



The Way Forward in  
the US: Nuclear Waste  
Management

Yucca Mountain

Allison  
Macfarlane

AAAS

San Diego

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# Disclaimer

- \* I do not represent the views of the Blue Ribbon Commission on America's Nuclear Future
- \* I simply present here my own views on nuclear waste disposal

# The Waste Situation

- \* No country has solved the nuclear waste problem after almost half a century of nuclear energy use
- \* International consensus on geologic repositories as the solution to the waste problem; none opened for high-level waste

# The US Waste Situation

- \* Obama administration doesn't support nuclear Waste disposal at Yucca Mountain
  - \* Funding for FY 2011 was zeroed in Obama budget
  - \* YM DOE program shutting down
- \* Established a Blue Ribbon Panel to evaluate potential solutions to the waste problem

# Siting a Geologic Repository

- \* Use multi-barrier system
  - \* Natural: long travel times, dilution in groundwater, sorption
  - \* Engineered: waste form, canisters
- \* Siting Criteria (from IAEA, 2003)
  - \* Long-term tectonic stability
  - \* Low-groundwater content and flow
  - \* Stable geochemistry at depth, including a reducing environment and equilibrium between rock and water
  - \* Excavatable
  
  - \* Also need
    - \* Deep enough, large perimeter/far from populations - but accessible to transport
    - \* No potential for human intrusion



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# Is Yucca Mountain a Reasonable Site?

- \* Depends on time frame
  - \* For 1,000 years, yes
  - \* For  $\geq 10,000$  years, maybe not
- \* Violates 2 of 4 IAEA siting criteria
  - \* Tectonically active
  - \* Oxidizing (not reducing) geochemical environment within the repository
- \* Thus requires more "engineered fixes" and there is greater uncertainty as to how the repository will perform over time compared to sites in other countries

# Are There Alternatives to Repositories?

- \* Short answer: No
- \* Other Waste Management Strategies
  - \* Long-term above-ground storage
  - \* Reprocessing
    - \* Both Still require a repository eventually
- \* Countries with repository programs
  - \* Sweden, Finland, France, Germany, UK, Canada, China, Russia, Switzerland, Japan
  - \* Of above, those that reprocess
    - \* France, Germany (no longer), UK, China (just beginning to), Russia, Switzerland (no longer), Japan



# Reprocessing as Waste Management

## \* Advantages

- \* Extends uranium resource
- \* Reduces volume of long-lived actinides
- \* Can tailor waste form to repository

## \* Disadvantages

- \* Still need a repository
  - \* Size about same if reprocess or not
- \* Not cost effective (never has been)
- \* Increases overall waste volume
  - \* intermediate and low-level
- \* Proliferation risks

# Reprocessing's effects on repository capacity

- \* Doesn't reprocessing reduce the volume of waste?
  - \* From 20 tonnes spent fuel reprocessing makes
    - \* 2-4 tonnes HLW
    - \* 20-30 tonnes ILW
    - \* 70-95 tonnes LLW
- \* BUT: volume is not the appropriate unit of measure for determining capacity
  - \* heat production and concentration of low-solubility species

# Reprocessing's Effects on Repositories

- \* Spent MOX fuel
  - \* Not recycled
  - \* 3 times heat output of spent LEU fuel
    - \* needs more capacity
  - \* 25% more I-129 in spent MOX
  - \* 2 times minor actinides in spent MOX
  
- \* Separated Pu
  - \* Countries that reprocess generate large stockpiles of separated Pu

# Potential Solutions

- \* If Yucca Mtn is abandoned
  - \* We still need a repository
  - \* If there's an expansion of nuclear power, may need multiple repositories
    - \* 20-30 Mt spent fuel/Gwe/yr
    - \* For 400 Gwe, 8,000-12,000 Mt/yr
  - \* Will likely need >1 repository even if Yucca Mtn approved because of capacity constraints
  - \* Multiple repositories may restore a sense of fairness to waste issue – share the burden

# Potential Solutions

- \* Rethink repository siting
  - \* Need new **criteria**
    - \* Based on IAEA criteria
    - \* Need geologists involved in decision-making
  - \* Need to develop a **process** for siting
    - \* German plan (AkEnd)
      - \* Seek all sites that fit geologic criteria
      - \* Seek subset based on weighted criteria
      - \* Select 3-5 for surface exploration
      - \* Give communities at identified sites opportunity to reject sites
      - \* Select 2 sites for subsurface exploration
      - \* Give communities opportunity to weigh in
      - \* Site selection

# How to Evaluate Sites?

- \* How to down-select among a few sites?
- \* Use best geologic judgment available
- \* Compare sites – do not evaluate one in a vacuum
- \* Rethink radiation dose standards for sites
  - \* What does 15 mrem/yr limit at 10,000 years really mean? What does 350 mrem/yr at 1,000,000 years mean?
  - \* What is reasonable?

# Solutions

- \* Reprocessing not a good solution
  - \* Plenty of U, expensive, creates more waste, still need a repository
- \* Best solution for high-level nuclear waste: geologic repositories
  - \* Yucca Mt may not be suitable for the long-term
    - \* Tectonically active, oxidizing environment
  - \* Most likely, we'll need more than Yucca Mtn
  - \* We need a "Plan B" for high-level waste in the US
    - \* Interim storage for now
    - \* Seek alternative sites for repositories
    - \* Need to have multiple repositories
      - \* Ensures that burden perceived to be shared
      - \* Ensures that nuclear power can expand without constraints of waste
    - \* Need to move waste management out of the DOE
    - \* Need to rethink site evaluation – no more performance assessment as the sole "decider"
- \* Can we resolve waste problem before large expansion of nuclear?

