

# Deep Borehole Disposal

## The retrieve-ability conundrum

Rod McCullum  
Waste Management 2017  
Phoenix AZ  
March 8, 2017

# Retrieve-ability

Sec. 122. Notwithstanding any other provision of this subtitle [42 U.S.C. 10131 et seq.], any repository constructed on a site approved under this subtitle [42 U.S.C. 10131 et seq.] shall be designed and constructed to permit the retrieval of any spent nuclear fuel placed in such repository, during an appropriate period of operation of the facility, for any reason pertaining to the public health and safety, or the environment, or for the purpose of permitting the recovery of the economically

valuable contents of such spent fuel. The Secretary shall specify the appropriate period of retrievability with respect to any repository at the time of design of such repository, and such aspect of such repository shall be subject to approval or disapproval by the Commission as part of the construction authorization process under subsections (b) through (d) of section 114 [42 U.S.C. 10134(b)-(d)]. [42 U.S.C. 10142]



## NRC Regulations

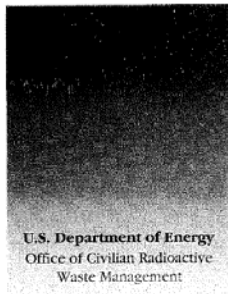
### § 63.111 Performance objectives for the geologic repository operations area through permanent closure.

(e) *Retrievability of waste.*

(1) The geologic repository operations area must be designed to preserve the option of waste retrieval throughout the period during which wastes are being emplaced and thereafter, until the completion of a performance confirmation program and Commission review of the information obtained from such a program. To satisfy this objective, the geologic repository operations area must be designed so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated, unless a different time period is approved or specified by the Commission. This different time period may be established on a case-by-case basis consistent with the emplacement schedule and the planned performance confirmation program.



*The  
Nuclear Waste  
Policy Act,  
As Amended  
With Appropriations  
Acts Appended  
February 1995*



U.S. Department of Energy  
Office of Civilian Radioactive  
Waste Management

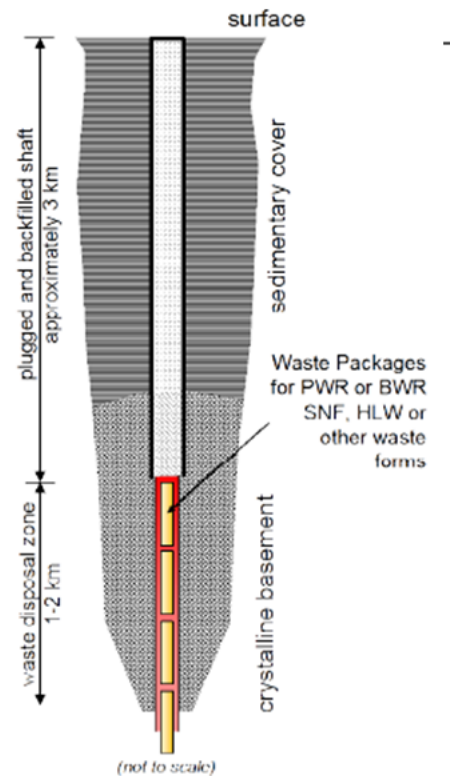
## 3 Reasons why is retrieve-ability important

1. The waste might have resource value
2. Safety concerns might be identified after emplacement
3. Future generations might be smarter than us

# The Conundrum

- Deeper disposal is intuitively safer
- Deeper disposal is intuitively less retrievable, or not retrievable at all

