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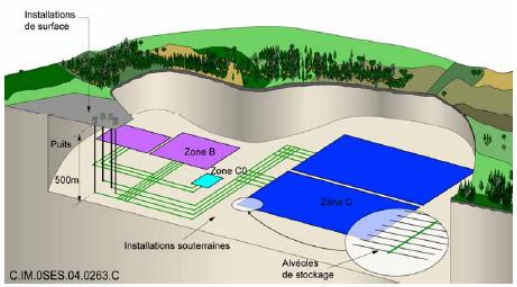

Storage, Transportation, and Disposal of Spent Nuclear Fuel in the US

March 6, 2018

Reference:

Bonano, E., Kalinina, E., and Swift, P. (2018), The Need for Integrating the Back End of the Nuclear Fuel Cycle in the United States of America. MRS Advances, 1-13. Doi:10.1557/adv.2018.231
https://www.cambridge.org/core/journals/mrs-advances/article/need-for-integrating-the-back-end-of-the-nuclear-fuel-cycle-in-the-united-states-of-america/3FCDE8B66CBC7A7CCC06875BB0EBF101

U.S. DEPARTMENT OF ENERGY
NNSA National Nuclear Security Administration

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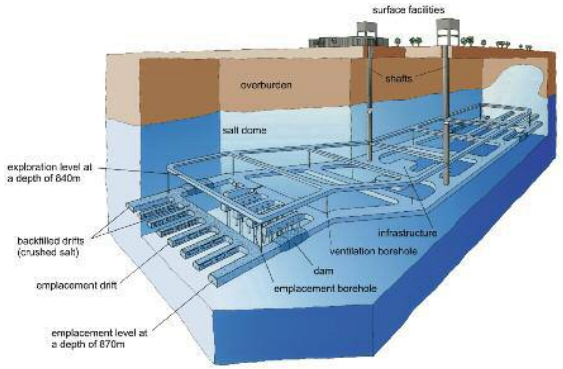
Spent Nuclear Fuel and High-Level Radioactive Waste Disposal: The Goal

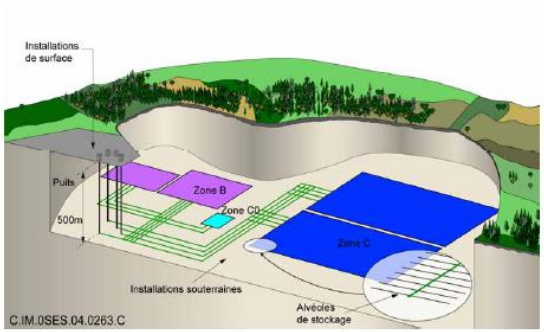
"There has been, for decades, a worldwide consensus in the nuclear technical community for disposal through geological isolation of high-level waste (HLW), including spent nuclear fuel (SNF)."

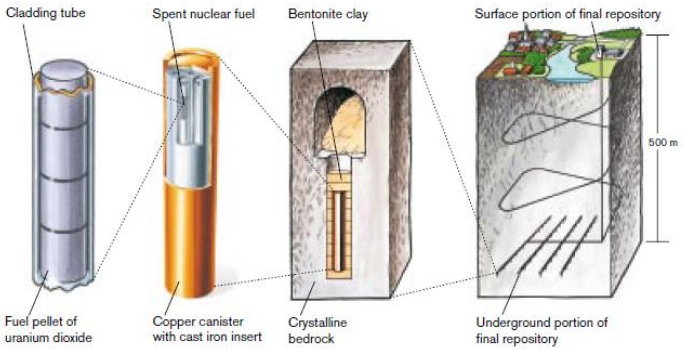
"Geological disposal remains the only long-term solution available."

