Perspectives in Radioactive Waste Management

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NEA TDB course on the thermodynamic data collection and assessment
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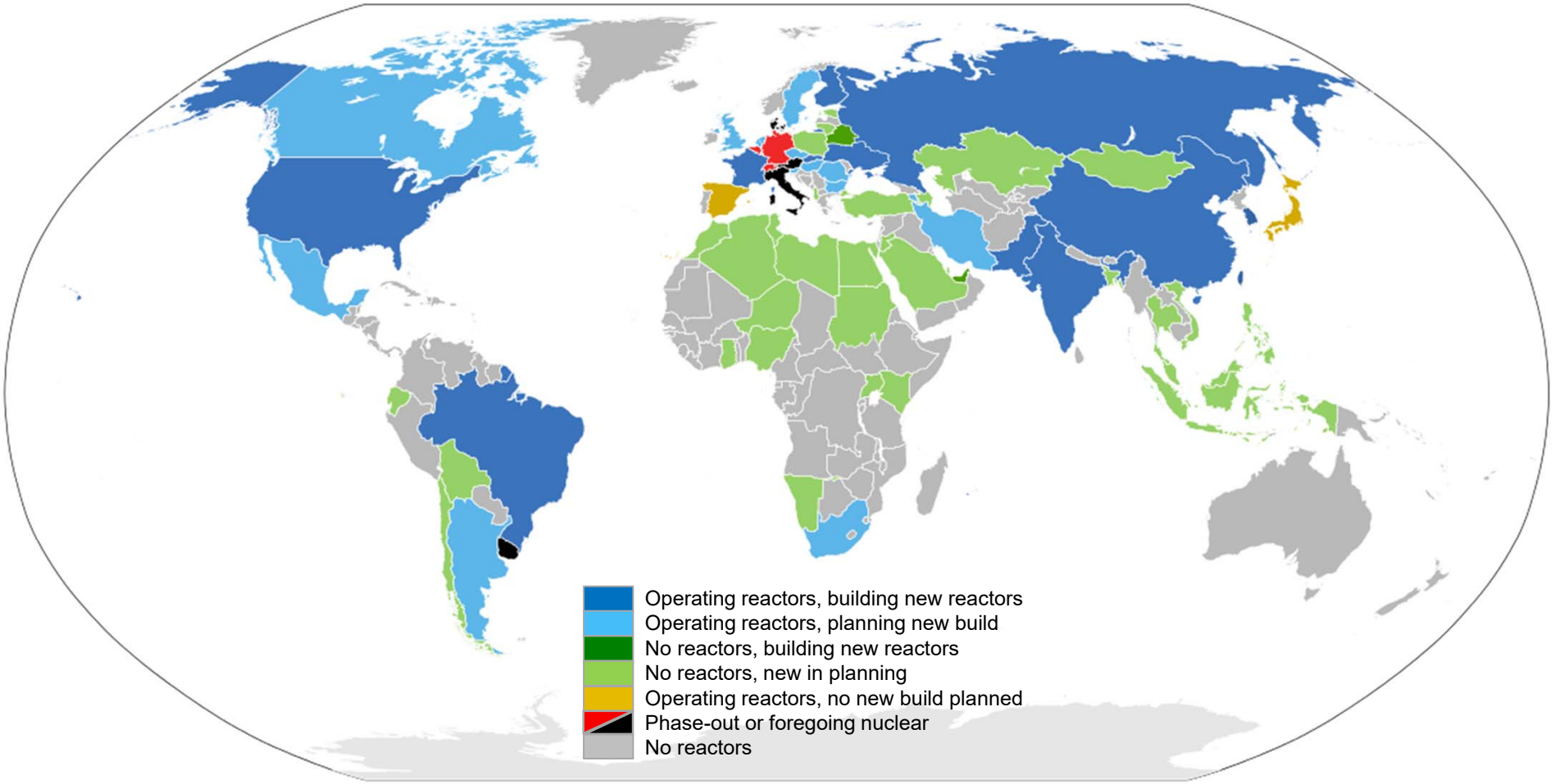
Global View of Nuclear Power Today



