# Used Nuclear Fuel

## Montana Legislature, Energy & Telecommunications Interim Committee – January 18, 2022

Rod McCullum
Nuclear Energy Institute

NUCLEAR ENERGY INSTITUTE

# Categories of Radioactive Waste

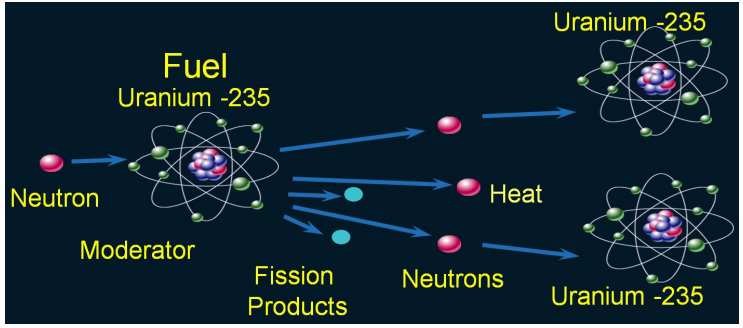
| Category | What it is | What we do with it |
|---|---|---|
| Low-level Waste (Class A, B, C) | Contaminated materials from power plants and other nuclear facilities | Routinely disposed of in specially designed landfills |
| Greater than Class C Waste (GTCC) | Highly contaminated power plant components | Can be stored with used nuclear fuel or potentially disposed of in the same facilities as low-level waste |
| **High-level Waste** | **Used Nuclear Fuel*** | **Stored at reactor sites in pools or dry casks** |

*Certain byproducts of nuclear weapons production are also designated as high-level radioactive wastes. These are separately managed at government facilities.

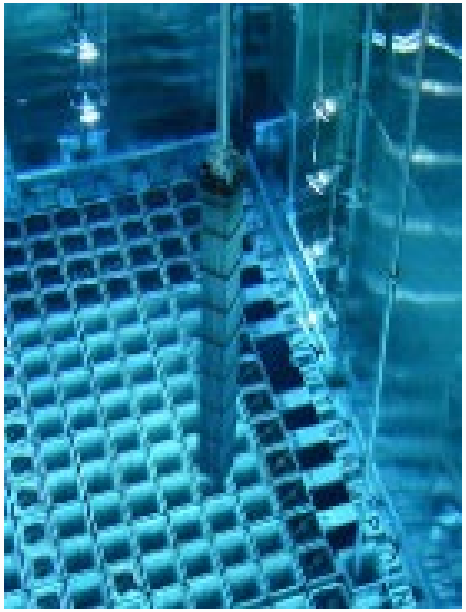
# What is Used Nuclear Fuel?

## New Nuclear Fuel

There is little to no outward difference between the condition of the fuel before it goes into the reactor and when it is discharged. However, inside the fuel rods, the radioactive byproducts of nuclear fission remain. The condition of cladding is carefully monitored at every stage.

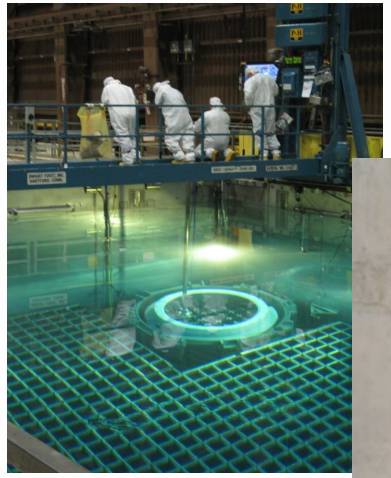


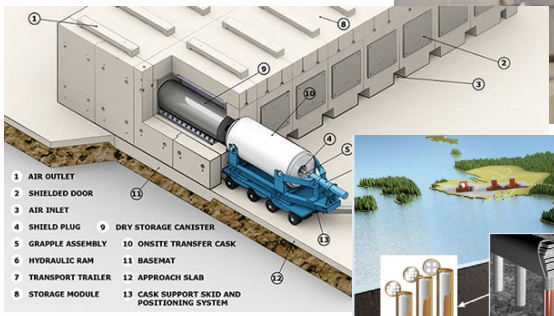

## Used Nuclear Fuel

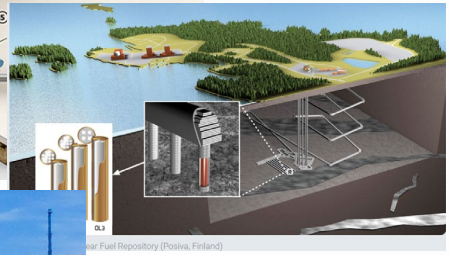


# Used Fuel Management

- Inside the plant* – cooled and shielded under 20+ feet of water
- Outside the plant* – contained in robust dry cask storage systems
- Away from the plant – dry cask storage systems can be moved to consolidated facilities for more efficient management
- Away from the plant and back again – recycling can extract more energy
- Away from civilization – international scientific consensus backs permanent disposal in a deep geologic repository



