

History of Repository Regulations

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Overview

- Regulatory authorities
- Timeline of regulatory development
- Initial regulations
- 1987 Court remand and public review
- 1992 WIPP and Yucca Mountain split
- WIPP regulations and implementation
- Yucca Mountain regulations and implementation

Regulatory Authorities

- EPA
 - NWPA: "generally applicable standards for protection of the general environment from offsite releases from radioactive material in repositories"
 - RCRA: regulation of mixed (radioactive and hazardous) waste
- NRC - technical requirements and criteria for use in licensing repositories, consistent with EPA standards
- DOE – guidelines for recommending sites for repositories

Regulatory Development Timeline



EPA 40 CFR 191 (1985)

- For geologic repositories for transuranic waste, high-level waste, spent fuel
- Three components
 - Basic “containment” requirements – limit impacts on affected populations
 - Protection requirements – for individuals and ground water near repository
 - Assurance requirements – enhance confidence in compliance
- “Controlled area” around repository not subject to requirements

Containment

- Protects populations, not individuals, through limits on quantities of materials released from repository
 - Releases that could produce 1,000 premature deaths in 10,000 years per 100,000 metric tons
 - Based on analyses of generic repositories
 - Comparable to impacts of uranium ore bodies
 - Based on capability of the technology
 - Limits selected “because mined geologic repositories appear capable of providing such good protection”
 - Not to be interpreted as setting a level of "acceptable risk" that should not be exceeded under any circumstances
- Regulates probability of exceeding limits
 - Compliance shown with Performance Assessments (PA)
 - Take into account "all significant processes and events that may affect the disposal system"
 - Include inadvertent human intrusion (drilling for resources)
 - Feasibility of implementation in licensing questioned

Containment, cont.

- 10,000 year performance period
 - Long enough to allow definitive judgments about relative capabilities of sites and media
 - Substantially longer period rejected because it would entail considerably more uncertain calculations
 - EPA endorsed comparative site evaluations to 100,000 years included in DOE siting guidelines
- “Reasonable expectation” standard of proof
 - “Unequivocal proof of compliance is neither expected nor required because of the substantial uncertainties inherent in such long-term projections”

Protection

- Individual protection: maximum allowable annual radiation doses to individual members of the public (25 millirem)
- Groundwater protection: limits concentrations of and dose from radionuclides in nearby irreplaceable sources of groundwater supplying drinking water for thousands of persons
- Less stringent compliance requirements
 - applicable for only the first 1000 years after disposal
 - assume undisturbed performance of the repository
 - full performance assessment not necessary

Assurance

- Compensate for uncertainties inherent in projecting performance for 10,000 years
- Qualitative requirements for multiple-barrier disposal systems that would
 - not rely upon perpetual maintenance by future generations (PA cannot assume active institutional control after 100 years)
 - be located where it is unlikely there would be exploration for natural resources
 - not preclude removal of most of the wastes in a reasonable period of time after disposal
- Not applicable to NRC-licensed repositories

NRC 10 CFR 60 (1983)

- Nuclear Waste Policy Act specified
 - Use of multiple barriers
 - Stages of licensing
 - Construction authorization
 - License to “receive and possess” (operation)
 - Closure (decommissioning)

Individual barrier requirements

- Must be met in addition to EPA system criteria
 - *Waste package* must provide substantially complete containment of the waste for 300 to 1000 years
 - *Engineered barrier system* must limit release rate of key radionuclides to 1/100,000 per year after 1000 years
 - *Ground-water travel time* from the repository to the accessible environment must exceed 1000 years
 - NRC could approve other values
- Compensate for calculational uncertainties inherent in showing compliance with EPA system performance goal

Other NRC provisions

- Site criteria - specified favorable and potentially adverse site conditions
 - No strict go/no-go disqualifying conditions
 - Evaluation of site must analyze extent to which such conditions contribute to or detract from isolation
- “Reasonable assurance” standard of proof
 - Proof of performance for many thousands of years is not to be had in the ordinary sense of the word
 - “Reasonable assurance” allows for the time period, hazards, and uncertainties involved
- Ability to retrieve waste starting as late as 50 years after end of waste emplacement

