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Fuel Cycle Technologies Perspectives

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Outline

- Mission
- Blue Ribbon Commission Program Impacts
- Used Nuclear Fuel Disposition Program
- Fukushima Daiichi Events Program Impacts
- Concluding Remarks

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Mission

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Fuel Cycle Technologies (FCT) - Mission

Ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions.

Goal 3: Secure Our Nation

- Enhance nuclear security through defense, nonproliferation, and environmental efforts.

DOE

Advance nuclear power as a resource capable of making major contributions in meeting the Nation's energy supply, environmental, and energy security needs by resolving technical, cost, safety, security and regulatory issues through research, development, and demonstration.

NE

Develop sustainable fuel cycles and Used Fuel waste management strategies that improve resource utilization, minimize waste generation, improve safety and limit proliferation risk.

FCT

http://energy.gov/sites/prod/files/2011_DOE_Strategic_Plan_.pdf
http://www.ne.doe.gov/pdfFiles/NuclearEnergy_Roadmap_Final.pdf

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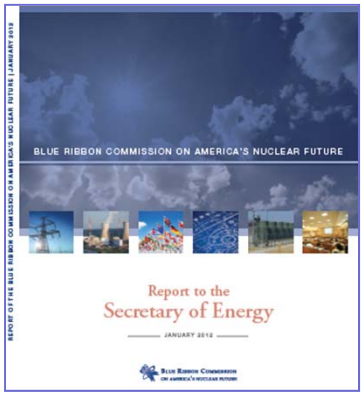
Objectives – Currently Evolving



Blue Ribbon Commission

www.brc.gov

- Recommendations could lead to near term program shifts and a major restructuring in the longer term.
- Potential to consider consolidated storage and associated transport to centralized storage location.

Fukushima Event

- May lead to shifting program priorities.
- Focus on the development of advanced LWR fuels with enhanced accident tolerance.

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Current Program Objectives

Near Term

- **Address BRC recommendations for Used Fuel Disposition – *Administration strategy to Congress within 6 months***
- **Increase focus on advanced LWR fuels with enhanced accident tolerance.**
- Down select fuel cycle options for further development.

Medium Term

- **Complete implementation plan for developing a Test and Validation Complex for extended storage of used nuclear fuel.**
- **Evaluate benefits of various geologic media for disposal.**
- Conduct science based, engineering driven research for selected fuel cycle options.

Long Term

- **Execute Test and Validation Complex for extended storage of Used Fuel.**
- **Conduct engineering analysis of disposal site(s) for selected geologic media.**
- Demonstrate the selected fuel cycle options at engineering scale.

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FY 2011-12 Budget Summary

Dollars in thousands

Activity/Sub-Activity	FY 2011 Current	FY 2012 (a) Request	FY 2012 (a) Appropriation
Separations and Waste Forms	37,133	36,893	32,420
Advanced Fuels	50,648	40,443	59,000
Transmutation R & D	5,721	3,109	0
Modeling and Simulation	22,350	0	10,000 (b)
Systems Analysis and Integration	23,775	20,466	17,132
MPACT	6,674	7,864	5,176
Used Nuclear Fuel Disposition	32,535	37,249	60,000 (c)
Fuel Resources	3,592	4,646	3,623
Total	**182,428**	**150,670**	**187,351**

a. Does not include SBIR/STTR contribution.
b. Assess issues related to the aging and safety of storing spent nuclear fuel in fuel pools and dry storage casks.
c. Includes:
   $10 M for development and licensing of standardized casks
   $3 M for developing models for potential partnerships to manage waste
   $7 M for characterizing potential geologic repository media

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Blue Ribbon Commission Program Impacts

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

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".* – ***Administration strategy to Congress within 6 months***

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

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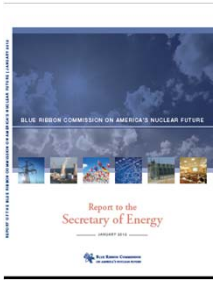
BRC Assessment of Current DOE-NE UFD Program

(Section 7.8 Near-Term Steps)



"Strongly believes that new institutional leadership is critical to getting the nation's nuclear waste management program on track"

"Recognizes that it could take several years for a new organization to be authorized, funded, staffed, and fully launched"

Confirms the importance for *"DOE to keep the program moving forward through non-site specific activities, including R&D on geological media and work to design improved engineered barriers"*

Recommends the continuation of activities currently conducted under the DOE-NE Used Nuclear Fuel Disposition Campaign

"Identify alternatives"

"R&D on transportation, storage, and disposal options for SNF from existing and future fuel cycles"

"Other non-site specific generic activities, such as support for and coordination with states and regional state government groups on transportation planning"