## Reference Concept\*



\* Brady et al., 2009. SAND2009-4401  
Arnold et al., 2011. SAND2011-6749

# Commercial Used Fuel – Size Matters

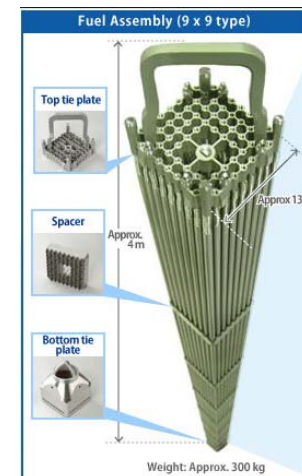
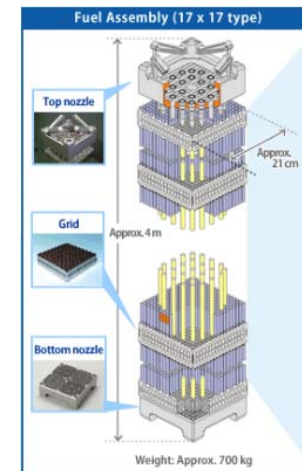
## Feasibility of Borehole Deployment vs. Depth and Diameter

(adapted and expanded from Beswick, 2008)

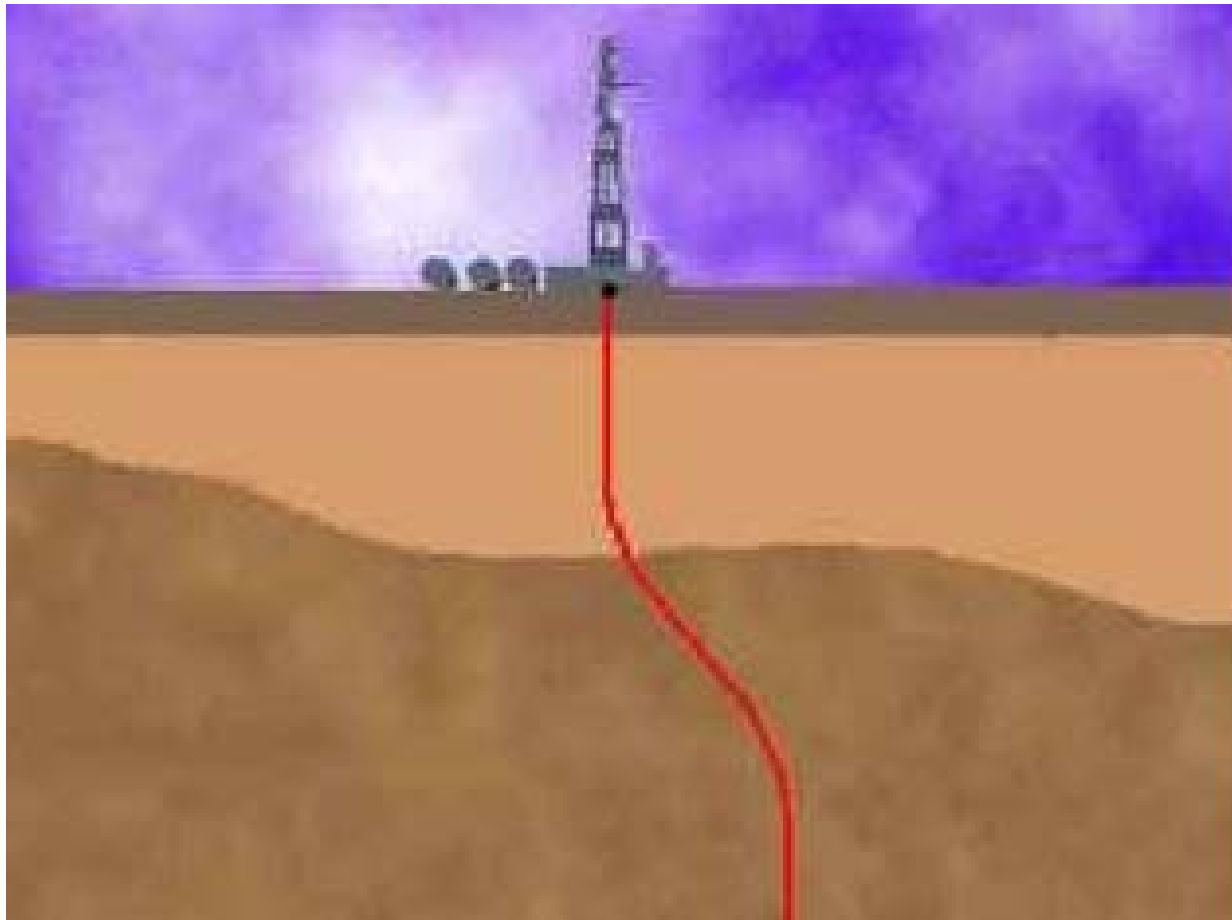
GREEN = mature; YELLOW = feasible; RED = further RD&D