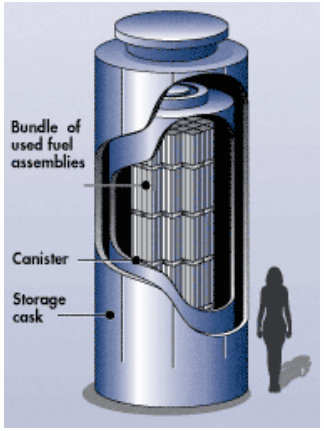


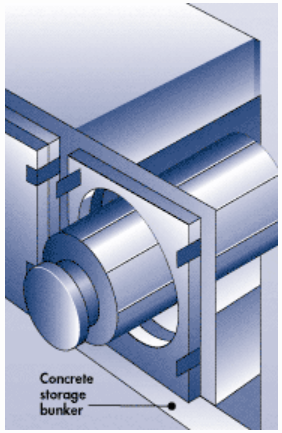



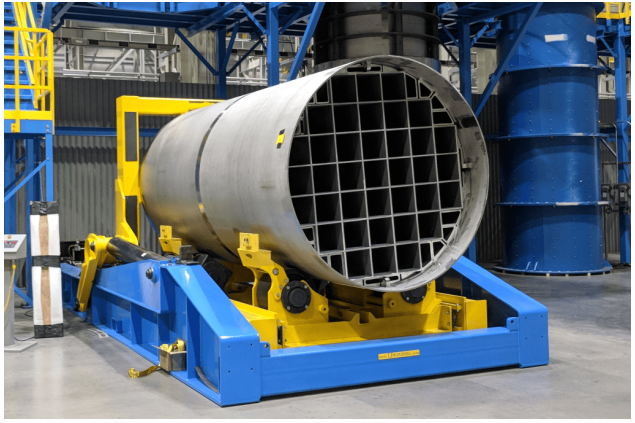


* In place currently in the US

# Dry Cask Storage – Safety by Design



## Defense-in-Depth

- Solid ceramic fuel
- Zirconium cladding
- If any defects in cladding – stainless steel damaged fuel can added around assembly
- Engineered interior basket
- Inert atmosphere
- Welded stainless steel canister (1/2” – 5/8” thick)
- Concrete cask or storage module (20” – 30” thick)
- Inspection and monitoring
- Time
- No driving energy force
- No moving parts
- Transportable

# Dry Cask Storage of Used Nuclear Fuel in the US

**All the used nuclear fuel generated, if stacked, would only cover one football field ~12 yards high**

## Used fuel inventory*

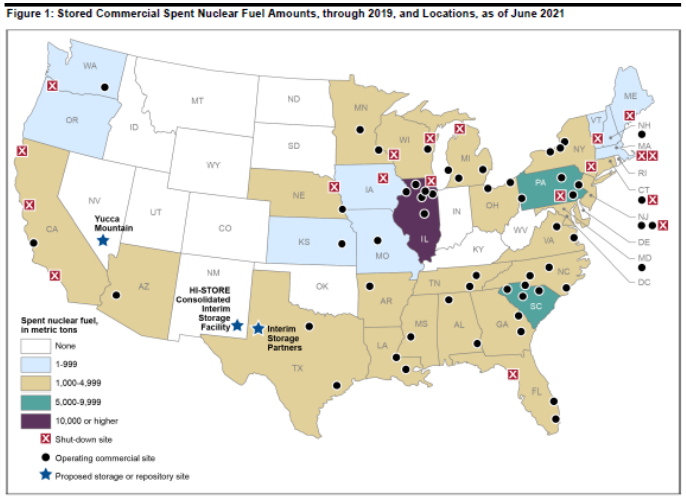
- Approximately 87,000 MTU
- Increases 2 - 2.4k MTU annually

