Spent Nuclear Fuel and High-Level Waste Disposition Program

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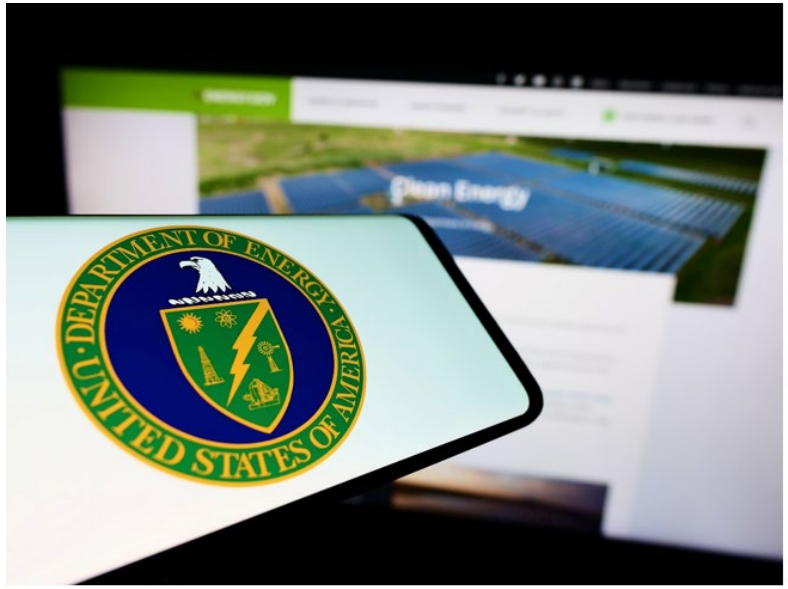
U.S. DEPARTMENT of ENERGY | Office of Nuclear Energy

Spent Fuel and High-Level Waste Disposition



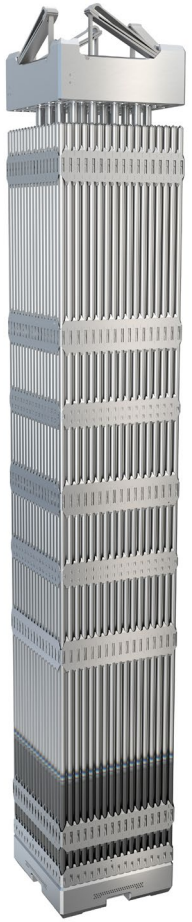
DISCLAIMER

This is a technical presentation that does not take into account contractual limitations or obligations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (Standard Contract) (10 CFR Part 961)

To the extent discussions or recommendations in this presentation conflict with the provisions of the Standard Contract, the Standard Contract governs the obligations of the parties, and this presentation in no manner supersedes, overrides, or amends the Standard Contract.

This presentation reflects technical work which could support future decision making by the U.S. Department of Energy (DOE or Department). No inferences should be drawn from this presentation regarding future actions by DOE, which are limited both by the terms of the Standard Contract and Congressional appropriations for the Department to fulfill its obligations under the Nuclear Waste Policy Act including licensing and constructing of a spent nuclear fuel repository.

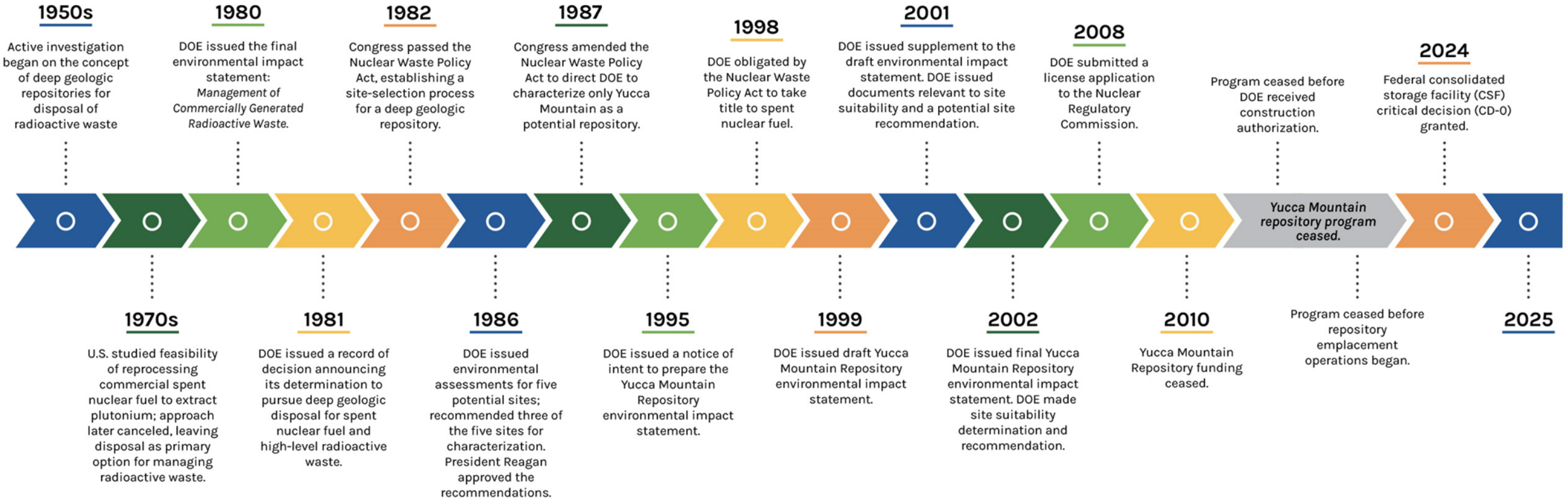
Pressurized Water Fuel Assembly



- Unlike popular “POP Culture” it is a solid metal structure.
- Designed to withstand high temperature and pressure it will see in the reactor.
- Standard fuel assembly has 17 x 17 rods.
- Approximately 14 feet long.
- Weighs approximately 1200 pounds.
- Stays in a reactor for 3 cycles.
- Looks almost same after it has been in the reactor as it does when it comes out after 4 to 6 years.