DOE 10 CFR 960 (1984)

- Guidelines for screening and recommending sites for repositories
 - Assumed multiple site evaluation and comparison process established by NWPA
 - Based on criteria identified in NWPA
 - Also linked to NRC site criteria
 - Site *comparisons* based on 100,000 year performance projections
- Key issue: use of qualitative vs quantitative disqualifying conditions
 - Guidelines emphasize qualitative conditions for screening and comparisons
 - Final site selection uses PA to evaluate expected ability of site to meet EPA and NRC system performance requirements

1987 Court Remand

- Federal court vacated disposal portion in 1987 and remanded to EPA due to issues related to protection requirements:
 - Unexplained inconsistency of individual dose standard with Safe Drinking Water Act
 - Lack of adequate notice/comment on groundwater protection standard
 - 1000 year period for both protection requirements
- Court upheld
 - 10,000 year performance period
 - Reasonable expectation standard of proof
 - “It would be irrational for the Agency to require proof which is scientifically impossible to obtain”
 - Allowability of groundwater contamination in “controlled area” up to 5km from repository
 - Possibility is inherent in concept of geologic repository

1987-1992

- All major issues reopened for discussion
 - Multiple draft revisions circulated
 - EPRI-sponsored public workshops
 - Congressional hearings
 - NAS Board on Radioactive Waste Management
 - “Rethinking High Level Radioactive Waste Management”
 - Symposium on regulations
 - ACNW, NWTRB comments
- Key issues
 - Workability of quantitative, probabilistic standard
 - 10,000 year limit (too long or too short?)
 - Stringency of release limits
 - Quantitative individual barrier requirements
 - Probabilistic treatment of human intrusion
 - Public perceptions of “changing the standards”

1990 NAS “Rethinking” Report

- Criticized overemphasis on use of models for numeric predictions
 - “Computer modeling techniques and geophysical analyses can and should have a key role in the assessment of long term repository isolation. In the face of public concerns about safety, however, geophysical models are being asked to predict the detailed structure and behavior of sites over thousands of years. The Board believes that this is scientifically unsound and will lead to bad engineering practice.”
- Criticized early, detailed regulations
 - “The United States appears to be the only country to have taken the approach of writing detailed regulations before all of the data are in. As a result, the US program is bound by requirements that may be impossible to meet.”
- Recommended a flexible approach
 - Define goal broadly “in ultimate performance terms rather than immediate requirements so increased knowledge can be incorporated in the design of a specific site”

1992: Congressional Action

- Energy Policy Act of 1992 directs EPA to issue site-specific regulation for Yucca Mountain, based on technical findings and recommendations from the NAS
- WIPP Land Withdrawal Act directs EPA to finalize revision of 40 CFR 191 applicable to WIPP but not Yucca Mountain

WIPP Land Withdrawal Act

Required final version of 191 in one year

- Fix only the parts remanded by the court
- Does not apply to Yucca Mountain
- Made EPA (not DOE) the determining agency for WIPP's compliance
- Required compliance recertification every 5 years
- Exempted WIPP from RCRA land disposal restrictions but not from other RCRA requirements governing mixed waste
 - Implemented by State of New Mexico

WIPP path forward

- EPA issued final rule in 1993
 - Extended compliance period for individual dose standard and ground water standard to 10,000 years
 - Changed individual dose limit to 15 mrem
- EPA issued implementing rule in 1994
 - 40 CFR 194 provided clear guidance on requirements for “reasonable expectation” of compliance
- Regulatory process works
 - EPA certifies compliance in 1998
 - Appeals Court for DC Circuit upholds EPA Certification
 - Operation begins in 1999
 - New Mexico issues RCRA permit in 1999
 - First mixed waste shipment in 2000
 - EPA recertifies compliance in 2006
 - DOE applies for next recertification in 2009

