

COMPLIANCE DETERMINATION STRATEGY

RRT 3.2.2.4

FAVORABLE CONDITION: UNSATURATED ZONE HYDROGEOLOGIC CONDITIONS

APPLICABLE REGULATORY REQUIREMENT(S):

10 CFR 60.122 (b)(8)(i-iv)
10 CFR 60.21 (c)(1)(ii)(B)
10 CFR 60.21 (c)(1)(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 Section 3.2.2 of 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, and 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 concerns the favorable condition set forth in 10 CFR 60.122 (b)(8)(i-iv) that focuses on whether the site provides: (a) low moisture flux in the host rock and in the overlying and underlying hydrogeologic units; (b) a water table located sufficiently below the underground facility such that fully saturated voids do not connect the water table and the underground facility; (c) a laterally extensive low hydraulic conductivity hydrogeologic unit above the host rock capable of inhibiting the downward movement of water or diverting the downward moving water to a location beyond the limits of the underground facility; and (d) a host rock that is under free drainage conditions.

In interpreting this regulatory requirement, the staff has concluded that: (a) this favorable condition should only be evaluated against present day conditions; (b) "host rock" refers to the Topopah Spring Welded (TSw) unit; and (c) "low moisture flux" refers to a quantity which is considered small since the site is classified as being in a semi-arid region and when compared to values observed in other places of the world.

A low moisture flux in the host rock and in the overlying and underlying hydrogeologic units would be favorable to repository performance because it would contribute to relatively slow radionuclide release and transport. At this time it appears that the site possesses this favorable condition. This is because the host rock is the Tsw unit and consists of a thin upper vitrophyre, a thick central densely welded, devitrified ash-flow sheet zone, and a thin lower vitrophyre (Montazer and Wilson, 1984). Overall the unit is intensely fractured, and is characterized by a very low matrix hydraulic conductivity. In fact, the Site Characterization Plan (Volume IV, Part B) recognizes that matrix saturated hydraulic conductivity values are "near (the) lower limit of meaningful measurement" (DOE, 1988). Due to the low hydraulic conductivity values of the matrix, the host rock should indeed exhibit very low moisture fluxes, provided that matrix flow is the dominant mechanism of moisture transport. This is likely, because to date no air drilled holes have encountered water flowing in fractures within the repository block. Therefore, it appears that to reach a determination as to the existence of this favorable condition, the host rock needs to be evaluated to determine if fracture flow is presently occurring at the site. The collection of this information can be achieved using standard techniques, so that only a Safety Review would be required.

While it has been interpreted that this favorable condition applies to present day conditions, future increases in moisture flux could negatively affect site performance. However, future flux increases are considered as potentially adverse conditions, and will be addressed in Sections 3.2.2.9 (Potentially Adverse Condition: Changes to Hydrologic Conditions) and 3.2.4.2 (Potentially Adverse Condition: Changes to Hydrologic System from Climate) of the License Application.

A water table located sufficiently below the underground facility, such that fully saturated voids do not connect with the water table and the underground facility, would be favorable to site performance because radionuclide transport would be slower. At this time the site probably possesses this favorable condition. The proposed repository horizon is located in the lower part of the Tsw unit at a depth of approximately 310 meters below the ground surface (with reference to borehole USW-G4). In general, the water table is located about 500 to 700 meters below the ground surface (Robison, 1984), providing a depth of about 200 to 300 meters from the repository horizon to the water table. In any case, even though it appears likely that the site possesses this favorable condition, the use of standard techniques to collect this information should be adequate to reach a decision with respect to the existence of this favorable condition. Therefore, only a Safety Review would be required.

It is recognized that future potential water table rises could negatively affect repository performance. However, this would constitute a potentially adverse condition which will be addressed under Section 3.2.2.11 (Potentially Adverse Condition: Potential for the Water Table to Rise and Inundate a Repository) of the License Application.

The existence of a laterally extensive low hydraulic conductivity hydrogeologic unit above the host rock, capable of inhibiting the downward movement of water, could have a favorable effect on repository performance by reducing the flux through the host rock. If present day water movement only occurs within the matrix, it is likely that this favorable condition will be found at the site. However, irrespective of whether or not this favorable condition is found at the site, standard site characterization techniques should be adequate to evaluate whether this favorable condition is present. Therefore, a Safety Review should be adequate to evaluate the site for this favorable condition.

The existence of a laterally extensive low hydraulic conductivity hydrogeologic unit above the host rock capable of diverting the downward moving water to a location beyond the limits of the underground facility could have a favorable effect on repository performance by reducing the flux through the host

rock. At this time, DOE has not indicated that it plans to claim credit for this favorable condition because it is unlikely that lateral diversion would occur over such a large distance (DOE, 1988). It is anticipated that standard site characterization techniques will be adequate to identify whether this favorable condition exists at the site. Therefore, a Safety Review should be adequate to evaluate the site for this favorable condition.

It is recognized that even if the site presently possesses a laterally extensive low hydraulic conductivity hydrogeologic unit that has these favorable properties, the site may be negatively affected by future changes in hydrologic conditions. Such changes constitute a potentially adverse condition and will be covered in Section 3.2.2.9 (Potentially Adverse Condition: Changes to Hydrologic Conditions) of the License Application.

A host rock that is under free drainage conditions would be favorable to repository performance because it would reduce radionuclide release by decreasing the length of time waste packages would experience saturated conditions. It is anticipated that the host rock will have enough open fractures so that if saturated conditions were to form at the repository, water would drain through the fractures and re-establish unsaturated conditions. A Safety Review should be adequate to evaluate this favorable condition, because standard site characterization techniques can be used to establish if this condition exists at the site.

