Regulatory and Licensing Topics Relevant to Deep Borehole Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States

SNL-MIT Workshop on Deep Borehole Disposal

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The Nuclear Waste Policy Act

- **No disposal options other than Yucca Mountain are possible without amending the NWPA**
  - **Sec. 113(c)(3): "If the Secretary at any time determines the Yucca Mountain site to be unsuitable for development as a repository, the Secretary shall…**
    - **(F) report to Congress [within 6 months with a] recommendation for further action, … including the need for new legislative authority."**
- **If Yucca Mountain does not receive a construction license, no federal interim storage options are possible without amending the NWPA**
  - **Sec. 148(d)(1): "construction of such facility may not begin until the Commission has issued a license for the construction of a repository under section 115(d)."**

The Nuclear Waste Policy Act (cont.)

- Special provisions potentially relevant to deep boreholes
  - Sec. 161(d): Additional site criteria specific to crystalline rock should such sites be considered at any time after enactment
    - "seasonal increases in population"
    - "proximity to public drinking water supplies, including those of metropolitan areas; and"
    - Impacts on tribal lands

The Nuclear Waste Policy Act (cont.)

- **Retrievability**
  - **Sec. 122. "Notwithstanding any other provision of this subtitle, any repository constructed on a site approved under this subtitle 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." [emphasis added]**

Regulations for Long-term Performance of Repositories

- Yucca Mountain regulations (40 CFR part 197 and 10 CFR Part 63) apply only to Yucca Mountain
- Existing regulations that predate the 1987 NWPA amendment could, in principle, be applied to other disposal concepts for SNF/HLW without revision
  - EPA 40 CFR part 191 (implemented for the Waste Isolation Pilot Plant [WIPP])
  - NRC 10 CFR part 60 (never implemented)

Regulations for Long-term Performance of Repositories (cont.)

1985 EPA Standard 40 CFR part 191 (revised 1994)

- 10,000-yr Containment Standard (cumulative release)
  - Requires consideration of human intrusion
    - 30 boreholes/sq km/10,000 yr for repositories "in proximity to sedimentary rock formations," 3 boreholes/sq km/10,000 yr for other locations
  - Release limits normalized to initial inventory
  - Cumulative limits remove uncertainty associated with exposure pathways and future human lifestyles
- 10,000-yr Individual Protection Standard (15 mrem/yr)
  - Undisturbed performance only (no intrusion)
- 10,000-yr Groundwater Protection Standard
  - Undisturbed performance only (no intrusion)

Regulations for Long-term Performance of Repositories (cont.)

- 1983 NRC Standard 10 CFR part 60 (revised 1985-1996)
  - Requires compliance with EPA standards at 40 CFR 191
  - Also requires
    - Substantially complete containment in waste packages for 300 years
    - Release rate of each radionuclide from the engineered barrier system shall not exceed one part in 100,000 per year of the inventory of that nuclide at 1000 years
    - Fastest path of likely radionuclide travel to the accessible environment shall be at least 1,000 years

Implications of Existing US Regulations for Deep Borehole Disposal

- 40 CFR part 191
  - Normalized cumulative release standard could apply same standard to single boreholes or disposal arrays
    - Total allowable release for large disposal arrays could be relatively large
  - Retrievability is required to be possible
    - 40 CFR 191.14(f): "Disposal systems shall be selected so that removal of most of the wastes is not precluded for a reasonable period of time after disposal."
    - "..any current concept for a mined geologic repository meets this requirement…" "Rather, it is intended to call into question any other disposal concept that might not be so reversible…" (EPA 1985, 38082 FR 50)
  - Human intrusion specifications may be inappropriate for deep boreholes
- 10 CFR part 60
  - Subsystem requirement for the waste package may be inappropriate for deep boreholes
  - Allows irretrievability with license amendment
    - 10 CFR 60.46(a)(1) "an amendment shall be required … [for] any action which would make emplaced high-level radioactive waste irretrievable…"

Implications of Existing US Regulations for Deep Borehole Disposal (cont.)

- Regulation of Underground Injection Wells under the Safe Drinking Water Act of 1974
  - 40 CFR parts 144-148 set requirements for Federal Underground Injection Control Program
  - Regulations focus on subsurface injection of fluids, but may apply to deep borehole disposal
  - 40 CFR 146.5(a) defines Class 1, Type 3, injection wells as: "Radioactive waste disposal wells which inject fluids below the lowermost formation containing an underground source of drinking water within one quarter mile of the well bore"
  - Permitting authority varies from state to state
    - Compliance with 40 CFR part 144 was considered for WIPP; DOE concluded that emplacement in WIPP did not constitute "injection" (DOE/CAO-1996-2184, BECR Section 8.1)

International Perspectives

- **International Atomic Energy Agency**
  - ***Geological Disposal of Radioactive Waste,* Safety Requirements No. WS-R-4 (2006)**
    - **Section 1.14: "Geological disposal, as a concept, encompasses a range of options, including disposal in specially mined and engineered facilities, disposal in pre-existing mines and excavations, and disposal in deep boreholes."**
    - **Section 1.8: "The *operational period* … may include activities for waste retrieval, if considered necessary, prior to closure…"**

Perspectives on Retrievability

- **Ethical, social, and political considerations are probably beyond the scope of this workshop**

- **Two quotes to consider**
  - **“**The introduction of provisions for retrievability must not be detrimental to long-term safety. Thus, for example, locating a repository at a depth that is less than optimum from a long-term safety perspective in order to facility retrieval is unlikely to be acceptable….” (NEA 2001, *Reversibility and Retrievability in Geologic Disposal of Radioactive Waste: Reflections at the International Level)*
  - “… deep borehole systems may not be the best choice if permanent and irreversible disposal is not intended.” (Brady et al., 2009)

backup

Dose vs. Cumulative Release Standards

- **Dose**
  - Emphasis on low annual dose or risk
  - Can be open-ended in time (or to peak dose)
  - Uncertainty in human behavior (e.g., water use and diet) is large
  - Encourages dilution and gradual release as well as isolation
  - Encourages smaller initial inventories
- **Cumulative Release**
  - Emphasis on isolation
  - Meaningful only for specified time period
  - Allowable limit is a function of time
  - Focuses on uncertainty in barrier system performance
  - No benefit for dilution
  - Normalization to initial inventory (as in 40 CFR 191) removes incentive for smaller repositories

Implications for Deep Borehole Disposal (cont.)

- Any new standards are likely to be based on annual dose or risk
  - Consistent with IAEA guidelines and recommendation of the 1995 National Academies report on Yucca Mountain standards
- Any new standards are likely to extend to 1 million years
  - Consistent with recommendation of the 1995 National Academies report on Yucca Mountain standards
- It may be appropriate for new standards to reconsider
  - Human intrusion scenarios
  - Retrievability