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Research and Development Activities Related to the Direct Disposal of Dual Purpose Canisters

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This is a technical presentation that does not take into account the contractual limitations under the Standard Contract. Under the provisions of the Standard Contract, DOE does not consider spent fuel in canisters to be an acceptable waste form, absent a mutually agreed to contract modification. To ensure the ability to transfer the spent fuel to the government under the Standard Contract, the individual spent fuel assemblies must be retrievable for packaging into a DOE-supplied transportation cask.

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Outline

- What is a Dual Purpose Canister?
- Dispose or Repackage?
- Ongoing R&D

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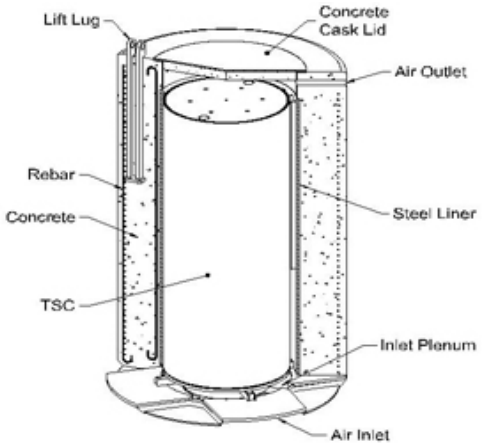
Examples of Dual-Purpose Canisters



- Magnastor ® Dual-Purpose Canister (DPC) system
- Capacity up to 37 pressurized water reactor (PWR) assemblies 87 boiling water reactor (BWR) assemblies)
- Thermal limits: 35.5 kW storage, 24 kW transport

Pictures and data from NAC International website 22Feb2013

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Examples of Dual Purpose Canisters (cont.)

- NUHOMS ® canisters are the only ones stored horizontally.
- NUHOMS® canisters in use with multiple loading configurations (24 & 32 PWR, 56 & 61 BWR)

- Over 50% of U.S. used nuclear fuel (UNF) is stored in Transnuclear (TN) designed systems
  - >650 TN casks
  - >23,000 assemblies
  - 31 U.S. sites at the end of 2010

Pictures and data from Transnuclear/AREVA

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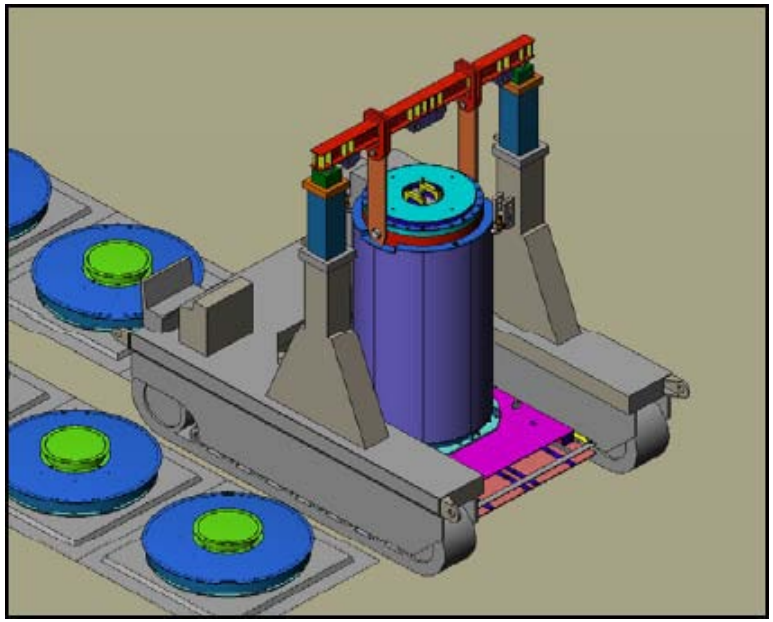
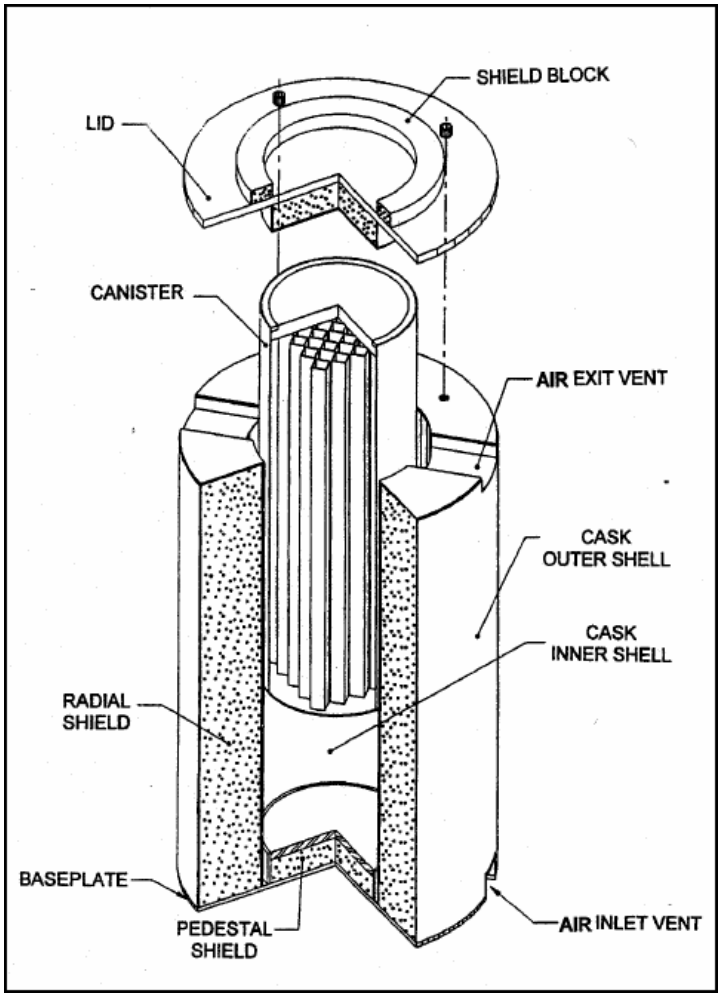
Examples of Dual Purpose Canisters (cont.)