## ISFSI** storage

- 153,840 assemblies
- 43,500 MTU (50%)
- 3,477 casks/modules loaded
- 73 Operating dry storage ISFSIs
- 20 sites where reactor operations have ceased

## Long-term commitment

- First Casks Loaded in 1986
- Licenses being extended to 60 years
- Licenses extensions approved at 32 sites
- Licenses renewable for additional 40 yr. periods
- NRC determined casks safe for “at least” 100 yrs



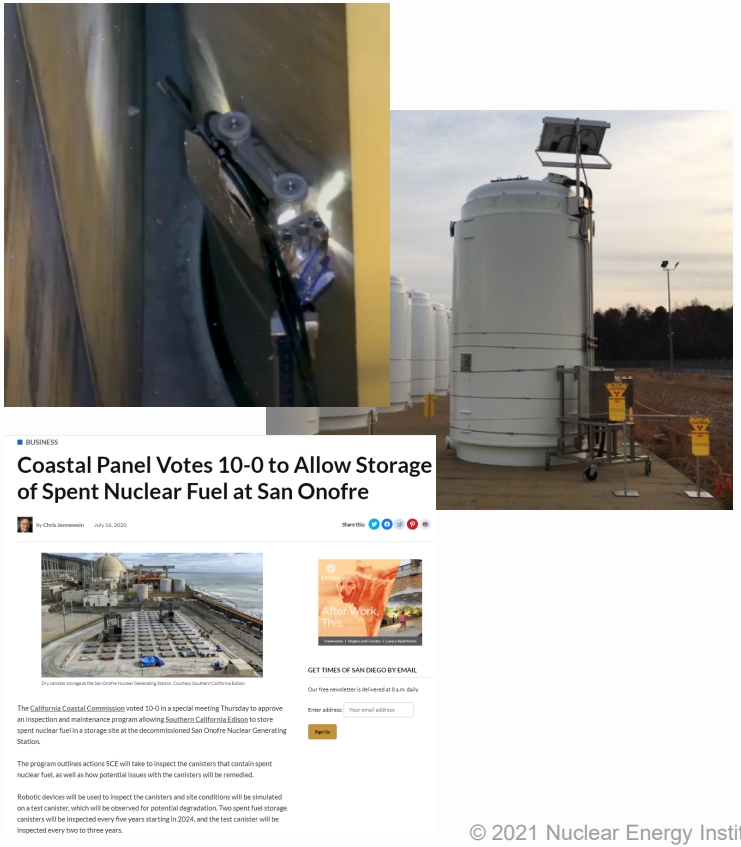

**All of the pools and casks in which this fuel is stored could be comfortably arranged inside a single Walmart Distribution warehouse**

*As of June 2021

** ISFSI = Independent Spent Fuel Storage Installation

# Dry Cask Storage Aging Management

- Dozens of inspections have been completed in the field with no degradation identified
- Technology for inspection, mitigation, and repair (if necessary) is advanced
- Internal fuel integrity is being confirmed by DOE/EPRI R&D
- Inspection and repair technologies have been demonstrated at San Onofre and are being pro-actively deployed there
- Industry is making a significant investment in aging management infrastructure (could be optimized if inventory is consolidated)

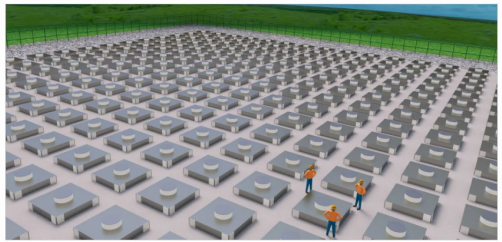




# Consolidated Interim Storage

- A more efficient near-term means of managing the used nuclear fuel
  - Centralize aging management infrastructure
  - Results in fewer sites requiring security protection
- It creates economic opportunity at both ends
  - Environmental Justice will be key consideration
- Temp. solution while permanent disposal advances at an appropriate pace
- Two sites under active consideration (both linked to decommissioning projects)



Pictorial view of the proposed the HI-STORE CIS Facility under NRC review

Holtec / Eddy-Lea Energy Alliance

Southeastern New Mexico

- NRC license application under review
- Addressing State Concerns


Interim Storage Partners (ISP)

Andrews Texas

- NRC license approved
- State Legislation blocking under litigation

(A 3rd site in Utah is also NRC licensed but not currently being pursued)