Advanced accident tolerant fuel design. Credit Business Wire

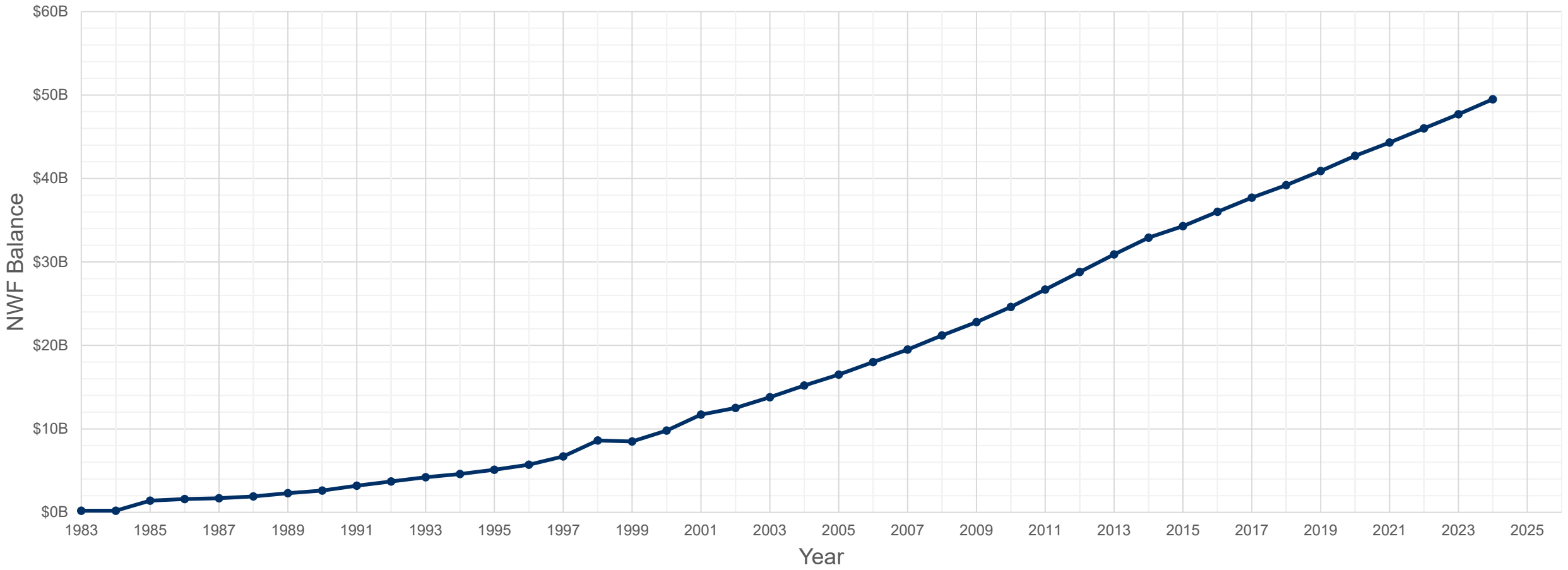
Timeline History of Deep Geologic Repository Program



New Executive Orders

- Report detailing plan for backend of the fuel cycle to be produced in 240 days
  - Currently under discussion and preparation by agencies within DOE
- Considering reprocessing and recycling of SNF
  - Different ways to reprocess depending on the SNF you are using as a feed stock
- Disposal in a deep geological repository
  - Allowing a national discussion to start
- 3 new reactors to go critical by early 2026
- Reactor Test Bed at Idaho National Laboratory

Nuclear Waste Fund (NWF) Balance



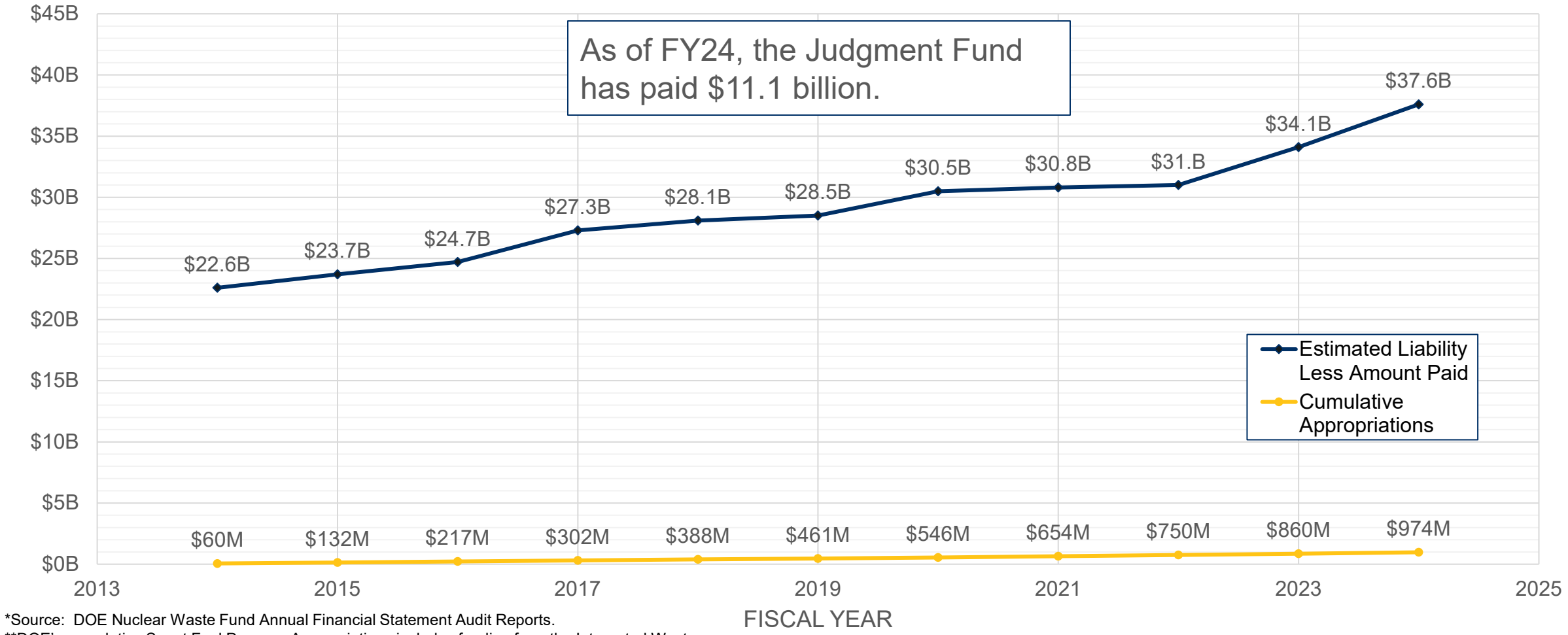
Data through Fiscal Year 2024. The NWF balances reflect past fees and interest collected from owners and generators of nuclear waste and investment earnings. Source: US Department of Energy's Nuclear Waste Fund Annual Financial Statement Audit Report

