2026
  - Designed and licensed by 2042
  - Operational in 2048
- Transportation
  - Build on experience in industry and with WIPP
  - Capability to service facilities safely and securely
  - Ongoing planning activities provide foundation for implementation
- One full-scale storage facility and one repository for now, possible additions based on consent-based process

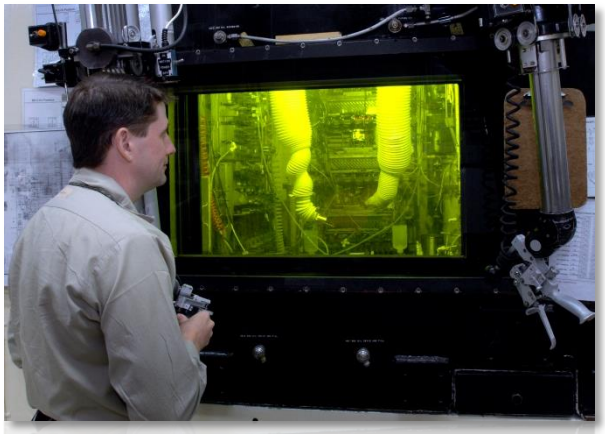
Disposition Options for Current UNF

UNF can be divided into 3 categories based on retention needs

Disposal

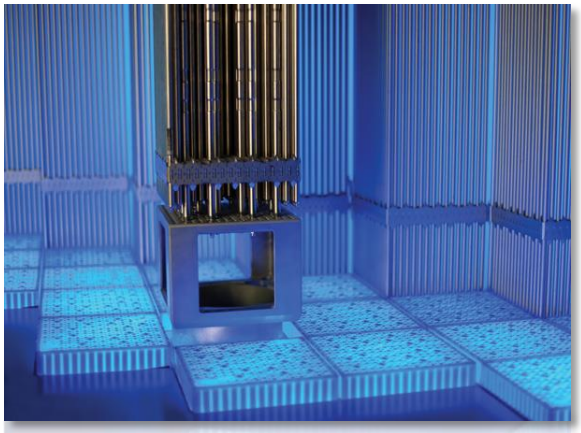
- Excess material not needed for other purposes

Retain for Research



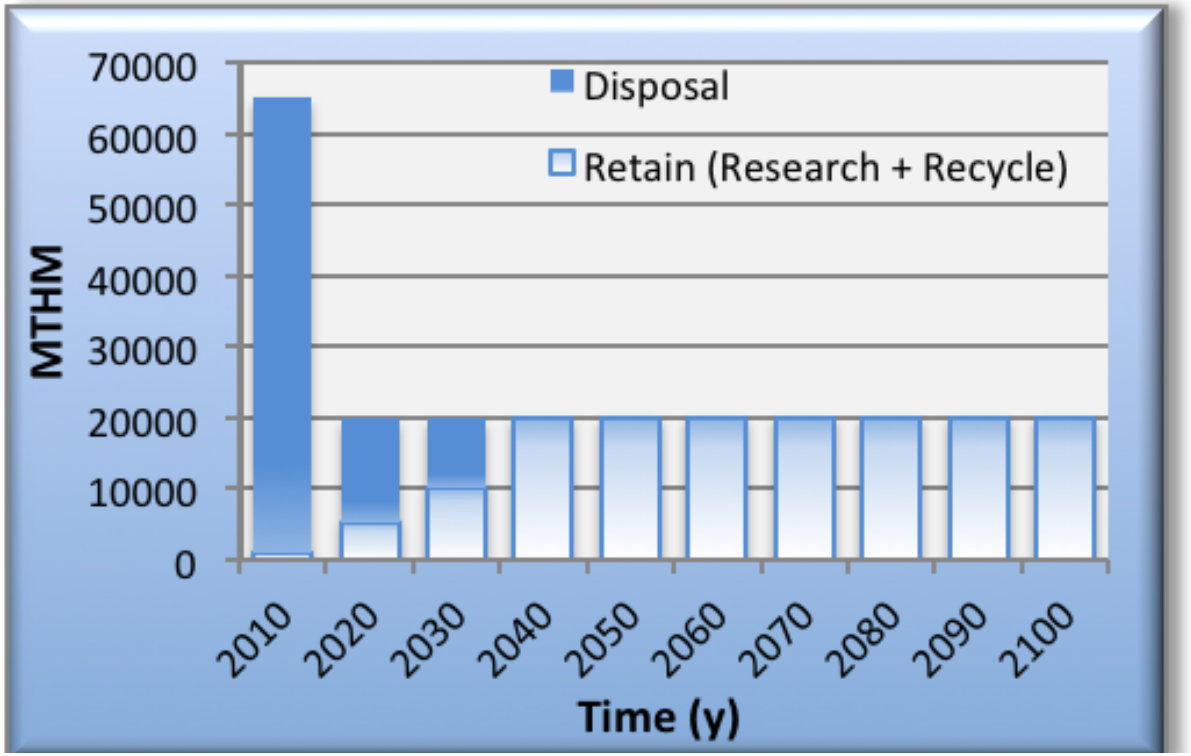
- Material needed for R&D to support
  - UNF management
  - Advanced fuel cycle development

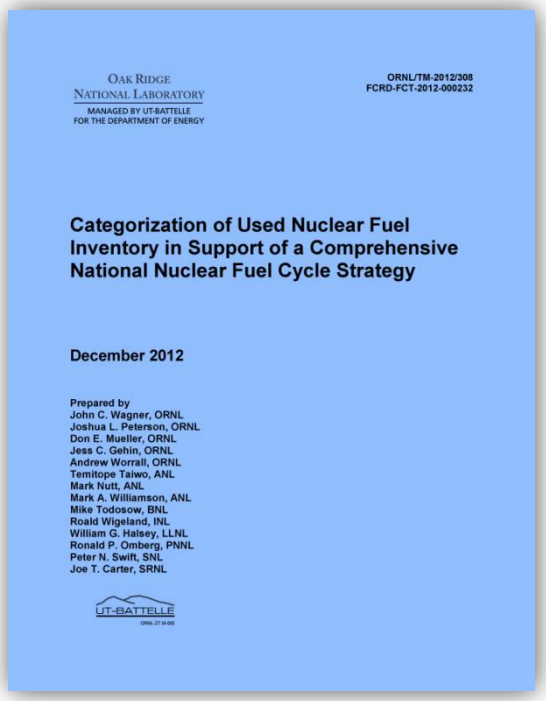
Retain for Recycle



- Material with inherent and/or strategic value

Oak Ridge National Laboratory's Technical Assessment of U.S. Used Nuclear Fuel Inventory




OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

ORNL/TM-2012/308
FCRD-FCT-2012-000232

Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy

December 2012

Prepared by
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Peter N. Swift, SNL
Joe T. Carter, SRNL

UT-BATTELLE

http://info.ornl.gov/sites/publications/Files/Pub37993.pdf

- Conclusion: Disposal of 98% of current UNF inventory with no adverse impact on deployment of future alternative fuel cycles

Storage and Disposal Options

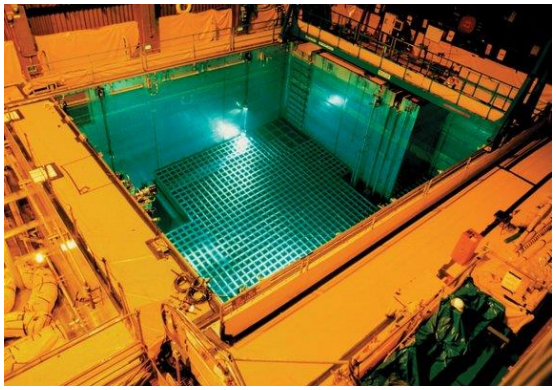
Storage Options

Pool Storage: essential to reactor operations, but nearing capacity, ~ 80% of existing US reactors have dry storage facilities on site

