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2009 National Conference

U. S. Nuclear Regulatory Commission

An Introduction to the Nuclear Fuel Cycle

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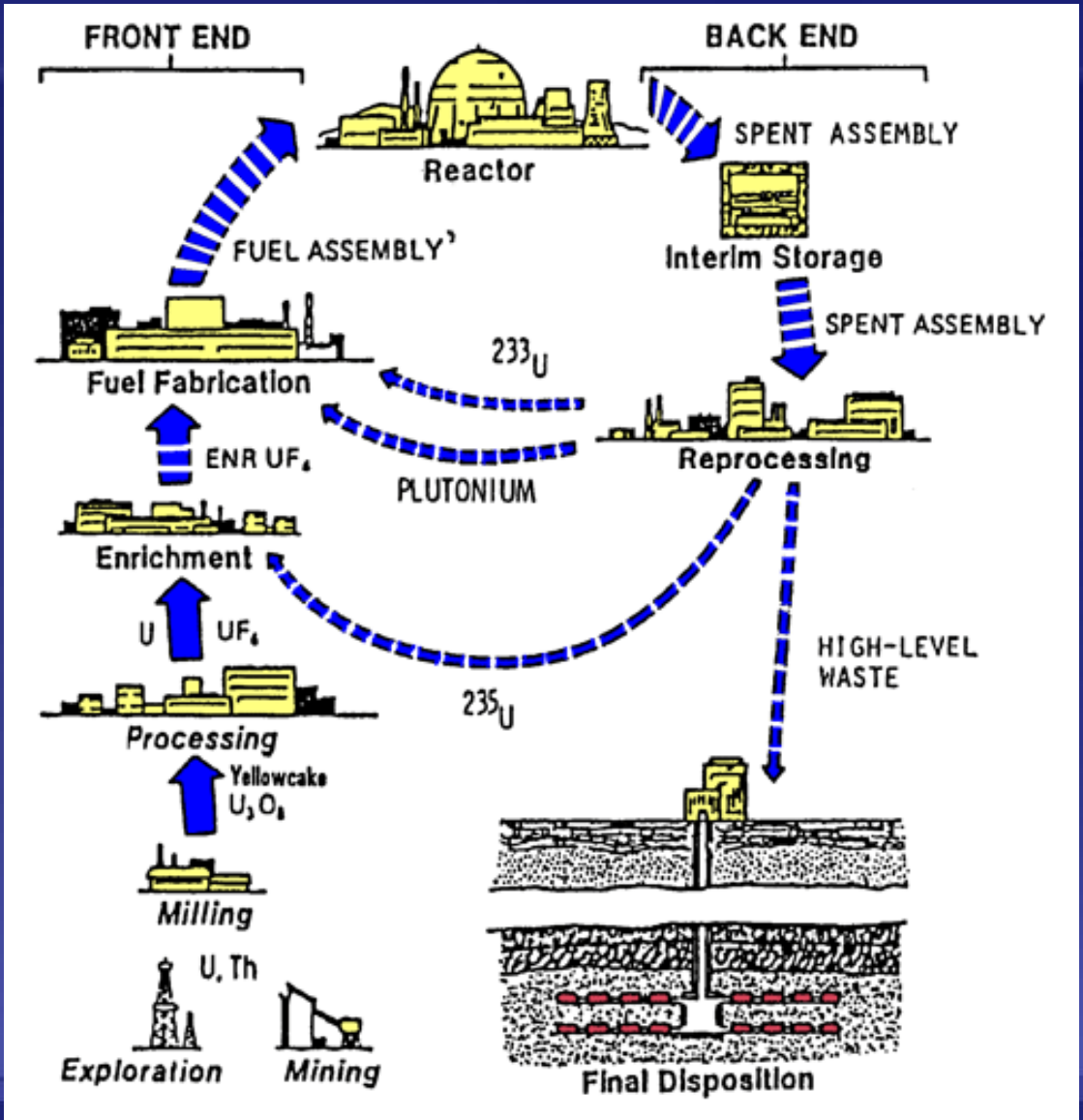
October 31, 2009