Nuclear Waste Fund (NWF) Contributions by State

Total Contributions to the Nuclear Waste Fund by State*					
Alabama	$948.9 million	Louisiana	$407.4 million	New York	$1,011.8 million
Arizona	$686.6 million	Maine	$251.9 million	North Carolina	$1,034.6 million
Arkansas	$367.1 million	Maryland	$426.4 million	Ohio	$381.5 million
California	$953.9 million	Massachusetts	$188.4 million	Oregon	$75.5 million
Colorado	$0.2 million	Michigan	$829.0 million	Pennsylvania	$1,947.3 million
Connecticut	$931.4 million	Minnesota	$449.2 million	South Carolina	$1,498.7 million
Florida	$887.0 million	Mississippi	$250.4 million	Tennessee	$596.9 million
Georgia	$846.1 million	Missouri	$243.1 million	Texas	$812.3 million
Illinois	$2,261.2 million	Nebraska	$300.2 million	Vermont	$272.3 million
Iowa	$137.1 million	New Hampshire	$201.2 million	Virginia	$837.0 million
Kansas	$225.3 million	New Jersey	$769.6 million	Washington	$198.9 million
				Wisconsin	$416.4 million

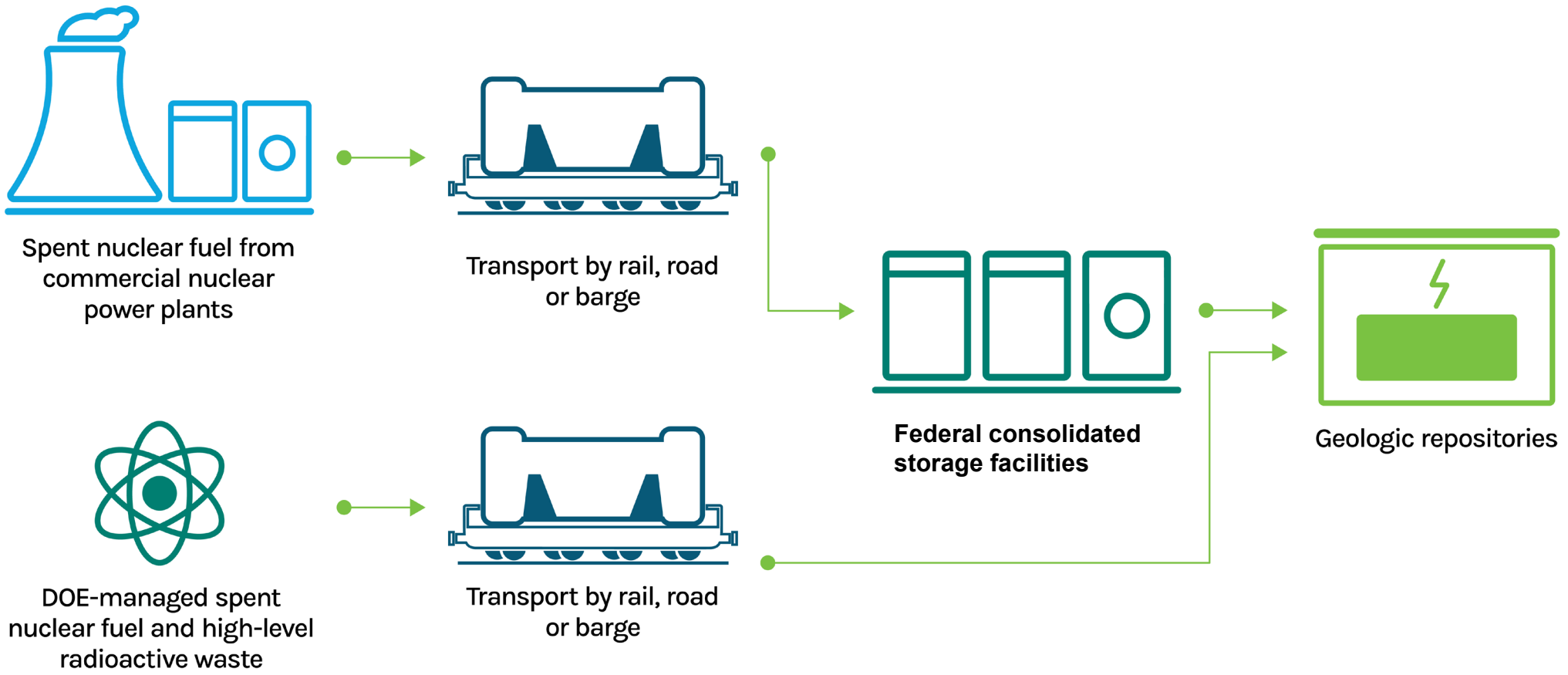
*Data through December 2024.
Source: U.S. Department of Energy Office of Standard Contract Management
https://www.energy.gov/sites/default/files/2025-04/NWF%20Net%20Payments%20%26%20Balances%20by%20State_2024.1231.pdf

Estimated DOE Liability Less Amount Paid vs. Cumulative DOE Spent Fuel Program Appropriations FY 2014-2024

