

# NUCLEAR WASTE

## Reprocessing & Storage

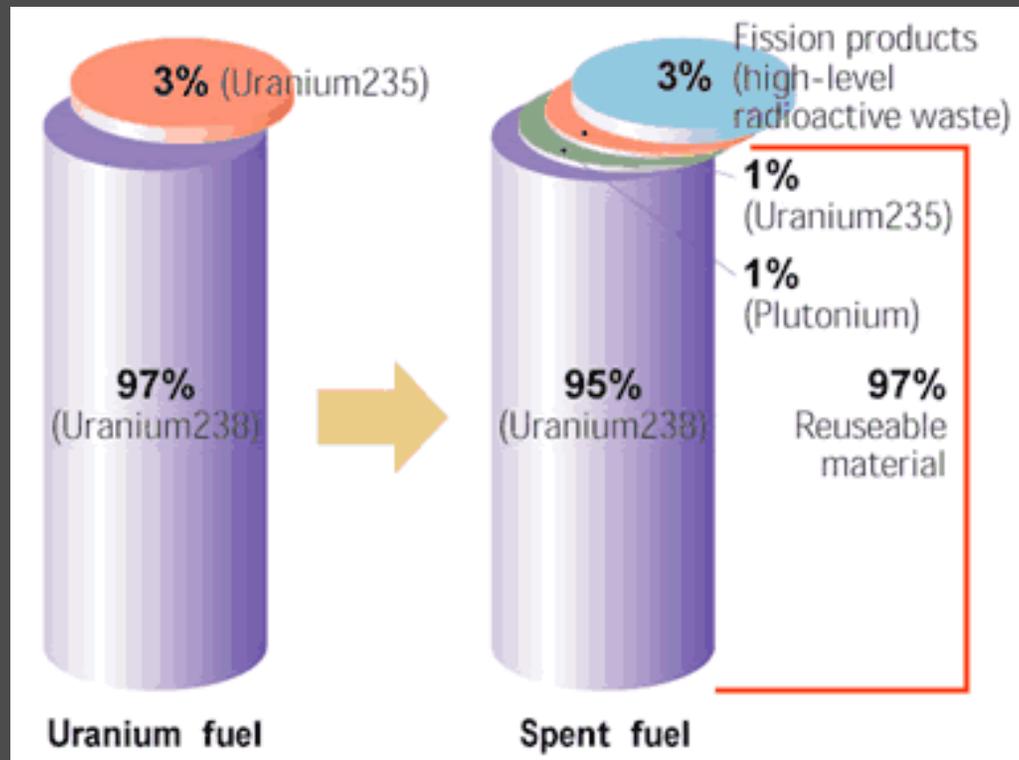
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# Types of Waste

- High-Level Waste (HLW)
- Intermediate-Level Waste (ILW)
- Low-Level Waste (LLW)

# Reprocessing

- Concept & history



# Reprocessing

## ⦿ Pros

- Reduces the level of nuclear waste
- Extracts more energy per volume of fuel
- Potentially cheaper

# Reprocessing

## ⦿ Cons

- Still creates waste
- Waste has a longer half-life
- Waste is more “potent” per volume

# MOX

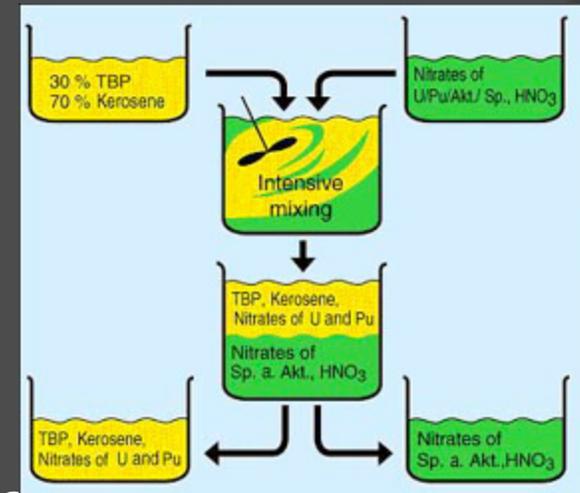
## ⦿ Mixed Oxide Fuel

- Contains Uranium and Plutonium oxides
- 4-9% Plutonium used in place of enriched Uranium
- 6 grams of MOX creates same energy as 1 ton of coal
- Plutonium waste is a concern

# PUREX

## ● *Plutonium and Uranium Recovery by Extraction*

- Europe's favorite
- Mixes spent fuel with acid
- Then with organic solvent
- Reduces volume of waste and creates usable reprocessed fuel



