

**U.S. DEPARTMENT OF ENERGY VIEWS ON PROPOSED  
NUCLEAR REGULATORY COMMISSION REGULATIONS  
FOR A POTENTIAL YUCCA MOUNTAIN REPOSITORY**

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**ABSTRACT**

The Nuclear Regulatory Commission (NRC) proposed new regulations for the disposal of spent nuclear fuel and high-level radioactive wastes in a potential geologic repository at the Yucca Mountain site in Nevada on February 22, 1999. The proposed regulations would establish and provide the basis for applying risk-informed, performance-based licensing criteria. The U.S. Department of Energy (DOE) endorses this approach as it allows resources to be focused on technical issues that are of the greatest importance to protecting the health and safety of the public. A total system performance assessment (TSPA) will be used to demonstrate the ability of the proposed repository to meet NRC's postclosure performance objectives. DOE believes that this approach will enable NRC to make a determination of reasonable assurance regarding repository safety following permanent closure. DOE believes that analysis of the highly unlikely human intrusion scenario proposed in the regulations should be used only to assess the resilience of the repository and not compliance with the overall system performance objective. The proposed regulation requires that preclosure performance be evaluated using an integrated safety analysis. DOE agrees with this approach and believes the regulation should clarify that the criteria for consideration of natural design basis events should be consistent with those used for other NRC-licensed facilities. DOE also believes that the performance confirmation requirements of the proposed regulation should not be prescriptive, but should instead allow DOE the flexibility to focus on the key factors used in the performance assessment.

**INTRODUCTION**

In February 1999, NRC proposed new regulations (10 CFR Part 63) (1) that specify licensing criteria for the disposal of spent nuclear fuel and high-level radioactive wastes (HLW) in a potential geologic repository at the Yucca Mountain site in Nevada. Yucca Mountain is the only site approved by Congress for characterization to determine whether it is suitable for development as a geologic HLW repository. If the Yucca Mountain site is found to be suitable and is approved following a recommendation by the Secretary of Energy, DOE must obtain NRC approval for repository construction, receipt and possession of nuclear waste, and, eventually, authorization to close the repository and terminate the license. The proposed regulations would establish and provide the basis for applying risk-informed, performance-based licensing criteria for these NRC decisions.

The proposed criteria focus on overall system performance during the operational period and following repository closure. The proposed regulation does not specify subsystem performance objectives, siting criteria, and other detailed technical criteria, such as those found in the generic regulations for geologic repositories (10 CFR Part 60) (2), which were originally promulgated in

1983. The proposed approach, which is consistent with NRC's ongoing emphasis on the development of regulations that give the highest attention to the issues of most importance to protection of public health and safety, is strongly endorsed by DOE. As stated in the supplemental material published with the proposed regulations, a risk-informed, performance-based regulation "is an approach in which risk insights, engineering analysis and judgement (e.g., defense in depth), and performance history are used to:

- (1) Focus attention on the most important activities,
- (2) Establish objective criteria for evaluating performance,
- (3) Develop measurable or calculable parameters for monitoring system and licensee performance,
- (4) Provide flexibility to determine how to meet the established performance criteria in a way that will encourage and reward improved outcomes, and
- (5) Focus on the results as the primary basis for regulatory decision making."

DOE agrees that the focus on overall system performance allows both DOE as the applicant and NRC as the regulator to emphasize resolution of the technical issues that are of greatest importance in evaluating the health and safety aspects of repository performance, both during operations and following permanent closure. DOE also agrees that the proposed regulations generally provide appropriate flexibility for DOE to determine how to best satisfy the performance criteria and allow NRC to focus on the results as the primary basis for regulatory decision making. DOE documented its views in the comments officially submitted to NRC in June 1999.

As NRC notes in its proposed regulation, when the Environmental Protection Agency (EPA) issues its final environmental radiation protection standards for Yucca Mountain, NRC's regulations may need to be amended. EPA's proposed standards (40 CFR Part 197) (3) were published in August 1999. These standards are substantially different from those in the NRC's proposed regulation and, if retained in the EPA's final standards, would likely require NRC to amend its regulation to be consistent, as required by the Nuclear Waste Policy Act of 1982 (4) and the Energy Policy Act of 1992 (5). DOE's views on the proposed EPA standards are documented in the comments submitted to EPA in November 1999.