Source data: World Nuclear Association
Update 2015

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Nuclear Power Plants

- ~ 430 operating worldwide
- ~66 under construction
- International Atomic Energy Agency (IAEA) information
- Many designs
- Issue of Aging

Dungeness B (UK) uses advanced gas-cooled reactor

Civaux (France) using pressurized-water reactors

Diablo Canyon(USA) 4-loop pressurized water reactor

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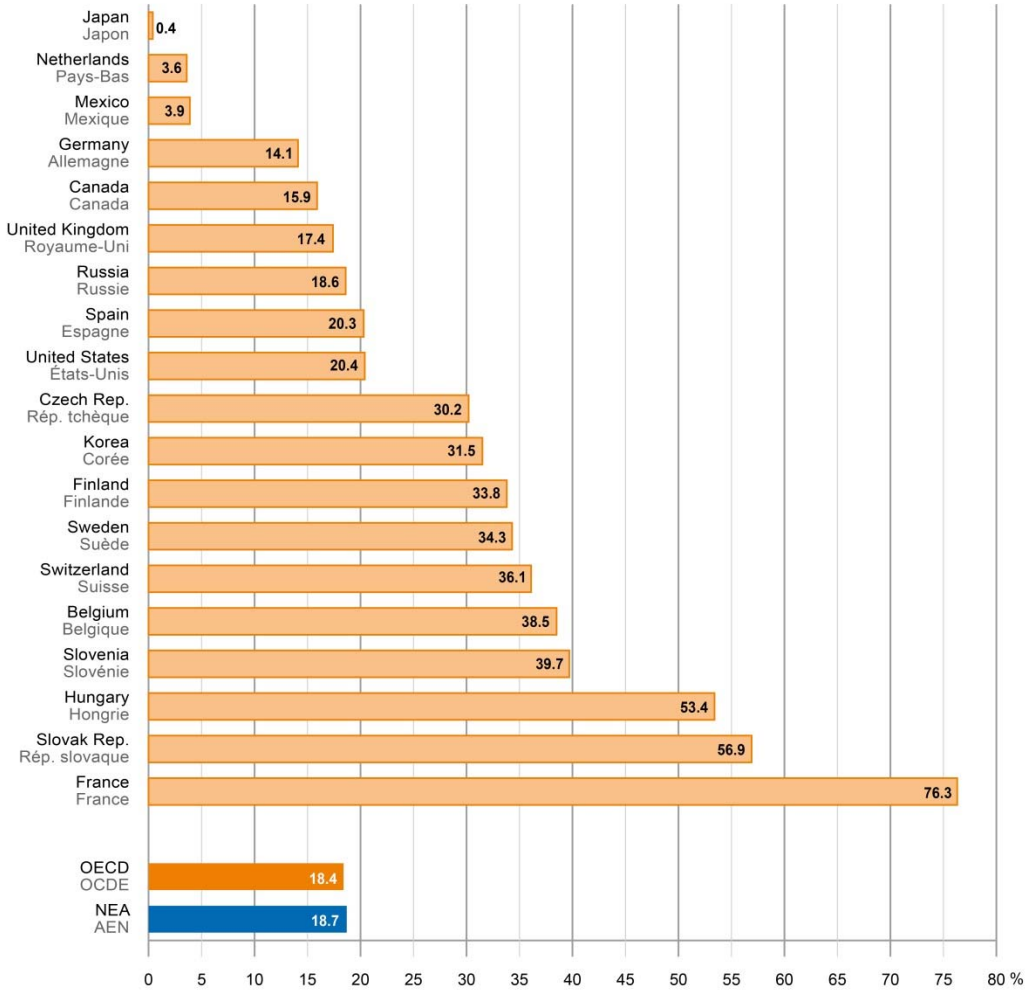
Nuclear power share of total electricity production (1 January 2016)



