



U.S. DEPARTMENT OF
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**Management, Transportation, Storage
and Disposal of Used Nuclear Fuel and High-
Level Radioactive Waste in the
United States**

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INMM 30th Spent Fuel Management Seminar
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**An Adaptive, Consent-Based Path to
Nuclear Waste Storage and Disposal**

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- In January 2013, the Administration issued the Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste.
 - The Strategy embraced the core findings of the Blue Ribbon Commission on America's Nuclear Future and affirmed that any workable solution for the final disposition of used fuel and nuclear waste must be based not only on sound science, but also on achieving public acceptance at the local, state and tribal levels.
 - The Administration supports working with Congress to develop a consent-based process that is transparent, adaptive and technically sound.
 - The Blue Ribbon Commission and the Administration Strategy also emphasize the importance of pursuing consolidated interim storage in parallel with evaluating at alternative sites for geologic disposal. A first priority is consent-based siting of a pilot-scale storage facility to accommodate used fuel from shutdown reactors.

February 12, 2014



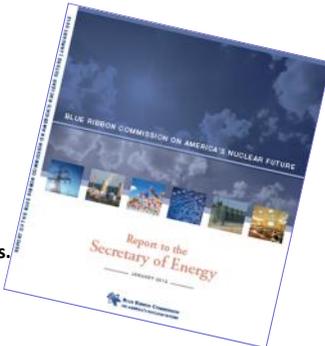
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Blue Ribbon Commission Recommendations

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.



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Key Elements of Administration Strategy

January 2013

Consent-based Facilities Siting

- Agreement at multiple jurisdictional levels
- Open and transparent communication of benefits and risks
- Mutually agreed upon off-ramps

System Design

- Pilot interim storage facility
- Consolidated interim storage facility
- Geologic repository
- Transportation system designed, regulated, and executed for safe and secure interstate shipping

Governance & Funding

- A new organization, empowered with the authority to succeed
- Timely access to sufficient funding
- Fees collected; applied to their intended purpose

Phased,
Adaptive,
Staged

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Implementation of Administration's Strategy

As noted in the Department's FY-15 Budget Request –

“Full implementation of the Administration Strategy will require new legislation, however, in the meantime the Department is taking action on the Strategy to the extent possible within existing authorities.”

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Blue Ribbon Commission Recommendations Use of Existing Authority

The Blue Ribbon Commission identified a series of activities that the Department could begin to implement under its existing authority and encouraged steps forward in these areas. The Department is doing work in all of these areas.

■ Storage

- “Using existing authority in the NWPA, DOE should begin laying the groundwork for implementing consolidated storage and for improving the overall integration of storage as a planned part of the waste management system”

■ Transportation

- “DOE should complete the development of procedures and regulations for providing technical assistance and funds ..., and begin providing funding, for working with states and regional state-government groups and training local and tribal officials ... in preparation for movement of spent fuel from shutdown reactor sites to consolidated storage.”

■ Disposal

- “DOE should keep a repository program moving forward through valuable, non-site specific activities, including R&D on geological media, work to design improved engineered barriers, and work on the disposal requirements for advanced fuel cycles.”
- “DOE should develop an RD&D plan and roadmap for taking the borehole disposal concept to the point of a licensed demonstration.”

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Areas of Focus Used Nuclear Fuel Programs

On this foundation, the Department has developed two areas of focus –

- **Used Nuclear Fuel Disposition R&D Campaign (\$49M in FY15)** – *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.*
- **Nuclear Fuels Storage and Transportation Planning Project (\$22.5M in FY15)** – *Lay the groundwork for implementing interim storage, including associated transportation, per the Administration’s Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste, and develop a foundation for a new nuclear waste management organization.*

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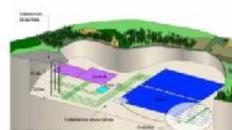


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Used Nuclear Fuel Disposition R&D

Elements of the Used Nuclear Fuel Disposition R&D Campaign include –

- Storage and Transportation R&D
 - Fuel retrievability and transportation after extended storage
 - Extended storage of used nuclear fuel
 - Transportation of high-burnup used nuclear fuel
- Disposal R&D
 - Provide a sound technical basis for the assertion that the U.S. has multiple viable disposal options
 - Increase confidence in the robustness of generic disposal concepts
 - Evaluate the feasibility of the deep borehole disposal concept
 - Evaluate the technical feasibility of the direct disposal of existing storage and transportation canisters



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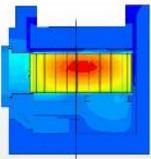
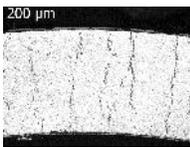
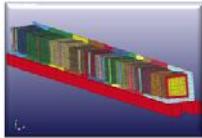