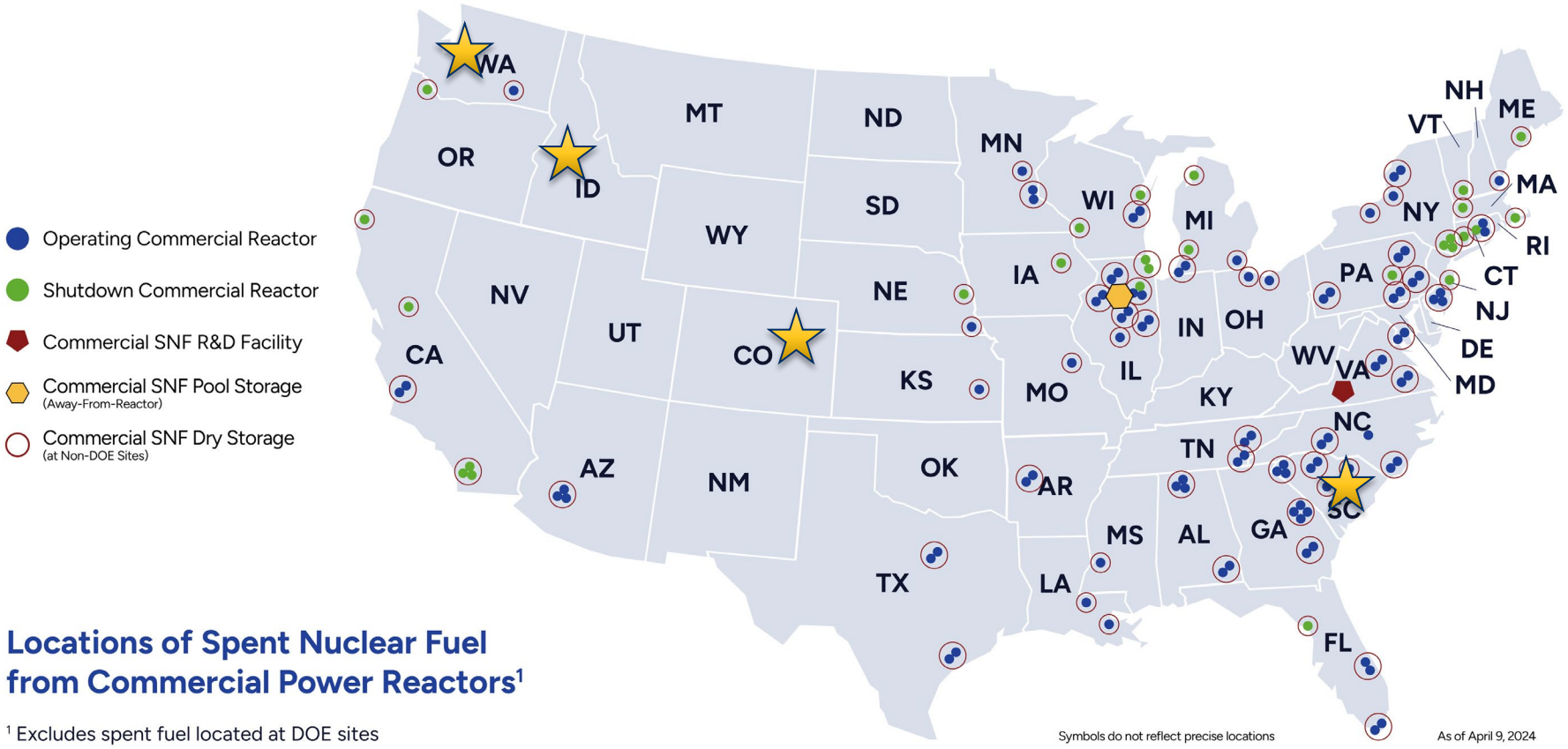


*Source: DOE Nuclear Waste Fund Annual Financial Statement Audit Reports.
**DOE's cumulative Spent Fuel Program Appropriations includes funding from the Integrated Waste Management System, Used Nuclear Fuel Disposition, and the Nuclear Waste Fund Oversight Programs.

Integrated Waste Management System for SNF and HLW



U.S. Spent Nuclear Fuel (SNF) in Context



Locations of Spent Nuclear Fuel from Commercial Power Reactors[1]

[1] Excludes spent fuel located at DOE sites

1958

Start of nuclear power

2025

94 operating commercial reactors at 54 nuclear power plants in 28 states

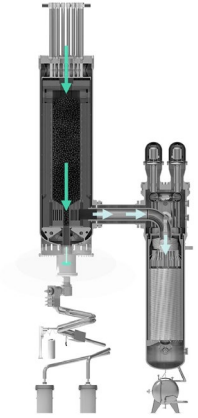
- 20 nuclear power plants have shut down
- ~95,000 metric tons of SNF
- Discharge ~2000tHM/y

End of Current Fleet

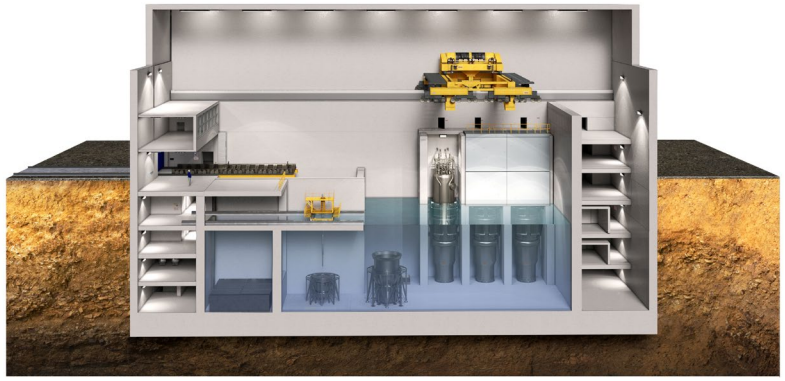
United States estimated to have up to approximately 180,000 metric tons of commercial SNF.

Considering Waste Management for Advanced Reactors

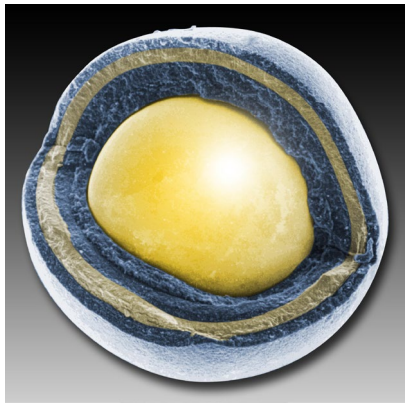
Natrium Small Modular Reactor (SMR) - TerraPower



Xenergy SMR



NuScale SMR facility

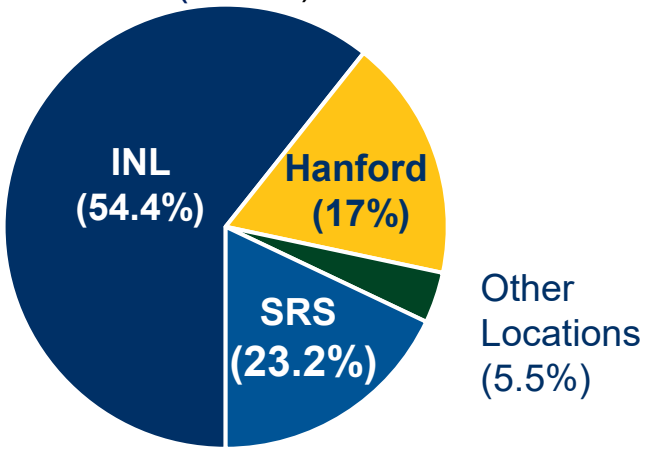


Tri-Structural Isotropic Fuel (TRISO) nuclear fuel pellet.