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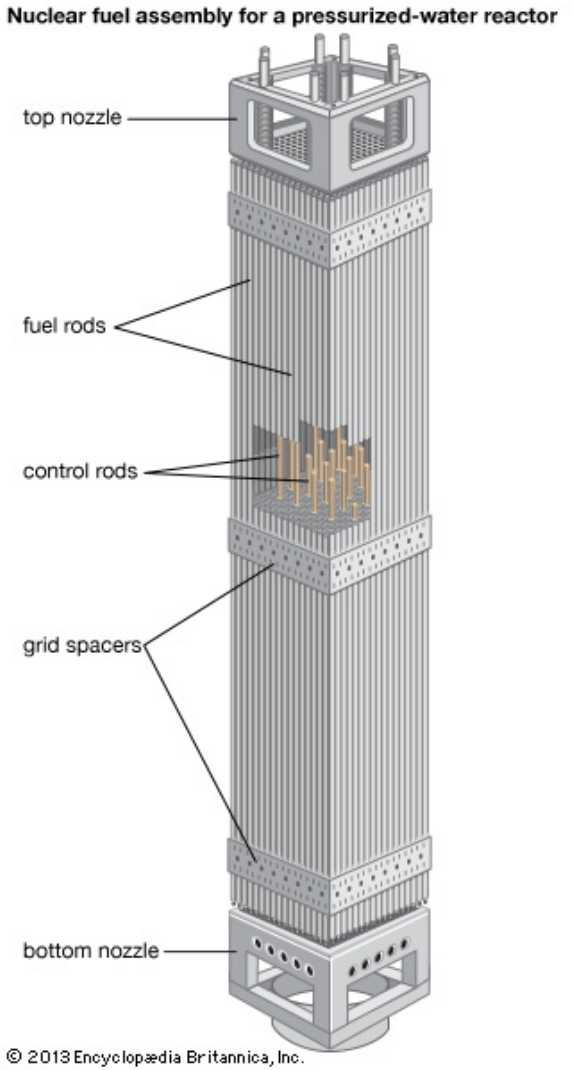
Spent Fuel – the source of nuclear waste

- Spent fuel is uranium oxide fuel that has completed its irradiation cycle in the reactor
- It is 95 to 96% uranium with a remaining enrichment level of U-235 that is approximately that of natural uranium
- It is 1% plutonium, and 0.1% other actinides
- It is 3-4% fission products (Sr, Cs, Tc, and many others)



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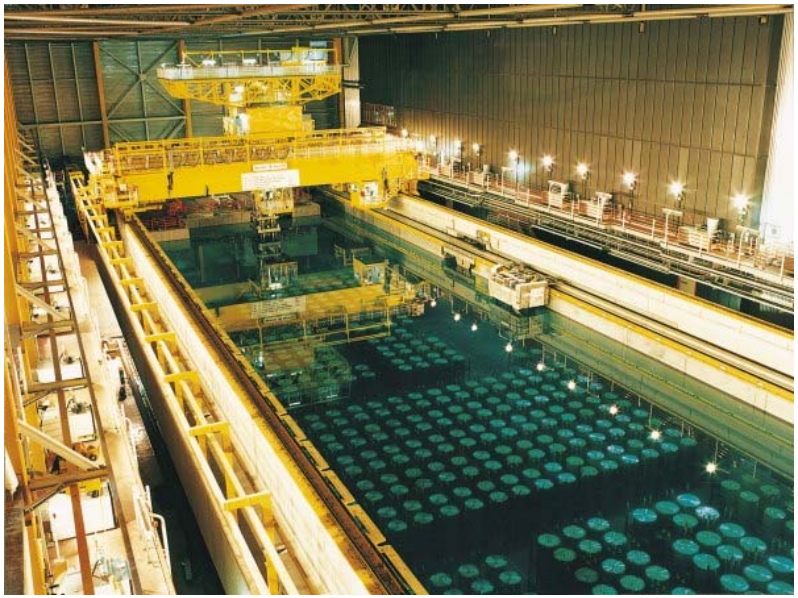
Fate of Spent (Used) Fuel

Dry Storage Vaults at Idaho National Laboratory (USA)



Used Fuel Storage Pond at Sellafield (UK)