## **POSTCLOSURE PERFORMANCE**

NRC's proposed regulations specify a single, all-pathways limit on annual individual dose as a performance objective to be applied for 10,000 years after repository closure. The performance objective applies to the average member of a critical group representative of those individuals expected to receive the highest dose from an undisturbed repository. DOE believes the performance objective is appropriate as it is a reasonable fraction of the existing limit for dose to the general public from multiple sources and is consistent with limits established for other large, regulated nuclear facilities. DOE also agrees with the 10,000-year compliance period from both a technical and policy perspective.

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The ability of the potential Yucca Mountain repository to meet the postclosure performance objective will be demonstrated by a TSPA that meets the requirements of the proposed regulations. DOE has been continuously improving and updating its TSPA methodology, having conducted analyses in 1991 (6), 1993 (7), 1995 (8), and 1998 (9). It is confident that the results of the TSPA evaluations conducted for licensing, together with the supporting information for these analyses, can provide an adequate basis for the "reasonable assurance" determination of the safety of the repository that NRC is required to make prior to construction authorization. This level of confidence is supported by the numerous prelicensing interactions that have taken place among DOE and NRC staff on issues relevant to the evaluation of the postclosure performance of the proposed repository system.

NRC has identified the nine key technical issues (KTIs) that it currently believes are most critical to assessing postclosure repository performance. The approach for TSPA is NRC's central and integrating issue for the other eight KTIs<sup>(a)</sup>. NRC is documenting the resolution status of each KTI in a series of Issue Resolution Status Reports (IRSRs) that are updated as necessary to reflect the current status based on work conducted by both DOE and NRC staff and their contractors. The acceptance criteria for resolution of the KTIs, originally developed as part of the IRSRs, will be incorporated in NRC's review plan for the Yucca Mountain license application. This review plan is being developed by NRC in parallel with completion of its rulemaking on the licensing criteria for a potential geologic repository at the Yucca Mountain site. The quantitative methods used by DOE in the TSPA for evaluating repository performance and characterizing the uncertainties associated with these evaluations incorporate relevant aspects related to the KTIs and their resolution.

The proposed regulations also establish a performance objective for the repository in the event of a limited, stylized human intrusion into the engineered barrier system. This performance objective requires the repository to meet the same postclosure performance objective in the event of an assumed human intrusion scenario as is applied to the repository absent an intrusion. The scenario in the proposed regulations is a single borehole-drilling event that takes place 100 years after repository closure. The borehole is assumed to penetrate a waste package and extend to the saturated zone below the water table. DOE believes that analysis of this proposed, highly unlikely human intrusion scenario should be used only to inform a qualitative judgement on the resilience of the repository to such an intrusion. Such an approach is consistent with the stated purpose of the human intrusion recommendation in the 1995 report of the National Academy of Sciences (NAS) Committee on Yucca Mountain Standards (10). This report was prepared pursuant to the Energy Policy Act of 1992 (5), wherein EPA was directed to contract with NAS to provide recommendations on reasonable standards for a repository at Yucca Mountain. DOE believes that the purpose of the human intrusion scenario should be to assess the resilience of the repository system in terms of its ability, after an intrusion, to recover and continue to isolate waste from the accessible environment over the long term. The post-intrusion performance of the repository should be satisfactory if the dose rate returns, over a reasonable period of time, to a value close to the dose rate absent human intrusion.

## **MULTIPLE BARRIERS**

The proposed regulations require that the repository include multiple barriers, consisting of both natural barriers and an engineered barrier system. NRC defines a barrier as “any material or structure that prevents or substantially delays movement of water or radioactive materials.” DOE agrees that multiple barriers are appropriate for the repository since the uncertainty associated with the long-term performance of both engineered and natural barriers can be significant and the ability to confidently demonstrate that any single barrier will function as expected cannot be assumed. Also, in a disposal system consisting of multiple barriers, overall system safety is distributed over several barriers and performance is robust even if one barrier, or an independent process within a single barrier, fails to function as expected. The requirement for multiple barriers, therefore, provides a degree of defense in depth for the repository.

## **PRECLOSURE PERFORMANCE**

The proposed regulations specify preclosure performance objectives to protect the workers and the general public during the period of repository operations. The dose limits specified in these performance objectives are consistent with NRC requirements for spent nuclear fuel handling and storage facilities and appear appropriate to DOE. The proposed regulations require that compliance with the preclosure performance objectives be demonstrated through an integrated safety analysis (ISA) of the repository. An ISA would be a systematic examination of the potential hazards, which would ensure that all relevant hazards that could result in unacceptable consequences have been evaluated adequately and protective measures have been identified so that the repository will comply with the preclosure performance objectives. DOE agrees that an ISA is an appropriate approach to demonstrate compliance with the preclosure performance objectives.