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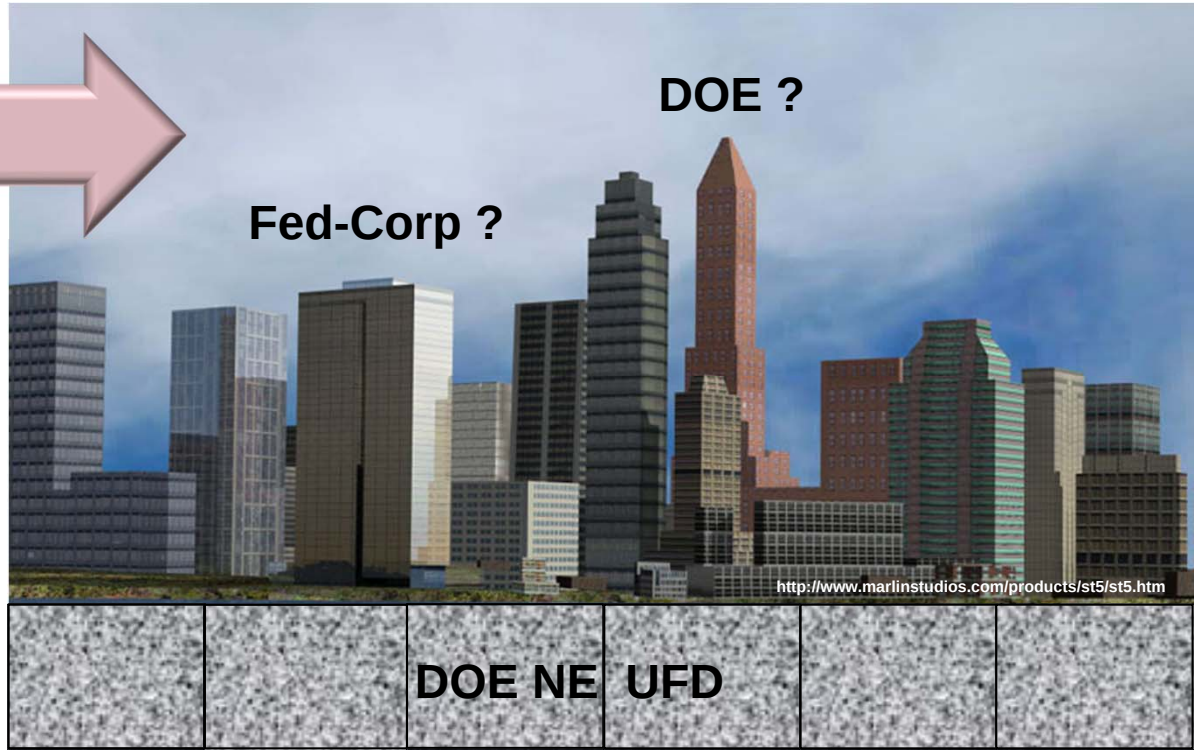
Used Nuclear Fuel Disposition Program

Building the Foundation to Support the Potential New Waste Management Organization

DOE- NE
UFD Campaign



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FY2012 - Activities in Storage

(Blue items are new/expanded activities utilizing the additional FY12 funding provided over the President's Budget Request)

- **Begin laying the ground work for implementing consolidated storage.**
  - **Building on previous DOE work and industry storage licensing efforts, evaluation of design concepts for consolidated storage will be initiated.**
  - **Develop communication packages for use in interaction with potential host communities, which describe various attributes of a consolidated storage facility.**

- **R&D to better understand potential degradation mechanisms in long term dry cask storage including:**
  - **Continue material testing to support modeling and simulation of used fuel aging;**
  - **Complete the identification of data gaps to support license amendments beyond 40 years for dry storage;**
  - **Define facilities needed to conduct the required additional testing of irradiated nuclear fuel. Data with respect to high burn-up fuel is particularly needed.**

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FY2012 - Activities in Transportation

(Blue items are new/expanded activities utilizing the additional FY12 funding provided over the President's Budget Request)

- **In conjunction with the R&D identified previously to support extended storage, data gathered will continue to support the licensing of transportation casks required to transport used fuel following extend periods of storage.**
- **Revisit the recommendations of the 2006 National Academy report on transportation of spent fuel and high level radioactive waste and prepare a report on plans to address these recommendations. This will include re-engaging the regional transportation groups to understand stakeholder issues.**
- **Begin finalization of the procedures and regulations for providing technical assistance and funds (pursuant to section 180 (c) of the NWPA) for training local and tribal officials in areas traversed by spent fuel shipments, in preparation for movement of spent fuel from shutdown reactor sites to consolidated storage.**
- **Begin conducting evaluations to improve efficiency of transportation by serving decommissioned sites. This will include evaluation of the hardware requirements, timing, and costs.**

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FY2012 - Activities in Disposal

(Blue items are new/expanded activities utilizing the additional FY12 funding provided over the President's Budget Request)

