



U.S. DEPARTMENT OF  
**ENERGY**

**Nuclear Energy**

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# **Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste**

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**United States Nuclear Waste Technical Review Board  
Washington D.C  
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# President Obama's Nuclear Energy Goals

"We have an obligation to leave our children a planet that's not polluted or damaged, and by taking steady, responsible steps to cut carbon pollution and an all-of-the-above approach to develop homegrown energy ...

Thanks to the ingenuity of our businesses, we're starting to produce much more of our own energy. We're building the first nuclear power plants in more than three decades in Georgia and South Carolina."

- Georgetown University June 26<sup>th</sup>, 2013



## Secretary Moniz on Nuclear Energy

“The United States is strongly committed to ensuring the safe, secure, and peaceful uses of nuclear energy while steadfastly preventing the proliferation of nuclear weapons...

As we look collectively at the challenge of working to reduce carbon emissions while facilitating global development, nuclear energy clearly has a role to play. In that regard, I suggest that we should begin looking beyond the era of “Atoms for Peace” toward a model of “Atoms for Prosperity.”



*2013 IAEA General Conference  
September 16, 2013*

# Role of U.S. Department of Energy for Sustainable and Innovative Nuclear Energy

## Conduct Research, Development, and Demonstration to:

- Reduce regulatory risk
- Reduce technical risk
- Reduce financial risk and improve economics
- Manage nuclear waste
- Minimize the risks of nuclear proliferation and terrorism
- Foster international and industry collaboration