# The US Repository Program – Yucca Mtn.

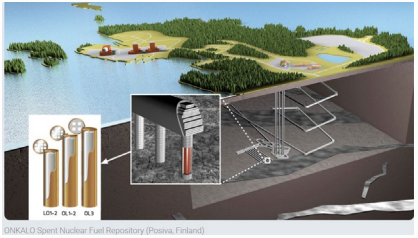

**Figure 3: Timeline of Key Events in the Federal Government's Plans for Managing Commercial Spent Nuclear Fuel, 1934–2020**

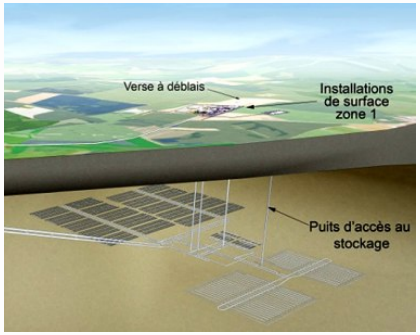
| | |
|---|---|
| **Development of nuclear power** | |
| 1934 | Enrico Fermi splits the atom; achieves world's first nuclear fission |
| 1954 | Congress passes Atomic Energy Act of 1954, providing direction for the peaceful use of atomic energy |
| 1955 | U.S. begins using nuclear power to generate electricity |
| **Development of geologic disposal** | |
| 1957 | National Academy of Sciences recommends geologic disposal for disposing of nuclear waste |
| 1970 | U.S. begins search for potential repository sites |
| 1970 | Lyons, Kansas, site selected as the first national repository |
| 1972 | Government withdraws from operations at Lyons site due to technical uncertainties and public opposition |
| **Nuclear Waste Policy Act of 1982 (NWPA) and Yucca Mountain** | |
| 1983 | The President signs the NWPA, establishing the process for selecting a disposal site |
| 1986 | Department of Energy (DOE) recommends three sites for further study, including Yucca Mountain |
| 1987 | Congress amends NWPA, directing DOE to study only Yucca Mountain |
| 1988-2002 | DOE studies Yucca Mountain extensively |
| 1998 | DOE misses deadline to begin accepting spent nuclear fuel |
| Feb. 2002 | DOE recommends Yucca Mountain as the nation's first disposal site and the President submits recommendation to Congress |
| Apr. 2002 | The Governor of Nevada submits notice of disapproval to Congress |
| July 2002 | The President signs joint resolution approving Yucca Mountain |
| 2008 | DOE submits license application for construction of repository to Nuclear Regulatory Commission |
| 2009 | The presidential administration determines Yucca Mountain is not a workable solution and DOE suspends activities at the site |
| **Blue Ribbon Commission and consent-based siting** | |
| 2010 | The Secretary of Energy establishes the Blue Ribbon Commission on America's Nuclear Future |
| 2012 | Blue Ribbon Commission recommends DOE adopt a consent-based approach to siting nuclear waste facilities |
| 2013 | DOE releases *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* |
| 2015 | The Secretary of Energy announces DOE will pursue consent-based approach to siting facilities for interim storage and disposal |
| Jan. 2017 | DOE issues draft consent-based siting process |
| 2020 | Consolidated Appropriations Act, 2021 appropriates $27.5 million to DOE for nuclear waste disposal activities under the NWPA, as amended, including interim storage activities, of which $7.5 million is to be derived from the Nuclear Waste Fund |