NRC Mission

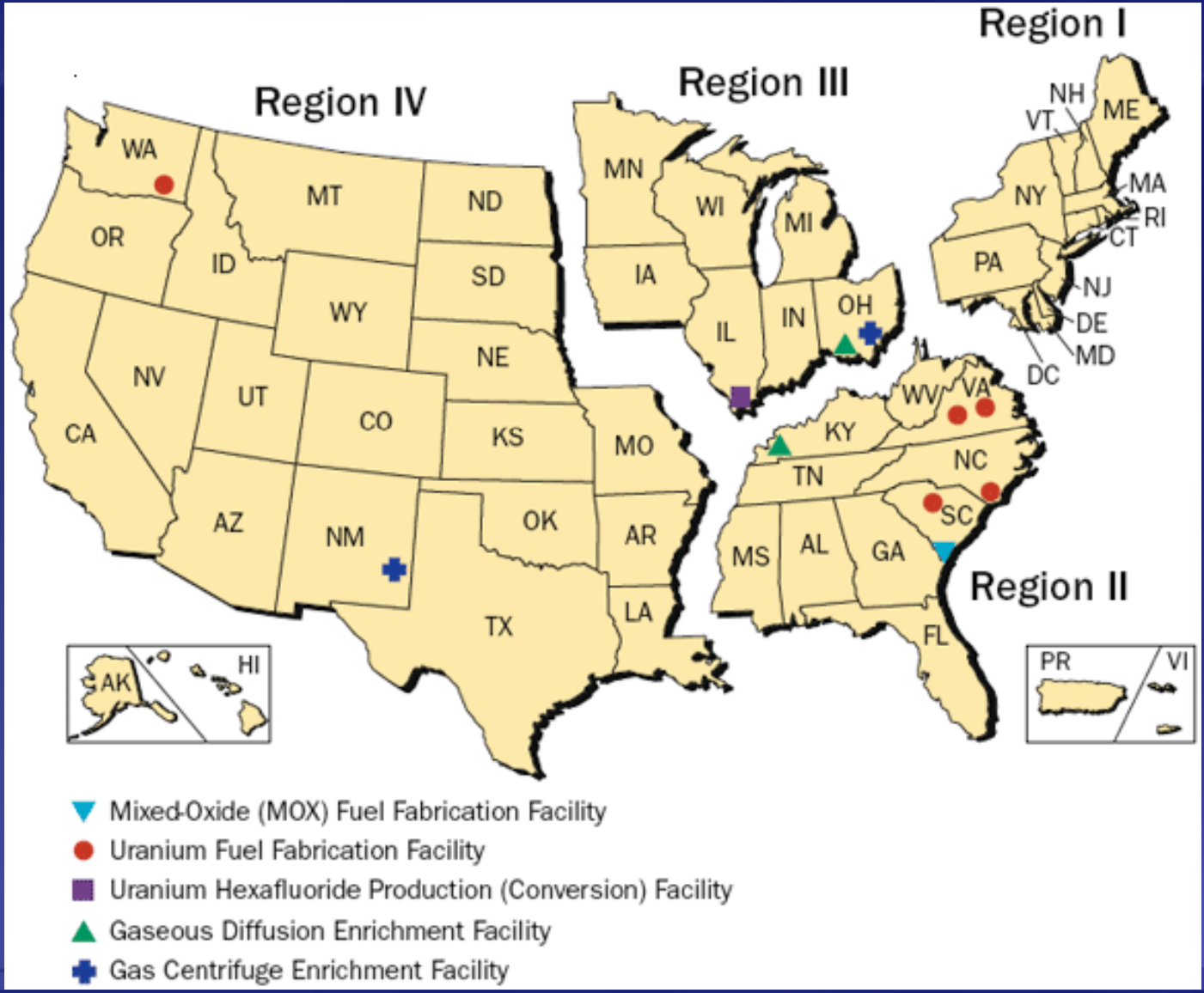
Mission: Regulate civilian uses of nuclear material - nuclear reactors that generate electricity, research reactors, reactor fuel production facilities, medical and industrial applications.