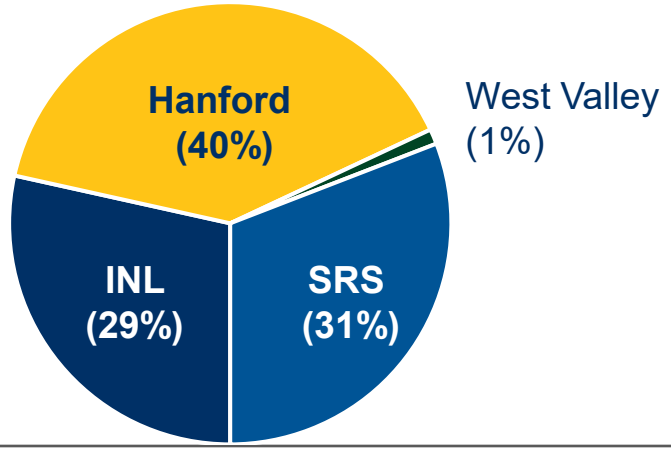
- In accordance with the NWPA reactor operators should sign **an amended standard contract** with DOE that provides confidence the SNF can be disposed in a deep geologic repository.
- DOE's integrated project team conducted technical assessment of storage, transportation, and disposal

DOE Environmental Management: Projected Canisters Requiring Repository Disposal

Percentage of DOE Standard Canisters (DSCs)



Percentage of DOE HLW Canisters



DOE Site	SNF Canisters [1]	HLW Canisters [2]
Hanford	577	10,300 – 10,400
INL	1,862	6,500 – 7,500
SRS	793 [4]	8,113
Other (SNF)/West Valley (HLW)	188	278
Totals [3]	3,420	25,191 – 26,291

1. Hanford will place SNF into both DOE Standard Canisters (DSCs) and Multi-Canister Overpacks. All other site will package SNF into DSCs.

2. HLW canisters from all sites (except Hanford) will be 2 feet in diameter and 10 feet high. Hanford's HLW canisters will be 2 feet × 15 feet.

3. Other than West Valley, canister projections are best available estimates based on current site plans and are subject to change.

4. SNF Canisters at SRS are a best estimate and numbers can be reduced based on Accelerated Basin De-Inventory (ABD) objectives. Estimate is based on all SNF packaged into 18 inch diameter and 15 feet high DSCs.

Naval Reactors Road-Ready Dry Storage

- Until 1991, DOE planned to reprocess all Naval spent fuel at the Idaho Nuclear Technical and Engineering Center (INTEC).
- Packaging Naval spent fuel for disposal began in 2003.
- Canisters are stored temporarily in robust concrete overpacks.
- 209 canisters are in dry storage (~33 MTHM) as of December 31, 2024.
- Over 900 shipments to date.

Research Center for Storage of SNF and HLW

- **Spent Nuclear Fuel Center for Applied Research in Storage & Transportation** anticipated to launch October of 2025.
- Applied research to demonstrate no issues.
- Built around the HBURC shipment from North Anna to INL.
- HBURC supports the safe long term dry storage of high burnup fuel at nuclear power plant sites
- Move the cask from operating reactor site to Idaho National Laboratory in 2027, open in 2029.
- Reduce liability to U.S. taxpayer
- Not the only country to use GE, Framatome and Westinghouse fuel.
- Looking for interested international partners to collaborate and coordinate R&D.

Atlas Railcar

- 12-axle railcar built to transport SNF containers
- In summer of 2024, certified by the Association of American Railroads to transport up to 480,000 pounds on all major U.S. freight railroads
  - Also have certified buffer railcars and a rail escort vehicle for armed escorts that was designed and tested in collaboration with Naval Reactors
- Only purpose-built railcar for transporting commercial SNF certified for transport in North America
- Working with Micro Reactor Companies to explore shipping reactors to and from destinations.

Potential Shipping Route For HBURC Cask ~2,600 miles

POTENTIAL RAIL ROUTES FOR HBURC SHIPMENT

DOE-NE Package Performance Project

- What is a PPP?
  - Physical demonstrations on a rail-sized spent nuclear fuel (SNF) transportation cask
  - NRC licenses SNF cask designs.
  - It is not a qualification test.
  - It is not a science project.

Completion of a PPP depends on continued availability of funding and alignment with administration priorities

Naval Reactors 2025 Transportation Exercise in Fort Hall

Previous Testing and Programs/ Projects

- Four impact tests conducted at Sandia National Laboratories in the 1970's
  - Cask transport systems in highway and rail transport modes
- UK Central Electricity Generating Board (CEGB) Flask Test Project from 1981-1984
  - Conducted with Magnox spent fuel flask (cask)
  - "Operation Smash Hit"
- Plans by NRC in early 2000's for a Package Performance Study (PPS)
- Drop tests in Germany at PATRAM 2004
  - German and Japanese casks

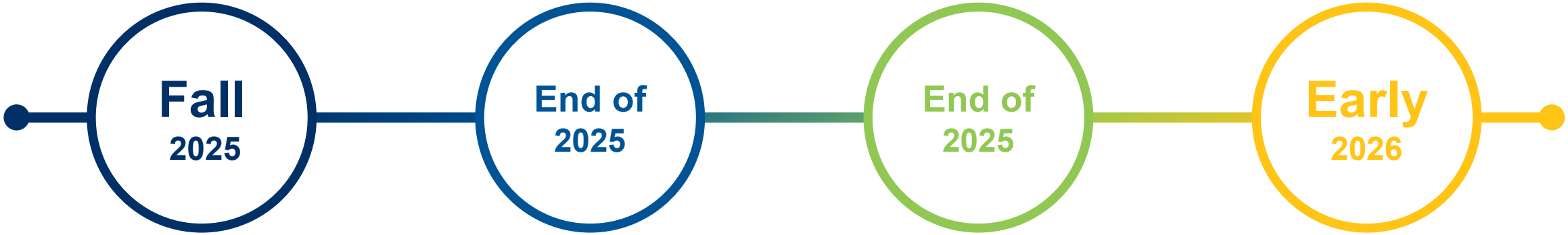
Truck tractor-trailer with SNF shipping cask.