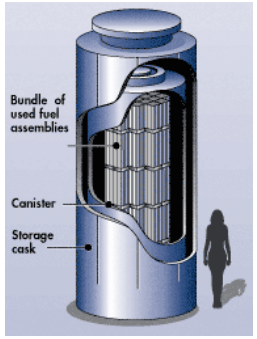
Dry Storage: horizontal and vertical concepts are in use. R&D in progress to support the technical basis for license extensions beyond original 20-yr period

On-site storage of irradiated nuclear fuel is standard industry practice

http://www.storenuclearfuel.com/current-sites/kewaunee/



http://www.nrc.gov/waste/spent-fuel-storage/pools.html



http://www.nrc.gov/waste/spent-fuel-storage/diagram-typical-dry-cask-system.html

http://www.storenuclearfuel.com/current-sites/haddam-neck/

Disposal Options

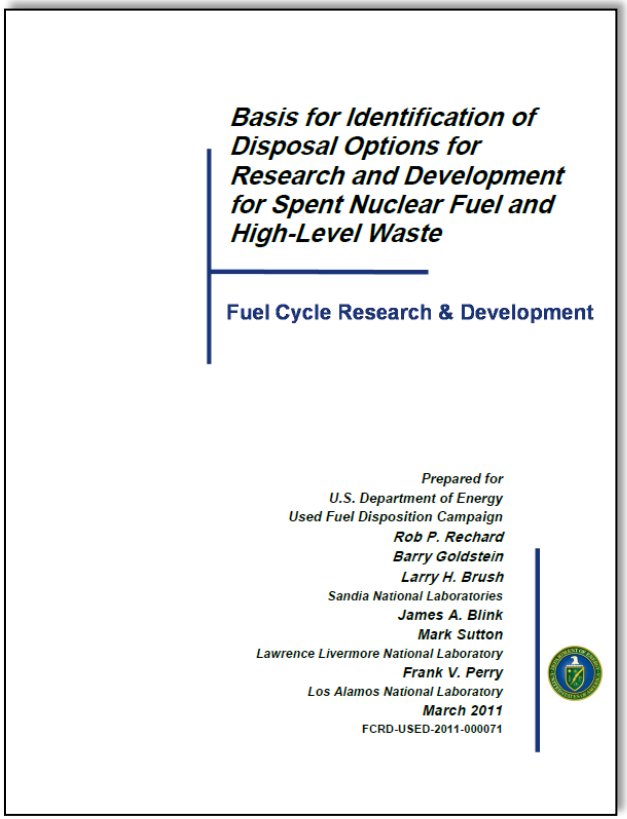
- Disposal options have been proposed and evaluated for 50+ years
- Consensus for at least thirty years, both in US and internationally, that deep geologic disposal is the preferred option
  - Multiple in-depth reviews from the late 1950s to the present have noted the need for geologic disposal
    - "**Geological disposal remains the only-long-term solution available**", National Research Council Board on Radioactive Waste Management, 2001, p. 3
    - "**One or more geologic repositories eventually will be needed in the United States**", Nuclear Waste Technical Review Board, June 2011, p.1.
    - "**Every nation that is developing disposal capacity plans to use a deep, mined geologic repository for this purpose. Other disposal options (e.g., deep boreholes) have been considered and may hold promise in the long-term but are at a much earlier stage of development.**" Blue Ribbon Commission on America's Nuclear Future, 2012, p. 11.
  - Definitive US work on disposal options dates from the 1970s, summarized in the 1980 *Final Environmental Impact Statement, Management of Commercially Generated Radioactive Waste*, DOE/EIS-0046F.

Disposal Options (cont.)

- International Experience
  - Consensus on deep geologic disposal is world-wide
    - International Atomic Energy Agency (IAEA)
    - Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD)
  - All nations using nuclear energy are facing similar questions about waste management
  - Several nations have advanced repository programs
    - Sweden, Finland (mined repositories planned in crystalline rock)
    - France, Switzerland, Belgium (mined repositories in clay/shale rock at various stages of planning)
    - Germany (mined repository in salt under evaluation)
    - Other nations with active repository research programs
      - Canada, United Kingdom, Japan, Korea, China, Taiwan, Czech Republic, Spain
- The US experience is not unique

Disposal Alternatives are Well Documented

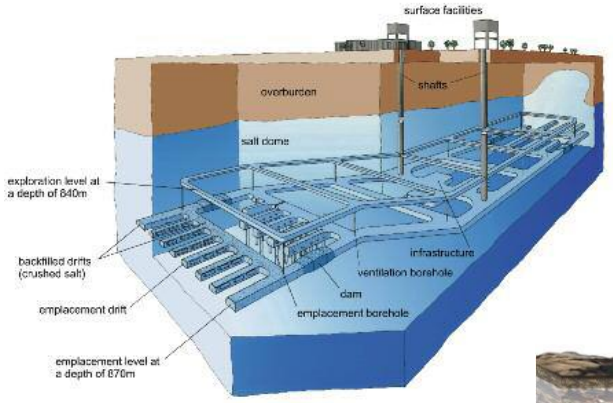
- Potential media for mined geologic disposal
  - *Salt*
  - *Clay/shale*
  - *Carbonate rocks and chalk*
  - *Granitic rocks*
  - *Basalt*
  - *Volcanic Tuff*
- Alternative settings for geologic disposal
  - *Saturated zone versus unsaturated zone*
  - *Continent interior*
  - *Coastal areas*
  - *Islands*
- Alternatives to mined disposal
  - *Deep boreholes in igneous/metamorphic basement rock*
  - *Shallow boreholes in alluvium*
  - *Sub-seabed*
  - *Well injection*
  - *Rock Melt*
- Alternatives to geologic disposal
  - *Engineered Mountain/Mausoleum*
  - *Ice-Sheet Disposal*
  - *Space Disposal*

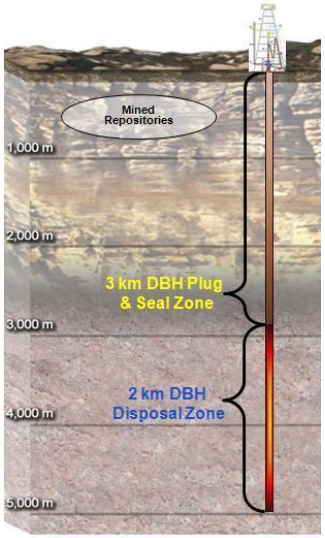


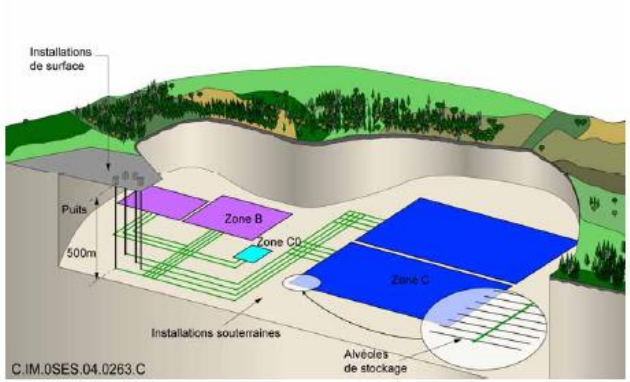
http://www.ne.doe.gov/FuelCycle/neFuelCycle_UsedNuclearFuelDispositionReports.html