# UREX+

## ⦿ URanium **Ex**traction

- Similar to PUREX
- Saves space in storage facilities
- Removes Uranium only(majority of spend fuel)
- Uranium can be reused

# Electrometallurgical “

## ⦿ Pyroprocessing

- Being developed by the U.S. DOE
- Separates nuclides in nuclear waste stream
- Still in development

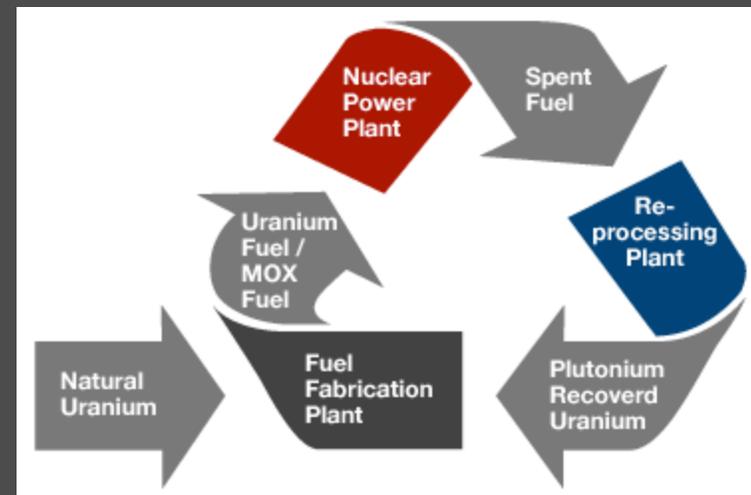
# ATW

- ⦿ Accelerator Transmutation of Waste
  - Intended to change actinides (long-lived) into fission products
  - Then changes fission products into short lived nuclides
  - Reduces generated waste, and shortens its radioactive life-span
  - Still being developed

# Closed Nuclear Fuel Cycle

## Goals:

- Reduce Waste
- Conserves Uranium Resources
- Easier to control



# Waste Storage

- ⦿ Nuclear power is the only energy-producing technology which takes full responsibility for all its wastes.
- ⦿ The amount of radioactive wastes is very small compared to wastes produced by fossil fuel electricity generation.
- ⦿ Used nuclear fuel may be looked at as just waste or a resource.
- ⦿ The radioactivity of all nuclear wastes diminishes with time.

# Waste Storage

- **Pros:**

- Safe & Reliable.
- Helps safeguard against waste being used for non-civil means.

- **Cons:**

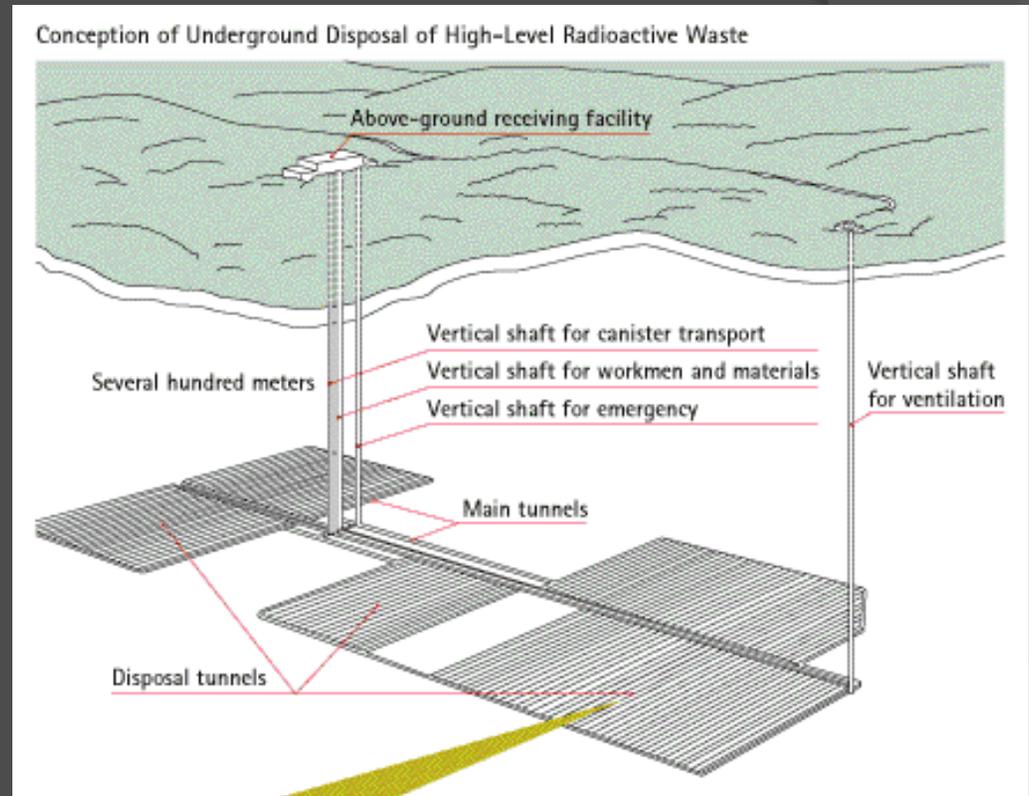
- Radioactive waste “in your back yard”.
- Potential for catastrophes.

