Moving SNF from the Decommissioned (and Operating) Plants

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This briefing includes draft results of work performed under contract to DOE NE by an industry team led by EnergySolutions, of which TerranearPMC is a member

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Projected UNF Inventory as of 12/31/2012[1]

Reactor Site Type	Number of Sites	Pool Storage		Dry Cask Storage	
		Number of UNF Assemblies	Metric Tons	Number of Dry Storage Casks	Metric Tons
Operating Sites with solely Pool Storage	21	58,935	18,514	--	--
Operating Sites with Pool & Dry Cask Storage	44	121,866	33,460	1,144	13,458
Totals for Operating Sites	**65**	**180,801**	**51,974**	**1,144**	**13,458**
Shutdown Sites with solely Pool Storage	2	5,443	1,693	--	--
Shutdown Sites with solely Dry Cask Storage	8	--	--	198	1,794
Totals for Shutdown Sites	**10**	**5,443**	**1,693**	**198**	**1,794**
Overall Totals	**75**	**186,244**	**53,667**	**1,342**	**15,252**

[1] Projection based on Total System Model (TSM) models and assumptions, many of which are global in nature and may not reflect actual UNF handling and storage operations at individual reactor sites.

- Total projected lifetime inventory for all shutdown and current operating reactors **~ 130,000 - 140,000 MT**

Prerequisites & Up-Front Activities

- Resolve all legal and legislative issues – a BIG (but necessary) requirement. One example:
  - DOE Standard Contract issues (e.g., canistered fuel in dry storage is not explicitly covered under the standard contracts, oldest fuel first priority)
- Near & long term transportation package procurements and transportation planning
  - Transport casks are expensive, take a long time to procure and cask inventory requires maintenance and safe storage
  - Need to implement the 180(c) funding for emergency preparedness well in advance of the first shipment (3+ years)
  - Develop and procure rail cars that meet AAR S-2043 Requirements
  - Transportation planning is complicated by degraded railroad shortline infrastructure and the number of states and tribes affected
  - Access to sites (either by direct rail, heavy haul and/or barge to rail head)
  - Rail access to the CSF

UNF Retrieval Methods

- Currently shutdown sites
  - Transportable Storage Cask Transfer
    - Humboldt Bay
  - Horizontal Transfer Using Two Methods:
    - Transfer from horizontal storage module (Rancho Seco)
    - Transfer from vertical storage cask that is down-ended to horizontal position (Big Rock Point)
  - Stationary Shielded Transfer (Transfer Cask)
    - Trojan
    - Haddam Neck
    - Yankee Rowe
    - Zion
    - Maine Yankee
    - Lacrosse
- Operating sites (and shutdown sites with an operating pool),
  - Use the pool for UNF transfer if needed, or dry transfer for DPCs and TSCs.
- Bottom Line: NO new technology needed

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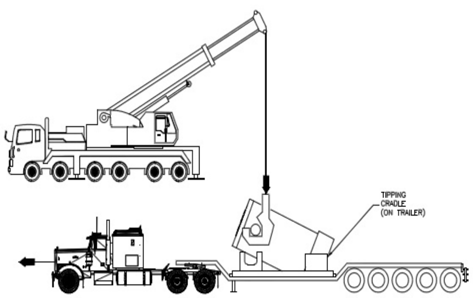
Pickup Methods for Shutdown Sites