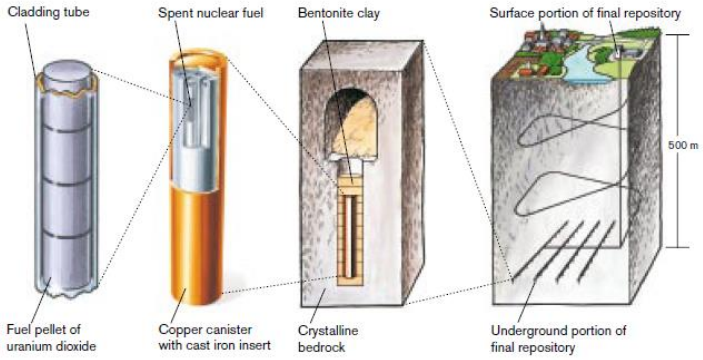
U.S. Disposal R&D Focuses on Four Options

- Three mined repository options (granitic rocks, clay/shale, and salt)
- One geologic disposal alternative: deep boreholes in crystalline rocks

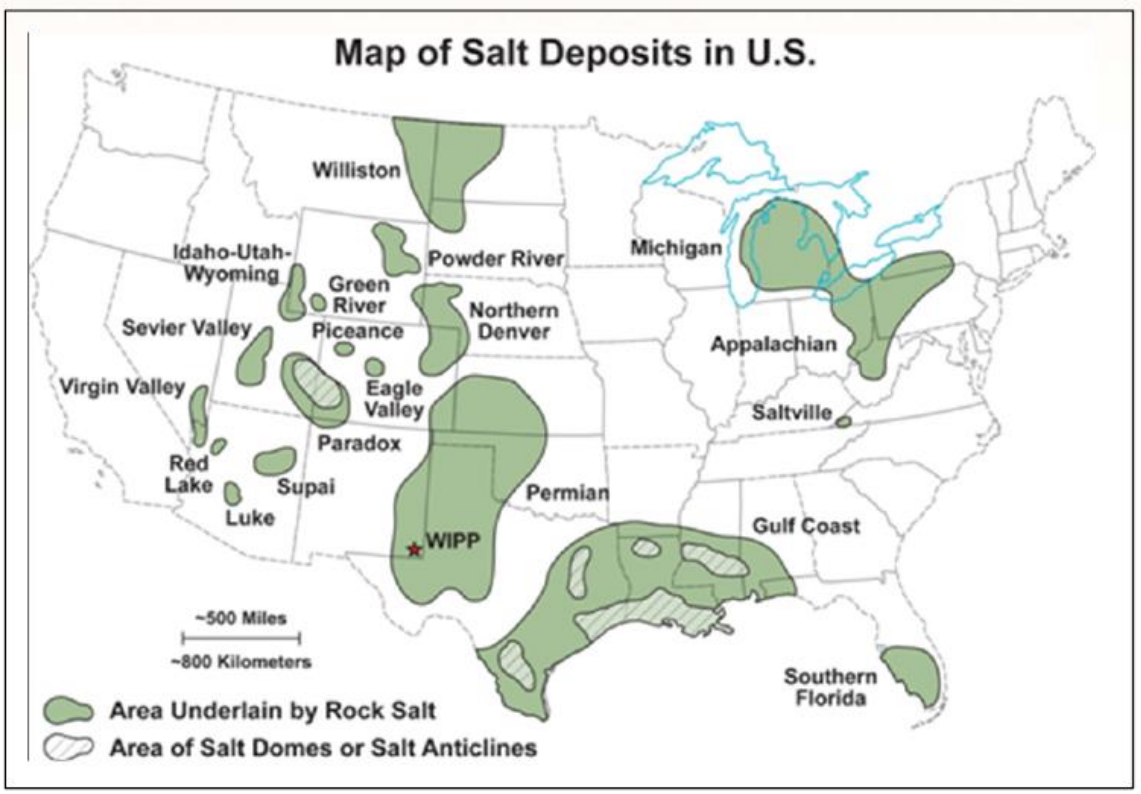








Salt Deposits in the United States

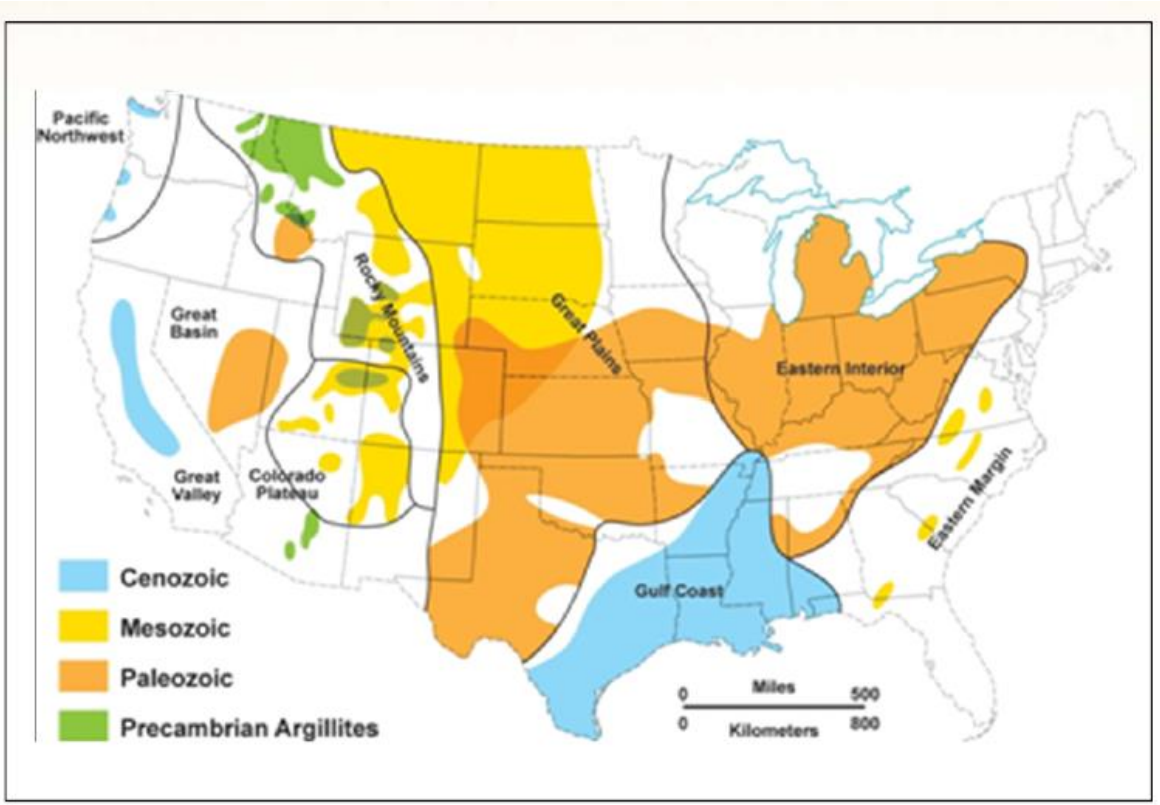


Source: Hardin et al., 2011; Hansen et al., 2011

The US had an active salt repository program until 1987

Significant subsurface investigations at Project Salt Vault, Avery Island, and WIPP