- Promote common defense and security
- Protect the environment
- Protect public health and safety

Stages of the Nuclear Fuel Cycle



NRC Regions and FC Facilities



Fuel Cycle: Front End

- Uranium Recovery: extracting or *mining* natural uranium ore, concentrating or *milling* the ore, producing "yellowcake," which is transported to a fuel cycle facility and transformed into fuel for nuclear power reactors.

- Regulatory Responsibilities- extraction methods:
  a) conventional mining (deep underground shafts or shallow open pits) Office of Surface Mining, U.S. Department of the Interior, and States;
  b) in situ recovery or situ leach recovery (uranium ore chemically altered underground) U.S. Nuclear Regulatory Commission

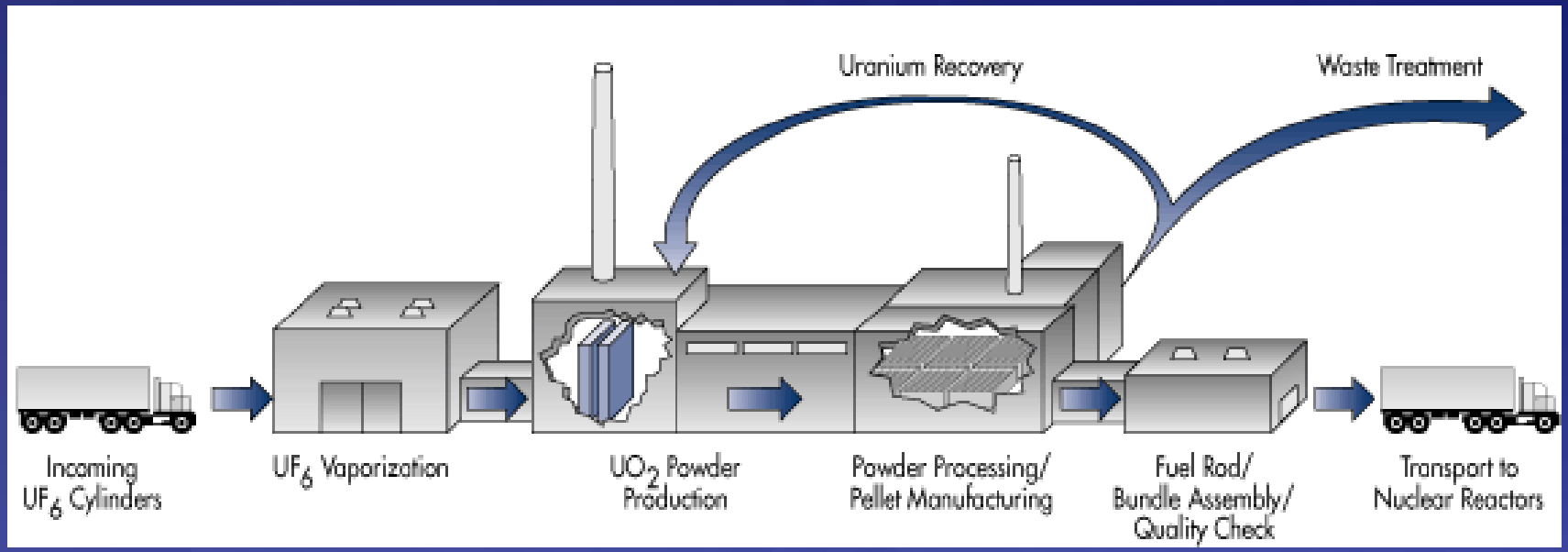
Fuel Cycle: Front End (cont.)

- Uranium Enrichment: fuel for nuclear reactors needs higher concentration of U-235 than in natural uranium ore for nuclear chain reaction (U-235 to about 5%). US uses only gaseous diffusion: Paducah, KY, Portsmouth, OH.

