Used Nuclear Fuel

NCSL Nuclear Legislative Working Group

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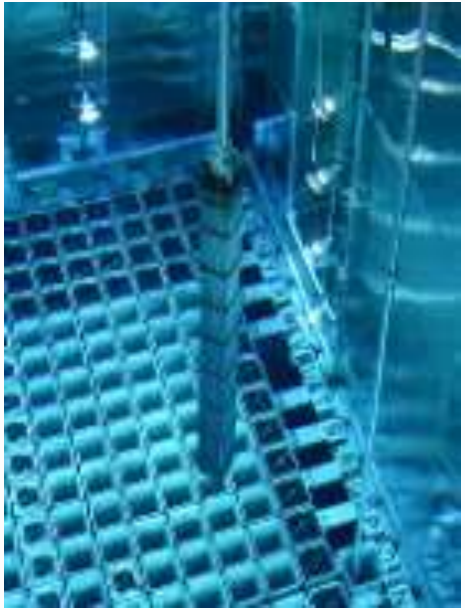
NUCLEAR ENERGY INSTITUTE

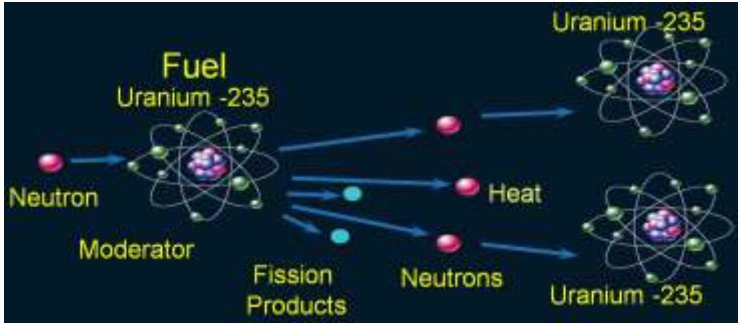
What is Used Nuclear Fuel?

New Nuclear Fuel

Used 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 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 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

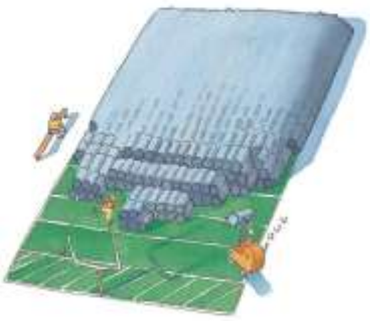
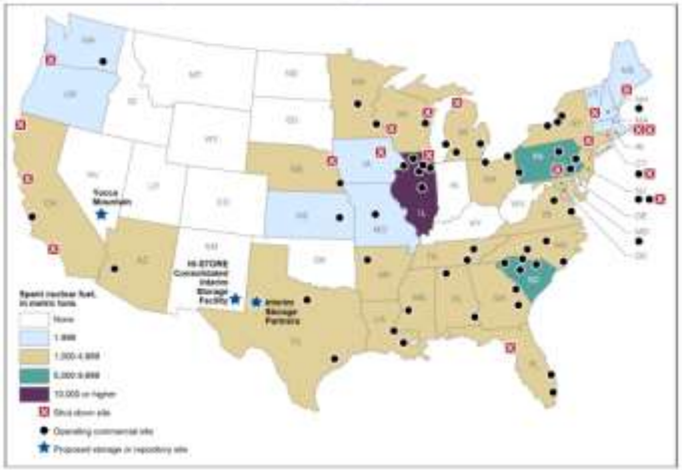


Figure 1: Stored Commercial Spent Nuclear Fuel Amounts, through 2019, and Locations, as of June 2021



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

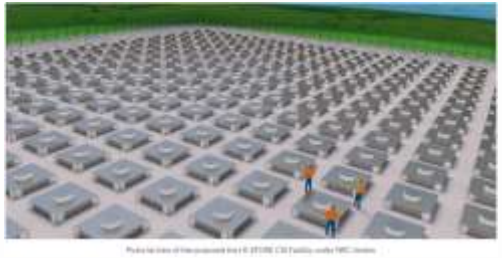
Dry Cask Storage Aging Management

- 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)


Coastal Panel Votes 10-0 to Allow Storage of Spent Nuclear Fuel at San Onofre

Consolidated Interim Storage

- A more efficient near-term means of managing the used nuclear fuel
    - Aging management infrastructure and security protection at fewer sites
- It creates economic opportunity at both ends
    - Environmental Justice will be key consideration
- Temp. solution while permanent disposal advances at an appropriate pace
- DOE pursuing consent-based siting approach
- Two private sites also under consideration (both linked to decommissioning projects)



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
- Texas litigating license
- State Legislation bans development

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

The US Repository Program – Yucca Mtn.