Energy Policy Act of 1992

- Directed EPA to issue “health-based” standard for Yucca Mountain based on dose to individuals
 - “Based upon and consistent with” findings and recommendations of mandated NAS study
- Posed specific questions for NAS
 - Is a health-based standard based on dose reasonable?
 - Can post-closure oversight be assumed to prevent breaches of repository barriers?
 - Can scientifically supportable predictions of human intrusion be made?
- Mandated perpetual oversight of repository
- Directed NRC to assume post-closure oversight could prevent breaches
 - subject to NAS findings

NAS Yucca Mountain Standards Report

- Answered congressional questions
 - Health-based standard based on dose is reasonable
 - If risks from very low doses are deemed negligible
 - Not reasonable to assume post-closure oversight can prevent breach of repository
 - Scientifically-supportable predictions of human intrusion are not possible
- Made specific recommendations and findings
 - Regulate to time of peak dose within limits of geologic stability (up to 1,000,000 years)
 - Regulate based on risk rather than dose
 - Analyze human intrusion using stylized scenario
 - Individual barrier requirements are unnecessary and possibly counterproductive

EPA 40 CFR 197 – Round One

- Initial proposal in 1999, final rule 2001
- 15 mrem individual dose
- Same ground water standard as 40 CFR 191
- Compliance measured no farther than 18 km from repository
- 10,000 year regulatory period
 - Too much uncertainty in peak dose projections
 - DOE EIS to show peak dose projections
- Reaffirmed “reasonable expectation”
- Stylized analysis of human intrusion scenario

NRC 10 CFR 63 – Round One

- Initial proposal in 1999, final rule 2001
- Dropped quantitative barrier requirements
 - Advances in PA eliminated need
 - Substituted requirement for demonstration of existence of multiple barriers
- Included 10 CFR 60 retrievability requirement
- Adopted “reasonable expectation” for postclosure performance, retained “reasonable assurance” for preclosure
 - Specified requirements for PA

DOE 10 CFR 963

- DOE left general siting guidelines in place, developed specific set for Yucca Mountain
- Removed all guidelines related to site comparisons
- Focused on total performance of repository system as test of suitability
 - Eliminated evaluations of individual site characteristics
- Used for site recommendation in 2002

2004 Court Remand

- Multiple challenges to EPA and NRC rules
 - Inconsistency of 10,000 year period with NAS recommendation to regulate at time of peak dose
 - Inclusion of ground water standard
 - 18 km compliance point
 - NRC failure to require multiple independent barriers with primary reliance on geology
- Court rejected all but 10,000 year challenge
 - Vacated EPA and NRC 10,000 year time limits
 - Directed EPA to
 - revise regulation as needed to be consistent with the NAS recommendation, or
 - ask Congress to change the requirements of the Energy Policy Act

EPA 40 CFR 197 – Round Two

- Proposed revision in 2005, final in 2008
- Changed only regulatory time frame
- Adopted a two-tier approach
 - Retained 15 mrem for first 10,000 years
 - 100 mrem for peak dose (to 1,000,000 years)

NRC 10 CFR 63 – Round Two

- Incorporated EPA's revised standards
- Defined approach for treating climate changes after 10,000 years – per EPA request
- Deemed technical basis for PA to 10,000 years sufficient to support PA to 1,000,000 years

License Application

- Yucca Mountain license application addresses final NRC regulations (incorporating EPA standards)
- Licensing proceeding to test compliance still underway
 - Petition to withdraw LA under consideration
 - NV lawsuits challenging final EPA and NRC rules stayed by DC Circuit pending resolution of petition

Summary

- Developing repository regulations posed unprecedented challenges
- Regulatory development process experienced major delays and reversals
- Repository developers lacked definitive performance standards for extended periods
- Two different sets of regulations have evolved
 - One designed for, applicable only to Yucca Mountain
 - One now in use at WIPP and potentially applicable at other repositories
- A new repository siting process may require more regulatory evolution using insights from experience with both existing sets of regulations