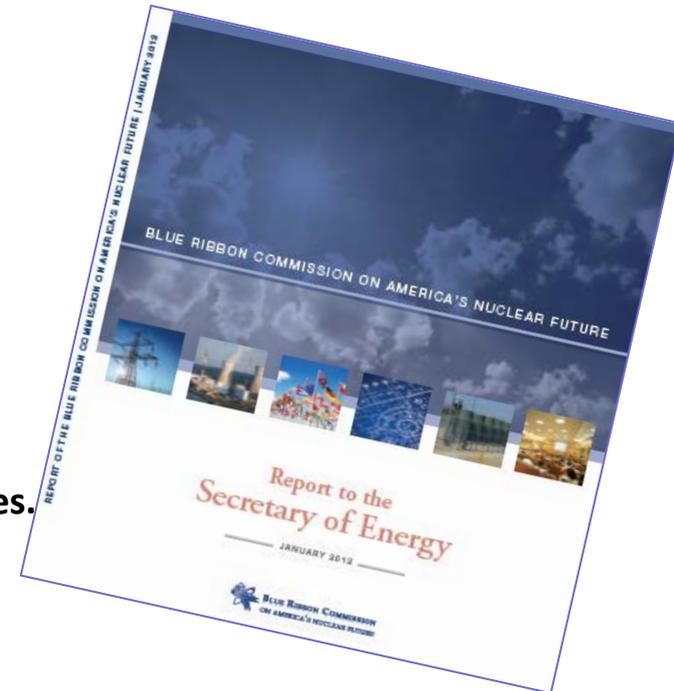
Vogtle – October 2013

*Source: Southern Co.*



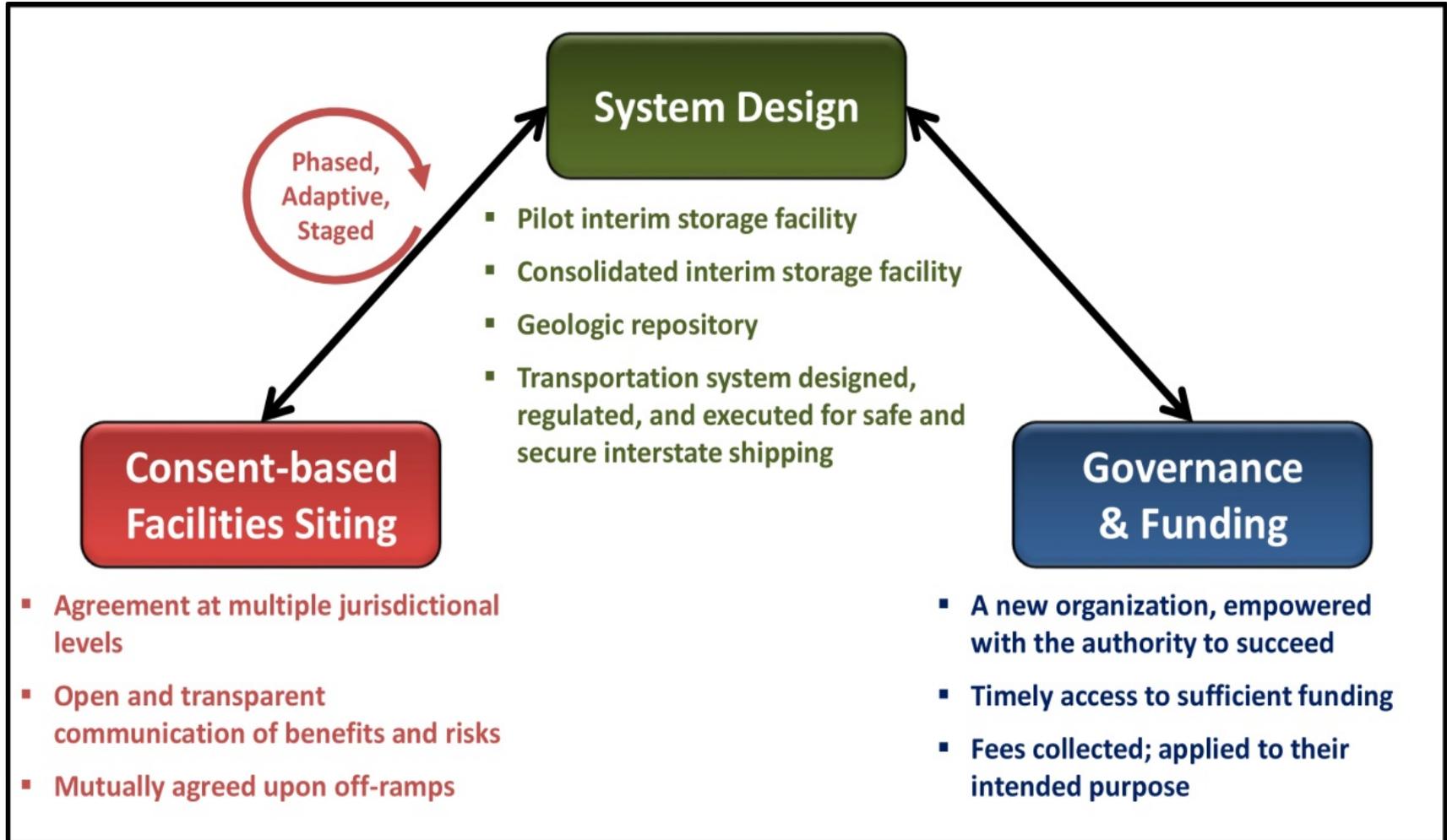
# Blue Ribbon Commission Recommendations

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.





# Key Elements of Administration Strategy



# Congressional Activity

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- **Senators Wyden, Murkowski, Feinstein, and Alexander introduced comprehensive nuclear waste legislation – Nuclear Waste Administration Act of 2013 (S. 1240)**
    - Establishes a siting process for storage and repository facilities that relies on consent agreements and Congressional ratification
    - Establishes a new organization – Nuclear Waste Administration – run by a single Administrator and overseen by an Oversight Board
    - Addresses funding reform by creating a new Working Capital Fund in which fees are deposited and are available as needed
  
  - **Path to passage is difficult to predict**
    - Court cases still pending
    - Some factions in Congress ready to “move on” from Yucca Mountain, while others not