Shale Deposits in the United States



Source: Hardin et al., 2011; Hansen et al., 2011

The US had an active shale repository program in the 1970s and early 1980s

Map includes a range of clay-rich lithologies

- plastic clays
- indurated shales and argillites

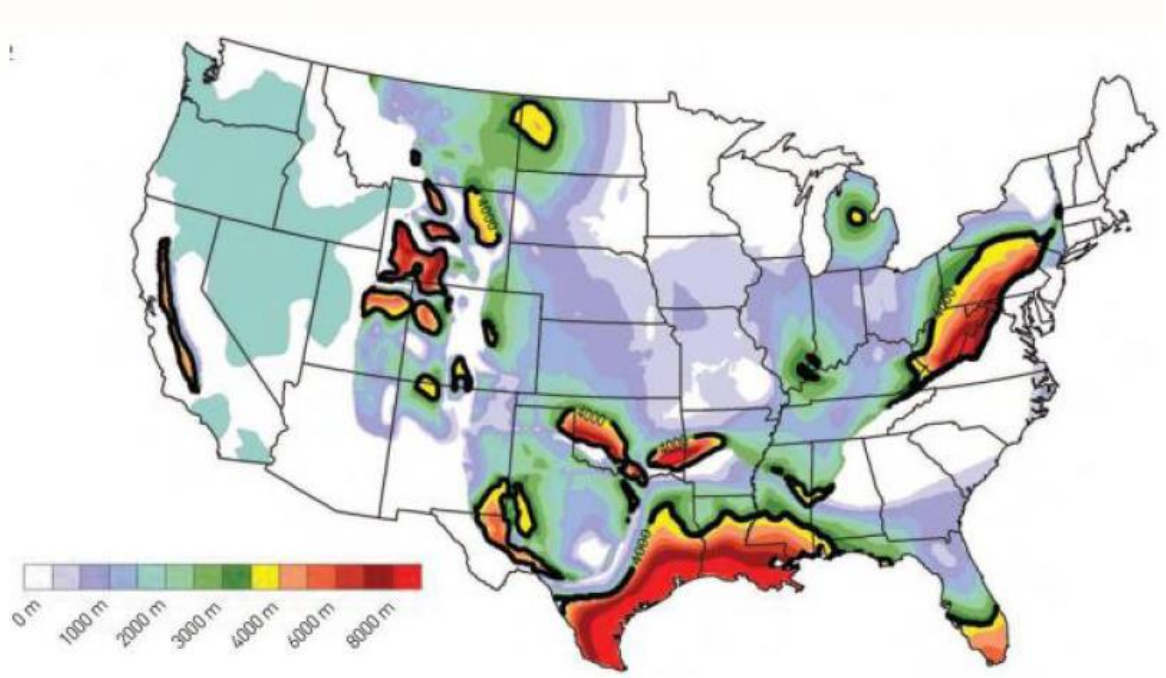
Granite Outcrops in the United States

Source: Hardin et al., 2011; Hansen et al., 2011

The US had an active R&D and siting program for crystalline rock until 1986

Map includes a range of crystalline rock types

Depth to Crystalline Basement Rocks



Source: Hardin et al., 2011; Hansen et al., 2011

Basement rocks with 2 km of the surface are potentially suitable for borehole disposal concepts

Map is incomplete in western US

What Might a Siting and Licensing Process Look Like?

What Might a Siting Process Look Like?

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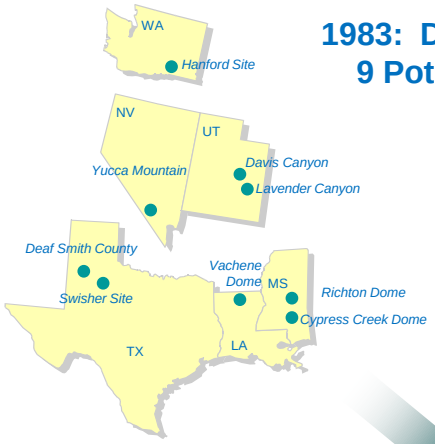


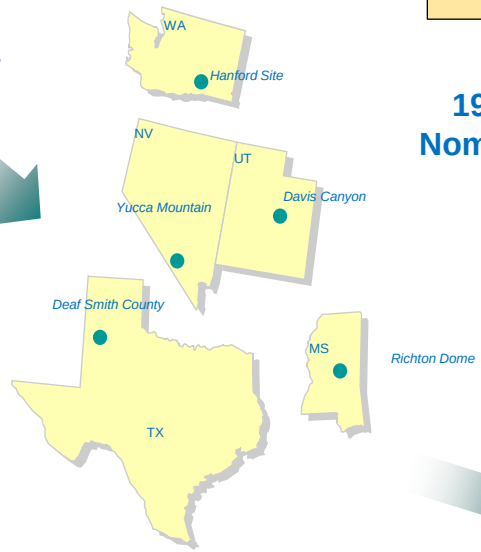
1983: DOE identifies 9 Potential Sites

The NWPA of 1982 (sec. 112) requires

DOE to consult with affected governors and issue siting guidelines

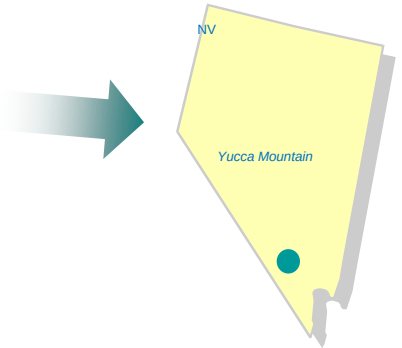
The Secretary to nominate at least five sites

The Secretary to recommend 3 sites for characterization



1986: Secretary of Energy Nominates 5 Sites, 3 Approved for Further Study

1987: NWPA Amended to Mandate One Site for Characterization



What Might Siting Criteria Look Like?

- Criteria in the NWPA Section 112(a) remain in effect
  - Consult: CEQ, EPA, USGS, and interested Governors
  - Concurrence of NRC
  - "...shall specify detailed geologic considerations that shall be primary criteria for the selection of sites in various geologic media."
  - "...shall specify factors that qualify or disqualify any site..." [including] **"...** factors pertaining to the location of valuable natural resources, hydrology, geophysics, seismic activity, and atomic energy defense activities, proximity to water supplies, proximity to populations, ..."
  - **"...** take into consideration the proximity to ... waste ...**"**
  - "... shall specify population factors that will disqualify any site ..."
  - **"...** consider the cost and impact of transporting**"**
  - "... consider the various geologic media"
  - "... use guidelines ... in considering candidate sites for recommendation"
- DOE's 10 CFR Part 960 guidelines issued in 1984 remain in effect
  - Detailed specification of the siting process
  - Emphasis on qualifying and disqualifying conditions at the subsystem level

What Regulations Apply to Disposal?

- Yucca Mountain regulations (EPA 40 CFR part 197 and NRC 10 CFR part 63) apply only to Yucca Mountain
  - Limits on estimated mean annual dose for 1 million years
- Existing regulations that predate the 1987 NWPA still apply at all other sites (but NRC has indicated intent to update)
  - EPA 40 CFR part 191 (implemented for the WIPP)
    - Cumulative normalized release standard (rather than annual dose)
    - 10,000 years (rather than 1 million years)
    - Emphasis on human intrusion
  - Additional requirements in NRC 10 CFR part 60 (never implemented)
    - Substantially complete containment in waste packages for 300 years
    - Release rate from the engineered barrier system shall not exceed one part in 100,000 per year of the inventory of that nuclide at 1000 years
    - 1000-year travel path