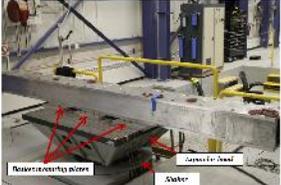
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Used Nuclear Fuel Disposition Extended Storage & Transportation R&D

Better understand degradation mechanisms relevant to long-term storage and subsequent transportation:

- Potential for corrosion of stainless steel canisters
- Thermal history of used fuel in storage
- Effects of hydride formation and reorientation on the material properties of high-burnup cladding
- Mechanical loads on fuel assemblies during normal conditions of transport



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Used Nuclear Fuel Disposition Cask Storage Demonstration R&D

▪ The Cask Storage Demonstration contract was awarded to the EPRI Team to evaluate extended storage of high burnup used nuclear fuel:





ELECTRIC POWER
RESEARCH INSTITUTE



Dominion



AREVA Federal Services
AREVA Transnuclear
AREVA Fuels

•North Anna Nuclear Power Plant

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Nuclear Fuels Storage and Transportation Planning Project

Begin laying the ground work for interim consolidated storage –

- Perform systems analysis and design studies for interim storage facilities
- Promote better integration of storage into waste management system
- Compile lessons-learned relative to siting process
- Evaluate system benefits of standardization

Prepare for the large-scale transportation –

- Collaborate with stakeholders on revised NWPA Section 180(c) Policy and National Transportation Plan
- Evaluate the inventory, transportation interface, and shipping status of used nuclear fuel, with initial focus on shut-down reactor sites
- Assess and address transportation needs

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Laying the Groundwork for Consolidated Interim Storage

- **Evaluating interim storage design concepts, with input from industry contractors**
 - Recently initiated new Task "*Generic Design Alternatives for Dry Storage of Used Nuclear Fuel*"
- **Preparing facility functions and requirements**
- **Evaluated costs and impacts of opening non-disposable storage canisters**
- **Developing data on alternative generic design concepts for receiving, storing, handling, and repackaging UNF canisters to support systems analyses**

Implementation of near-term tasks recommended by the Blue Ribbon Commission related to systems analysis and design studies for an interim storage facility.







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Preparing for the Large-Scale Transportation of UNF and HLW

- **Collaborating with stakeholders through State Regional Groups (SRG) and tribal representatives**
 - Revised NWSA 180(c) policy
 - National Transportation Plan
 - Routing options
- **Planning for design, testing, and acquisition of rail cars and transportation casks**
- **Assessing needs and developing plan for removing UNF from shutdown reactor sites**
- **Developing new routing capabilities and investigating routing options from shutdown reactor sites**

Implementation of near-term tasks recommended by the Blue Ribbon Commission related to working with stakeholders and developing plans and capabilities for the ultimate shipment of spent nuclear fuel and high level waste.






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Stakeholder Tool for Assessing Radioactive Transportation (START)

- **Cover the entire continental U.S.**
- **Represent physical and operating characteristics of freight surface transportation modes**
 - Highway
 - Rail
 - Barge
- **Include relevant proximate features (e.g., tribal lands, emergency responders, schools, environmentally-sensitive land use)**
- **Flexible, modular system architecture to support functionality, feature and data updates**
- **Leverage geographic information systems (GIS) technology**
- **Support users via web-based application with secure internet access**

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Progress in Evaluating Disposal Options

The Department is moving forward with preliminary evaluations of alternative disposal options

- Technical feasibility of different disposal concepts
- Options for disposing of different waste forms, including both commercial and defense-related wastes
- Actions to fill R&D gaps regarding deep borehole disposal, which is the least-developed of the concepts under consideration

The Department also is engaging in international collaboration in the area of disposal R&D

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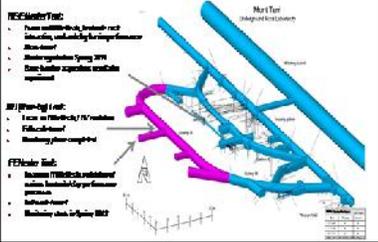


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Disposal R&D International Collaboration

Formal collaborative R&D arrangements with ongoing programs in Europe and Asia



- Mont Terri: Underground research laboratory in clay (Switzerland)
- Grimsel: Colloid Formation and Migration Project in granite (Switzerland)
- DECOVALEX: (Development of Coupled Models and their Validation against Experiments)
- 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)

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Evaluation of Options for Permanent Geologic Disposal of Spent Nuclear Fuel and High Level Radioactive Waste in Support of a Comprehensive National Nuclear Fuel Cycle Strategy

In 2014, Sandia National Laboratories led a team that completed a comprehensive inventory of spent nuclear fuel and high level waste requiring geologic disposal and identified potential disposal options for each of the waste forms in the inventory.