# Commingling

- **“The Commission therefore urges the Administration to launch an immediate review of the implications of leaving responsibility for disposal of defense waste and other DOE-owned waste with DOE versus moving it to a new waste management organization”** *Blue Ribbon Commission*
- **“As supported in the Administration’s Strategy and recommended by the BRC, DOE has initiated an analysis of the pros and cons of commingling civilian and defense waste.”** *Secretary Moniz, U.S. Senate Energy and Natural Committee, July 30<sup>th</sup>, 2013*



# What Has Changed Since 1985?

	Legislative Framework	Waste Inventory	DOE's Mission	Technical Basis for Disposal	Programmatic Considerations
<b>1985</b>	Multiple repository sites being evaluated under NWPA	<ul style="list-style-type: none"> <li>Essentially all DOE SNF would be reprocessed</li> <li>All DOE HLW would be vitrified</li> </ul>	Support for defense program	<ul style="list-style-type: none"> <li>No operating repositories world-wide</li> <li>Limited site-specific information</li> </ul>	<ul style="list-style-type: none"> <li>Commercial repository projected in 1998</li> <li>Only repository options were full commingling of DOE and commercial waste or full segregation into separate repositories</li> </ul>
<b>2013</b>	1987 Nuclear Waste Policy Amendments Act leaves no alternative path under the NWPA for a repository other than Yucca Mountain	<ul style="list-style-type: none"> <li>Essentially all DOE SNF will be disposed of as-is</li> <li>Vitrified HLW is still largest component, but HLW exists in other forms (e.g., calcine)</li> <li>Inventory now includes DOE-managed non-defense wastes (e.g., West Valley HLW, Three Mile Island &amp; Ft. St. Vrain SNF)</li> </ul>	<ul style="list-style-type: none"> <li>Environmental cleanup</li> <li>NNSA fuel take-back program</li> </ul>	<ul style="list-style-type: none"> <li>28 years of additional repository R&amp;D in US and other nations</li> <li>14 years of operating experience at WIPP</li> </ul>	<ul style="list-style-type: none"> <li>Commercial repository projected in 2048</li> <li>DOE/State agreements mandate DOE SNF removal by 2035</li> <li>Multiple repository concepts are possible for different DOE wastes</li> </ul>



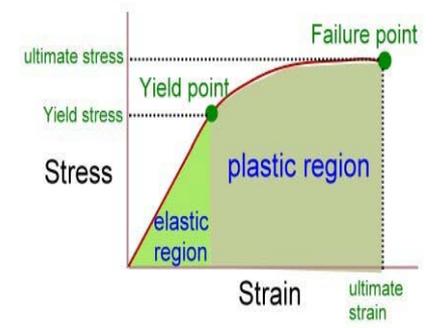
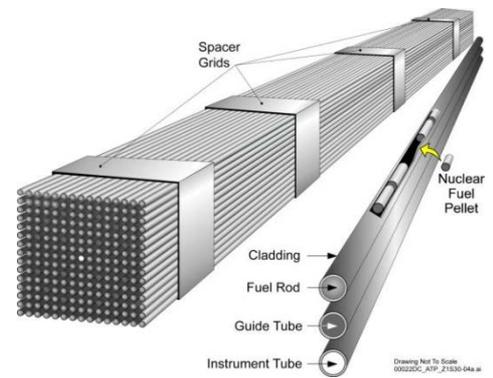
# Nuclear Waste Management R&D

- Lay the preparatory groundwork for implementing Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Waste*
  
- Conduct generic studies and Research and Development
  - Waste management System Analyses to provide quantitative estimates of system impacts of utility actions and inform future decisions
  - Plans for integration of waste management system
  - Large scale transportation of UNF and HLW, with initial focus on removing UNF from the shut-down reactor sites
  - Standardization of storage, transportation, and disposal canister
  - Degradation mechanisms in long term dry storage of UNF
  - Foundational information, resources, and capabilities needed to support future implementation decisions and actions