It is possible that free drainage conditions may not exist at the site in the future. Free drainage conditions may not exist if, in the future, perched water bodies were to form at the repository horizon or the water table were to rise up to the level of the repository. However, these situations are addressed under Sections 3.2.2.12 (Potentially Adverse Condition: Perched Water Bodies) and 3.2.2.11 (Potentially Adverse Condition: Potential for the Water Table to Rise and Inundate a Repository) of the License Application.

SUMMARY:

It has been assumed that this favorable condition should only be evaluated against present day conditions, that "low moisture flux" refers to a quantity which is considered small when compared to similar values observed in other places of the world, and that "host rock" refers to the Topopah Spring welded (Tsw) unit. This regulatory requirement should only require a Safety Review because standard site characterization techniques should be adequate to determine the presence or absence of these favorable conditions.

REVIEW STRATEGY:

Acceptance Review:

In conducting the acceptance review of this favorable condition, the reviewer should determine if the information presented in the license application and its references for determining compliance with the applicable regulatory requirements is complete in technical breadth and depth with respect to the information requested by Section 3.2.2 of the regulatory guide "Format and Content of the License Application for the High-Level Waste Repository (FCRG)." The reviewer should also determine whether Section 3.1 of the license application contains all appropriate information, identified in Section 3.1 of the FCRG, that the staff needs to support the Safety Review described below.

The information presented in the license application should be presented in such a way that the assumptions, data, and logic lead to a clear demonstration of compliance with the requirements. The reviewer should not be required to conduct extensive analyses or literature searches. The reviewer should also determine whether a range of alternative interpretations and models have been described.

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, 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.

It should be noted that the information contained in Section 3.2.2.4 of the License Application will be reviewed considering information contained in sections of the license application described in Table 3.2.2.4-1. If it is determined that the information presented in the sections of the license application described in Table 3.2.2.4-1 is inadequate to support this Safety Review, additional information will be requested from the DOE as part of this review.

Safety Review:

This regulatory requirement is limited to consideration of present day favorable unsaturated zone hydrogeologic conditions. It is not concerned with DOE's demonstration through appropriate investigations of evidence of other hydrologic conditions which may take effect at the geologic repository in the future. These topics will be covered under Sections 3.2.2.9 (Potentially Adverse Condition: Changes to Hydrologic Conditions), 3.2.4.2 (Potentially Adverse Condition: Changes to Hydrologic System from Climate), 3.2.2.12 (Potentially Adverse Condition: Perched Water Bodies), and 3.2.2.11 (Potentially Adverse Condition: Potential for the Water Table to Rise and Inundate a Repository) of the License Application.

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)(8)(i-iv). Specifically, DOE will need to: (1) provide information to determine whether and to what degree this favorable condition is present (i.e., that the site provides a low moisture flux, a water table substantially below the repository, a laterally extensive low hydraulic conductivity zone above the host rock, and free drainage conditions); (2) assure the sufficiency of field data collection; and (3) evaluate the information presented under Item (1) using assumptions and analysis methods that adequately describe the presence or absence of the favorable condition. 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.

The first step in the NRC review will be to evaluate the DOE analysis to determine if it has been correctly assumed that this regulatory requirement topic should only be evaluated against present day conditions, that "low moisture flux" refers to a quantity which is considered small when compared to similar values observed in other places of the world, and that "host rock" refers to the Topopah Spring welded (TSw) unit. The reviewer should focus on additional data which can refine knowledge of the favorable condition of unsaturated zone hydrogeologic conditions, and should perform, as necessary, simple verification analyses 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.

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 the DOE in its license application.

RATIONALE FOR REVIEW STRATEGY:

Not applicable

Contributing Analysts:

NRC: W. Ford

CNWRA: A.C. Bagtzoglou, G.W. Wittmeyer

Date of Analysis: 07/01/93

APPLICABLE REGULATORY REQUIREMENTS FOR EACH TYPE OF REVIEW:

Type 1:

10 CFR 60.122 (b)(8)(i-iv)
10 CFR 60.21 (c)(1)(ii)(B)
10 CFR 60.21 (c)(1)(ii)(F)

Type 3:

10 CFR 60.122 (b)(8)(i-iv)

REFERENCES:

Montazer, P., and W. E. Wilson, 1984, "Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada," United States Geological Survey, Water-Resources Investigations Report 84-4345.

Robison, J. H., 1984, "Ground-Water Level Data and Preliminary Potentiometric-Surface Maps of Yucca Mountain and Vicinity, Nye County, Nevada," United States Geological Survey, Water-Resources Investigations Report 84-4197.

Scott, R. B., R. W. Spengler, S. Diehl, A. R. Lappin, and M. P. Chornack, 1983, "Geologic Character of Tuffs in the Unsaturated Zone at Yucca Mountain, Southern Nevada," in Mercer, J. W., P. S. Rao, and I. W. Marine, eds., Role of the Unsaturated Zone in Radioactive and Hazardous Waste Disposal: Ann Arbor, Michigan, Ann Arbor Science, p. 289-335.

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

U.S. Nuclear Regulatory Commission (NRC) 1989. *NRC Staff Site Characterization Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada*. NUREG-1347.

TABLE 3.2.2.4-1 Sections of the License Application Which May Provide Input To The Favorable Condition: Unsaturated Zone Hydrogeologic Conditions

License Application Section	Section Title
Geologic Setting	
3.1.1	Geologic System
3.1.2	Hydrologic System
3.1.3	Geochemical System
3.1.4	Climatological and Meteorological Systems
Siting Criteria	
3.2.2.3	Favorable Conditions: Groundwater Travel Time Substantially Exceeding 1000 Years
3.2.4.1	Individual Favorable Condition: Annual Potential Evapotranspiration