The Evolving Role of a Consolidated Storage Facility for Used Nuclear Fuel in the USA

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Background

- One of the Blue Ribbon Commission recommendations was that prompt efforts should be made to develop consolidated interim storage facilities for Used Nuclear Fuel (UNF).
- A DOE response to this recommendation was the placement of contracts with three industry teams, including one led by Energy*Solutions* (ES).
  - Intention was to provide an industrial perspective to augment the work already done by the US National Laboratories
- Scope of work was to produce design concepts to support the future selection of a consolidated commercial UNF storage option.
  - Included UNF transport from power utility sites, handling and storage at the Consolidated Storage Facility (CSF), & making the UNF suitable for eventual transfer to a geologic repository
- ES team comprised NAC International, Talisman International, Booz Allen Hamilton, Sargent & Lundy, TerranearPMC and Exelon Nuclear Partners.
- Work completed in the period July to December 2012.
- Comprehensive draft report submitted to the DOE in November 2012.

Overview of UNF Storage at Reactors in the USA

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- Projection through December 2012 (based on Total System Model and assumptions)
- Total UNF in wet and dry storage: 68,919 metric tons, increasing at 2000-2100 tons/year

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**

* Zion site expected to move UNF into dry storage by the time the CSF is operational. Morris site is not expected to use dry storage.

** Only Shutdown Site with Transportable Storage Canisters is Humboldt Bay, CA (~30 tons)

Concepts for Retrieval from Shutdown Sites

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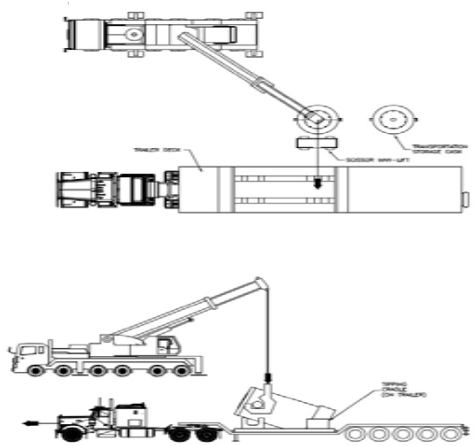
- Four methods identified as the most practical options for UNF retrieval from the nine (excl. Morris) shutdown sites:
  - Transportable Storage Cask (TSC) Transfer - *Humboldt Bay (CA)*
  - Horizontal Transfer, from horizontal storage modules to horizontally oriented transport casks – *Rancho Seco (CA)*
  - Horizontal Transfer, from a down-ended vertical storage cask to a horizontally orientated transport cask – *Big Rock Point (MI)*
  - Stationary Shielded Transfer – *Trojan (OR), La Crosse (WI), Zion (IL), Haddam Neck (CT), Maine Yankee (ME), Yankee Rowe (MA)*