- **Continue conducting R&D on generic geological media. The lessons learned in this country and internationally in evaluating the performance of repositories in various geologic environments are valuable; however, advanced understanding is needed to be able to prepare a detailed license application for any new site and new media.**
- **Work on geologic disposal will include:**
  - **Initiating workshops to determine the best approaches for understanding the behavior of salt in response to heat producing radioactive waste;**
  - **Working with industry to initiate the development of an RD&D plan and roadmap for the borehole disposal concept;**
  - **Expanding work with our international partners for disposal in granite and clay rocks.**

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FY2012 - Other Strategic Activities

(Blue items are new/expanded activities utilizing the additional FY12 funding provided over the President's Budget Request)

- **Initiate work on standardized cask systems to enable storage, transportation, and disposal without repackaging of the used fuel including:**
  - **Initiating the evaluation of transporting and disposing existing nuclear power plant storage and transportation systems;**
  - **Expanding the efforts already initiated on a "can-in-can" packaging concept that would allow flexibility in used fuel handling;**
  - **Conducting system evaluations of various used fuel packaging approaches. Work with the cask vendors and users, to evaluate possible approaches and specifications for advanced standardized packaging systems that would reduce handling of used fuel.**
- **Initiate development of models for potential partnerships to manage waste**

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BRC Recommendations Related to Other Fuel Cycle Activities

BRC Recommendations:

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.**

Front End | **Back End**

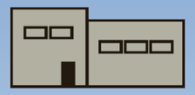
Uranium Resources

- Conventional production
- Innovative approaches

Fuel Fabrication

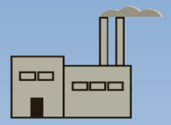
- Safety enhanced LWR fuel
- Higher performance

Reactors



Interim Storage

- Evaluating extended time frames
- Transportation after storage



Recycle

- Separations
- Recycled fuel
- Secondary waste treatment

Disposal

- Alternative geologies
- Alternative waste forms

DOE-NE is committed to the support R&D on alternative fuel cycles

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Fukushima Daiichi Events
Program Impacts

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Response to Events

- **TMI** *(From NRC backgrounder)*
  - **Enhanced regulatory framework, emergency response planning and training**
  - **Heightened regulatory oversight**
  - **Upgraded plant design and equipment requirements**
- **Fukushima - DOE-NE Research Impacts**
  - **Reducing the need for Operator Actions in Accident Response, enhances overall safety**
    - **Passive Systems enhance safety**
      AP-1000, ESBWR, SMRs, HTGRs
    - **Better understanding of dry cask storage systems**
  - **Re-engineering barriers can reduce complications**
    - **SiC cladding**
    - **Enhanced fuel properties**
  - **Re-evaluation of potential natural phenomena**
    - **Re-evaluation of U.S. seismic criteria**
  - **Targeted use of Modeling and Simulation**
    - **Improved modeling of operating reactors**

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Advanced LWR Fuels with Enhanced Accident Tolerance

Vision:
LWR fleet with enhanced accident tolerance providing a substantial fraction of the national clean energy needs

Mission:
Develop advanced fuels and non-intrusive reactor system components (e.g. instruments, auxiliary power sources) with improved performance, reliability and safety characteristics during normal operations and accident conditions

10-year Goals
- ***Insert a LTA into a operating commercial reactor***
- ***Demonstrate non-intrusive components that enhance safety (e.g. instrumentation with enhanced accident tolerance)***

Must be acceptable to vendors/utilities
- ***Better safety performance (e.g. during normal, design basis accidents and beyond design basis accidents)***
- ***Reliability and fuel configurations similar to current fleet***
- ***Acceptable economics***
- ***Favorable neutronics and licensing characteristics***

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Accident Tolerance Fuels Workshops Announcements

Definition of Fuels with Enhanced Accident Tolerance

Fuels with enhanced accident tolerance are those that, in comparison with the standard UO_2 – Zircaloy system, can tolerate loss of active cooling in the core for a considerably longer time period while maintaining or improving the fuel performance during normal operations.

Metrics Needs

To demonstrate the enhanced accident tolerance of candidate fuel designs, metrics must be developed and evaluated using a combination of design features for a given LWR design, potential improvements and the design of advanced fuel/cladding system.

Workshops (information and POC will be posted on http://nuclear.energy.gov/):

National Workshop on attributes and metrics – planned for Spring 2012

International Workshop on attributes and metrics – planned for Summer 2012

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Concluding Remarks

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Concluding Remarks

- **The Fuel Cycle Research and Development Program is developing used fuel waste management strategies and sustainable fuel cycles to help advance nuclear power as a resource necessary for ensuring the nation's energy security.**
  - **Program plans are closely tied to DOE goals and continue to adjust to meet changing priorities.**
- **A strategy for implementing the BRC recommendations is being formulated that will be reported – to Congress within 6 months.**
- **The Used Fuel Disposition program is laying the foundation for the development of storage, transportation and disposal options.**
- **In light of the events at Fukushima Daiichi, we are pursuing opportunities to enhance the accident tolerance of light water reactor based systems.**