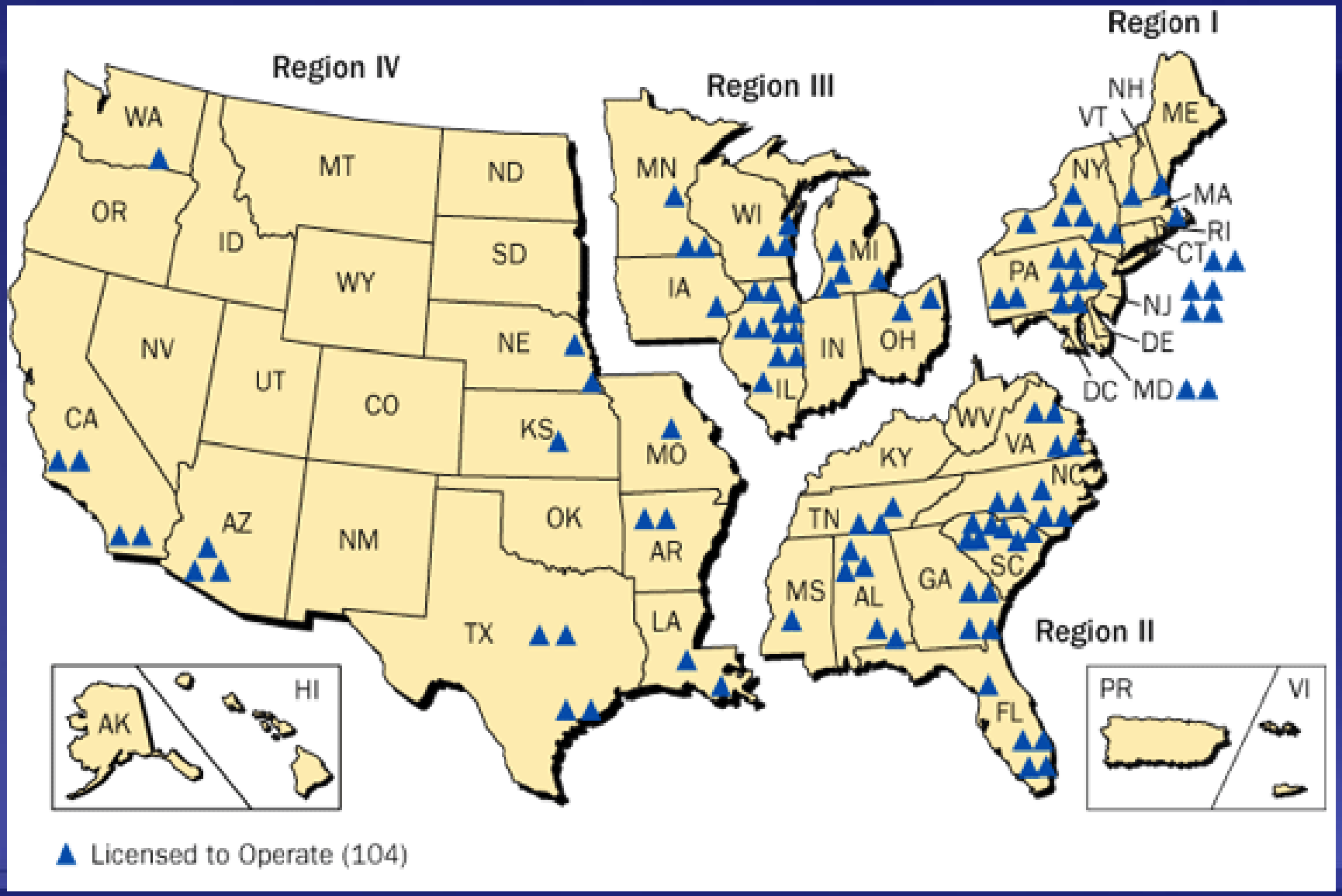
- Regulatory Responsibilities: UF6 Production - Atomic Energy Act, as amended, NRC license under 10 CFR Parts 40 (source material) and 70 (special nuclear material); Environmental Impact Statement (18-month process); Safety Evaluation Report, formal hearing, public participation (raise important safety or environmental issues). SAFETY is paramount.

Fuel Cycle: Front End (cont.)