Sources: DOE and GAO. | GAO-21-603

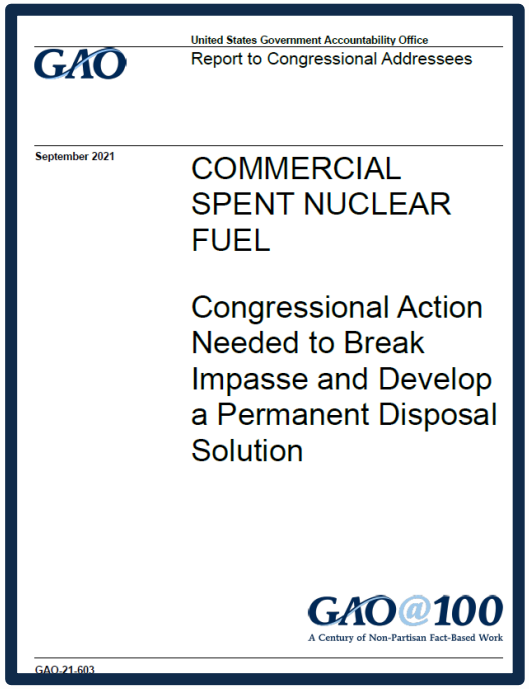
# Global Context

- Nations making progress on spent nuclear fuel disposal
  - Finland – repository licensed and under construction
  - France – site identified, in public consultation toward pilot phase
  - Canada – List of 22 candidate sites narrowed down to 2, geologic investigations under way
  - Switzerland – geologic investigations supporting siting process underway
  - Sweden – repository slowly progressing through licensing process
- All of these are following some version of a consent-based adaptive/phased process
- France, Sweden, and Switzerland all have deployed CIS
  - Swedish Gov't recently approved expansion of CIS




# Recent Developments



United States Government Accountability Office

GAO

Report to Congressional Addressees

September 2021

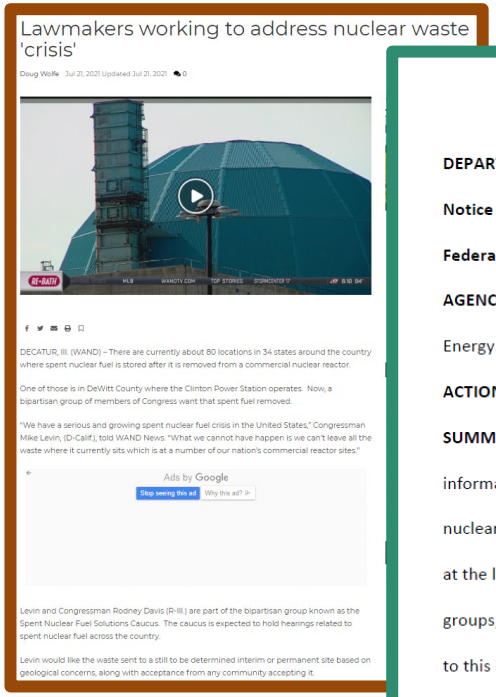
COMMERCIAL SPENT NUCLEAR FUEL

Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution

GAO@100

A Century of Non-Partisan Fact-Based Work

GAO-21-603



Lawmakers working to address nuclear waste 'crisis'

Doug Wolfe Jul 21, 2021 Updated Jul 21, 2021

DECATUR, Ill. (WAND) – There are currently about 80 locations in 34 states around the country where spent nuclear fuel is stored after it is removed from a commercial nuclear reactor.

One of those is in DeWitt County where the Clinton Power Station operates. Now, a bipartisan group of members of Congress want that spent fuel removed.

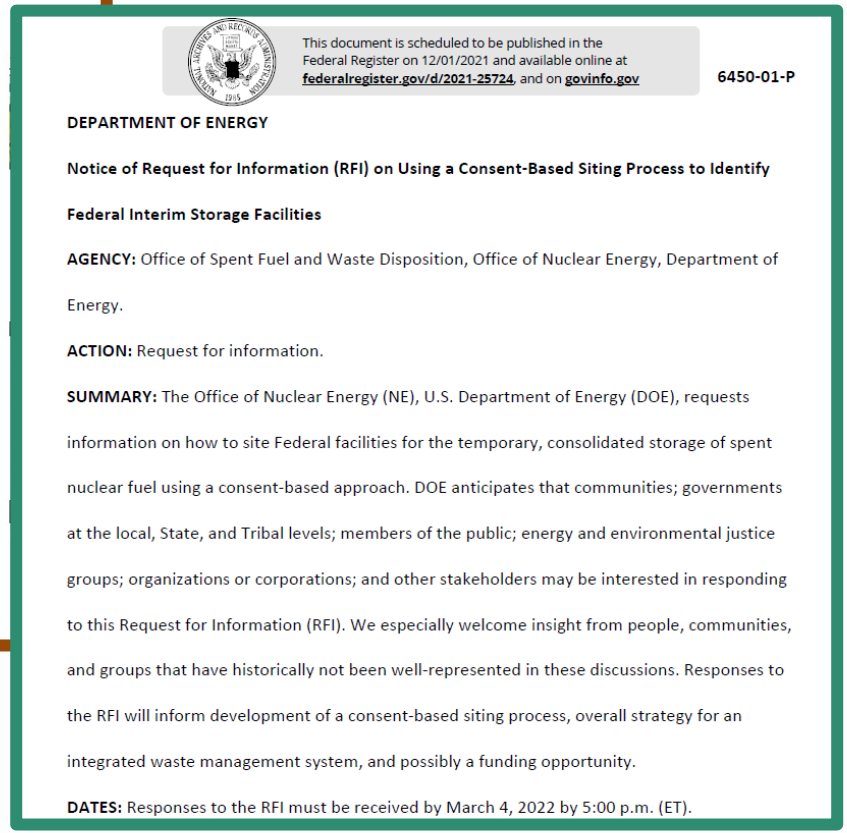
"We have a serious and growing spent nuclear fuel crisis in the United States," Congressman Mike Levin, (D-Calif.), told WAND News. "What we cannot have happen is we can't leave all the waste where it currently sits which is at a number of our nation's commercial reactor sites."