		Internal Clearance of Bore (Diameter)							
		Small		Medium		Large		Very-Large	
		<0.1-m	0.1-m (4-in)	0.3-m (12-in)	0.5-m (20-in)	0.75-m (30-in)	1.0-m (39-in)	>1-m	
Depth (km)	Shallow	0.5--1	█	█	█	█	█	█	<b>A</b>
	Medium	2	█	█	█	█	█	█	█
		3	█	█	█	█	█	█	█
	Deep	4	█	█	█	<b>B</b>	<b>E</b>	█	█
		5	█	█	█	<b>D</b>	<b>F</b>	█	█
	Very-Deep	6--12	█	<b>C</b>	█	█	█	█	█

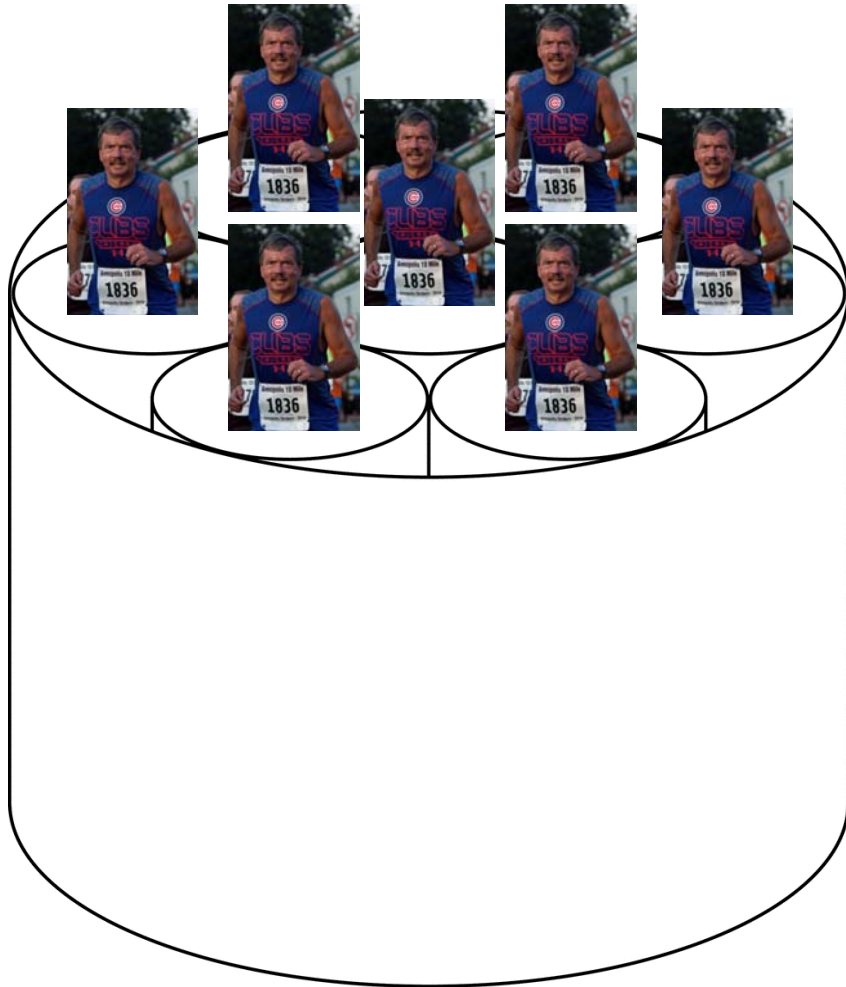
**Zone A:** Diamond mining in Kimberlite deposits, underground nuclear weapons testing, drilling of mine shafts  
**Zone B:** 0.66 m diameter borehole drilled and cased to 3.8 km  
**Zone C:** Three scientific boreholes drilled to depths beyond 5 km: 6.7 km, 9 km (0.165 m diameter) and 12.2 km (0.215 m diameter).  
**Zones D – F:** demonstrations needed to extend technology