- Holtec HI-STORM® 100U canister overpack system for below-grade storage (32 PWR/68 BWR)
- Based on HI-STORM 100 shielded overpack with bolted closure, and welded stainless “multi-purpose” canister for SNF (24-32 PWR/68 BWR)
- Uses HI-TRAC® (125 ton max.) transfer cask
- Mitigates aircraft crash hazard

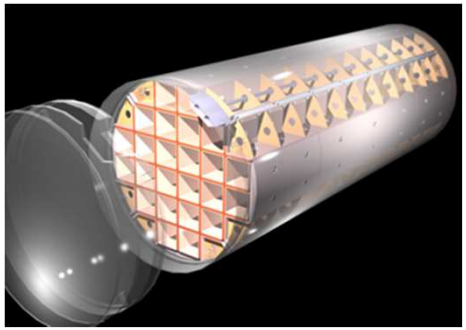




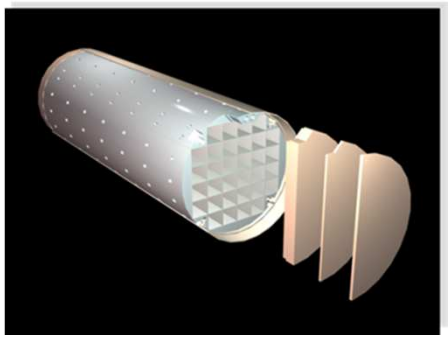
Pictures from EPRI Spent Fuel Storage Handbook

Evolution of Dry Shielded Canisters for Pressurized Water Reactors (PWRs)

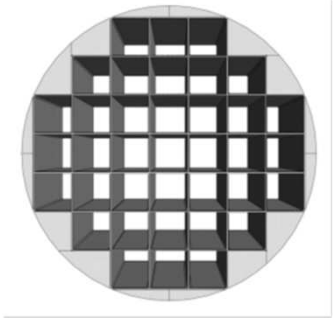
YEAR	NUHOMS® Canister	Assemblies Capacity	Loaded Weight
1985	7 P	7	10 tons
2000	24 PTH	24	40 tons
2003	32 PTH	32	55 Tons
2012	37 PTH	37	55 Tons



NUHOMS® 24PTH



NUHOMS® 32PTH



NUHOMS® 37PTH

AREVA

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Dispose or Repackage? Pros and Cons of Direct Disposal

Pros

- Minimize future handling of used fuel
  - Occupational dose
  - Cost
  - Potential for fuel damage
- Operational efficiency at reactor sites
- Potential transportation cost savings
- Potential disposal cost savings
  - Fewer waste packages (but likely greater spacing in the underground)
  - Lower repository operating costs