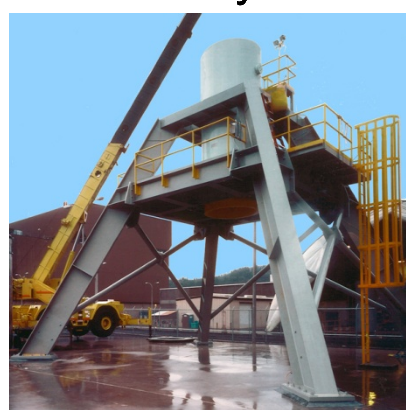
Horizontal DPC Transfer

Vertical/Horizontal DPC Transfer

TSC Transfer



Stationary Shielded DPC Transfer



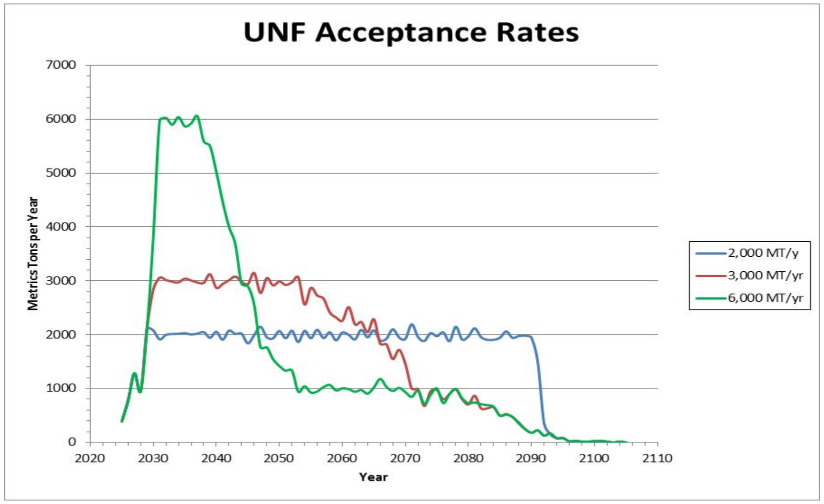
Transportation to the CSF

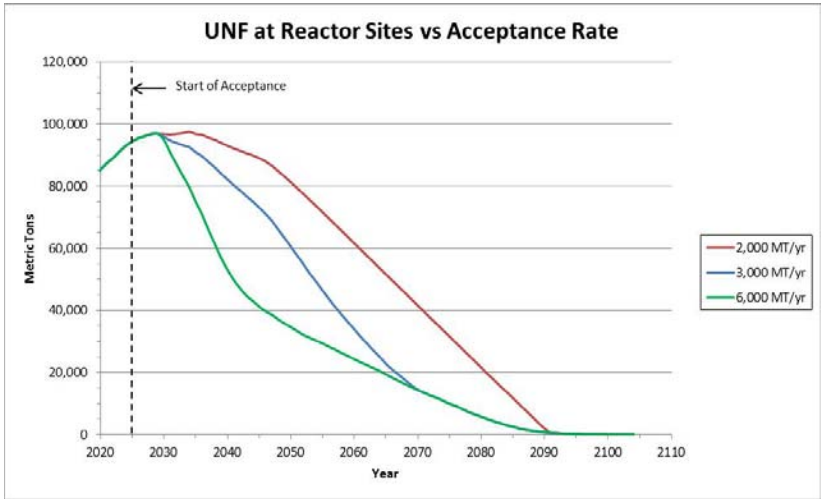
- Assume that all (or almost all) UNF shipment to the CSF will be by rail
- Current transportation cask designs will (mostly) be adequate for transportation to the CSF. However,
  - Some current storage systems are not licensed for transport (e.g. TN-32, Nuhoms 24P); assume that one-time licenses will be granted, or UNF will be repackaged
  - Assume that high burn-up fuels will able to be transported in the future based on additional technical review, the receipt of burn-up credit and/or authorization to include moderator exclusion in transport package designs
  - For bare UNF transport, new cask designs will be needed, including partial loading capability for high heat assemblies
- The selection of rail routes has significant impacts on operations planning. Route selection remains a challenge, but the focus has shifted away from DOE to the railroads
  - Publication of new rules in 49 CFR 172.820 that require the railroads to do annual assessments of safety and security on their lines
  - DOE should enter discussions with the railroads about the shipping sites and possible destination sites as soon as possible so the railroads can establish potential routes. This will determine which states and tribes will receive initial 180(c) grants.