- Typical Light Water Reactor Low-Enriched Uranium Fuel Fabrication Facility:

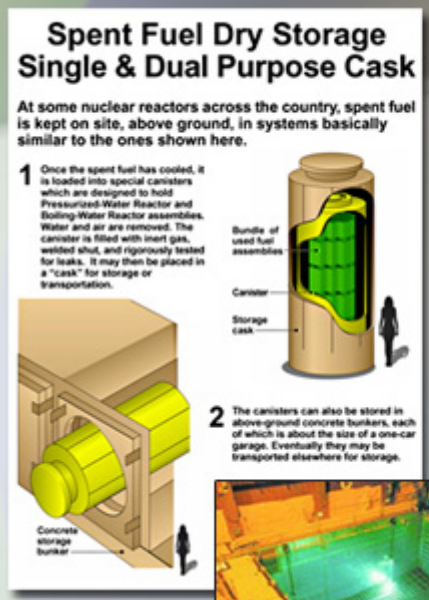


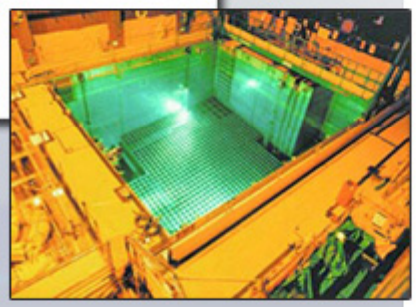
Power Reactors

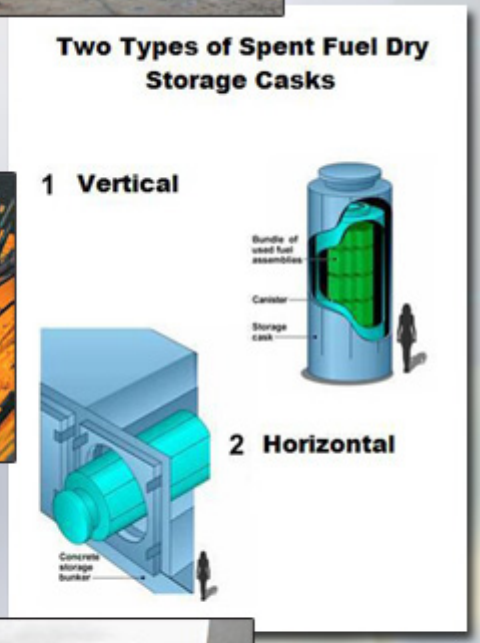


Fuel Cycle: Back End

- Spent Fuel Storage:
  - Spent Fuel Pool
  - Dry Cask Storage



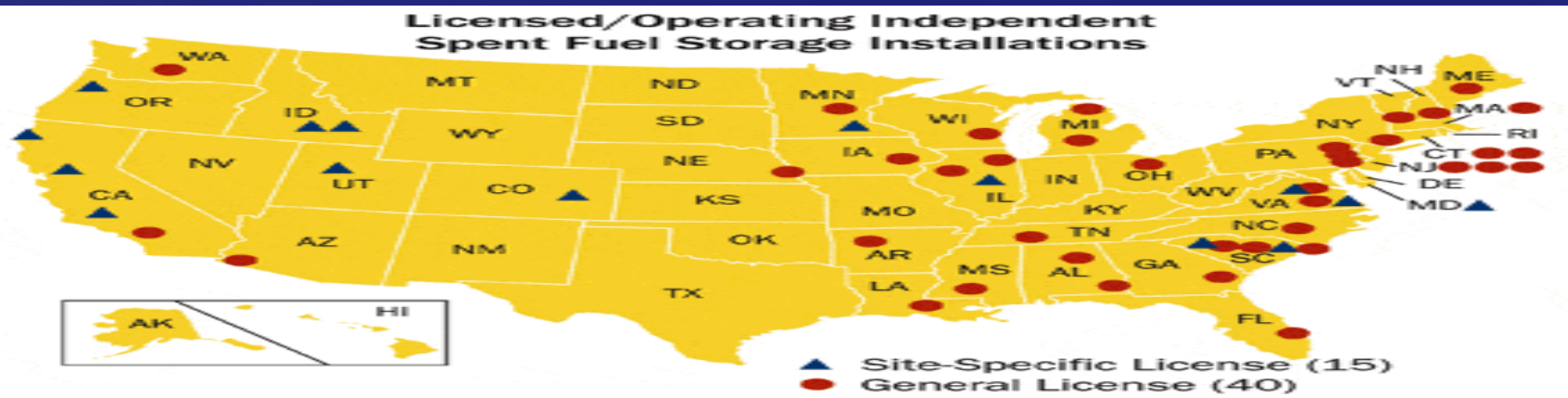




NRC regulates spent fuel through a combination of regulatory requirements, licensing; safety oversight, including inspection, performance; enforcement; operational experience evaluation; and regulatory support activities.

10 CFR 72: Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater then class C.

Locations of Independent Spent Fuel Storage Installations



ALABAMA
- Browns Ferry
- Farley

ARIZONA
- Palo Verde

ARKANSAS
- Arkansas Nuclear

CALIFORNIA
- Diablo Canyon
- Rancho Seco
- San Onofre
- Humboldt Bay

COLORADO
- Fort St. Vrain

CONNECTICUT
- Haddam Neck
- Millstone

FLORIDA
- St. Lucie

GEORGIA
- Hatch

IDAHO
- DOE: TMI-2 (Fuel Debris)
- Idaho Spent Fuel Facility

ILLINOIS
- GE Morris (Wet)
- Dresden
- Quad Cities

IOWA
- Duane Arnold

LOUSIANA
- River Bend

MAINE
- Maine Yankee

MARYLAND
- Calvert Cliffs

MASSACHUSETTS
- Yankee Rowe

MICHIGAN
- Big Rock Point
- Palisades

MINNESOTA
- Monticello
- Prairie Island

MISSISSIPPI
- Grand Gulf

NEBRASKA
- Ft. Calhoun

NEW HAMPSHIRE
- Seabrook

NEW JERSEY
- Hope Creek
- Oyster Creek
- Salem

NEW YORK
- Indian Point
- James A. FitzPatrick

NORTH CAROLINA
- McGuire

OHIO
- Davis-Besse

OREGON
- Trojan

PENNSYLVANIA
- Limerick
- Susquehanna
- Peach Bottom

SOUTH CAROLINA
- Oconee
