DRAFT PROPOSED NRC REGULATIONS FOR THE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN A PROPOSED GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN

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OUTLINE

- LEGISLATIVE BACKGROUND
- NAS RECOMMENDATIONS
- CONCEPTUAL APPROACH FOR DRAFT PROPOSED 10 CFR PART 63
- TECHNICAL CRITERIA

NUCLEAR WASTE POLICY ACT OF 1982 (NWPA)

- NRC criteria for spent fuel and HLW disposal must
  - provide for use of a system of multiple barriers
  - include restrictions on retrievability
  - not be inconsistent with generally applicable EPA standards

ENERGY POLICY ACT OF 1992 (EnPA)

- EPA must issue new standards for protection from radionuclide releases from a repository at Yucca Mountain that are:
  - Health-based; prescribe maximum annual dose equivalent
  - Based on and consistent with NAS recommendations
  - The only such standards applicable to the Yucca Mountain site
- NRC criteria to conform to final EPA standards within one year

NATIONAL ACADEMY OF SCIENCES (NAS) REPORT: "Technical Bases for Yucca Mountain Standards"

- Limit annual risk to average member of critical group
  - starting point: range of risks equivalent to 0.02 - 0.2 mSv per year
  - international consensus 0.05 - 0.3 mSv per year for HLW disposal
- Define reference biosphere and critical group characteristics by rule
- Evaluate consequences of human intrusion separately using a stylized calculation that is defined by rule
- Imposing subsystem performance requirements might result in suboptimal repository design
- Conduct assessment over time frame that includes peak risk (within limits of geologic stability); no scientific basis for limiting time period

NRC STAFF DRAFT PROPOSED 10 CFR PART 63 CRITERIA: Conceptual Approach

- Performance-based, risk-informed criteria
  - Preclosure and postclosure performance objectives
  - Compliance based on quantitative analyses of system performance
  - No additional quantitative measures (e.g., quantitative subsystem requirements, ground-water protection)
- Geologic repository must include a system of multiple barriers
- Limit potential for speculation during licensing
  - Specify assumptions and characteristics for selection of reference biosphere and critical group
  - Specify calculation and assumptions for consequence analyses of single human intrusion event

PRECLOSURE CRITERIA

- Performance Objective
  - Comparable to those for other operating facilities licensed by NRC
  - Surface facilities and underground operations area designed and operated so that exposures remain within NRC's limits for workers and the public established at 10 CFR Part 20, "Standards for Protection Against Radiation"
- Compliance Demonstration
  - Comprehensive, systematic and quantitative safety analysis
- Requirements for retrievability
- Emergency planning criteria

POST CLOSURE CRITERIA

- **PERFORMANCE OBJECTIVE**
  - Individual Dose Limit of 0.25 mSv/year Total Effective Dose Equivalent
  - Compliance period of 10,000 years
  - Geologic repository includes a system of multiple barriers

- **COMPLIANCE DEMONSTRATION**
  - Performance assessment
  - Characteristics of Reference Biosphere and Critical Group specified for use in performance assessment
  - Separate calculation specified to evaluate consequences of assumed human intrusion

INDIVIDUAL DOSE LIMIT OF 0.25 mSv/yr

- Proposed in absence of EPA standards; NRC regulations will conform to final EPA standards when they become available
- Sole quantitative limit for postclosure performance
- Selected based on consistency with Commission direction and NRC regulation of other related activities
  - Low-level waste disposal
  - Decommissioning
- International constraints vary between 0.05 and 0.3 mSv/yr
- NAS recommended risk equivalent of between 0.02 and 0.2 mSv/yr
- Used for comparison with probabilistic calculation of expected annual dose calculated from repository performance assessment

COMPLIANCE PERIOD OF 10,000 YEARS

- Provides for analyses of a broad range of geologic conditions and degradation processes affecting both natural and engineered barriers
- Radiological hazard of waste decreases significantly over 10,000 years
- Consistent with earlier court ruling, other regulations and NRC guidance
  - U.S. Court of Appeals upheld EPA selection of 10,000 year compliance period for 40 CFR 191
  - Applied at Waste Isolation Pilot Plant (40 CFR 191 & 194)
  - Draft NRC guidance on performance assessment for low-level waste disposal
- Usefulness of analyses for compliance beyond 10,000 years uncertain

PERFORMANCE ASSESSMENT MUST BE DEFENSIBLE AND TRANSPARENT

- Include site data to define all relevant parameters and conceptual models
- Account for uncertainties
- Consider alternative models and provide basis for models used
- Consider events with a 10^{-4} chance of occurring over 10,000 years
- Consider degradation, deterioration, or alteration of engineered barriers
- Support topics most important to performance with greatest rigor
- Use expected annual dose as basis for decision making
- Explain fully how estimated performance is achieved

REPOSITORY MUST INCLUDE SYSTEM OF MULTIPLE BARRIERS

- No quantitative limits placed on performance of individual barriers
- DOE has flexibility in presenting evidence for multiple barriers
  - Identify barriers important to waste isolation
  - Describe their capability to perform as barriers, accounting for uncertainties in their characterization and modeling
  - Provide technical basis for description of barrier capability
- Demonstration of multiple barriers will include
  - Capability of individual barriers to perform their intended function
  - Relationship of that function to limiting radiological exposure
- Understanding of system resiliency is needed to provide defense in depth and enhance confidence that performance objectives will be met

REFERENCE BIOSPHERE & CRITICAL GROUP

- Arid to semi-arid conditions
- Farming community located ~ 20 km down gradient from site
  - Vicinity of U.S. Route 95 and Nevada Route 373, near Lathrop Wells
  - Consistent with present knowledge and conditions (depth to water table, diet includes some locally produced food)
  - Larger water demand of community increases likelihood of intercepting radionuclides
  - Provides for multitude of pathways (ingestion pathway through consumption of contaminated water, crops, and animal products; inhalation and direct pathways from surface contamination)
- Land use, lifestyle, diet, human physiology, and metabolic pathways assumed constant to limit speculation

CONSEQUENCES OF HUMAN INTRUSION

- In a separate calculation, evaluate consequences of assumed intrusion event on total system performance
- Assume a single vertical borehole that penetrates one waste package and creates a pathway to the saturated zone
- Assume intrusion event occurs 100 years after permanent closure