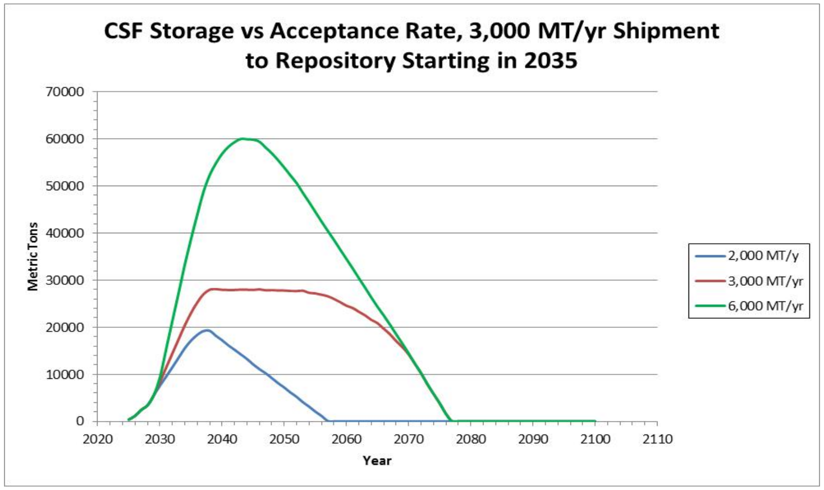
Modeling System Performance

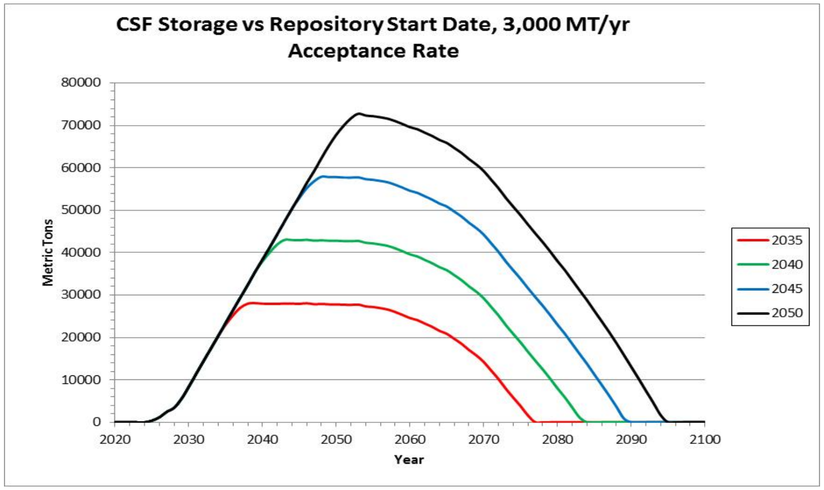
- System models are used to assess hardware and operating requirements, and predict costs and constraints for defined conditions. Some examples (in order of increasing complexity):
  - Spreadsheet models - simple but can provide insights
  - CALVIN – Visual Basic “push” model of system with CSF and repository
  - Total System Model (TSM) – real time object-oriented simulation developed for DOE under Yucca Mountain Project
- Typically these system models are not specifically designed for optimization, however by varying key inputs and/or constraints, a range of system performance parameters can be determined
  - Typical inputs include UNF acceptance rate, acceptance order (e.g., shutdown reactors first) waste form (e.g., DPCs, bare UNF, standard transportation and disposal (STAD) canisters), start date for waste acceptance, repository start date, shipment rate to repository
  - Typical constraints include transportation cask capacities and heat limits, CSF receipt and processing capacity, transportation cask fleet size

Typical Results from System Modeling









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Inputs/Constraints That Could Significantly Affect System Performance and Costs

- Acceptance rates from reactors; example - transportation costs:

Acceptance Rate (MT/yr)	Trans Casks	Cask Cars	Buffer Cars	Escort Cars	Fleet Cost ($M)	Shipping Cost($M)	Total Trans Cost ($M)
3000	60	74	52	26	530.4	929.8	1460.2
2000	51	65	46	23	459.6	961.9	1421.5
6000	81	98	68	34	706.3	916.6	1622.9

- Acceptance priority (e.g., shutdown sites first)
- UNF waste form (accepted from reactors)
  - DPCs
  - Bare UNF
  - STADs
- Number and location of CSFs
- CSF processing and repackaging capability
- Repository start date
- Development of a standardized transportation cask
- DOE could make decisions that will significantly affect the total cost
  - For example, optimizing on lowest total cost will produce different results than optimizing on lowest risk, or maximizing throughput.

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Conclusions

- Moving UNF from reactors to a CSF will be expensive (~ $5 – 7 Billion) and time-consuming (70+ years). However, no new technologies need to be developed
- There are a significant number of prerequisites and up-front activities that must be performed before UNF can be removed from reactor sites
- System models (e.g., TSM) can be used to assess hardware and operating requirements, predict costs and constraints for defined conditions. By analyzing the impact of varying key inputs and/or constraints system models can support optimization efforts
- There are a number of system inputs, assumptions, and constraints that can significantly affect system performance (and costs)
- Decisions made by DOE may significantly affect the total cost