



**Thinking of Disposal? Don't Forget the  $N \times 10^3$   
Dry Storage Systems Already Loaded in U.S.  
(Where  $N > 2$ )**

**Andrew Sowder, Ph.D, CHP**  
Senior Project Manager, Used Fuel & HLW Management

NWTRB Dry Storage Workshop  
Washington, D.C.  
November 18 – 19, 2013

# History and Evolution of Dry Storage in the U.S. (a cats and dogs story)

AT A SINGLE  
US ISFSI:

- Vertical and Horizontal Systems
- Bare Fuel Casks and Canister Systems

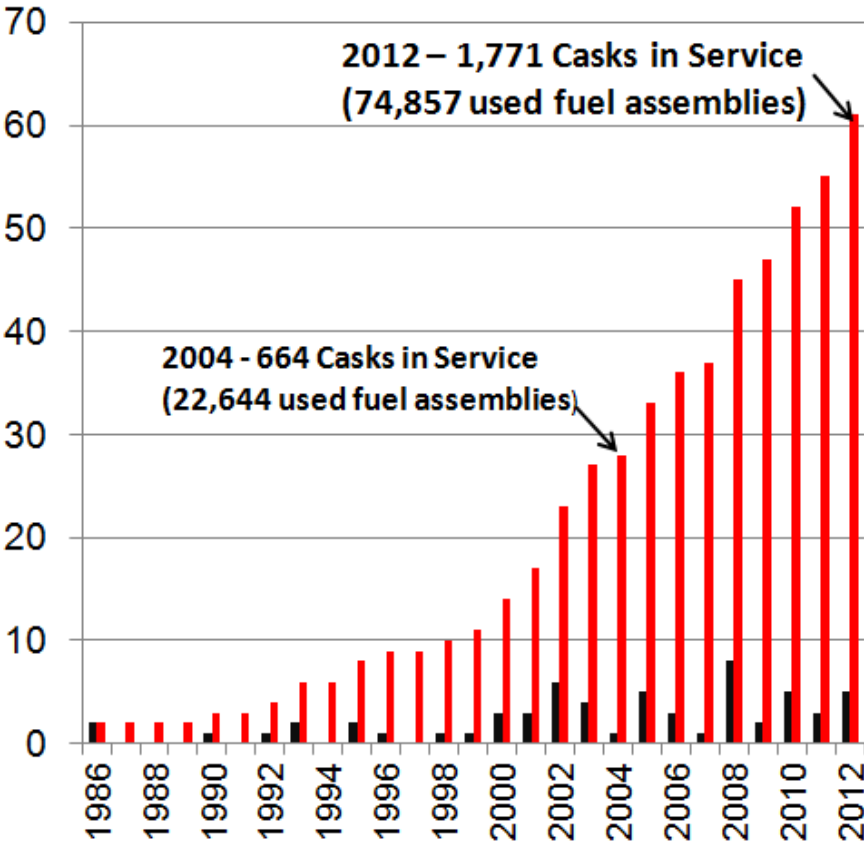
Pad 1



Pad 2



Pad 3



Source: Nuclear Energy Institute

# EPRI projections for dry storage systems loaded at nuclear power plant sites through 2020

Package Type	Number of Packages Loaded
Storage-Only Canister Systems	220
Dual-Purpose Canister Systems	2,155
Dual-Purpose Metal Casks	135
Storage Only Metal Casks	101

EPRI, 2008: 1018051

## ASSUMPTIONS:

- Plants with existing ISFSIs that are loading CSNF into metal dual-purpose casks would continue to do so through 2020;
- Plants with existing ISFSIs would continue to load CSNF into packages with similar capacities through approximately 2013;
- Plants with new ISFSIs would load high capacity DPCs (32-PWR or 61/68 BWR); and
- From approximately 2014 forward, all CSNF would be loaded into higher capacity DPCs at existing and new ISFSIs (except at those sites currently loading CSNF into metal dual-purpose casks as noted in the first bullet, above).
- EPRI projects that as many as 135 dual-purpose metal casks could be in storage at reactor sites by 2020. In addition, approximately 101 metal dry storage casks or other storage-only systems have already been loaded for dry storage at reactor sites.