Standards Can Affect the Consideration of Disposal Options

Sandia National Laboratories

Dose Standards

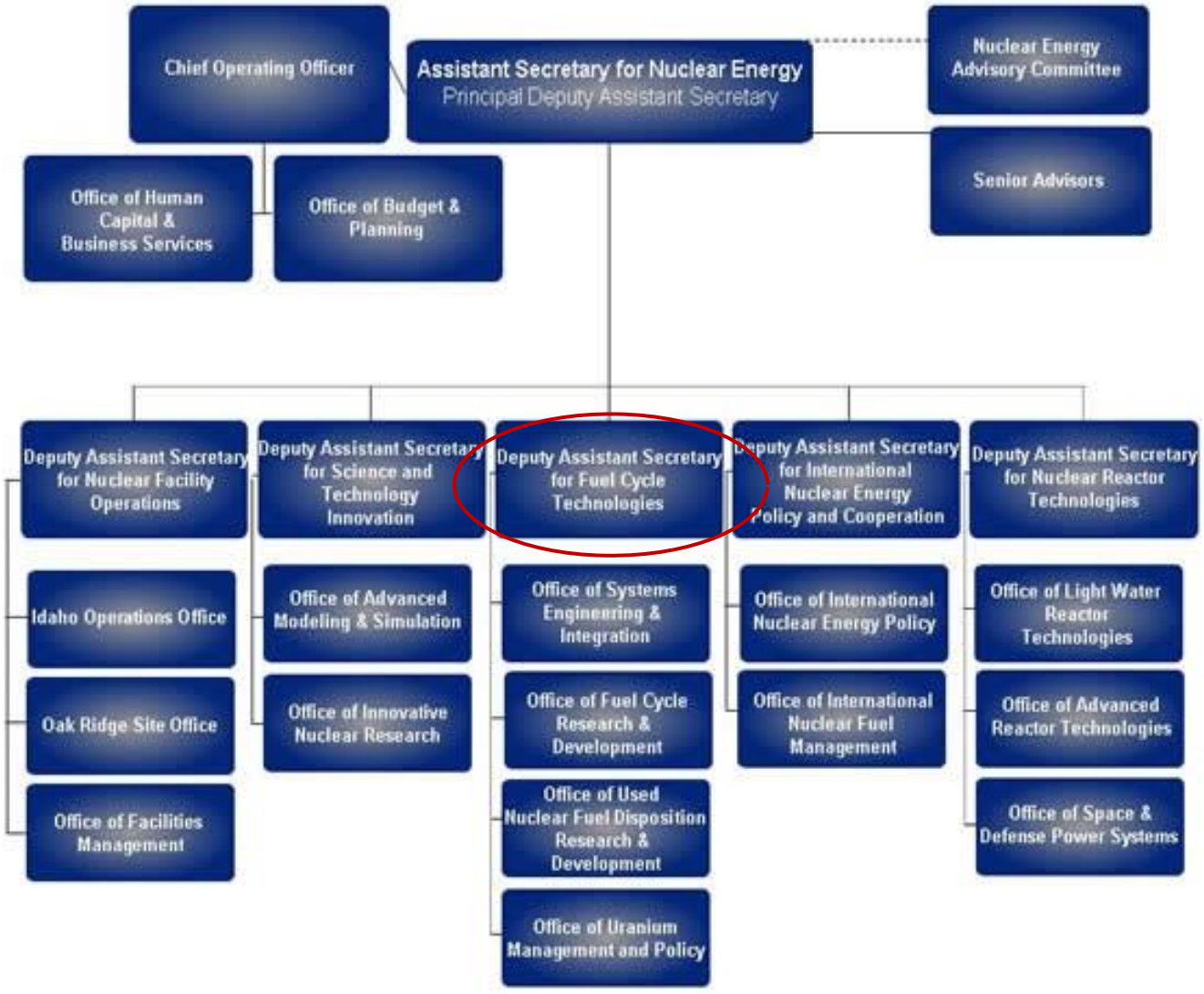
- Emphasis on low annual dose or risk
- Can be open-ended in time (or to peak dose)
- Uncertainty in human behavior (e.g., water use and diet) is large
- Encourages dilution and gradual release as well as isolation
- Encourages smaller initial inventories

Cumulative Release Standards

- Emphasis on isolation
- Meaningful only for a specified time period
- Allowable limit is a function of time
- Focuses on uncertainty in barrier system performance
- No benefit for dilution
- Normalization to initial inventory (as in 40 CFR part 191) removes incentive for smaller repositories