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Conclusions of the Sandia Study

The Sandia study looked at questions such as –

- Is a “one size fits all” repository a good strategic option?
- Do different waste forms perform differently enough in different disposal environments to warrant different approaches?
- Do some disposal concepts perform better with or without specific waste forms?

Among the conclusions were –

- Both “one size fits all” and multiple repositories are technically feasible
- No wastes require a specific disposal concept, and all geologic media considered in the analysis could potentially be used for all waste forms
 - Disposal of very large waste forms (i.e., dual purpose dry storage canisters) is potentially feasible, but poses greater challenges
- Some waste forms may warrant physical separation from others even in a single repository
- Deep borehole disposal might a good option for some small and low-volume waste types

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Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel

- Over the last year, the Department has done a technical assessment of options for disposal of its inventory of DOE-managed high-level radioactive waste and spent nuclear fuel.
- This assessment considered whether DOE- managed HLW and SNF should be disposed of with commercial SNF and HLW in one geologic repository, or whether there are advantages to developing separate geologic disposal pathways for some DOE-managed HLW and SNF.
- Disposal options analyzed --
 - Dispose of all HLW and SNF waste, regardless of origin, in a common repository
 - Disposal of some DOE-managed HLW and SNF in a separate mined repository
 - Disposal of smaller waste forms in deep boreholes



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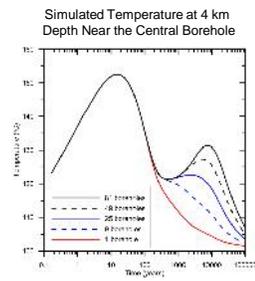
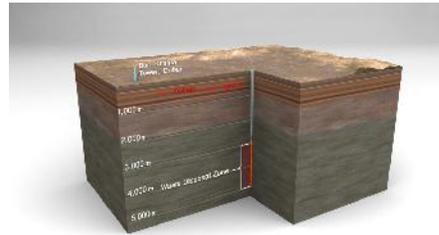
Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel

- **Key Conclusions and Recommendations**
 - Concludes that there are multiple options for disposal of DOE-managed HLW and SNF that are technically feasible and have the potential to provide long-term isolation of this waste.
 - Concludes there are potential programmatic advantages to a phased strategy that allows for flexibility in disposal pathways for some DOE- managed HLW and SNF.
 - Recommends the Department begin implementation of a phased, adaptive, and consent-based strategy with development of a separate repository for some DOE-managed HLW and SNF.
 - Recommends the Department retain the flexibility to consider options for disposal of some smaller DOE-managed waste forms in deep boreholes rather than in a mined geologic repository.

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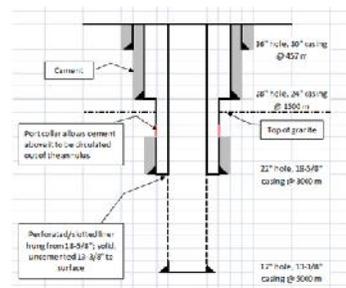
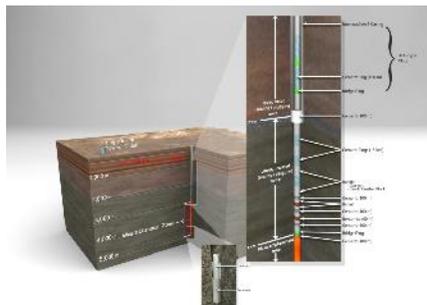
Evaluating the Feasibility of the Deep Borehole Disposal Concept

- Disposal concept consists of drilling a borehole or array of boreholes into crystalline basement rock to about 5,000 m depth
- Approximately 400 waste canisters would be emplaced in the lower 2,000 m of the borehole
- Upper borehole would be sealed with compacted bentonite clay and cement plugs
- Several factors suggest the disposal concept is viable and safe:
 - Crystalline basement rocks are common in many stable continental regions
 - Existing drilling technology permits dependable construction at acceptable cost
 - Low permeability and long residence time of high-salinity groundwater in deep continental crystalline basement at many locations suggests very limited interaction with shallow fresh groundwater resources



Elements of a Deep Borehole Field Test

- Demonstrate the feasibility of characterizing and engineering deep boreholes
- Demonstrate processes and operations for safe waste emplacement downhole
- DOE is currently reviewing responses to its October 2014 Request for Information (RFI) that solicited input from entities potentially interested in hosting a field test.





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Conclusions

The Department of Energy is committed to moving forward with development of management strategies and technologies for the storage and disposal of used nuclear fuel and high-level radioactive waste.

■ **The Used Nuclear Fuel Disposition program is:**

- Laying the foundation for the development of storage, transportation and disposal options.
- Evaluating the behavior of used high burnup used nuclear fuels during storage and transportation.
- Evaluating disposal options in several geologic media, including borehole disposal and direct disposal of existing canisters.