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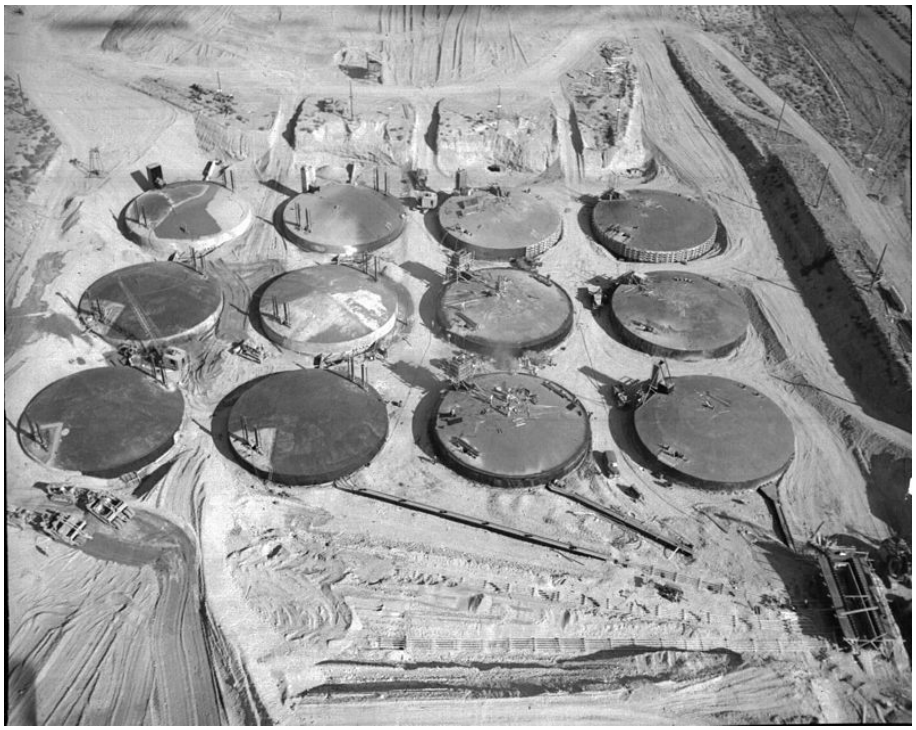
Liquid Nuclear Waste from Reprocessing

Store in Tanks or Seepage ponds (pre 1970 in the US)



Hanford Waste Storage Tanks

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Solid Radioactive Waste

Solids become low level or intermediate (TRU) waste

Low level waste
Shallow land burial

- **Medicinal waste (a good thing)**
- **Nuclear research labs**

Transuranic Waste in the WIPP

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Surface Contamination in Seepage Ponds

Example here is Mayak – but there are many throughout the nuclear world where significant reprocessing activities took place

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Mistakes Happen

Three Mile Island accident, 1979 Pennsylvania, USA

Chernobyl, 1986. Ukraine

Fukushima, 2011. Japan

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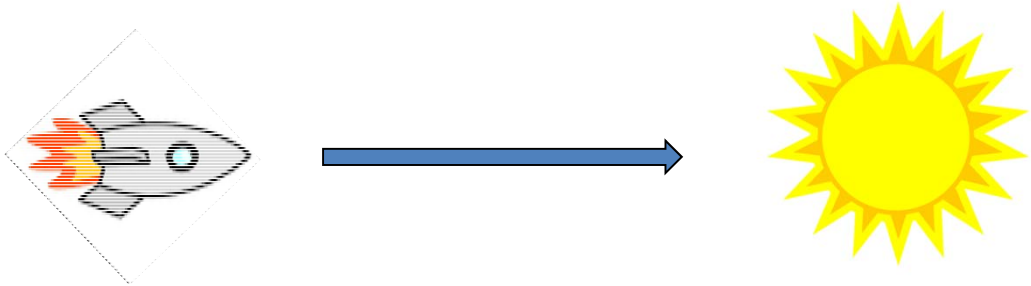
Nuclear Repository/Remediation Concepts
Many have been proposed over the years

- Deep seabed disposal (dilution is the solution)
- Ice cap meltdown
- Put in a rocket ship and send into the sun
- Transmutation
- Recycle actinides to burn up
- Geologic isolation before/after Reprocessing
- Deep borehole concept

- What is missed?