# Used Nuclear Fuel Disposition R&D: Storage and Transportation

- Develop technical basis and conduct system analyses to study different storage scenarios and eventual transportation
- Study degradation mechanism for extended storage of used nuclear fuel in dry storage casks
- Generic design studies for standardized storage, transportation, aging, and disposal canister



## Used Fuel Disposition R&D: Standardization and Integration

- Various designs of storage canisters currently used by the utilities are certified for storage only or storage and transportation. None of these are certified for disposal.
- A standardized disposable canister, which once sealed will never be opened, will be highly effective and economical in integration of waste management system
- DOE awarded contracts to two industry teams led by AREVA and Energy Solutions to prepare feasibility study of Standardized Storage, Transportation, Aging, and Disposal (STAD) Canisters
- Industry contractors, through technical evaluation and system analysis approach, established feasibility of STAD canisters and recommended multiple design concepts
- DOE is developing a quantitative assessment of standardization, which will analyze the system implications of differing levels of integration

# Used Nuclear Fuel R&D: Extended Storage

**Better understand potential degradation mechanisms in long term dry cask storage including:**

- **Complete the identification of data gaps to support extended dry storage**
- **Continue material testing to support modeling and simulation of used fuel aging**
- **Participate with industry and others on full-scale cask storage demonstration of high burnup used fuel**





# Extended Storage R&D Cask Storage Demonstration Contract

- The Cask Storage Demonstration contract was awarded to the EPRI Team, which consists of:



ELECTRIC POWER  
RESEARCH INSTITUTE



**Dominion**

- Surrey Plant
- North Anna Plant



**AREVA Federal Services**  
**AREVA Transnuclear**  
**AREVA Fuels**



# Extended Storage R&D Cask Storage Demonstration

- **The near-term activities are focused on experimental and analytical work that can be conducted immediately, without any modification to existing facilities.**
- **The goals for the R&D program include:**
  - **Benchmarking the predictive models and empirical conclusions that will be developed from short-term laboratory testing for aging of dry storage cask system components; and**
  - **Building confidence in the ability to predict the performance of these systems over extended time periods.**
  - **Provide a platform to store used high burnup fuel, monitor and inspect material degradation process in extended, up to 10 year, storage environment.**





## Used Nuclear Fuel Disposition R&D: Storage Issues and Challenges

- Dry Storage at Nuclear Power Plants is required to continue operations following full loading of spent fuel pools.
- Many of the storage concepts are not compatible with transportation or disposal.
- Several sizes, shapes and varieties of technology (Jeff Williams will discuss).
- There is limited pool space, so utilities will continue to deploy dry storage in a manner that best meets their needs without consideration of down stream impacts.





## Used Nuclear Fuel Disposition R&D: Storage Issues and Challenges

- **Difficult problem to address because utilities needs are not the same as that of DOE**
- **Some storage casks do not have transportation certificates.**
- **Some casks with transportation certificates are loaded, but cannot be transported because of dose or thermal limits.**
- **DOE is evaluating the direct disposal of utility canisters that have been loaded for dry storage. Potential technical problems (physical size, criticality, thermal). (Tito Bonano will discuss).**
- **The alternative is to repackage. DOE is evaluating the implications of this and will discuss the results of industry input. (Rob Howard will discuss).**