Ads by Google

Stop seeing this ad Why this ad?

Levin and Congressman Rodney Davis (R-Ill.) are part of the bipartisan group known as the Spent Nuclear Fuel Solutions Caucus. The caucus is expected to hold hearings related to spent nuclear fuel across the country.

Levin would like the waste sent to a still to be determined interim or permanent site based on geological concerns, along with acceptance from any community accepting it.



This document is scheduled to be published in the Federal Register on 12/01/2021 and available online at federalregister.gov/d/2021-25724, and on govinfo.gov

6450-01-P

DEPARTMENT OF ENERGY

**Notice of Request for Information (RFI) on Using a Consent-Based Siting Process to Identify Federal Interim Storage Facilities**

**AGENCY:** Office of Spent Fuel and Waste Disposition, Office of Nuclear Energy, Department of Energy.

**ACTION:** Request for information.

**SUMMARY:** The Office of Nuclear Energy (NE), U.S. Department of Energy (DOE), requests information on how to site Federal facilities for the temporary, consolidated storage of spent nuclear fuel using a consent-based approach. DOE anticipates that communities; governments at the local, State, and Tribal levels; members of the public; energy and environmental justice groups; organizations or corporations; and other stakeholders may be interested in responding to this Request for Information (RFI). We especially welcome insight from people, communities, and groups that have historically not been well-represented in these discussions. Responses to the RFI will inform development of a consent-based siting process, overall strategy for an integrated waste management system, and possibly a funding opportunity.

**DATES:** Responses to the RFI must be received by March 4, 2022 by 5:00 p.m. (ET).

## TRANSPORTING USED NUCLEAR FUEL IN THE U.S. IS...

### ...PROVEN.

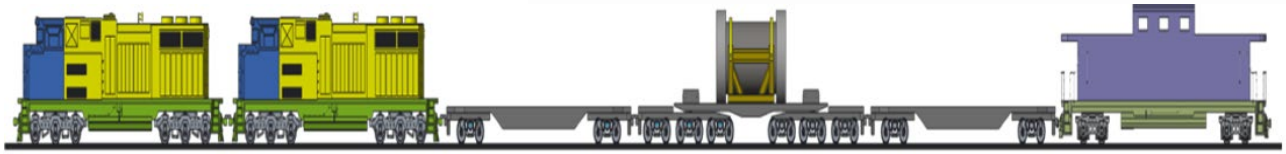
- Used nuclear fuel has been routinely transported across the U.S. for nearly 50 years for a variety of reasons other than consolidation and disposal.
- Used nuclear fuel has been regularly moved via rail, barge, or on public highways under guidelines and oversight of federal, state, and local authorities.


### ...SAFE.

- Used nuclear fuel is transported in robust containers called casks, which are designed to prevent the release of radioactive material.
- For every ton of used fuel, transport casks typically use about seven tons of material for protective containment, radiation shielding and impact absorption.
- Transport casks are designed, tested and licensed by the federal government to withstand potential punctures, fires, water immersion and drops.

## The Complete Used Fuel Train

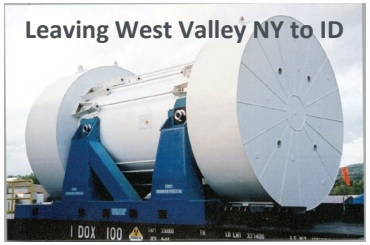
- Two locomotives
- Buffer cars
- Special purpose used fuel cars
- Escort vehicle



*IN NEARLY **50 YEARS** OF TRANSPORTING USED NUCLEAR FUEL, THERE HAS **NEVER** BEEN A RELEASE OF RADIOACTIVE MATERIAL TO THE PUBLIC.*

### ...IMPORTANT.

- Transportation of used fuel supports national security and the overall health of the US economy by assuring that the radioactive byproducts of defense activities, electricity generation, medical applications and scientific research are managed in the most effective manner possible.