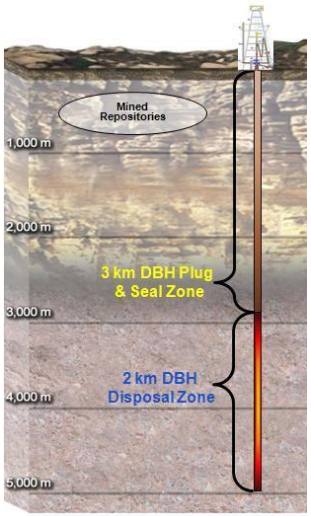
National Research Council, 2001

Deep geologic disposal has been planned since the 1950s







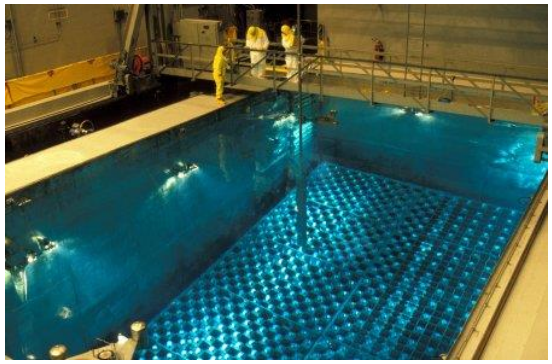


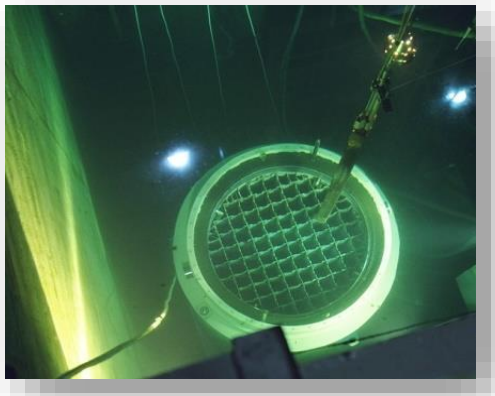
Geologic Disposal in the US: The Reality

Sandia National Laboratories

Commercial Spent Nuclear Fuel (SNF) is in Temporary Storage at 75 Reactor Sites in 33 States

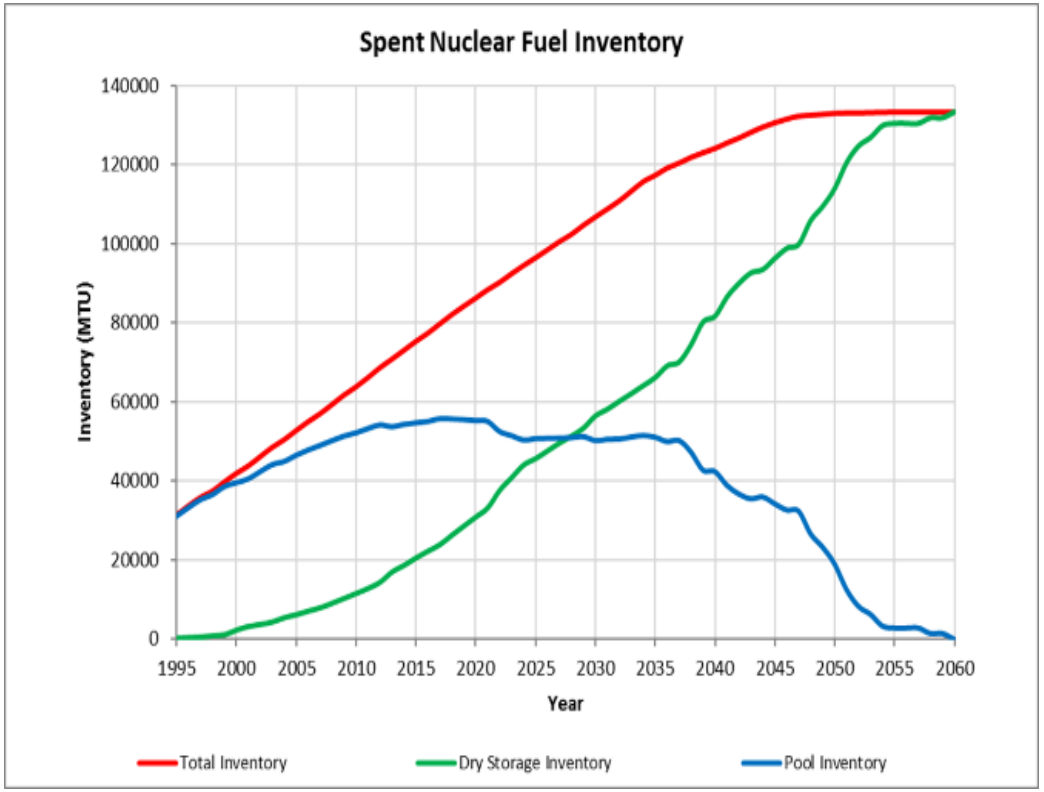
- Pool storage provides cooling and shielding of radiation
  - Primary risks for spent fuel pools are associated with loss of the cooling and shielding water
- US pools have reached capacity limits and utilities have implemented dry storage
- Some facilities have shutdown and all that remains is “stranded” fuel at an independent spent fuel storage installation (ISFSI)



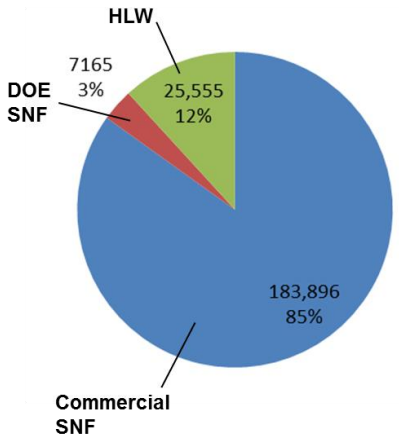


US Projections of Spent Nuclear Fuel (SNF) and High-Level Radioactive Waste (HLW)

Projection assumes full license renewals and no new reactor construction or disposal



Projected Volumes of SNF and HLW in 2048



Volumes shown in m^3, assuming constant rate of nuclear power generation and packaging of future commercial SNF in existing designs of dual-purpose canisters

