

# Integrated Approach to Storage, Transportation, and Disposal of Commercial Spent Nuclear Fuel Nuclear Industry Perspective

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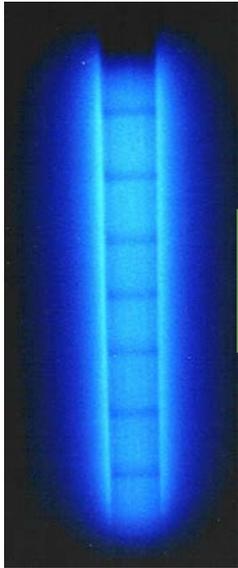
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STORIED HISTORY  
BRIGHT FUTURE

# Used Nuclear Fuel in Storage in the U.S.

December 2015



- Used fuel inventory
  - ~76,000 MTU (pools and casks)
  - Increases ~2000 MTU annually or less than 150-200 casks per year

- ISFSI\* storage
  - ~28,000 MTU (37%)
  - 2268 casks/modules loaded
  - 68 Operating ISFSIs

\*ISFSI = Independent Spent Fuel Storage Installation

# Shutdown Sites Without An Operating Reactor

- **California**

- Humboldt Bay\*
- Rancho Seco\*
- San Onofre\*

- **Colorado**

- Ft. St. Vrain

- **Connecticut**

- Connecticut Yankee\*

- **Florida**

- Crystal River

- **Illinois**

- Zion\*

- **Maine**

- Maine Yankee\*



Humboldt Bay



Rancho Seco



Trojan

- **Massachusetts**

- Yankee Rowe\*

- **Michigan**

- Big Rock Point\*

- **Oregon**

- Trojan\*

- **Vermont**

- Vermont Yankee\*

- **Wisconsin**

- LaCrosse\*
- Kewaunee\*

\* total of 325 used fuel casks at these sites

# Industry Used Nuclear Fuel Management Key Principles

- New management entity outside of DOE
- Access to the waste fund
- Consolidated interim storage for commercial used fuel and DOE high-level waste in a willing host community and state. Used fuel from shutdown sites without an operating reactor should have priority
- In parallel, completion of the Yucca Mountain licensing process followed by construction and operation

# Industry Used Nuclear Fuel Management Key Principles (continued)

- Community and states hosting Yucca Mountain and/or consolidated storage shall be eligible for benefits
- NWF Fee should not be raised above \$0 unless
  - Annual expenses exceed annual investment income (more than \$1 Billion/yr)
  - Projected life-cycle cost demonstrates fee must be reinstated to achieve full cost recovery
- Research, development and demonstration on improved or advanced fuel cycles to close the nuclear fuel cycle

# Integrated Used Fuel Management

## There really is only one option

- ~~a. All spent fuel placed in large dual-purpose canisters will eventually need to be repackaged into purpose-built casks for disposal~~
- b. The nation will need to construct one or more repositories that can directly accommodate large dual-purpose canisters for disposal, or
- ~~c. Spent fuel will remain indefinitely at interim storage facilities and be repackaged as needed, perhaps every century~~

In the vast majority of cases, for fuel already loaded into dry storage, the existing package is also the permanent waste form

# Integrated Used Fuel Management

- An integrated system must, at a minimum, connect the following elements\* by design
  - Storage at reactor sites
  - Transportation
  - Storage at consolidated sites
  - Aging management at reactor and consolidated sites (?)
  - Transportation (?)
  - Disposal
- Integration must be built on the system we have, not the one we wish we had

# A few words about aging management

- Aging management programs are being developed and implemented to monitor and ensure that cask systems will continue to maintain their safety functions.
- Delay in implementing final disposal are driving significant additional investment in dry storage aging management technologies
- The growing need to efficiently deploy these technologies increases the importance of centralized interim storage in an integrated system