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Repository Updates
Europe and Canada

- Repository projects in a few countries are advanced
  - Sweden: SKB
    - application for a site licence at Forsmark (in granite) for a repository for spent fuel is in process
  - Finland: Posiva
    - application in 2012 for a construction license for a repository for spent fuel in Olkiluoto (approved by STUK)
    - expected to apply for an operating licence for the repository (also in granite) in 2020
  - France: Andra
    - has moved to an industrial phase and has submitted its license application (in Clay) in 2015
- Other countries are in a step-wise siting process
  - Switzerland, Canada, and the UK

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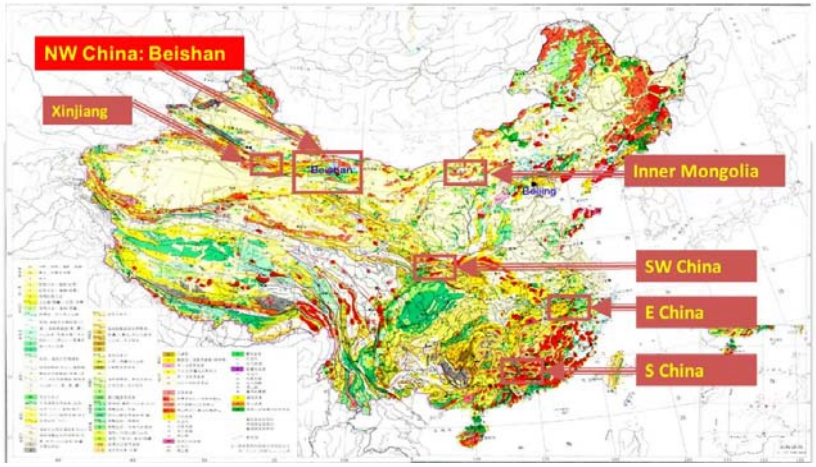
Repository Updates – cont.
China, Korea and Japan

China

- **Beishan region selected in 2015 (granitic site) – down-selected from 6 sites**
- **3 candidates evaluated to 1 repository (by 2050)**



Stepwise siting process in Japan and Korea

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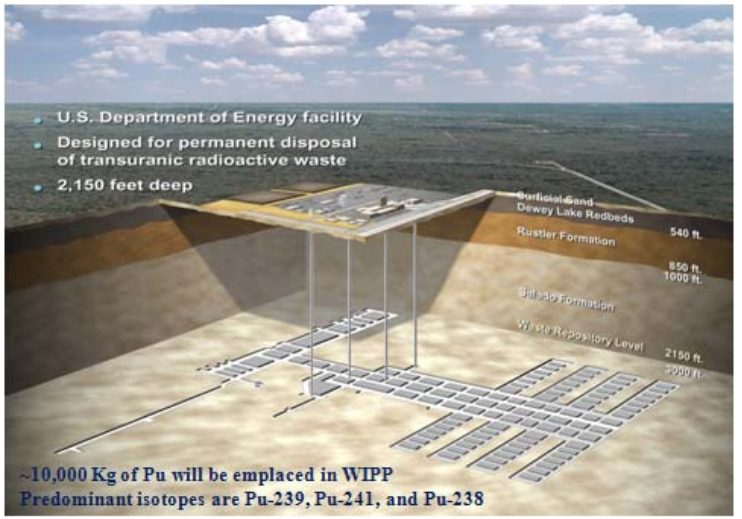
Repository Updates – cont.
United States

- **WIPP TRU repository continues to operate**
  - Defense waste focus
  - Possibly high level defense waste (reprocessed waste)
- **Spent fuel and HLW is yet undecided**

WIPP
Existing TRU Repository
Operating since 1999



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Nuclear Waste is not a "choice" it is a "reality" and its solution will span several generations of scientists, regulators, and politicians.

- This means that we should/must evaluate paths forward today, but understand that they will evolve with time due to cultural change and scientific progress
- A sustained and managed effort is needed to provide a high-quality peer-reviewed thermodynamic database throughout this timeframe – primary mission of the NEA-TDB

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