The proposed regulations define the criteria for the natural and human-induced design basis events to be considered in the ISA. DOE believes that the regulations should be clarified to require that the natural events considered in evaluating repository safety are consistent with those considered for other NRC-licensed facilities, such as nuclear power plants, and used successfully in many licensing proceedings. These events include consideration of the most severe natural phenomena that have been historically reported for the site and geologic setting, such as earthquakes, tornadoes, and flooding.

## **PERFORMANCE CONFIRMATION**

The proposed regulations require DOE to conduct a performance confirmation program that starts during site characterization and continues until permanent closure of a repository. Performance confirmation, as defined by NRC, means the program of tests, experiments, and analyses that is conducted to evaluate the accuracy and adequacy of the information used to determine, with reasonable assurance, that the postclosure performance objective for individual protection will be met. This program is to consist of testing and monitoring to indicate whether (1) subsurface conditions and changes in these conditions encountered during construction and operation are within the limits assumed in the licensing basis and (2) geologic and engineered systems and components intended to operate as barriers after permanent closure are functioning as intended and anticipated. The performance assessment requirements in the proposed

regulations discussed above permit DOE to exercise flexibility in selecting the approach to demonstrate how it meets the established performance criteria. However, the performance confirmation requirements in the proposed regulations contain a prescriptive list of geotechnical parameters to be measured as part of the program and do not explicitly focus the performance confirmation program on data linked to the performance assessment. The prescriptive requirements in the proposed regulation potentially address issues that are not important to the health and safety of the public and could divert resources from important safety issues. DOE believes that the regulations should require the performance confirmation program to focus only on those data and confirmation of only those geotechnical and design parameters that are important to the parameters and conceptual models used in the performance assessment.

## **FINAL REGULATIONS**

EPA, consistent with its obligations under the Energy Policy Act of 1992 (5), issued its proposed standards for a potential repository at Yucca Mountain, Nevada, for public comment in August 1999 (3). The EPA's proposed standards for repository performance include an individual protection standard and a separate groundwater protection standard that must be met for 10,000 years following repository closure. The EPA's final radiation protection standards for Yucca Mountain have yet to be issued. Once the final standards are promulgated, NRC must modify its Yucca Mountain regulations, as necessary, to be consistent with the EPA standards. DOE looks forward to expeditious action by both EPA and NRC on their final regulations so that the regulatory framework for the protection of the public health and safety from a potential repository at Yucca Mountain will be in place as a basis for future decisions on repository development.

## **REFERENCES**

1. 10 CFR (U.S. Code of Federal Regulations) 63, "Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain," 64 FR 8640 (February 1999).
2. 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," 48 FR 28194 (1983).
3. 40 CFR 197, "Environmental Radiation Protection Standards for Yucca Mountain, Nevada," 64 FR 46975 (August 1999).
4. Nuclear Waste Policy Act of 1982, Public Law 97-425 (1982).
5. Energy Policy Act of 1992, Public Law 102-486 (1992).
6. "TSPA 1991: An Initial Total System Performance Assessment for Yucca Mountain," SAND91-2795 (1992).
7. Civilian Radioactive Waste Management System Management and Operating Contractor, "Total System Performance Assessment—1993: An Evaluation of the Potential Yucca Mountain Repository," B00000000-01717-2200-00099, Revision 1 (1994).

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8. Civilian Radioactive Waste Management System Management and Operating Contractor, "Total System Performance Assessment—1995: An Evaluation of the Potential Yucca Mountain Repository," B00000000-01717-2200-00136, Revision 0 (1995).
9. U.S. Department of Energy, "Viability Assessment for a Repository at Yucca Mountain," DOE/RW-0508, Volume 3, Total System Performance Assessment (1998).
10. National Research Council, "Technical Bases for Yucca Mountain Standards," National Academy Press, Washington, D.C. (1995).

**FOOTNOTES**

- (a) The eight KTIs are igneous activity, structural deformation and seismicity, evolution of the near-field environment, container life and source term, thermal effects on flow, repository design and thermal-mechanical effects, unsaturated and saturated zone flow under isothermal conditions, and radionuclide transport.