Approx. 77,000 MTHM (metric tons heavy metal) of commercial SNF in storage in the US today

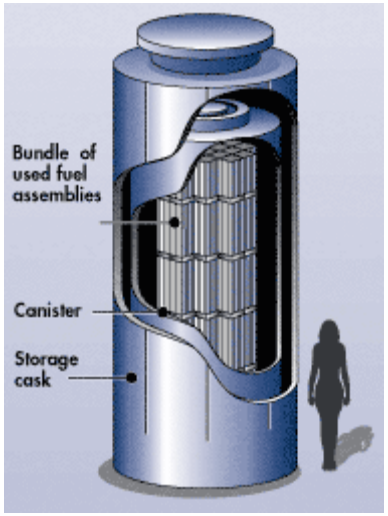
- Approx. 27,000 MTHM in dry storage at reactor sites, in approximately 2,700 cask/canister systems
- Balance in pools, mainly at reactors

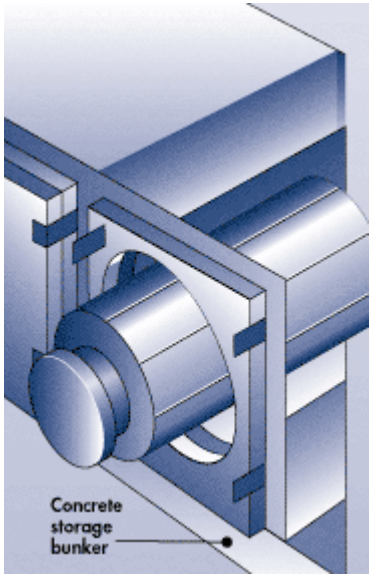
Approx. 2200 MTHM of SNF generated nationwide each year

- Approximately 160 new dry storage canisters are loaded each year in the US

Storage Terminology

- Dual purpose canister (DPC)
  - A canister that is certified for both storage and transportation of spent nuclear fuel
- Dry cask/canister storage systems
  - The most common type of dry storage cask system is the vertical cask/canister system shown above, in which the inner stainless steel canister is removed from the storage overpack before being placed in a shielded transportation cask for transport
    - Can be constructed both above and below grade
  - Horizontal bunker-type systems and vaults are also in use
  - Some older fuel is also stored as “bare fuel” in casks with bolted lids; few sites continue to load these systems
- Multiple vendors provide NRC-certified dry storage systems to utilities





Current Storage and Transportation R&D

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Spent fuel integrity

- Current tests and analyses indicate that spent fuel is more robust than was previously thought
- The *DOE/EPRI High Burnup Confirmatory Data Project* will obtain data after 10 years of dry storage to confirm current test and analysis results from parallel hot cell testing of "sister rods"

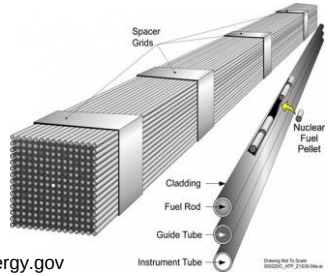
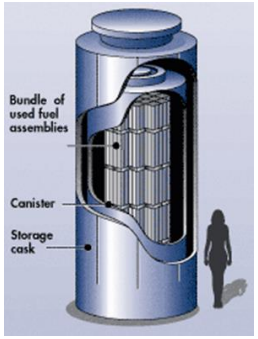


Photo: energy.gov

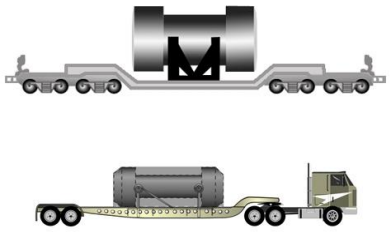
Storage system integrity

- *Stress corrosion cracking of canisters may be a concern in some parts of the country, and more work is needed in analysis and detection*
- *Monitoring and Aging Management practices at storage sites will be important to confirm storage system performance during extended service*



Spent fuel transportability following extended storage

- *The realistic stresses fuel experiences due to vibration and shock during normal transportation are far below yield and fatigue limits for cladding*



Energy.gov/pictures

Observations on Current Practice

Sandia National Laboratories

- Current practice is safe and secure
  - Extending current practice raises data needs; e.g., canister integrity, fuel integrity, aging management practices
- Current practice is optimized for reactor site operations
  - Occupational dose
  - Operational efficiency of the reactor
  - Cost effective on-site safety
- Current practice is not optimized for transportation or disposal
  - Thermal load, package size, and package design

Placing spent fuel in dry storage in dual purpose canisters (DPCs) commits the US to some combination of three options

1) Repackaging spent fuel in the future
2) Constructing one or more repositories that can accommodate DPCs
3) Storing spent fuel at surface facilities indefinitely, repackaging as needed

Each option is technically feasible, but none is what was originally planned