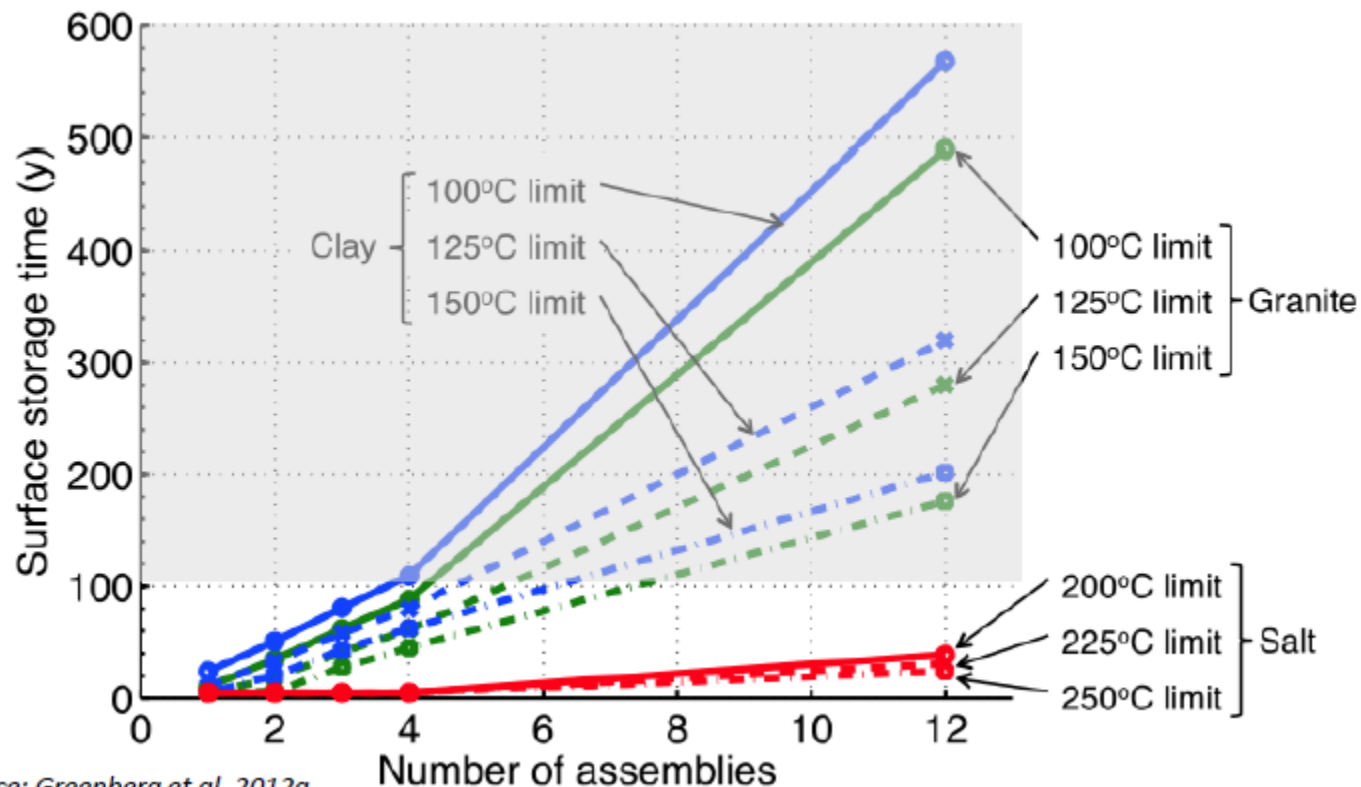
# Thermal Loading: Certainly Important but NOT Only or Independent Design Parameter

Decay Storage Needed to Meet WP Surface Temperature Limits vs. WP Size or Capacity (PWR Assemblies; 60 GW-d/MT Burnup)

Temperature limits based on current international and previous U.S. concepts:

- 100°C for clay buffers and clay/shale media (e.g., SKB 2006)
- 200°C for salt (e.g., Salt Repository Project, Fluor 1986)

Final temperature constraints will be site- and design-specific



Source: Greenberg et al. 2012a.  
Nuclear Waste Technical Review Board, October 17, 2012 (SAND2012-8074C)

# Example: Direct Disposal of DPC vs. TAD Canisters at Yucca Mountain

- Reference: Commercial spent fuel to be loaded into a standard transportation, aging and disposal (TAD) canister before loading into waste package for emplacement
- Proposed TAD capacity: 21 PWR/44 BWR
- Proposed Action includes nominal amount of non-TAD containerized CSNF arriving at Yucca Mountain
  - 10% or 307 DPC and storage only systems
  - DOE also considered a higher (25% or 966 DPC) case
  - EPRI projections indicate a higher number of DPCs should be considered (up to 2375 DPC and storage only systems)
- DPC disposal was not precluded by regulation or LA definition of a disposable canister - “A metal vessel for commercial and DOE spent nuclear fuel assemblies ... or solidified high-level radioactive waste suitable for storage, shipping, and disposal.” (DOE 2008, Section 2.1.1)

# Key Criteria for EPRI 2008 Analysis of Direct Disposal of DPCs (for Yucca Mountain)

- Size – Do they fit?
- Rock wall temperature – Do they undermine integrity of host geology?
- Seismicity and rockfall – Do they withstand anticipated seismic and rockfall events?
- Criticality – Do they maintain sub-critical conditions? If not, what are the effects? \*
- Long-term dose to the public – Do they maintain post-closure dose within regulatory limits?

\*EPRI evaluation of criticality impact on repository performance and found that, should a criticality event occur, the nature of the event would be such that the effect would be small.

# EPRI Evaluation of Direct Disposal of DPCs, Including Criticality (for Yucca Mountain)

- Two EPRI Reports Published in 2008, “Feasibility of Direct Disposal of Dual Purpose Canisters...” 1016629 and 1018051
- Evaluated implications of direct disposal of a larger (32 PWR/68 BWR) dual-purpose canister vs. TAD design (21 PWR/44 BWR)
- 100% DPC case and 2100 DPC/5010 TAD split
- Minimal differences expected between DPC and TAD performance
- A reasonable mixture of TADs and DPCs could be disposed of without alteration of repository design

**No technical obstacles associated with repository post-closure period that would categorically rule out direct disposal of DPCs**

# Together...Shaping the Future of Electricity