# The increasing cost of disposal delay...

Date of Audit Report	Amount Paid from Taxpayer Funded Judgement Fund	Estimated Liability Including Amount Paid
9/30/2015	\$ 5.3 Billion	\$ 29.0 Billion*
9/30/2014	\$ 4.5 Billion	\$ 27.1 Billion*
9/30/2013	\$ 3.7 Billion	\$ 25.1 Billion*
9/30/2012	\$ 2.6 Billion	\$ 22.3 Billion
9/30/2011	\$ 1.6 Billion	\$ 20.7 Billion

\*Assumes that DOE begins accepting used fuel in 2021

Data taken from DOE Annual Nuclear Waste Fund Audit Reports

# Past efforts to integrate

- DOE Multi-Purpose Canister (MPC) System
  - 1992, Feasibility Study
  - 1994, Design Specification
  - 1997, Funding/repository design uncertainties ended program
- DOE/Industry Transportation Aging and Disposal (TAD) Canister System
  - 2005, Proposal based on mature Yucca Mtn. repository design
  - 2007, Performance Specification
  - 2009, Vendor TAD license applications to NRC
  - 2010, Yucca Mtn. project terminated
  - 2013, 1<sup>st</sup> TADs would have been deployed had project continued
- NEI Intervention in the Yucca Mtn. Licensing Proceeding
  - 2008, NEI contentions Safety-01, Safety-02, and NEPA-01 asserted disposability of already loaded dual purpose canister systems in Yucca Mtn.

# Plant Impact of Smaller Capacity Canisters

- Not consistent with maintaining radiation exposure to workers As Low as Reasonably Achievable (ALARA)
- Accrues unnecessary costs:
  - New packaging, operational costs to repackage, increased number of shipments, etc.
- Major impact on spent fuel pool operations
- Requires disposal of used canisters as low-level waste
- Overall increased risk from handling operations

# NRC's regulatory framework recognizes the safety benefit of not re-packaging canisters

- NRC's definition of "Ready Retrieval" is provided in DSFM-ISG-2, Rev. 2
  - The ability to safely remove the spent fuel from storage for further processing or disposal. E.g. the ability to do one of the following:
    - remove individual or canned spent fuel assemblies from wet or dry storage,
    - remove a canister loaded with spent fuel assemblies from a storage cask/overpack,
    - remove a cask loaded with spent fuel assemblies from the storage location.
  - DSFM-ISG-2 Rev. 1 had called for retrieval of individual assemblies

# Direct Disposal of High Capacity Canisters

- Direct Disposal is achievable:
  - EPRI assessed feasibility of direct disposal of dual-purpose casks (EPRI Reports 1016629, 1018051)
  - Used Fuel Heat Load creates significant geologic uncertainties
  - But...
    - There is an opportunity for R&D to address uncertainties
    - Canister heat load is known and becomes less over time
    - Loaded canisters have been/are continuing to be aged for many decades
    - Consolidated storage will provide further aging opportunity
- Extended Storage will be necessary regardless of what disposal path is chosen
- Beginning with the end in mind – integration by design – can inform repository siting

# Answers to NWTRB Questions

1. What are the perceived impacts to the nuclear industry of integrating defense and non-defense wastes?  
*Could achieve cost/schedule benefits for defense wastes. Integration should not delay repository development.*
2. What is the impact on the industry's ongoing efforts to package and store commercial SNF?  
*Will continue to load existing systems for foreseeable future*
3. If DOE introduces relatively small standardized canisters for commercial SNF to gain efficiencies in the waste management system, how will this action be received by the industry?  
*Have already passed the point of no return on accepting large canisters*
4. What could be done to minimize or offset the impact of loading smaller canisters at nuclear power plant sites to avoid the need for repackaging later?  
*Recognize that the repository should be designed for the waste form (canisters), not vice-versa. Any repackaging (if needed) should not be performed at the nuclear power plant sites.*

# Conclusion

- The need to restart the repository program presents an opportunity to develop a better integrated used fuel management system
- For this to happen, clear goals need to be established at the outset
- Avoiding the unloading of already loaded dual purpose dry storage systems at nuclear power plants, to the extent practicable, should be first and foremost among these goals