

COMPLIANCE DETERMINATION STRATEGY

RRT 3.2.1.2 - FAVORABLE CONDITION: MINIMUM WASTE EMPLACEMENT DEPTH

APPLICABLE REGULATORY REQUIREMENT(S):

10 CFR 60.21(c)(1)(ii)(B)
10 CFR 60.21(c)(1)(ii)(F)
10 CFR 60.122(b)(5)

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 containment and waste isolation. 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 in Subparts E, G, H, I). Therefore, the staff will conduct a Safety Review of the license application to determine compliance with this regulatory requirement topic.

This regulatory requirement topic, concerning waste emplacement at a minimum depth of 300 meters from the ground surface, is a favorable condition and focuses on reducing the likelihood that the waste will be disturbed following permanent closure of the repository (NRC, 1983; pp. 58-59). (The ground surface shall be deemed to be the elevation of the lowest point on the surface above the disturbed zone.) The minimum waste emplacement depth of 300 meters is considered a favorable condition because the depth is considered advantageous for the isolation of waste by minimizing the effects of potential disruptive events such as human intrusion (NRC, 1983, p. 58) and extreme erosion (10 CFR Part 960.4-2-5). However, its absence would not be considered a reason for the disqualification of the site; it merely means that combinations of other favorable conditions and engineering measures will be relied on to meet the siting criteria set out in 10 CFR 60.122(a)(1) (NRC, 1983; pp. 58-59).

The Early Site Suitability Evaluation (ESSE) of Yucca Mountain (Younker et al., 1992; p. 2-74) indicates that, within the proposed repository area, the selected repository horizon in the Topopah Spring Tuff (nonlithophysal, welded tuff) is unable to contain all waste at depths below 300 meters. In spite of this, the proposed horizon is preferred over deeper units because other conditions favorable to waste isolation such as reduced thermal conductivity, porosity, and water content are all lower in the potential host rock

relative to deeper rocks. In addition, shallower waste emplacement also preserves a greater unsaturated thickness between the proposed repository and the water table.

Although the proposed host horizon occurs at depths greater than 300 m over most of the proposed repository block, present evidence indicates that the minimum depth to the upper contact is 220 m in the southwestern corner. In the vicinity of the repository block, the minimum depth to the upper contact of the proposed host horizon is found at 198 m in borehole UE25-a#1. This borehole is located outside of the exploratory block, about one kilometer to the east. Despite the shallow depth-to-contact, the repository will be located tens of meters below this contact, and the contact is deeper in all other boreholes. The ESSE states, however, that credible erosion rates are low enough that even emplacement depths shallower than 300 meters should be safe from exhumation. Estimated erosion rates ranging from < 1 m/10,000 yrs (Younker et al., 1992; pp. 2-77 to 2-79) to 82 m/10,000 yrs (Purcell, 1986) would tend to support this conclusion. Despite these apparently low current erosion rates, however, Miklas et al. (1992) note that it is important to consider the effects of climatic changes on precipitation and future erosion rates.

Geological methods and techniques, combined with standard surveying techniques that are currently available are sufficient to both identify the proposed repository horizon and to determine the depth to this horizon. For example, identification of the repository horizon can be made through careful examination of the core samples, geophysical well logs and chemical analyses. The depth to a given horizon can be determined from a combination of both surface and subsurface surveying techniques. Based on previous technical experience in this area, the staff have concluded that a safety determination can be made by evaluating the technical information submitted by DOE in its license application, and that the review is expected to require no additional analyses or tests (Types 4 or 5 reviews).

Based on the above considerations, this regulatory requirement topic will be reviewed by the staff as a Type 3 (Safety Review). Should future analyses and/or data arise such that this initial assessment is questioned, the type of review this regulatory requirement should receive will be reassessed in light of the additional information.

To summarize, the following statements and assumptions have been made in developing this CDS:

- (1) This regulatory requirement topic is limited to consideration of DOE's plans and design for waste emplacement at a minimum depth of 300 meters from the ground surface; and
- (2) If it is determined that waste emplacement at a minimum depth of 300 meters from the ground surface is not possible, the effects of shallower emplacement on the performance objectives pertaining to the isolation of waste must be evaluated in the context of favorable conditions and the other potentially adverse conditions (e.g., 10 CFR 60.21(c)(1)(ii)(B)). Evaluation of the performance of the repository will be achieved in those regulatory requirement topics dealing with the overall system performance objective (e.g., 10 CFR 60.112).

REVIEW STRATEGY:

Acceptance Review:

In conducting the Acceptance Review of waste emplacement at a minimum depth of 300 meters from the ground surface (with the ground surface deemed to be the elevation of the lowest point on the surface

above the disturbed zone), the reviewer should determine if the information presented in the license application and its references for determining compliance with the applicable regulatory requirements applicable to this favorable condition is complete in technical breadth and depth as identified in the FCRG. The reviewer should determine that all appropriate information necessary for the staff to review this favorable condition is presented such that the assessments required by the regulatory requirements associated with total system and subsystem performance objectives can be performed.

The reviewer should determine that the information presented in the license application is presented in such a manner that the assumptions, data, and logic leading to a demonstration of compliance with the requirement are clear and do not require the reviewer to conduct extensive analyses or literature searches. The review should also determine that controversial information and appropriate alternative interpretations and models have been adequately described and considered.