# Transportation

- ⦿ Since 1971, in that time there has been more than 20 000 shipments of used fuel and HLW.
- ⦿ There has never been a significant accident.
- ⦿ Shipped by rail in special containers.

# Underground Storage Facilities

- A safe, secure way to store hazardous waste.
- Not all sites have appropriate geologic conditions for disposal.
- Economically and environmentally responsible method for disposal.



# Yucca Mountain



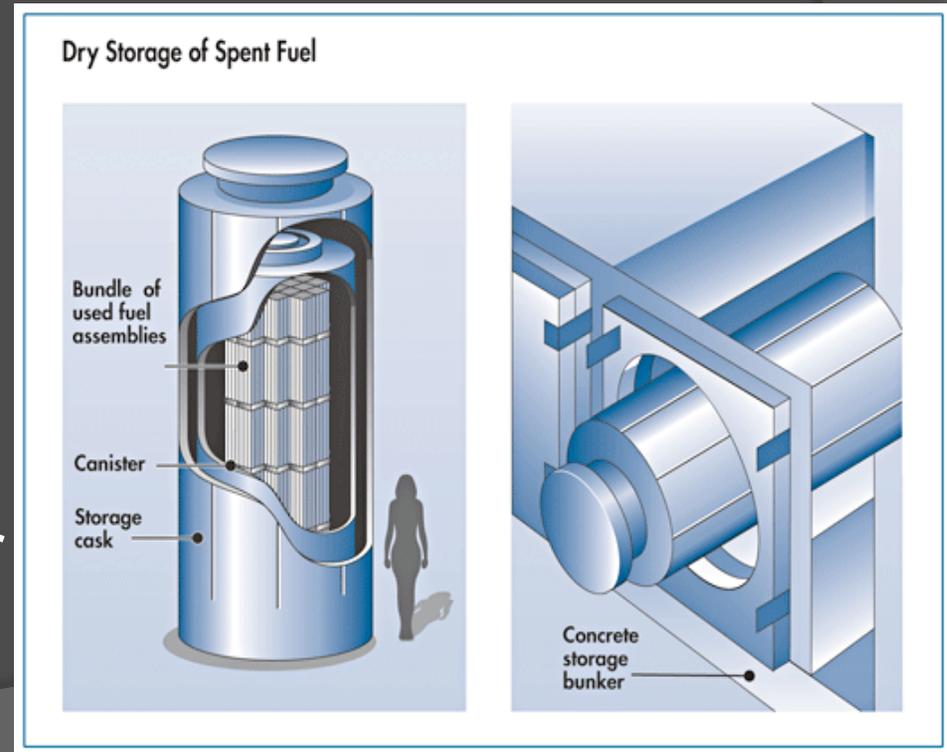
# Yucca Mountain

- First conceived during Reagan administration.
- Total cost to taxpayer > \$8 billion.
- Built out of porous volcanic tuff.
- History of seismic and volcanic activity.
- 9 Yucca-sized waste repositories needed by 2100 (1.8% annual growth)

# Dry-Cask Storage

- Fuel rods are cooled in on site pools for 5 years.
- made of a combination of concrete and high heat-resistant metal alloys

- Survive 30 ft free fall, 1 meter drop onto a 6" steel rod, 30 minutes in a 1475 degree F fire, Up to 8 hours underwater



# Vitrification

- In the UK and USA alkali borosilicate glasses are currently the material of choice for the vitrification and long-term storage of HLW because of its chemical and thermal properties, ease of processing and ability to hold large quantities of waste.



# Landfill Disposal for LLW

- Disposal pits are filled with 5,000 metal drums.
- Drums are covered in bentonite.
- Filled with mortar
- Covered in: soil, sand, and trees.



Questions?