Consolidated Storage Facility Concept

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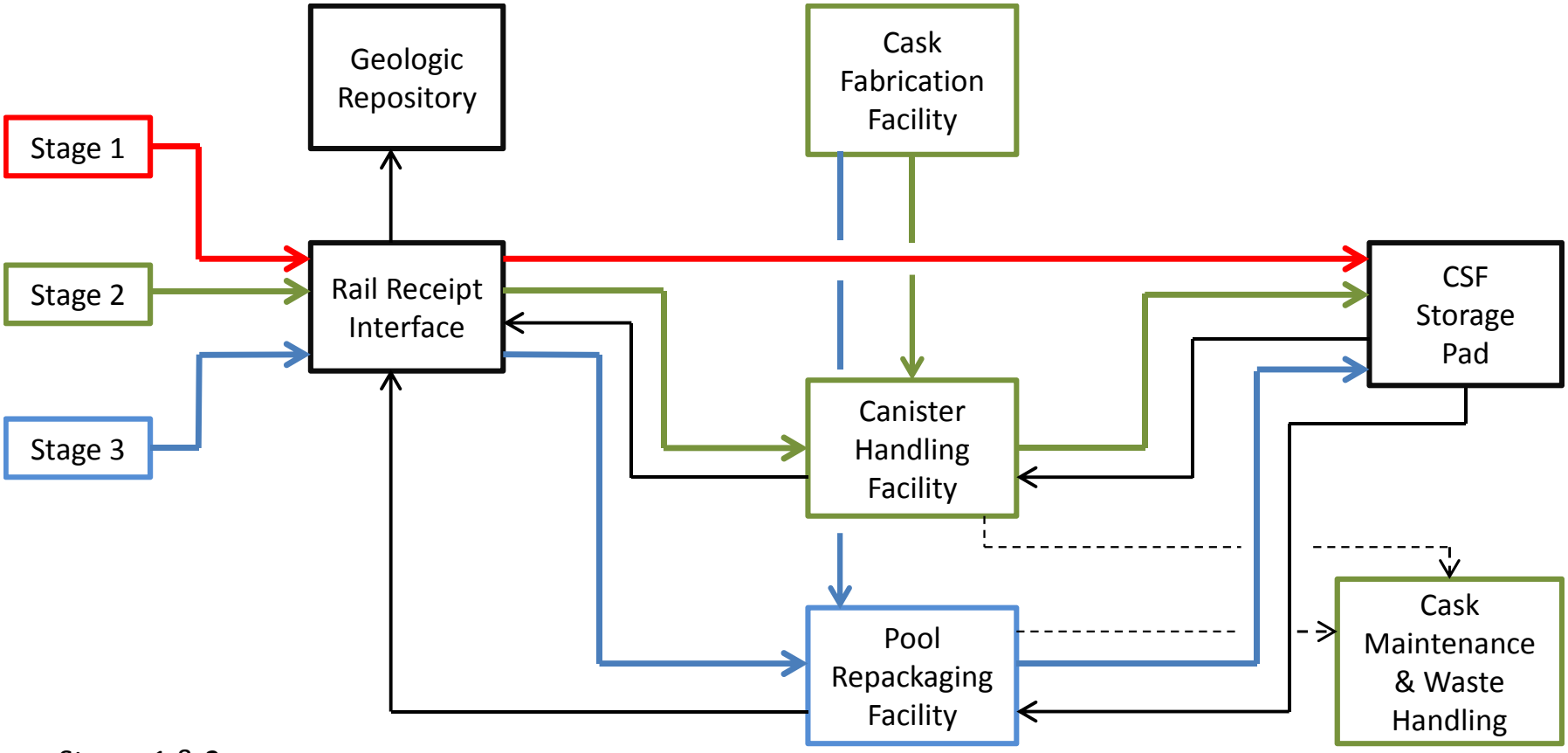
Concept for the CSF expands the UNF handling & storage capabilities over three stages:

- **Stage 1 – Receipt of Transportable Storage Casks (TSCs) only.**
  - Provides early capability to start consolidating UNF (only a limited amount of infrastructure is needed for receipt and transfer of TSCs to a storage pad).
  - TSCs would be received from the Humboldt Bay shutdown site and, optionally, operating sites that use TSCs.
- **Stage 2 – Addition of canister transfer capability** (can be initiated in parallel with Stage 1)
  - Provides the facilities needed to transfer dual purpose canisters (DPCs) from transportation casks into dry storage casks.
  - Priority given to DPCs from the remaining shutdown sites, followed by DPCs from operating sites.
  - Concept includes building and operating a Canister Transfer Facility, a Cask Fabrication Facility, an Administration Building, and expanded storage capacity.
- **Stage 3 – Addition of full facilities to provide 'gateway' to Geologic Repository**
  - Adds a Pool Repackaging Facility to allow receipt of 'bare' fuel and transfer of UNF assemblies into disposal canisters that are suitable for final geologic disposal.
  - Degree of repackaging capability needed will depend on future decisions about how to integrate final disposal canisters into the total waste management system
  - For example, is capability needed only to handle bare UNF received in casks or will it also be required to repackage UNF received in DPCs?

