Geologic Disposal

Elements of Technically Credible, Workable, and Publicly Acceptable Regulations

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Why Are Regulations Necessary?

The primary purpose of geologic disposal is to contain the waste and isolate radionuclides from the biosphere for long periods of time

- Regulations provide the framework for developing a disposal system with robust containment and isolation
- Regulatory standards provide performance objectives for evaluating containment and isolation, e.g.
  - Projected risk/dose to a designated receptor
  - Movement of radionuclides into the accessible environment
  - Concentration of radionuclides in environmental media
  - Latter two not directly related to impacts on humans

How Long to Apply Standards?

There is growing acceptance that periods up to 1 million years (or longer) must be considered, but no consensus on how to do this

- Significant uncertainties in projecting dose/risk
- Geologic indicators may be more predictable

What about EPA standards?

- 10,000-year “generally applicable” standard in 40 CFR part 191 upheld by First Circuit (1987)
- 1 million-year standard in 40 CFR part 197 predicated on Yucca-specific statute and NAS recommendation

What is the obligation to future generations?

Demonstrating Compliance

Performance assessment generates results that are compared to quantitative standards (risk/dose)

BUT

Regulatory judgment cannot simply compare generated results to the standard as pass/fail

- A poor site may "engineer" results for >10,000 years
- Is it "unsafe" to exceed standards at ~1 million years?

We can't "prove" these projections are correct, so EPA requires "reasonable expectation" that the standards will be met (based on the "full record")

Performance Assessment

Performance assessment is “tip of the iceberg”

- Site characteristics, history, stability
- Conceptual site model
- Field and laboratory studies (chemistry, materials, etc)
- Natural analogs
- Mathematical models (complex and simplified)
- “Reasonable expectation” includes these and more

Meaning of projections is increasingly questionable

- Assume human behavior is same in far future
  - This is almost certainly wrong, but what is right?
  - No other basis for projecting future societies (NAS)
- Dose/risk provides a benchmark, not a prediction

What Can We Learn From Others?

Finland: annual dose for "several thousand years"

- Annual release limits thereafter (related to background)

France: annual dose for 10,000 years (calculations thereafter)

Germany: lifetime risk for 1 million years OR

- Annual dose based on radionuclide releases

Sweden: annual risk for 100,000 years (calculations for up to 1 million)

Switzerland: annual dose for 1 million years (calculations to peak)

- Annual risk for "unlikely" scenarios

UK: "risk guidance level" to peak risk

All of these:

- emphasize increased uncertainty and use of supplemental or qualitative information at long times in making regulatory judgments
- address "unlikely" or disruptive scenarios in a separate analysis, sometimes with no standard applied
- use critical group (Germany unclear), sometimes larger population
- EPA's standards take conceptually similar approaches

References

Proposed/Final Rules:

- 40 CFR part 191
  - 47 FR 58196, December 29, 1982
  - 50 FR 38066, September 19, 1985
  - 58 FR 7924, February 10, 1993
  - 58 FR 66398, December 20, 1993
- 40 CFR part 197
  - 64 FR 46976, August 27, 1999
  - 66 FR 32074, June 13, 2001
  - 70 FR 49014, August 22, 2005
  - 73 FR 61256, October 15, 2008

Supplemental Material: (available through EPA)

- Response to Comments on 1999 Proposed Rule
- Response to Comments on 2005 Proposed Amendments