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

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Used Nuclear Fuel in Storage in the U.S.

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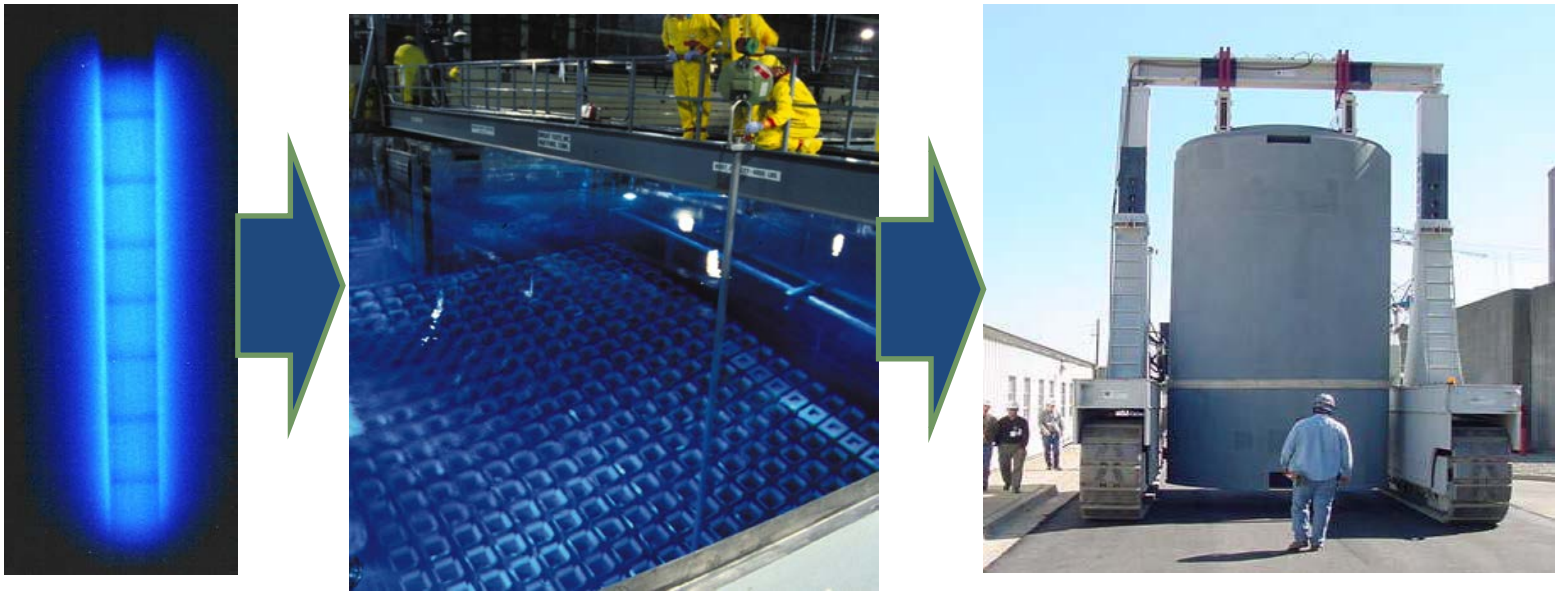

- Used fuel inventory
  - ~76,000 MTU (pools and casks)
  - Increases ~2000 MTU annually or less than 150-200 casks per year
- ISFSI* storage
  - ~28,000 MTU (37%)
  - 2268 casks/modules loaded
  - 68 Operating ISFSIs

*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 duel-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

*The deployment of recycling technologies will not completely eliminate the need for direct disposal of at least some portion of the used fuel inventory

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, 1st 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 SNP 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