Three Stages of Consolidated Storage Facility Construction/Operation



Stages 1 & 2 will be the pilot stage

Consolidated Storage Facility Site Layout

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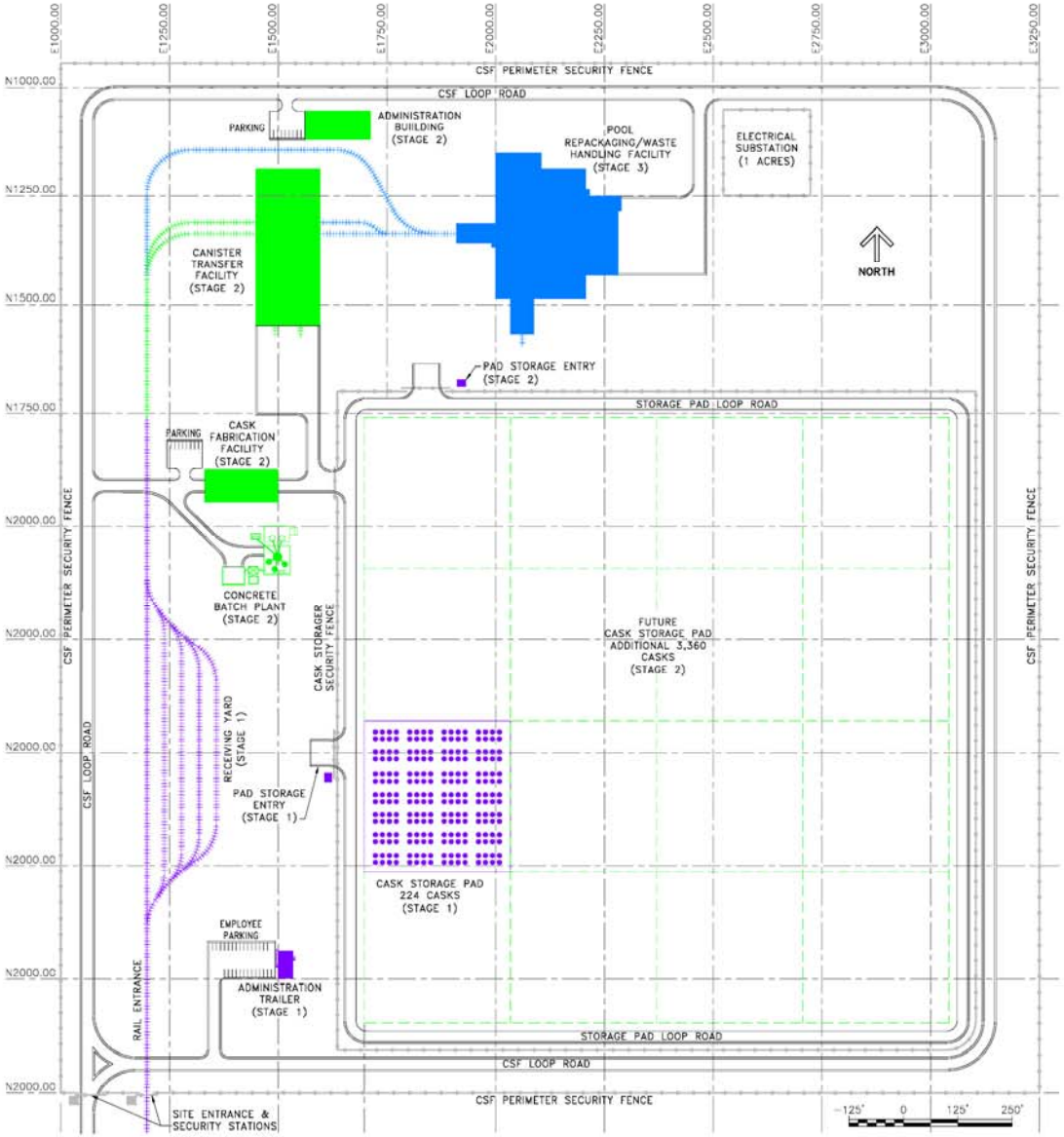
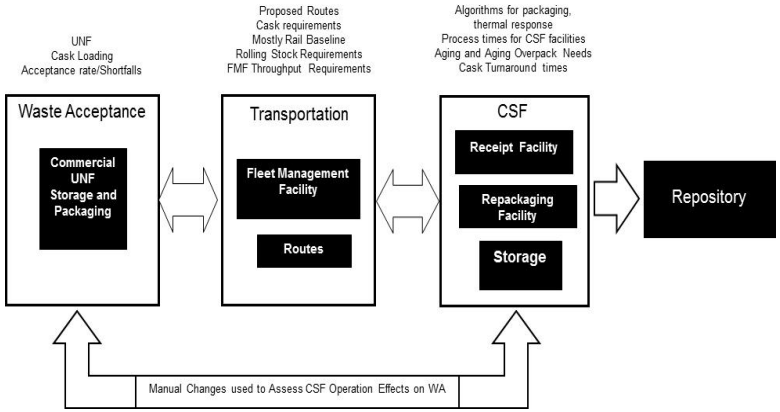
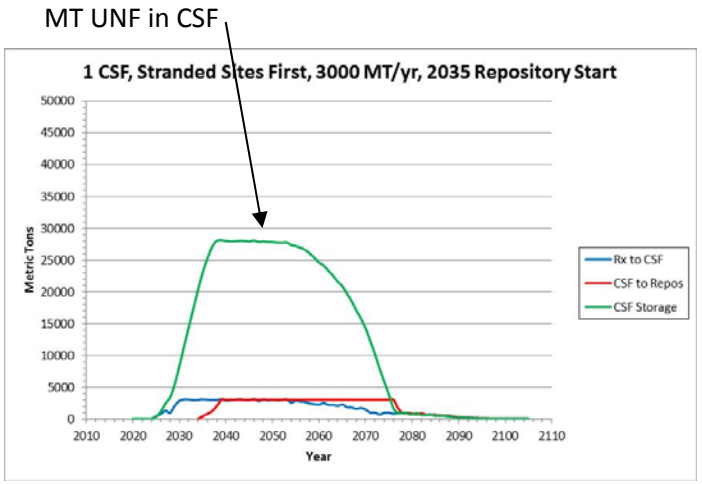