Locomotive impacting a tractor-trailer system.

SNF package mounted in a railcar.

Photos reproduced from National Academy of Sciences, *Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States*, 2006.

Collaboration-Based Siting Near-Term Roadmap



PUBLISH KEY DOCUMENTS

Includes:

- Site Screening Criteria document
- Revised Collaboration-Based Siting process document
- Federal Register Notice for Expression of Interest (EOI)

ISSUE EXPRESSION OF INTEREST

Includes:

- EOI application requirements
- DOE evaluation criteria and technical assistance (TA)
- Process for 3rd party independent reviews

REVIEW EOI APPLICATIONS

Includes:

- Conduct 3rd party independent reviews
- Down-select qualified sites
- Qualified communities receive TA

ISSUE TECHNICAL ASSISTANCE

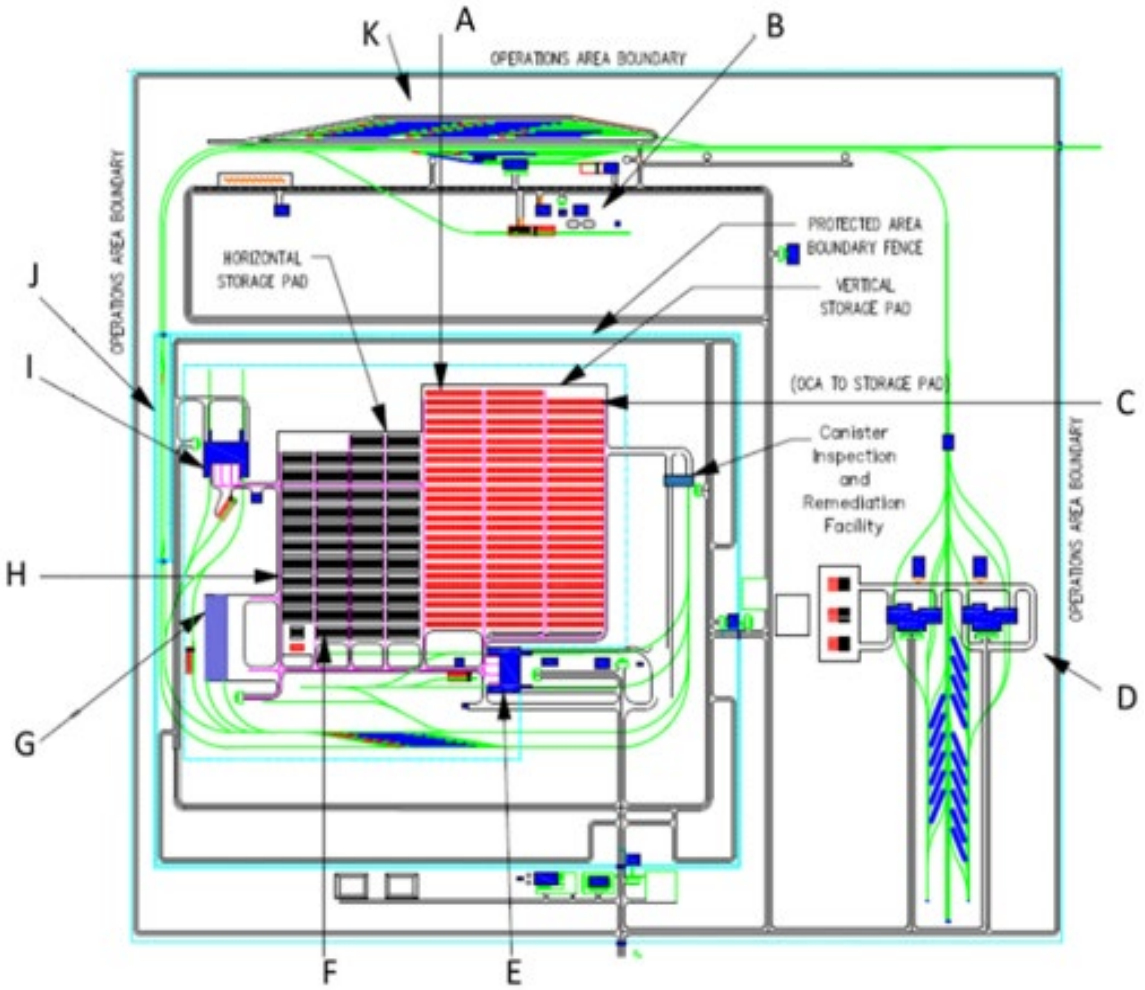
Includes:

- Provide TA to complete Community Assessment Report

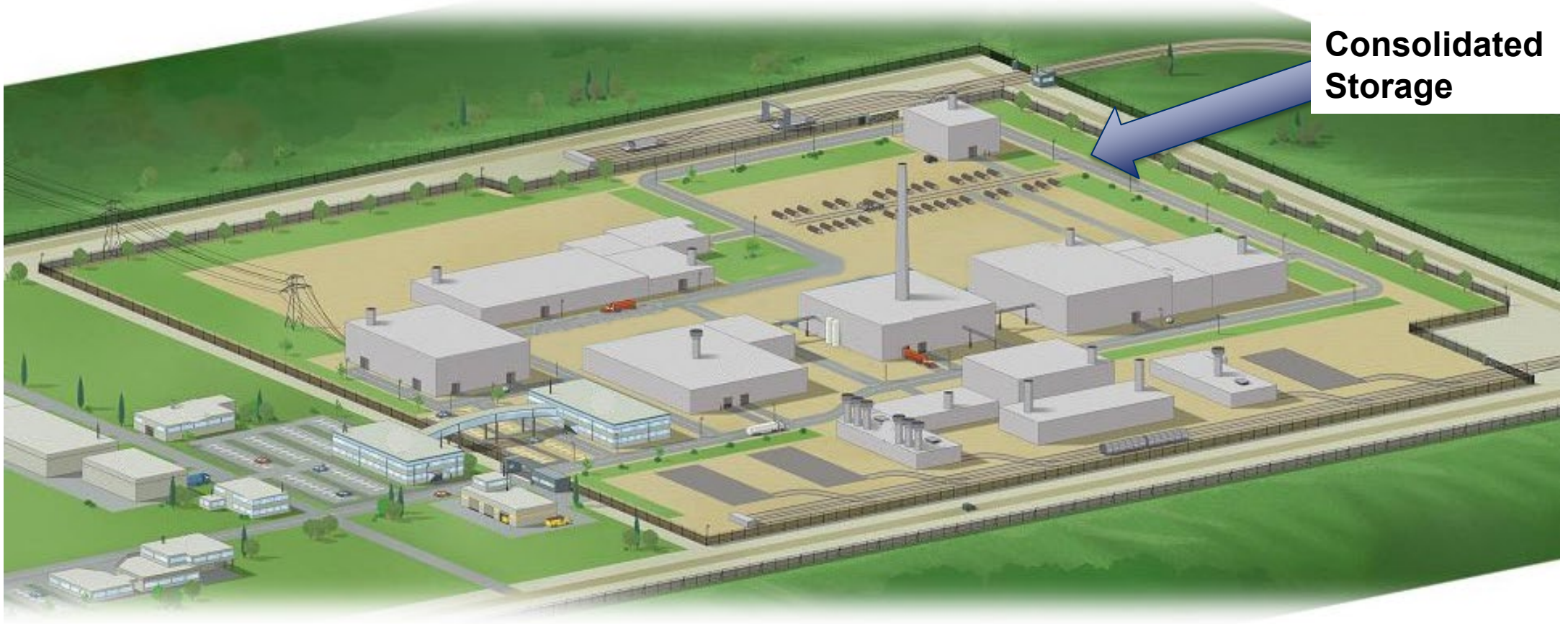
*Timeframes are best estimates and may be adjusted

Fuel Handling/Consolidated Storage Facility (CSF)

- Common fuel handling design before storage, disposal staging pad, or reprocessing.
- Authorized to design one or more.
- May 2024, approved as a DOE capital acquisition project.
- The design will be conducted in accordance with NRC regulations and guidelines.
- Currently completing social economic evaluation.

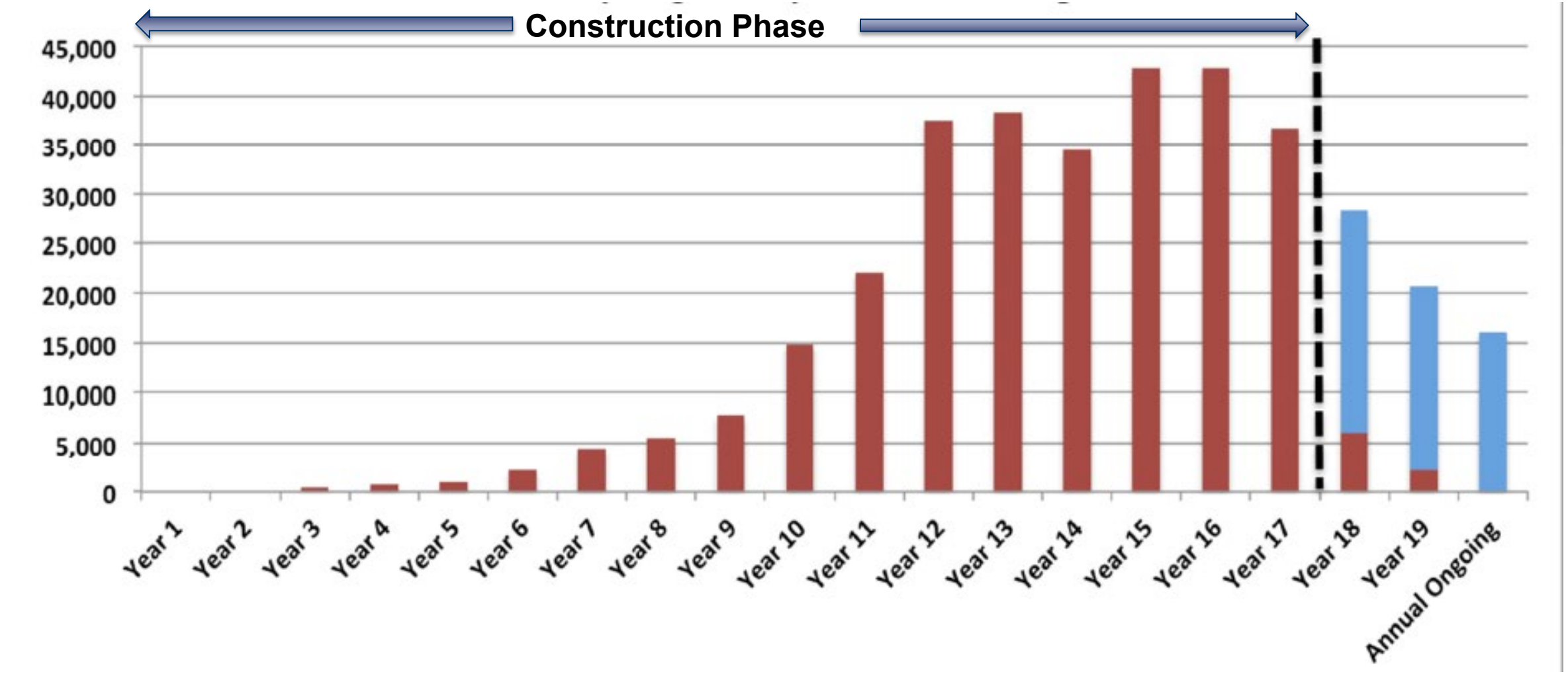


Integrated SNF Management Site Reprocessing Facility



Source: Orano Nebraska Presentation

Projected Total Employment 800mt/y Pilot Plant SE



Ref:-Global Nuclear Energy Partnership, International Nuclear Recycling Alliance Team. Primary and secondary employment