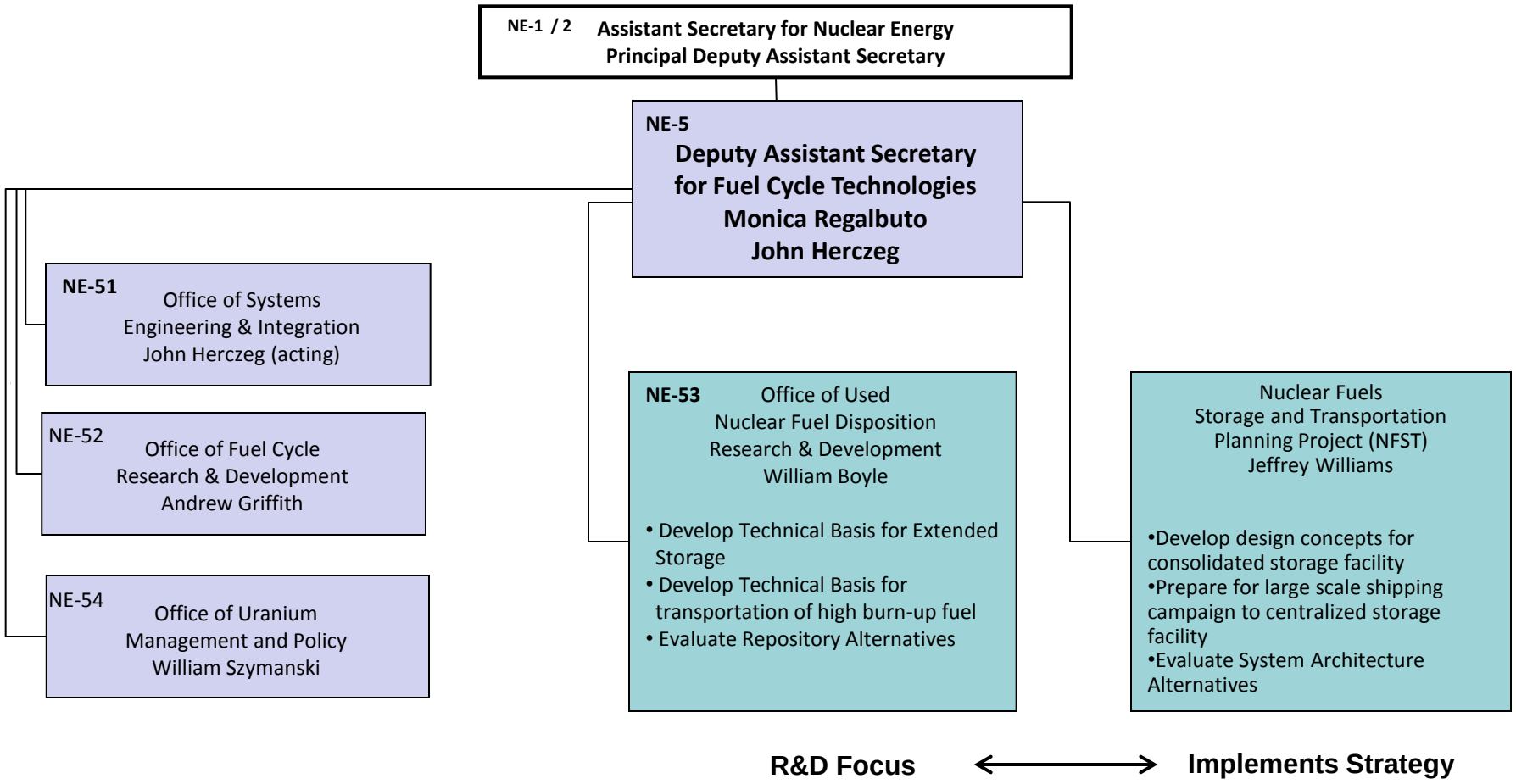
The DOE's Current R&D Activities

DOE Office of Nuclear Energy Organization Chart



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

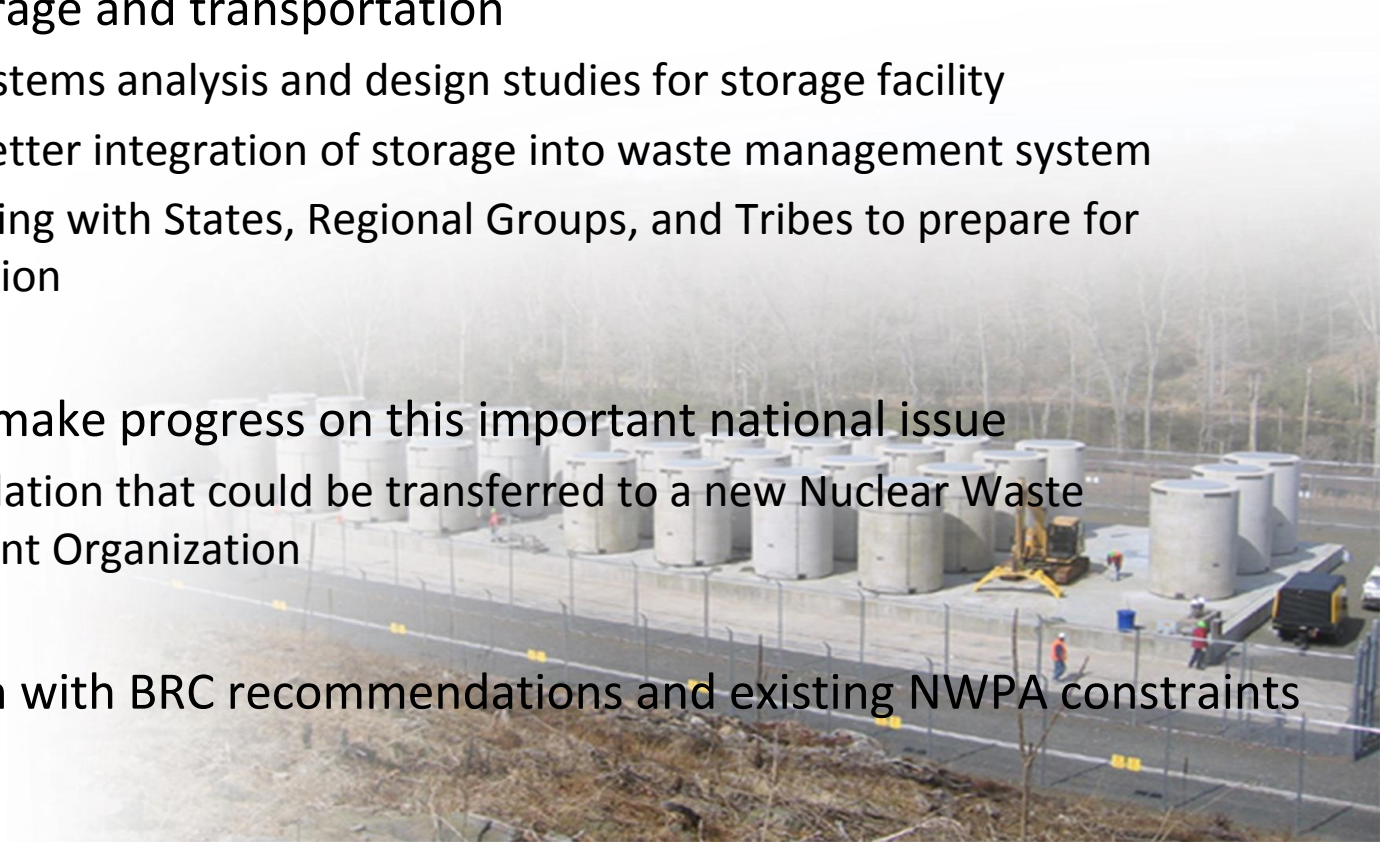
DOE Office of Nuclear Energy
Office of Fuel Cycle Technologies (NE-5)



Nuclear Fuel Storage and Transportation Planning Project

Sandia National Laboratories

- NFST Planning Project established to plan for potential storage and transportation activities, October 1, 2012
- Initial focus consistent with BRC recommendations for near-term actions related to storage and transportation
  - Perform systems analysis and design studies for storage facility
  - Promote better integration of storage into waste management system
  - Begin working with States, Regional Groups, and Tribes to prepare for transportation
- Purpose is to make progress on this important national issue
  - Build foundation that could be transferred to a new Nuclear Waste Management Organization
- Activities align with BRC recommendations and existing NWPA constraints



NFST System Analysis – System Architecture Evaluation

- Evaluate an integrated approach to storage, transportation, and disposal in the waste management system with an emphasis on providing flexibility.
- Evaluate the implications of on-site storage of UNF in large dry storage systems on direct disposal options.
- Consider factors including emplacement capability, thermal constraints, the need for re-packaging techniques, storage alternatives, transportation, impacts on utility operations.
- Evaluate measures for flexibility and order of magnitude cost factors associated with each alternative.

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

Disposal R&D within the UFDC

Sandia National Laboratories

- 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

Used Fuel Disposition R&D Campaign

The *DOE Office of Used Nuclear Fuel Disposition Research and Development and nine national laboratories participate in the DOE Office of Nuclear Energy's "Used Fuel Disposition Campaign"*

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

DOE's R&D Focus for Storage and Transportation

Sandia National Laboratories

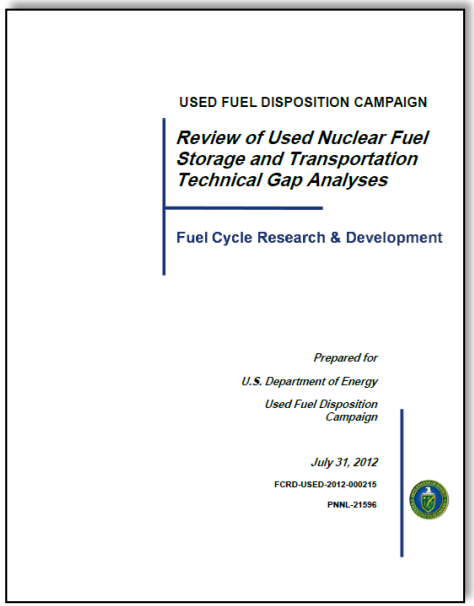
Prepare for extended storage and eventual large-scale transport of used nuclear fuel and high-level radioactive waste

Develop the technical basis for

- Extended storage of used nuclear fuel
- Fuel retrievability and transportation after extended storage
- Transportation of high-burnup used nuclear fuel

Storage and Transportation R&D

- DOE's Storage and Transportation R&D Activities are Guided by
  - Detailed analysis of gaps in the existing technical bases
  - Thorough review of comparable gap analyses by others
    - U.S. Nuclear Waste Technical Review Board
    - U.S. Nuclear Regulatory Commission
    - Electric Power Research Institute
    - International Atomic Energy Agency