CSF Cost and Schedule

- Initially six scenarios analyzed using the Total System Model
- Lifecycle cost estimates ranged from $5B to $7B
- Lifecycle costs exclude:
  - transportation costs from the CSF to the geologic repository
  - cost of disposal canisters
  - disposal costs of empty DPCs.
- Pilot stages 1 & 2 could start in 2021-2022, with full facilities to follow, starting in 2025
  - These dates based on the estimated minimum time it would take to complete front-end authorizations, acquisitions, and construction activities and implement the staged ramp-up of the CSF capability
  - Would need approvals and funding in 2013 to have a chance of achieving these dates.
- Based on these start dates, deactivation and decommissioning of the CSF is completed around 2112.





Scenario 1 (Base)

Benefits offered by the CSF Concept

- This CSF concept is developed considerably from the Independent Spent Fuel Storage Installations (IFSIs) concept
- Stage 1 is similar to an ISFSI, comprising a rail receipt facility, concrete pad, storage casks, monitoring equipment and security
  - Thus of limited attraction to host communities
- Stages 2 and 3 progressively increase the technical capability and host community attractiveness by adding more sophisticated facilities:
  - Stage 2 canister handling and cask fabrication facilities expand the CSF capabilities, add additional automation and enable more types of UNF to be accepted
  - Stage 3 pool facility:
    - allows bare fuel handling and re-packaging of fuel into repository-suitable canisters
    - opens the door for R&D activities that are needed to assess the performance of high burn-up fuels and other long term waste management challenges
    - allows repackaging operations to prepare waste for final disposal, which could commence before the repository is ready to operate.
    - makes the CSF an integral part of the overall waste management system to prepare waste for ultimate disposal
  - These all add varied work and human resource requirements compared with current dry storage installations

Why do we need a Staged Approach?

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- A staged approach is considered necessary to spread the capital cost for the CSF, so that it becomes at least possible to secure initial funding
- A staged approach enables stranded UNF from the shutdown sites to be moved early in the program
  - This will demonstrate progress to Congress and the public and help secure confidence in, and support for, the second and third stages
- A staged approach progressively pilots the whole system for packaging, transporting and off-loading UNF, relations with corridor states and tribes, in advance of large scale movements to the CSF and ultimately to the geologic repository
- A staged approach allows time for decisions to be made on:
  - the final geologic repository location and hence its geology and surrounding material matrix
  - the disposal canister requirements - which will differ depending on repository geology and surrounding matrix type

Challenges to Commencing UNF Consolidation

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- Estimate that front end actions will take at 8 to 10 years to complete.
- The required actions include:
  - Congressional authorization/funding & OECM CD approvals
  - Design, EIS & License Application Development
  - The actual NRC licensing process
  - Actions modifying the standard contract queue and form for waste acceptance from the Utilities
  - Cask and rail car procurements:
    - Development of rail cars to meet AAR S-2043 requirements
    - Transport casks are expensive, take a long time to procure and cask inventory requires maintenance and safe storage
  - Transportation, emergency response and security planning:
    - Transportation planning is complicated by degraded railroad shortline infrastructure and the number of states and tribes affected.

Closing Thoughts

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- Implementing a CSF makes strong economic sense for the shutdown reactors
  - offers economies of scale compared to operating nine shutdown reactor sites (reported cost of $8M/year per shutdown site).
- The CSF can be used as a pilot project for testing a consensus based approach to siting a repository.
  - Requires a more complete package than just storage operations.
  - This is a driver for changing the role of a CSF when compared to existing ISFSIs.
- With shorter licensing and design times than a repository, a CSF can be up and running before any repository construction begins:
  - Provides a test case for transportation of large amounts of UNF to a repository
  - Allows interactions with corridor states and tribes to be worked out and difficulties resolved long before a repository becomes operational.
- The CSF could reduce the overall cost and schedule for waste management.
  - By migrating bare fuel directly into a disposal configuration at the CSF, the high cost of hardware for interim storage solutions could be mitigated.
  - The CSF could also prepare the waste for disposal before the repository is ready to operate.


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