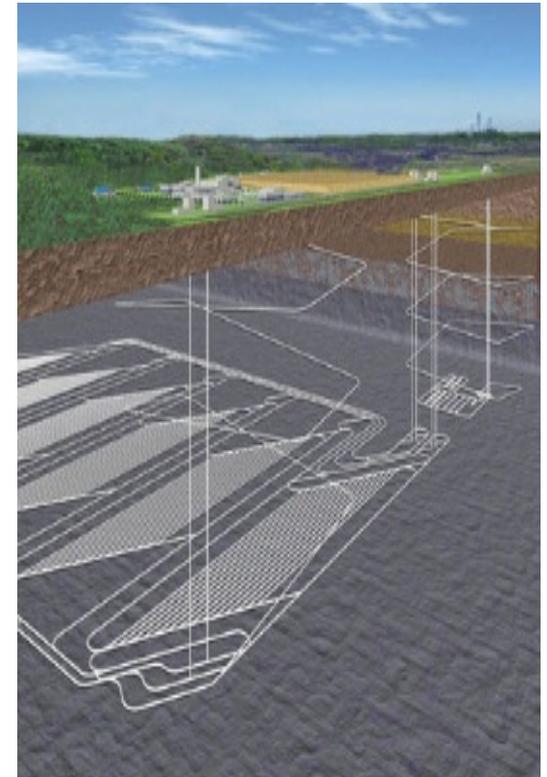


# Used Nuclear Fuel Disposition R&D: Transportation

- **Initiate planning for a large-scale transportation program**
- **Evaluate the inventory, transportation interface, and shipping status of used nuclear fuel at shut-down reactor sites**
- **Complete assessment of transportation needs, (e.g., cask, rail cars, support and security).**

# Used Nuclear Fuel Disposition R&D: Disposal

- **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 BRC recommendation for developing a near term plan for taking the borehole disposal concept to the point of a demonstration**





# Post Legislation Implementation: Key Near Term Activities

- **Establishment of a new organization to run this program**
- **Active engagement in a broad, national, consent-based process to site storage and disposal facilities**
- **Siting, design, licensing, and commencement of operations at a pilot storage facility**
- **Significant progress on siting and licensing of a larger consolidated interim storage facility**
- **Development of transportation capabilities to begin movement of fuel from shut-down reactors**
- **Reformation of the funding arrangements**

# Post Legislation Implementation: Geologic Disposal and Transportation

## ■ Geologic Repository

- Sited using consent-based process by 2026
- Designed and licensed by 2042
- Operational in 2048

