COMPLIANCE DETERMINATION STRATEGY

RRT 3.4 EFFECTIVENESS OF NATURAL BARRIERS AGAINST RELEASE OF RADIOACTIVE MATERIAL TO THE ACCESSIBLE ENVIRONMENT

APPLICABLE REGULATORY REQUIREMENTS:

10 CFR 60.21(c)(1)(ii)(D)
10 CFR 60.21(c)(2)(ii)(F)

TYPES OF REVIEW:

Acceptance Review (Type 1)
Safety Review (Type 3)

RATIONALE FOR TYPES OF REVIEW:

Acceptance Review (Type 1) Rationale:

This regulatory requirement topic is considered to be license application-related because, as specified in the license application content requirements of 10 CFR 60.21(c) and the regulatory guide "Format and Content for the License Application for the High-Level Waste Repository (FCRG)" it must be addressed by the U.S. Department of Energy (DOE) in its license application. Therefore, the staff will conduct an Acceptance Review of the license application for this regulatory requirement topic.

Safety Review (Type 3) Rationale:

This regulatory requirement topic is considered to be related to waste isolation. It focuses on the effectiveness of the natural barriers against the release of radioactive material to the accessible environment. It is a requirement for which compliance is necessary to make a safety determination for construction authorization as defined in 10 CFR 60.31(a) (i.e., regulatory requirements concerning whether the site and design comply with the performance objectives and other technical criteria in Subpart E of 10 CFR Part 60). Therefore, the staff will conduct a Safety Review of the license application to determine compliance with this regulatory requirement topic.

It is assumed that DOE will implement a system of multiple barriers in the design of the repository, as mandated in the Nuclear Waste Policy Act of 1982, as amended, in order to provide isolation of the high-level radioactive wastes. Such a system will consist of a combination of engineered barriers (i.e., the waste packages and the design/configuration of the repository) and natural barriers (provided by the geologic setting). The Commission has expressed previously its view that at some point in time following permanent closure, "the design capabilities of the engineered system will be lost and that the geologic setting -- the site -- must provide the isolation of the wastes from the [accessible] environment" (NRC, 1981; 46 FR 35282).

Therefore, a demonstration of the effectiveness of the natural barriers against release to the accessible environment will need to recognize that:

(1) the natural barriers of the geologic setting, in conjunction with the engineered barrier system for as long as the system functions, and alone thereafter, will need to provide for isolation of the wastes;

(2) increased levels of individual barrier performance (including the natural barriers) may be required in light of unanticipated processes and events, in accord with the provisions of 10 CFR 60.113(c); and

(3) the natural barriers will need to compensate for (i.e., offset) premature failure of or excessive early releases from the waste package and underground facility (see NRC, 1983; p. 491).

The effectiveness of the natural barriers to isolate waste is acceptable if:

(1) 10 CFR 60.112 is complied with;

(2) 10 CFR 60.113(a)(2) is complied with; and

(3) the analyses demonstrating compliance with 60.112 and 60.113(a)(2) adequately reflect the characteristics of the natural system.

10 CFR 60.113(a)(2) is the performance objective for the geologic setting. It stipulates that DOE locate the geologic repository so that pre-waste-emplacement groundwater travel time (GWTT) along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall be at least 1,000 years or such other travel time as may be approved or specified by the Commission. The travel time of groundwater incorporates particular properties of the geologic setting (e.g., porosity, permeability, and hydraulic gradient) that are considered an indication of how well the geologic setting could isolate wastes under existing conditions, and as such, compliance with the GWTT performance objective could be deemed a surrogate measure of the effectiveness of the natural barriers against release to the accessible environment.

Therefore, for the purposes of this review plan, it is assumed that compliance with this regulatory requirement topic will be demonstrated through compliance with the performance objective for the geologic setting (§ 60.113(a)(2)) and the overall system performance objective (§ 60.112). Any Key Technical Uncertainties associated with these compliance demonstrations will be addressed in the review plans and strategies for the specific performance objective (i.e., Sections 3.3, "Assessment of Compliance with the Groundwater Travel Time Performance Objective;" 6.1, "Assessment of Compliance with the Requirement for Cumulative Releases of Radioactive Materials;" and 6.2, "Assessment of Compliance with the Individual Protection" of the license application).