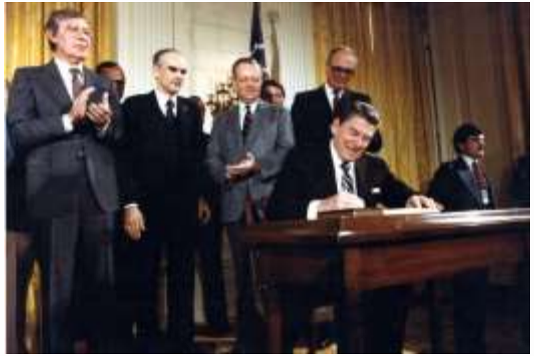


Figure 3: Timeline of Key Events in the Federal Government's Plans for Managing Commercial Spent Nuclear Fuel, 1934–2020

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

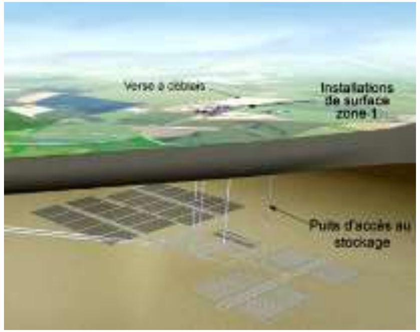
Blue Ribbon Commission and consent-based siting

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
  - Sweden – repository approved for constructing
  - 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
- 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'

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.

*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.

The Complete Used Fuel Train

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


Leaving West Valley NY to ID


Between Reactors in NC/SC


Routine US Navy Shipment


Routine French Shipment

Local Disposal?

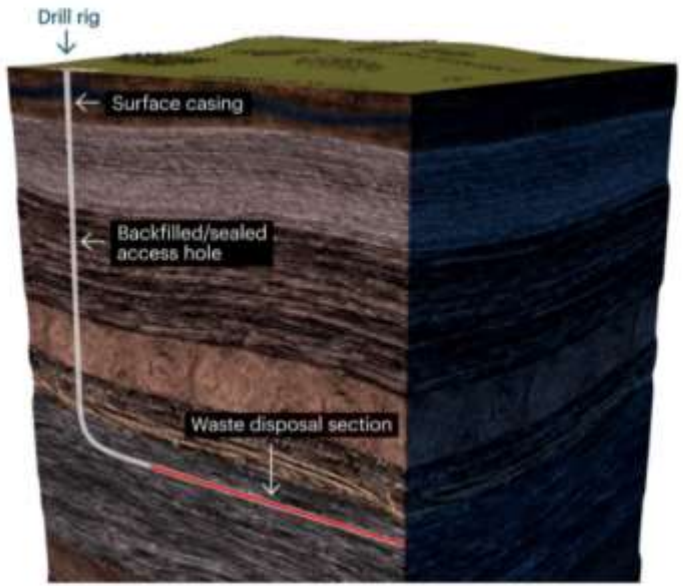
DEEP ISOLATION™

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

QUESTIONS?

ELR@NEI.ORG

By Third Way, GENSLER

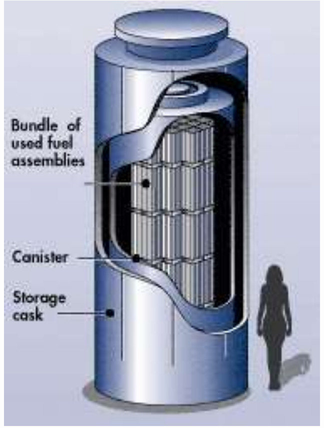
Backup Slides

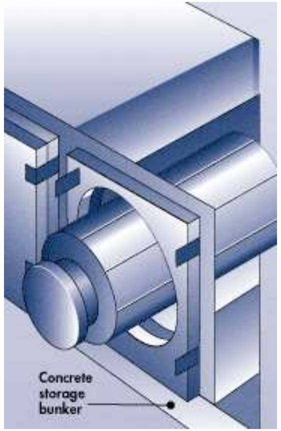
Categories of Radioactive Waste

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.

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