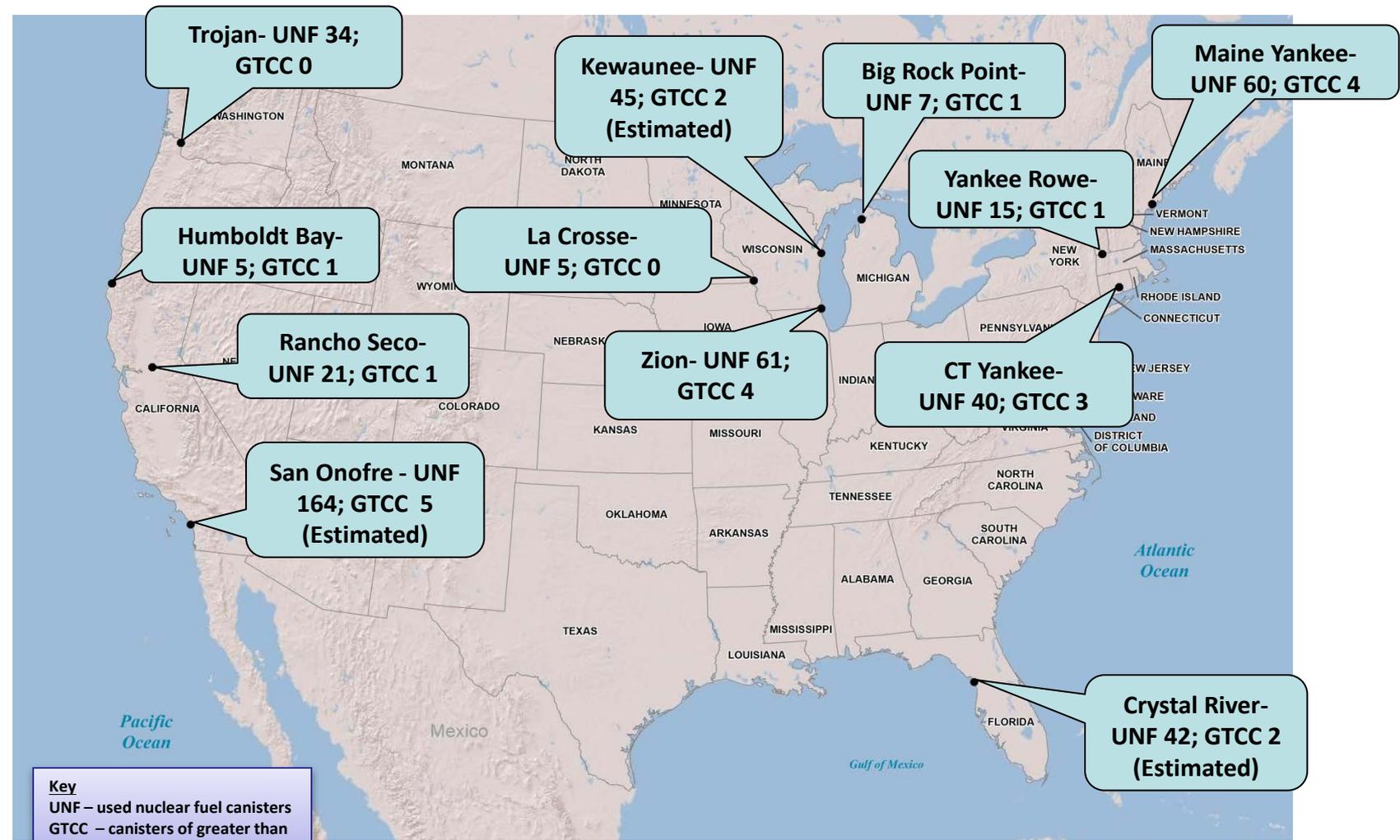
## ■ Transportation

- Build on experience in industry and with WIPP
- Capability to service facilities safely and securely
- Develop and implement a comprehensive large scale transportation plan to support the Pilot Storage Facility operation

- One of each facility for now, possible additions based on consent-based process



# Locations of Shutdown Reactor Sites



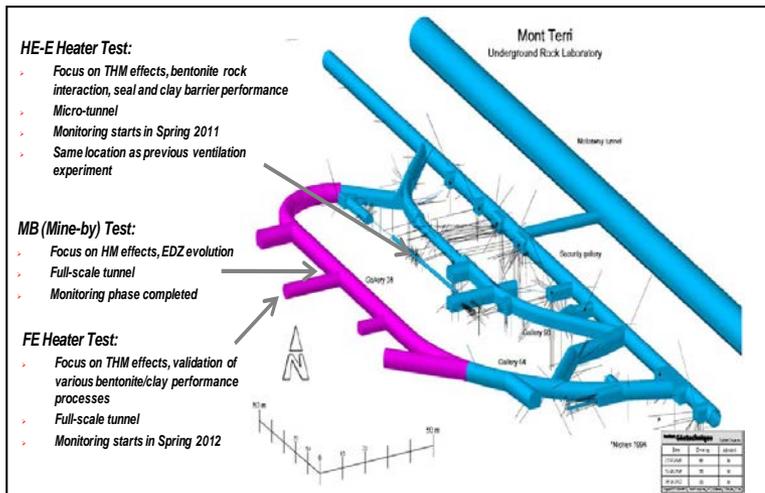
**Key**  
 UNF – used nuclear fuel canisters  
 GTCC – canisters of greater than class C waste



# Disposal R&D International Collaboration

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

Major current or soon-to-be started experiments



- ❑ **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 Aspo 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)

# Conclusion

The DOE Office of Fuel Cycle Technologies is actively developing used nuclear fuel management strategies and technologies and continues to conduct R&D on both open and closed fuel cycle technologies.

- The Used Fuel Disposition program is laying the foundation for the development of storage, transportation and disposal options
- Understanding the behavior of used High Burnup Fuels during storage and transportation is a key priority of our office.
- Standardization and Integration including generic studies for development of a storage, transportation, aging, and disposal canister
- Working on feasibility of direct disposal of large storage dual purpose canisters

Please visit the Office of Nuclear Energy web site for further program activities and information.

<http://energy.gov/ne/office-nuclear-energy>