Cons

- Will reduce flexibility in repository design options
  - Thermal load management
  - Operational constraints associated with very large and heavy packages
  - Mining considerations
- May reduce options for repository site selection
- May complicate evaluations of long-term performance
  - Thermal-Hydrologic-Chemical-Mechanical considerations
  - Criticality control

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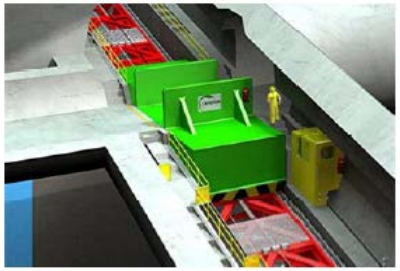
Engineering Challenges

- **Fully loaded DPCs with disposal overpacks (waste packages) and transfer casks (shielding) will be heavy**
  - Fully loaded DPC canister ~50 metric tons(MT)
  - DPC + waste package + transfer cask ≈ 150 MT
  - Heaviest waste package for YM (Naval SNF) was ~74 MT
- **Ramp versus shaft access?**
  - Cranes of sufficient capacity exist, shaft hoist designs are being considered (e.g., the German program is evaluating options for DPC payloads up to 175 MT)
  - Ramp concepts up to ~15% grade for rubber tires, 2.5% grade for rail
    - Andra has considered a funicular rail design up to 26.8% grade (15 degree incline)
- **Ground support for large openings**
- **Backfilling and sealing large openings**



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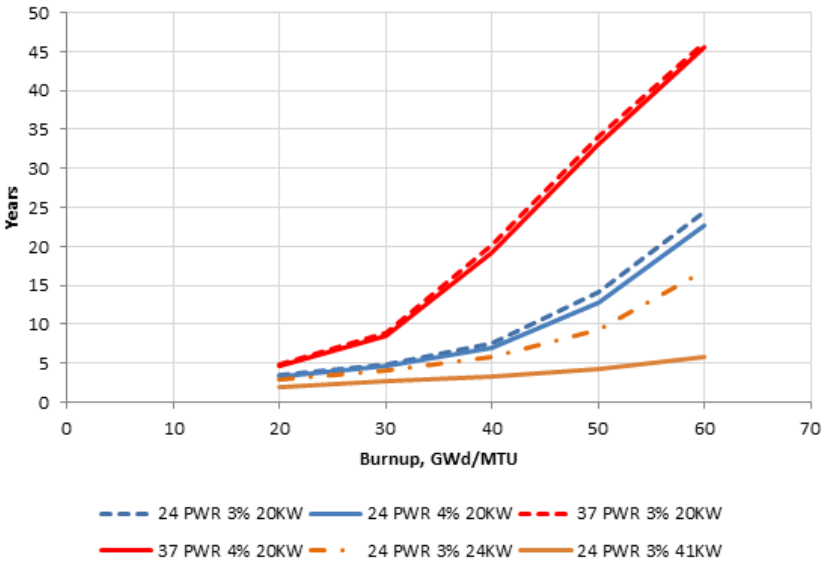
Long-Term Performance Challenges

- **Thermal Load Management**
  - DPCs are now loaded at about 20 kW
  - Canister design storage limits are typically 24 kW, maximum currently available is rated to 40.8 kW for storage
  - Hottest waste packages considered for Yucca Mountain emplacement were 18 kW
  - Other repository design concepts call for much cooler waste packages (e.g., SKB calls for initial load per package ≤ 1.7 kW)
- **Other performance considerations**
  - Engineered barrier performance at elevated temperatures (e.g., clay-based backfill/buffer performance)
  - Criticality control

Estimated Cooling Time for PWR fuel to Reach Specified Thermal Power, as a Function of Canister Size and Burnup



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Ongoing R&D to Support Direct Disposal of Dual Purpose Canisters

- **Generic Disposal Concepts and Thermal Load Management for Larger Waste Packages (presented to the Board by E. Hardin, Oct. 2012)**
  - Open (i.e., unbackfilled) emplacement modes allowing ventilation
    - Thermal analysis completed for clay/shale and granitic rocks
  - Thermal-mechanical analysis for large packages in salt
  - Alternative media (e.g., unsaturated alluvium)

Conclusions

- Direct disposal of dual purpose canisters may offer significant benefits for cost and operational efficiency
- Direct disposal of dual purpose canisters may also pose engineering challenges, reduce flexibility on repository siting and design, and complicate evaluations of long-term disposal repository performance
- Ongoing R&D will help inform decision making