Analyses and models that are used to predict future conditions and changes in the geologic setting must be supported by using an appropriate combination of such methods as field tests, *in situ* tests, laboratory tests which are representative of field conditions, monitoring data, and natural analog studies. It is assumed that the discussion of these analyses and models, and their supporting tests, data, and analog studies, will be presented in the appropriate areas of Chapter 3.0 of the license application.

Therefore, given these assumptions, this review strategy focuses on a determination of the adequacy of: (1) DOE's demonstration of the effectiveness of the natural barriers against release of radioactive material

to the accessible environment; and (2) the analyses and models used by DOE in the prediction of future conditions and changes in the geologic setting.

REVIEW STRATEGY:

Acceptance Review:

In conducting the *Acceptance Review*, the reviewer should determine if the information presented in the license application and its references for demonstrating compliance with the applicable regulatory requirements is complete in technical breadth and depth as identified in the regulatory guide "Format and Content for the License Application for the High-Level Waste Repository (FCRG)." The reviewer should determine that the information in this section of the license application is presented in such a manner that the logic leading to a demonstration of compliance with the requirement is clear and does not require the reviewer to conduct extensive literature searches.

Finally, the reviewer should determine if the U.S. Department of Energy (DOE) has either resolved all the NRC staff objections that apply to this requirement or provided all the information requested in Section 1.6.2 of the FCRG regarding unresolved objections. The reviewer should evaluate the effects of any unresolved objections, both individually and in combination with others, on: (1) the reviewer's ability to conduct a meaningful and timely review; and (2) the Commission's ability to make a decision regarding construction authorization within the three-year statutory period.

Safety Review:

The purpose of this section of the license application is to demonstrate the effectiveness of the natural barriers of the geologic setting against the release of radioactive material to the accessible environment. This information should be derived from the assessments presented and the conclusions reached by DOE in Chapters 3.2 ("Assessment of Compliance with the Siting Criteria"), 3.3 ("Assessment of Compliance with the Groundwater Travel Time Performance Objective"), 6.1 ("Assessment of Compliance with the Requirement for Cumulative Releases of Radioactive Materials"), and 6.2 ("Assessment of Compliance with the Individual Protection Requirements") of the license application.

In demonstrating compliance with the applicable regulatory requirements, DOE will need to show that the natural barriers of the geologic setting contribute to the isolation of radioactive waste from the accessible environment. In doing so, DOE will need to recognize that:

(1) increased reliance may be placed on the natural barriers to provide for isolation of the wastes as the performance of the engineered barrier system is compromised with time;

(2) increased levels of individual barrier performance (including the natural barriers) may be required in light of unanticipated processes and events (10 CFR 60.113(c)); and

(3) if need be, the natural barriers will need to compensate for (i.e., offset) premature failure of or excessive early releases from the waste package and underground facility.

The specific aspects of the license application on which the reviewer will focus are discussed below, and the *Acceptance Criteria* are identified in Section 3.0 of this review plan.

In conducting the *Safety Review*, the reviewer will, at a minimum, assess the adequacy and completeness of the data and analyses presented in the license application to support DOE's conclusions regarding the effectiveness of the natural barriers against the release of radioactive material to the accessible environment. In addition, DOE will need to provide information to identify the selection of which systems or components of the geologic setting are used to demonstrate the waste isolation capability of the site, and to support their selection.

In evaluating DOE's analyses, the reviewer should confirm that the analyses:

(1) identify and analyze those parameters and natural processes pertaining to the geologic setting that are important to meeting the performance objectives related to the isolation of waste;

(2) appropriately reflect consideration of the occurrence of anticipated processes and events, as well as the occurrence of unanticipated processes and events; and

(3) accurately reflect the results of the compliance demonstrations made relative to the performance objective for the geologic setting (see Section 3.3 of the license application) as well as the overall system performance objective (see Sections 6.1 and 6.2 of the license application).