- H.B. Robinson
- Catawba

TENNESSEE
- Sequoyah

UTAH
- Private Fuel Storage

VERMONT
- Vermont Yankee

VIRGINIA
- Surry
- North Anna

WASHINGTON
- Columbia

WISCONSIN
- Point Beach

Note: Data are current as of November 2008.
Source: U.S. Nuclear Regulatory Commission

Fuel Cycle: Back End (cont.)

- Reprocessing High-Level Radioactive Wastes*:
  - Spent (*used*) reactor fuel when it is accepted for disposal;
  - Waste materials remaining after spent fuel is reprocessed

* Neither a reprocessing facility nor a Federal waste repository is currently approved (licensed) in the United States, and spent fuel is in interim storage.

Fuel Cycle: Back End (cont.)

- High-Level Waste Disposal:
  - Yucca Mountain:
    - U. S. DOE - Application June 2008: DOE is responsible for designing, constructing, operating, and decommissioning a permanent disposal facility for HLW, under NRC licensing and regulation.
    - U. S. DOE - Developments in 2009: DOE is now considering alternatives to locating a HLW disposal facility at Yucca Mountain.
    - U.S. Environmental Protection Agency (EPA) is responsible for developing site-specific environmental standards for use in evaluating the safety of a geologic repository.
    - U.S. NRC is responsible for developing regulations to implement the EPA's safety standards, and for licensing and overseeing the construction and operation of the repository.

Nuclear Fuel Cycle

- Conclusion:
  - NRC and Other Federal Agencies Together
  - NRC Mission:
    - Promote common defense and security
    - Protect the environment
    - Protect public health and safety