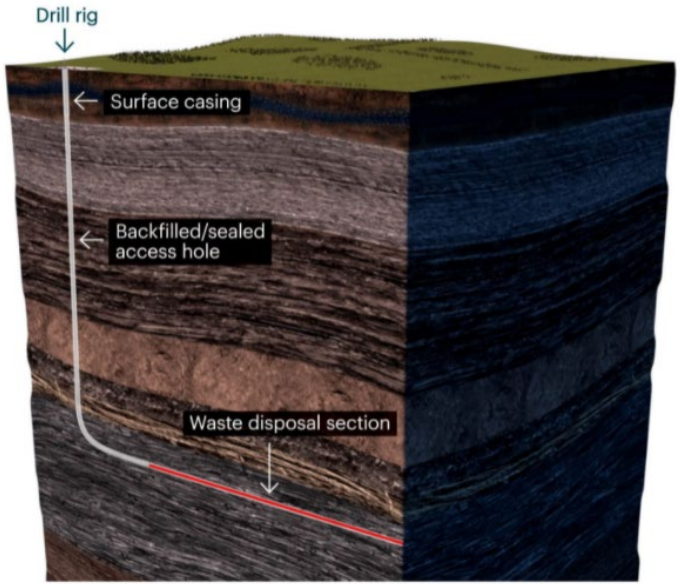

# Local Disposal?

**EPRI Report Says Deep Horizontal Boreholes Offer Safe, Affordable Nuclear Waste Disposal for Advanced Reactors**

**Berkeley, California** – A comprehensive report published today by the Electric Power Research Institute (EPRI) provides the most detailed analysis to date of how deep horizontal boreholes can offer a safe and secure disposal pathway for waste from advanced nuclear reactors.

The study, a first-of-its-kind collaboration among EPRI, Southern Company, Deep Isolation, the Nuclear Energy Institute, Auburn University and J Kessler and Associates, assesses the feasibility of onsite horizontal deep borehole disposal for advanced nuclear energy systems. The 173-page report examines physical site characteristics, disposal operations, safety performance analysis, and regulatory and licensing considerations. The report also outlines an approach to engaging with the public in ways designed to build trust and support for the undertaking.

Advanced nuclear reactors are a low-carbon source of energy, which makes them an important part of responding to the pressing need to address climate change.



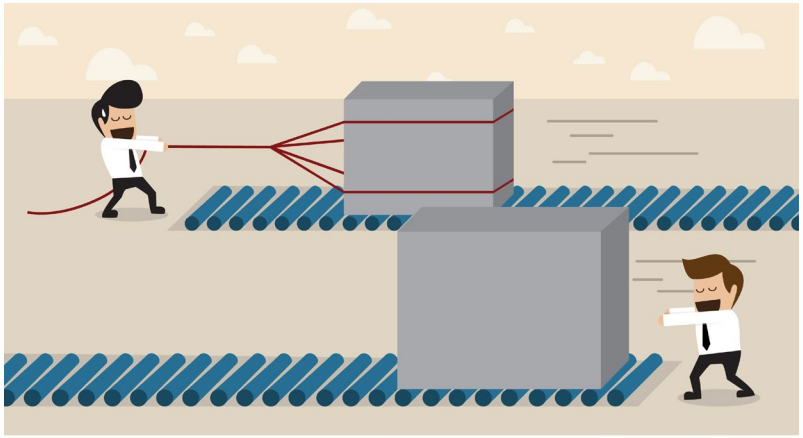
# Optimizing the value of nuclear feedstock

- Future reactors may economically recycle used nuclear fuel to extract even more energy from uranium already mined

- Initial new reactor startups will be on new fuel
- Between 6 and 9 advanced reactor suppliers may be able to power their machines with used fuel
- Most envisioned recycling strategies would not separate out pure plutonium

# Conclusion

- The biggest impediment to used fuel solutions is a lack of used fuel problems



- Interest in decarbonization is likely to create new used fuel management opportunities