In conducting its review, the staff will need to determine whether DOE has considered the favorable conditions of 10 CFR 60.122(b) determined to be present and potentially adverse conditions of 10 CFR 60.122(c) determined to be present or not absent, appropriately and differentially, as required by 10 CFR Part 60. Additionally, the staff will need to assure that DOE has evaluated the information presented in Section 3.2 of the license application, with assumptions and analysis methods that adequately describe the effectiveness of the natural barriers and ranges of relevant parameters. Finally, the reviewer must ensure that DOE's demonstration of effectiveness of the natural barriers accounts for the predicted future conditions and changes in the geologic setting, as appropriate, based on appropriate analyses and models, and that such analyses and models are adequately supported by tests, data, and/or analog studies.

In order to conduct an effective review, the reviewer will rely on staff expertise and independently acquired knowledge and information in addition to that provided by the DOE in its license application. For example, the reviewer should be familiar with the subsystem and overall system performance assessments conducted by the staffs of the DOE (e.g., Barnard *et al.*, 1992; Eslinger *et al.*, 1993), the NRC (e.g., Codell *et al.*, 1992), and the U.S. Environmental Protection Agency (with respect to the site for the Waste Isolation Pilot Project) (e.g., SNL, 1991), and in general, with those conducted internationally by the time of the license application submittal. Such knowledge should help form a background from which determinations of the adequacy of:

(1) the demonstration of effectiveness of the natural barriers; and

(2) the incorporation of future conditions and changes in the geologic setting into the demonstration, can be made.

The reviewer also should be aware of additional analyses and approaches that can be used to refine the performance assessments with respect to the effectiveness of the natural barriers, including analyses that can be used to confirm the resolution capabilities of the methodologies.

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APPLICABLE REGULATORY REQUIREMENTS FOR EACH TYPE OF REVIEW:

Type 1:

10 CFR 60.21(c)(1)(ii)(D)
10 CFR 60.21(c)(1)(ii)(F)

Type 3:

10 CFR 60.21(c)(1)(ii)(D)
10 CFR 60.21(c)(1)(ii)(F)

REFERENCES:

Barnard, R.W., *et al.*, "TSPA 1991: An Initial Total-System Performance Assessment for Yucca Mountain," Sandia National Laboratories, SAND91-2795, July 1992. [Prepared for the U.S. Department of Energy.]

Codell, R.B., *et al.*, "Initial Demonstration of the NRC's Capability to Conduct a Performance Assessment for a High-Level Waste Repository," Nuclear Regulatory Commission, NUREG-1327, May 1992.

Eslinger, P.W., *et al.*, "Preliminary Total-System Analysis of a Potential High-Level Nuclear Waste Repository at Yucca Mountain," Pacific Northwest Laboratory, PNL-8444, January 1993. [Prepared for the U.S. Department of Energy.]

Nuclear Regulatory Commission, "Format and Content For the License Application for the High-Level Waste Repository." Office of Nuclear Regulatory Research. [Refer to the "Products List" for the Division of High-Level Waste Management to identify the most current edition of the FCRG in effect.]

Nuclear Regulatory Commission, "Disposal of High-Level Radioactive Wastes in Geologic Repositories: Proposed Rule," *Federal Register*, vol. 46, no. 130, July 8, 1981, pp. 35280-35296, 1981.

Nuclear Regulatory Commission, "Staff Analysis of Public Comments on Proposed Rule 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," Office of Nuclear Reactor Research, NUREG-0804, December 1983.

Nuclear Regulatory Commission, "Performance Objectives Relating to Isolation of the Waste," Office of Nuclear Material Safety and Safeguards, Staff Position 60-002, August 1990.

Sandia National Laboratories, "Preliminary Comparison with 40 CFR Part 191, Subpart B for the Waste Isolation Pilot Plant, December 1991," WIPP Performance Assessment Division, SAND91-0893, 3 vols., December 1991. [Prepared for the U.S. Department of Energy.]