USED FUEL DISPOSITION CAMPAIGN

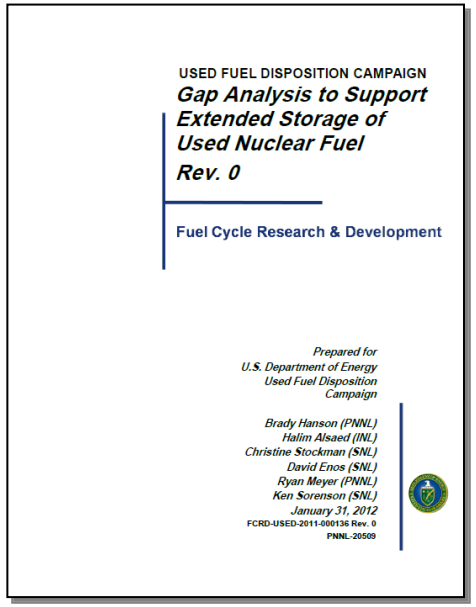
Review of Used Nuclear Fuel Storage and Transportation Technical Gap Analyses

Fuel Cycle Research & Development

Prepared for
U.S. Department of Energy
Used Fuel Disposition Campaign

July 31, 2012
FCRD-USED-2012-000215
PNNL-21596

http://energy.gov/sites/prod/files/Gap%20Analysis%20Rev%200%20Final.pdf


USED FUEL DISPOSITION CAMPAIGN

Gap Analysis to Support Extended Storage of Used Nuclear Fuel
Rev. 0

Fuel Cycle Research & Development

Prepared for
U.S. Department of Energy
Used Fuel Disposition Campaign

Brady Hanson (PNNL)
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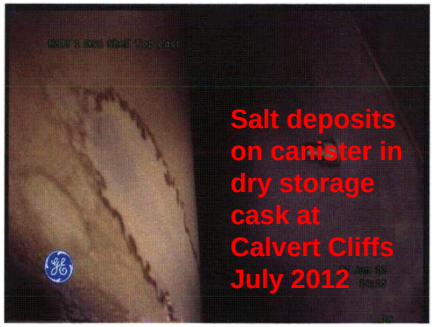
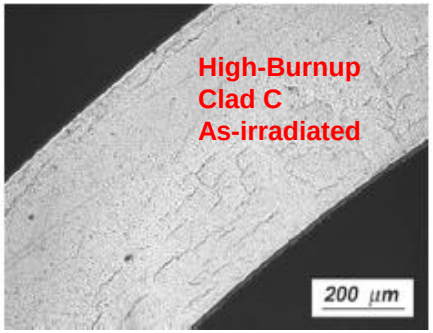
Ryan Meyer (PNNL)
Ken Sorenson (SNL)
January 31, 2012
FCRD-USED-2011-000136 Rev. 0
PNNL-20509

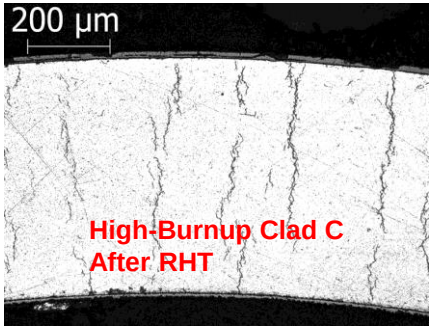
http://energy.gov/sites/prod/files/Gap%20Comparison%20Rev%200.pdf

Technical Challenges and Opportunities for Storage and Transportation Research

- Performance of spent fuel in extended storage
  - Aging of canisters, casks, cladding, internals
- Performance of high-burnup fuel in storage
  - Most reactors now generate higher-burnup fuel (up to 60 GWd/MT) than what is currently licensed for storage
  - Higher temperatures cause hydride reorientation in clad, subsequent embrittlement
- Spent fuel must be transportable at the end of extended storage
  - Retrievability
  - Criticality control
- Opportunities: collaboration with NRC, industry, and universities

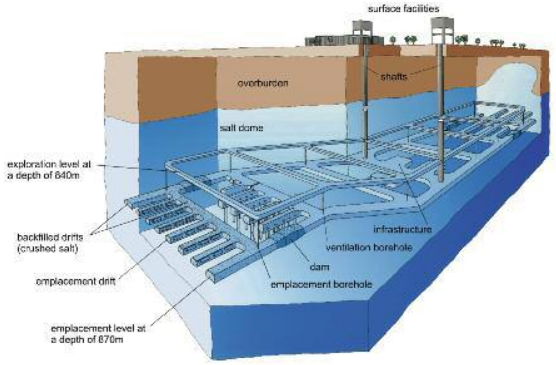


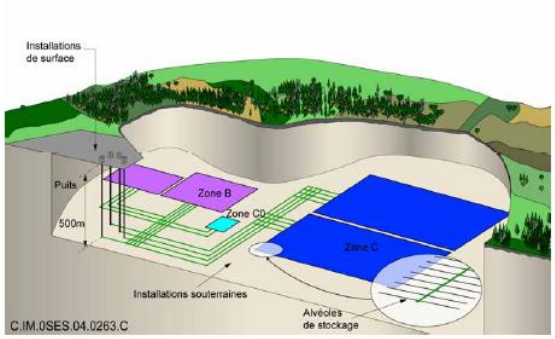


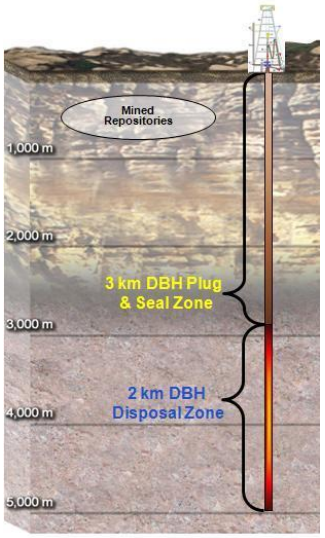


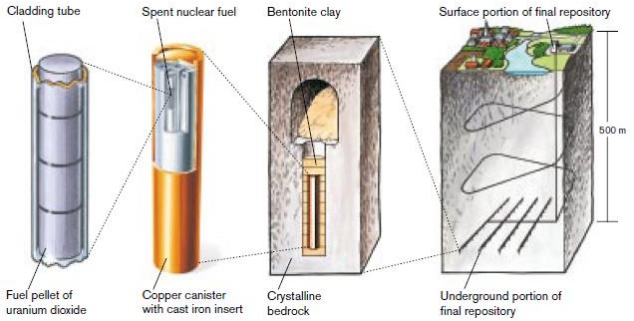
DOE's R&D Focus for SNF and HLW Disposal

- Provide a sound technical basis for multiple viable disposal options in the US
- Increase confidence in the robustness of generic disposal concepts
- Develop the science and engineering tools needed to support disposal concept implementation



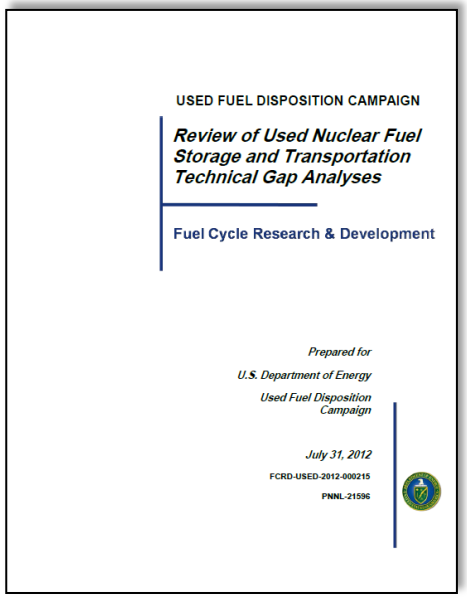




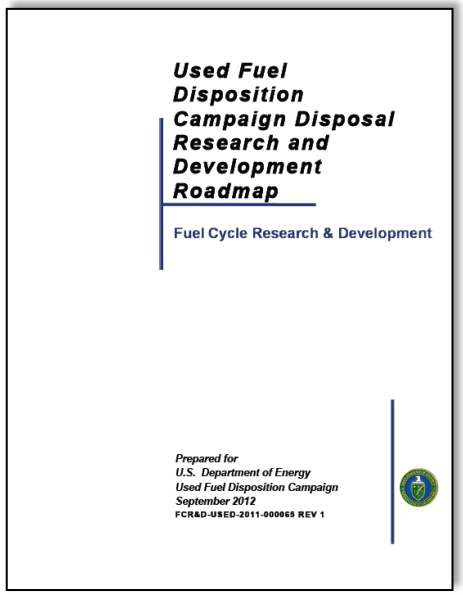


Disposal Research

- DOE's Disposal R&D activities are guided by
  - Recognition of four basic areas of R&D focus
    - Mined repositories in salt, clay/shale, and crystalline rock
    - Deep borehole concepts
  - Development of a Disposal R&D Roadmap that
    - Identifies R&D gaps
    - Prioritizes them based on adequacy of existing knowledge to support current stage of the program