# What would the way down look like?



# Rod Consolidation?



- Nobody in the commercial nuclear industry thinks this is a good idea
- Trading real present day operational costs and risks for uncertain long-term benefits is not good policy
- Even intact assembly disposal in deep boreholes would require significant fuel handling.

# HLW other than Commercial Used Fuel

- Some High-level Waste is in a form that is more amenable to DBD
  - These wastes are unlikely to have resource value
- Commercial used fuel could be reprocessed into a form that is more amenable to DBD
  - Enables the resource to be separated and saved
- In both cases reason #1 for retrieve-ability is eliminated, but reasons #2 and #3 remain



# Safety and Deep Borehole Disposal

- To scientists, going deeper is intuitively safer
- To the some, even an empty borehole is a scary prospect

## Test Drilling for Possible Rad Waste Disposal, Rejected in North Dakota, Faces Opposition in South Dakota

*Energy Dept. Eyes 26 States for Potential "Deep Borehole" Experiments*

By John LaForge

The US Department of Energy (DOE)—always looking to dispose of radioactive waste—was recently told to leave Pierce County, North Dakota where the agency had proposed one of its current radioactive waste experiments.

The DOE wants to drill large-diameter boreholes more than three miles into the earth to evaluate rock formations for potential deep disposal of high-level radioactive waste left from nuclear weapons production.

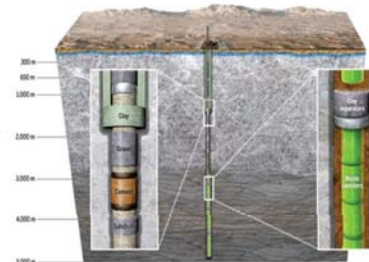
A February 16 public hearing in Rugby, the county seat, was attended by almost 300 opponents—both residents and political officials—who demanded guarantees that radioactive materials would never be a part of the test drilling.

The Battelle Memorial Institute, Inc.—with 22,000

Waste fuel rods—the vast majority of high-level radioactive waste—"have been ruled out as too big to easily fit in these boreholes," *Science* reported.

Warren Cornwall writing for the magazine said, "But [Energy Secretary Ernest] Moniz has said it could be ideal for some kinds of waste, particularly 1,936 slender, half-meter-long tubes of highly radioactive cesium-137 and strontium-90. Those are currently stored in a pool of water at a federal nuclear facility in eastern Washington State."

These "capsules" of cesium and strontium had been scheduled to be directly disposed of inside Yucca Mountain, in Ne-



The Department of Energy is considering drilling three-mile-deep boreholes to test the viability of granite bedrock as a potential disposal method for high-level radioactive waste.

- Demonstrating the safety of deep borehole disposal will require much more than scientific intuition
  - E.g. years of research in willing host communities
  - Would divert resources away from conventional repository programs

# The real value of Deep Borehole Disposal

# OPTIONALITY

# Retrieve-ability and Deep Borehole Disposal

- Future generations might be smarter than us



- Knowledge that research\* on this alternative is ongoing (or planned) could bolster confidence in conventional disposal – in case a need or desire to retrieve arises in the future
  - And provide economic benefits in repository host communities

# Questions?

Rod McCullum

Nuclear Energy Institute

[rxm@nei.org](mailto:rxm@nei.org)

202-739-8082