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

Safety Review:

This regulatory requirement topic is limited to consideration of DOE's demonstration, through appropriate investigations, of the presence (or absence) of the favorable condition regarding waste emplacement at a minimum depth of 300 meters from the ground surface. It is not concerned with considering the effects of extreme erosion or human intrusion associated with the presence of naturally occurring materials (e.g., NRC, 1983; pp.15-18). These topics will be covered under Sections 3.2.1.10 and 3.2.1.11, respectively, of the license application and its respective review plans.

The specific aspects on which the reviewer will focus are described 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, determine the adequacy of the data and analyses presented in the license application to support DOE's demonstrations regarding 10 CFR 60.122(b)(5). Specifically, the DOE will need to: (1) provide information to determine the degree to which the favorable condition has been characterized, and the extent to which it contributes to waste isolation; (2) demonstrate, if the favorable condition is absent, that combinations of other favorable conditions will be able to compensate and allow the criteria set out in 10 CFR 60.122(a)(1) to be met (NRC, 1983; pp. 58-59). These might include characteristics of the selected horizon such as low horizontal and vertical permeability that would justify selection of this unit as opposed to a deeper, perhaps less satisfactory stratigraphic unit; (3) assure the sufficiency of the lateral and vertical extent of the data collection; and (4) evaluate the information presented in support of Items (1) and (2), with assumptions and analysis methods that adequately describe the presence or absence of this favorable condition.

DOE will also need to provide an explanation of the measures used to support models used to assess the presence or absence of waste emplacement at a minimum depth of 300 meters. Analyses and models that will be used to predict future conditions and changes in the geologic setting shall be supported by using

an appropriate combination of such methods as field tests, *in-situ* tests, and laboratory tests that are representative of field conditions, monitoring data, and natural analog studies.

In conducting the aforementioned evaluations, the reviewer should determine that DOE uses: (1) analyses that are sensitive to evidence of whether the favorable condition is present or absent; and (2) assumptions which are not likely to overestimate effects of the favorable condition. In general, the reviewer will assess the adequacy of DOE's investigations for evidence of this favorable condition, both within the controlled area and outside the controlled area, as necessary, in the manner outlined in 10 CFR 60.21(c)(1)(ii)(B).

The reviewer will also determine if DOE has included a description of the proposed host horizon and the reasoning used in its selection. Possible reasons favoring the selection of a particular host rock are listed in 10 CFR 60.122(b)(2), including low horizontal and vertical permeability. To assess the depth at which the selected host horizon occurs, it will be necessary to describe how the horizon is identified in well logs and by geophysical means, and a listing of depth to intercept in all boreholes that penetrate the chosen horizon. Because it is a favorable condition, the inability to emplace the waste in the proposed horizon at a minimum depth of 300 meters from the ground surface is not in itself a reason for disqualifying the site from further consideration. If a shallower depth of waste emplacement is indicated, combinations of other favorable conditions will be relied on to meet the criteria set out in 10 CFR 60.122(a)(1) (NRC, 1983; pp. 58-59).

In order to conduct an effective review, the reviewer will rely on staff expertise and independently acquired knowledge, information and data such as the results of research activities being conducted by the NRC's Office of Nuclear Regulatory Research, in addition to that provided by DOE in its license application. The reviewer should focus on additional data which can refine knowledge of the favorable condition, and should acquire, as necessary, additional information to confirm the resolution capabilities of the methodologies. It is incumbent upon the reviewer to have acquired a body of knowledge regarding these and other critical considerations in anticipation of conducting the review to assure that the DOE site characterization program is sufficient in scope and depth to provide the information necessary for resolution of the concerns. DOE's early site suitability studies (Younker et al., 1992, p. 2-74) have indicated that the proposed repository horizon can not accommodate all waste at depths greater than 300 meters from the ground surface.

Contributing Analysts:

NRC: Harold Lefevre

CNWRA: David R. Turner

Date of Analysis: April 13, 1993

APPLICABLE REGULATORY REQUIREMENTS FOR EACH TYPE OF REVIEW:

Type 1:

10 CFR 60.21(c)(1)(ii)(B)
10 CFR 60.21(c)(1)(ii)(F)
10 CFR 60.122(b)(5)

Type 3:

10 CFR 60.122(b)(5)

REFERENCES:

DOE (U.S. Department of Energy), "Site Characterization Plan: Yucca Mountain Site, Nevada Research and Development Area, Nevada." Office of Civilian Radioactive Waste Management, DOE/RW-0199. 9 Volumes, December 1988.

Miklas, M.P., Jr., J.L. Russell, and A. Watson, "Draft Comments on Erosion Topical Report Outline," Letter Report, Center for Nuclear Waste Regulatory Analyses, May 1992.

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

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 Lists" for the Division of High-Level Waste Management to identify the most current edition of the FCRG in effect.]

Purcell, C., "Potential Erosion at the Yucca Mountain Nuclear Waste Site," FIN A0297, revised, Lawrence Livermore National Laboratory, Livermore, CA, 1986 Revised.

Yunker, J.L., W.B. Andrews, G.A. Fasano, C.C. Herrington, S.R. Mattson, R.C. Murray, L.B. Ballou, M.A. Revelli, A.R. Ducharme, L.E. Shepard, W.W. Dudley, D.T. Hoxie, R.J. Herbst, E.A. Patera, B.R. Judd, J.A. Docka, L.D. Rickertsen, J.M. Boak, J.R. Stockey, "Report of Early Site Suitability Evaluation of the Potential Repository at Yucca Mountain, Nevada," Science Applications International Corporation, SAIC-91/8000, January 1992.