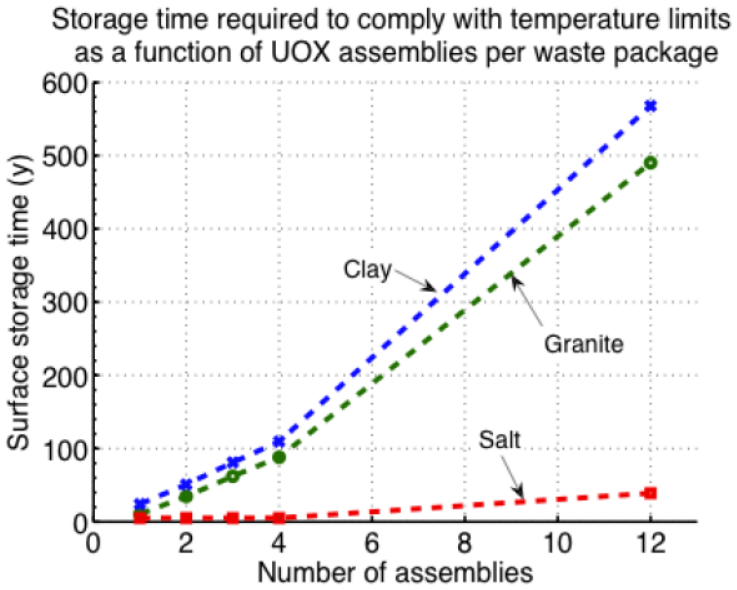
http://energy.gov/ne/downloads/basis-identification-disposal-options-research-and-development-spent



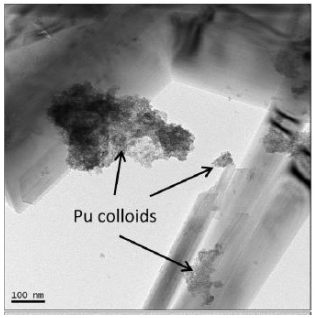
http://energy.gov/ne/downloads/used-fuel-disposition-campaign-disposal-research-and-development

Technical Challenges and Opportunities for Disposal Research

- Building confidence in multiple repository concepts without site-specific data
- Developing tools for characterizing complex natural and engineered systems
- Identifying constraints on disposal options
  - E.g., different media pose different thermal limits, constraining repository design and waste package size
- Matching engineered barriers to geologic environments
  - E.g., Alloy-22 packages in oxidizing environments, copper packages in reducing environments
- Opportunities for international collaboration
  - France, Germany, Sweden, Switzerland, Canada, Korea, Japan, Finland, UK, China, Czech Republic…



Minimum decay storage durations to limit peak PWR waste package surface temperature to 100°C (granite, clay) or 200°C (salt). (Hardin et al., 2011, Generic Repository Design Concepts and Thermal Analysis (FY11), FCRD-USED-2011-000143)



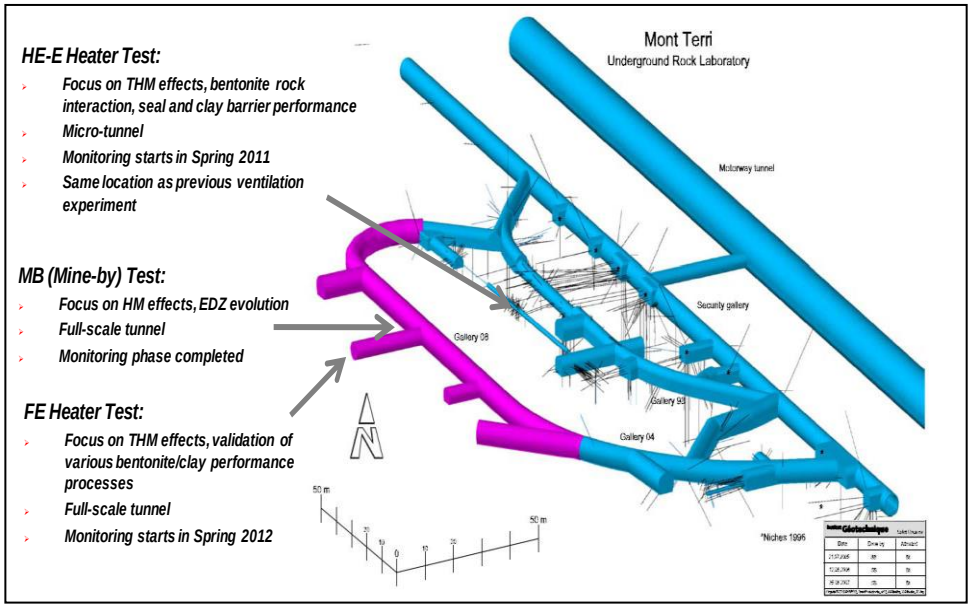
TEM of intrinsic Pu(IV) nano-colloids sorbed to goethite at 25° C for 103 days (Wang et al., 2011; Natural System Evaluation and Tool Development—FY11 Progress Report, FCRD-USED-2011-000223)

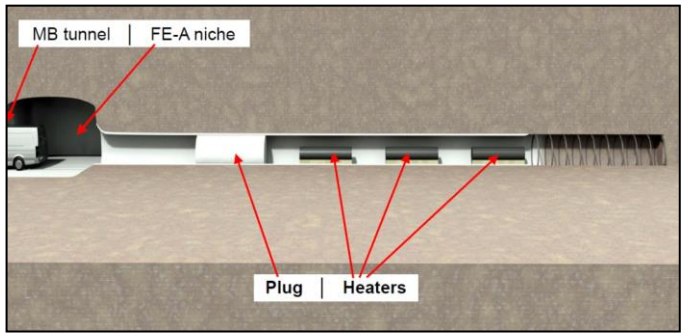
US Engagement in International Collaborations for Disposal Research

Collaborative R&D with ongoing programs in Europe and Asia

- Mont Terri: International underground research laboratory (URL) in clay in Switzerland
  - ***Joining the URL gives 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 began Spring 2012***
- KAERI Underground Research Tunnel (KURT)
  - ***Collaborative US/ROK experiments began in 2013***

Major current or soon-to-be started experiments





Summary and Conclusions

- Spent nuclear fuel is safely managed where it is today
  - Extended storage does not pose unprecedented technical challenges
    - However, additional technical support is needed for license extensions
  - Legal, political, and social challenges to extended storage may be significant
- The US has multiple viable disposal options
  - There is extensive international experience
  - R&D on generic disposal concepts reinforces confidence that the technical basis will be ready when national policy is determined
- Legal and regulatory constraints are potentially significant regardless of the path chosen

Discussion

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