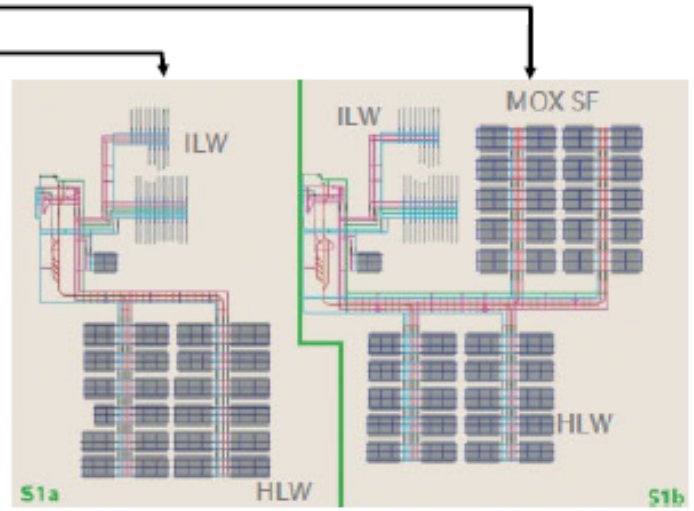
Information From Andra - France

Discussion of Repository Impact

Disposal of wastes from existing French NPPs from 40 yr of PWR operation:

- Without reprocessing:
  - SNF: 45,000 m^3 [WDP = 139,000 m^3]
  - 14 km^2 (60 yr decayed SNF)
- With reprocessing wastes and spent MOX fuel:
  - HLW: 6,330 m^3 [WDP = 14,550 m^3]
  - MOX: 5,625 m^3
  - 9.2 km^2 (60 yr decayed)
- With reprocessing wastes and no used MOX fuel:
  - 5.5 km^2 (60 – 70 yr decayed)
  - 4 km^2 (100 yr decayed)

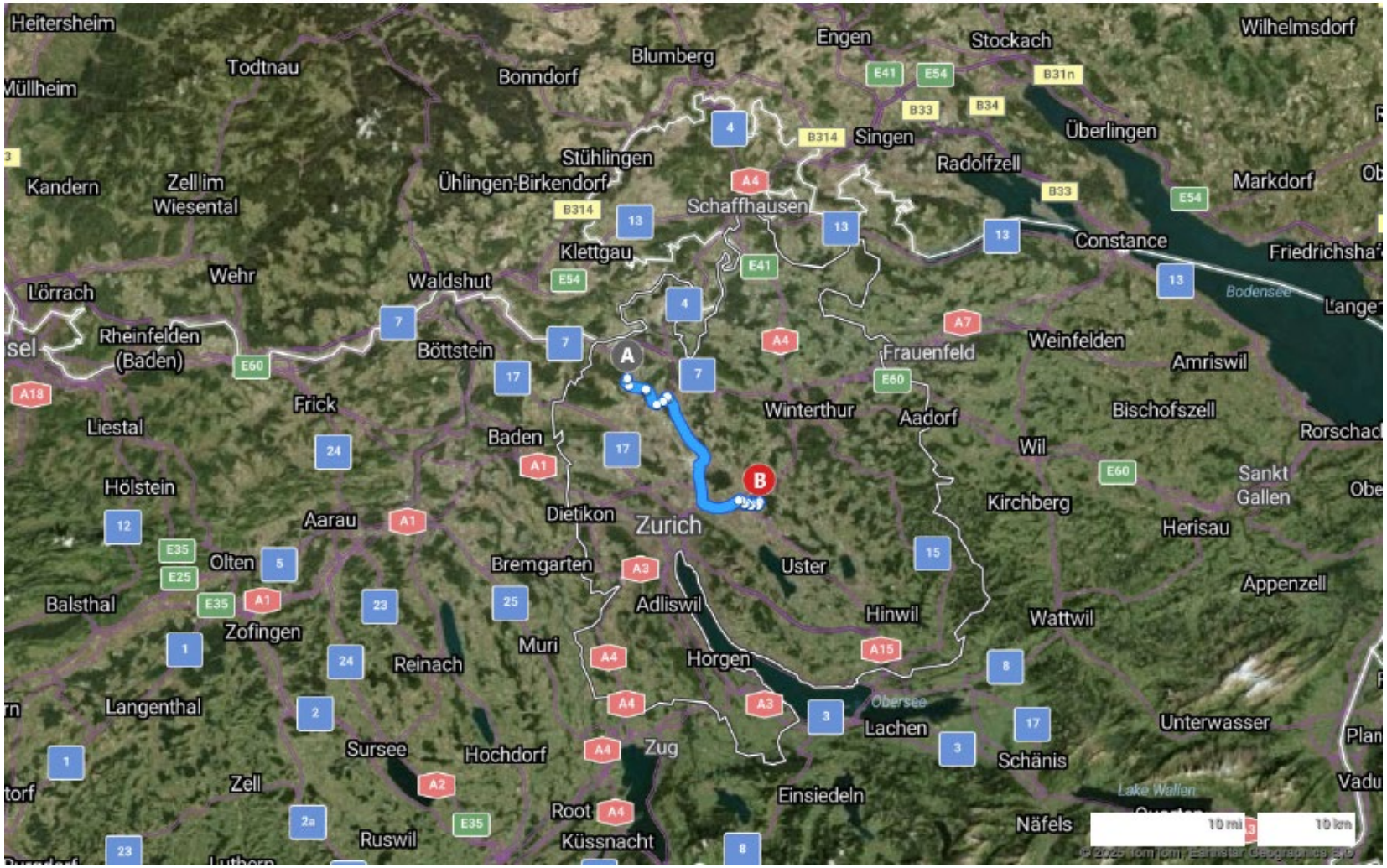
WDP: waste disposal package



No matter what the fuel cycle is, HLW is produced that needs to be disposed of in a deep geological repository.

- United States
- United Kingdom
- Germany
- France
- Japan
- Belgium
- Netherlands

Location of Swiss Deep Geological Repository



17 Miles from the center of downtown Zurich.

Approximately 28 mins by car.

Conclusion

- Thank you for offering us the chance to come to Wyoming to discuss the DOE program.
- We are at an exciting time for nuclear in the U.S. and the world
- The New Executive Orders aim to drive U.S. to energy dominance and security
- The SNF program is a multi-generational program and will span several hundred years.
- Siting of DOE owned and operated storage and disposal facilities will be through a collaborative siting process
- DOE will continue to invest the time and resources to safely manage the nations SNF and HLW securely and safely.