Progress in Dealing with the World's Stockpile of UNF

How Can Consolidated Storage & Reprocessing Help?

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Background

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- Used Nuclear Fuel in the USA is accumulating at about 2000 tons per year
- Nuclear Reactor fuel pools are now almost full, so newly discharged UNF displaces an equal amount into dry storage
- Reactor Utilities place UNF assemblies into welded canisters before these are placed in the dry storage casks
  - They are using the largest licensable canisters for this purpose
  - Typically these contain 37 PWR assemblies or 89 BWR assemblies
  - Large canisters minimize working time per ton of UNF thus reducing costs and worker dose-uptake
- However, the high heat output of these large canisters makes them unlikely to be suitable for final disposal in at least some repository geologies
- Thus before the UNF can be consigned to a future geologic repository it will likely need repackaging into smaller canisters
  - The size of these canisters cannot be defined until the repository is sited, its geology characterized and its heat dissipation abilities established

Overview of UNF Storage in the USA

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- Status at December 2012
- Total UNF in pool and dry storage: 68,919 metric tons, increasing at ~2000 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 (78%)**	**1,342**	**15,252 (22%)**

* During 2013, 4 nuclear sites (5 reactors) have announced shutdown plans. They will move all UNF from wet to dry storage

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

Why can't the Large Canisters by directly disposed in the future Repository?

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- The main reason is thermal:
  - the ability of the surrounding Repository geology to conduct heat away from the UNF packages
  - thus maintaining both UNF package and surrounding matrix temperatures within acceptable limits
- Possible Repository geologies include:
  - Granite, volcanic tuff, clay, shale, sedimentary rock, salt
  - Ventilated or unventilated designs
  - All have different heat removal capabilities
  - Most, if not all, of these are likely to be incompatible with 37PWR/89BWR canisters
    - We do know that 21PWR/44BWR canisters are compatible with the Yucca Mtn volcanic tuff in an initially ventilated design with water-ingress shields
- Another reason is criticality risk
  - Depends upon water ingress, long-term dispersion of in-built poisoning materials, and amount of UNF – and hence fissile material – present
- National Laboratories are researching these matters
  - But it seems likely that the large 37PWR/89BWR canisters will not be compatible with all Repository geologies

Why can't we use Repository-Friendly Standardized Canisters now?

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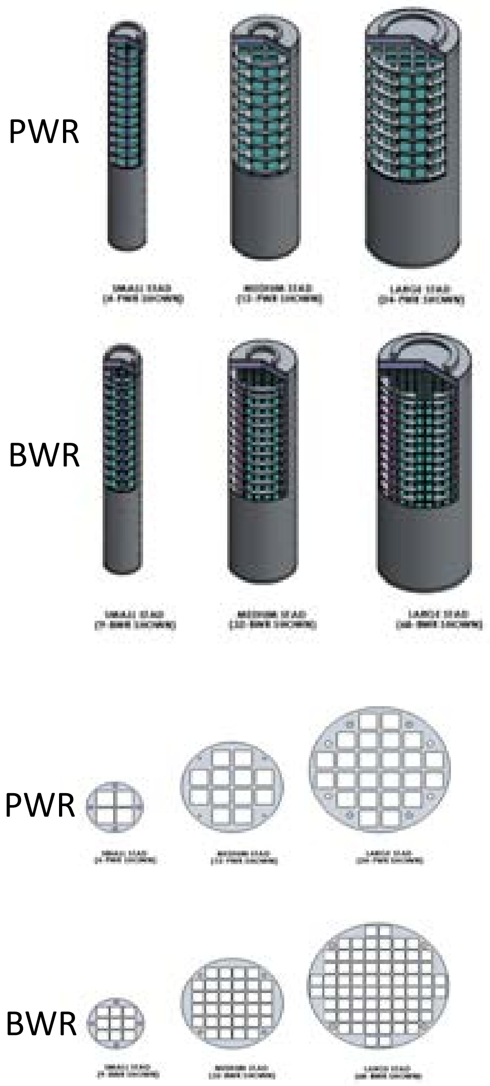
- Designs for Standardized Transport, Aging and Disposition (STAD) canisters exist.
  - Why can't they be used now?
- The Repository geology is not known, so STADs would need to have a heat output suitable for the "worst" (most restrictive thermal conductivity) geology
  - This would limit the STAD size to only 4 PWR or 9 BWR assemblies
  - Many more would thus be required to store all the UNF
  - This is potentially wasteful in the effort required to package , transport, store and repository-emplace these canisters
- The Reactor Utilities will not accept use of such small canisters
  - The NWPA standard contract promises to take bare fuel direct from the reactor pools
  - Loading even the large dry-store canisters is disruptive to pool operations, takes up extra workforce effort and imposes greater worker dose-uptake
  - Loading small canisters exacerbates this and is unacceptable to the Utilities



What are the Options?

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- **Do nothing** - and accept that a substantial UNF repackaging exercise will be eventually be needed before ultimate repository emplacement
  - Repackaging would take place at the ultimate Repository (or at Consolidated Interim Store - if this is built).
- **Do nothing** – and leave the UNF in dry storage at the Reactor Utility sites until it has cooled sufficiently to be compatible with *any* Repository geology
  - This could take 100 - maybe 200 - years
- **Build a Consolidated Interim Store** – move all dry-stored UNF to it and:
  - leave until is has cooled sufficiently to be compatible with *any* Repository geology
  - Repackage into repository-friendly STADs once the Repository geology is known
- **Build a Consolidated Interim Store with extensive pool storage** and move bare UNF to these pools
  - Package into STADs once the Repository geology is known
- **Reprocess some or all of the UNF**

Reprocessing of UNF – what are the Advantages?

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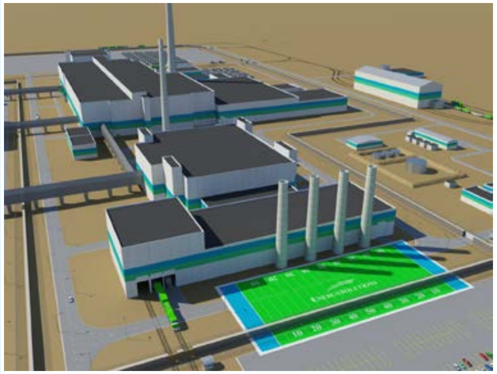
- The vitrified HL waste is a more robust wasteform for long term storage than UNF fuel assemblies
  - UNF assemblies were not designed to be a wasteform
- The vitrified HL waste is 6- to 8-fold smaller in volume than UNF
  - Because the bulk uranium (96wt%) is removed for recycling
  - Fewer waste packages to handle, less repository space needed
- Heat output comes only from fission products – not actinides – so it decays in ~100 years
  - Surface storage of the vitrified waste for ~100 years would allow much closer package emplacement in Repositories of any geology
- Fissile material (U, Pu, Np, Am) is removed from the waste for recycling and transmutation
  - So no criticality issues with waste storage
- Over 99.9% of the radioactivity in the UNF is encapsulated in the vitrified waste by modern 4th generation reprocessing plants
  - So reprocessing does not "spread activity around"

THORP Recycling in the UK



GNEP Conceptual Design

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