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**COMPLIANCE DETERMINATION STRATEGY
RRT 3.2.2.5 - POTENTIALLY ADVERSE CONDITION: FLOODING**

1.0 APPLICABLE REGULATORY REQUIREMENTS

- 10 CFR 60.21(c)(1)(ii)(A)
- 10 CFR 60.21(c)(1)(ii)(B)
- 10 CFR 60.21(c)(1)(ii)(F)
- 10 CFR 60.122(c)(1)

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 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 is related to 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 the applicable regulatory requirements.

For this potentially adverse condition (PAC), flooding of the underground repository and the possible effects on waste isolation are primarily pre-closure concerns as discussed in the Statement of Considerations for the final rule (48 FR 28212). Conceivable post-closure sources of groundwater which could induce flooding of the repository will be investigated as part of the analyses for other PACs and parts of the regulation (see Section 2.2.1 of this review plan). The Statement of Considerations for the final rule also suggests that the facility be designed to preclude massive inflows of water. Flooding from a surface water source through unsealed tunnels, ramps, or shafts could easily result in massive inflows of water to the repository. Open boreholes and wells could also transmit water downward from a flooded wash to the underground facility. However, the presence of unsealed, covered boreholes during the pre-closure period is not expected to allow large inflows of surface flood waters to an underground facility, even during major flooding events in washes.

A review of the region performed with maps and available literature indicates that there are no existing or planned manmade surface water impoundments, the failure of which could impact the site or waste isolation within the controlled area. The steep topography over much of the Yucca Mountain site suggests that flooding from extreme rainfalls may be limited to relatively small portions of the site. Therefore, the

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potential for a repository at Yucca Mountain to be flooded by surface water will depend on whether the portals of shafts, tunnels, and ramps are located in areas susceptible to flooding.

Glancy (1994) presented flooding estimates for tributaries of Coyote Wash, near Yucca Mountain. This work evaluated the flooding potential of a proposed exploratory shaft near the site. According to Glancy (1994, p. 30), "[O]n the basis of sparse present knowledge ... a possible peak flow of sediment-laden fluid of about 2,500 ft³/s can be anticipated in North Fork Coyote Wash (drainage area of about 0.094 mi²). South Fork Coyote Wash (drainage area of about 0.105 mi²) also can be expected to flow as much as 2,500 ft³/s." Where these tributaries join, Glancy (1994) estimated that a possible cumulative peak flow as large as 5,000 ft³/s could be anticipated.

A conventional analysis of flood flows and levels in on-site channels for floods up to the probable maximum flood (PMF) is expected to meet the intent of the requirements. No technical difficulties are expected in the conduct of a conventional flooding analysis, and therefore no key technical uncertainties have been identified. The fact that the flooding analysis will be tied to the engineering design for pre-closure operations rather than the overall performance assessment eliminates the need to determine probabilities for extremely rare floods (beyond the PMF) over long time periods. The conservatism inherent in standard flood determination procedures and design criteria will also assure that the requirements are met.

If the applicant chooses to depend on engineered protection (rather than judicious selection of location) to prevent flooding of shafts and access openings, the review may require a safety review supported by staff analyses (Type 4 review) to address debris transport, including the likelihood of increased water levels due to debris transport and deposition. This part of the analysis would primarily support the demonstration of compliance with the requirements in 10 CFR 60.133.

In summary, selecting a Type 3 review is based on the following assumptions:

- (1) The applicant will choose to show compliance with this regulatory requirement by locating the portals of shafts, ramps, and tunnels out of flood-prone areas of the site;
- (2) Post-closure sources of flooding of the repository will be evaluated within other sections of the license application;
- (3) No unusual engineering protection measures will be relied on, and erosion, debris transport, and damming effects will be conservatively accounted for or minimized in the PMF calculations;
- (4) Any water impoundments that may be built to support site operations will be located at elevations below the portals of nearby tunnels, ramps, or shafts; and
- (5) No significant climate changes are expected during the repository preclosure period.

If these assumptions are met, the Safety Review will mostly consist of evaluating DOE's estimates for probable maximum precipitation and probable maximum flood for washes at Yucca Mountain, along with verifying that flood-prone areas of the site are properly delineated with respect to portals for tunnels, ramps, and shafts. If these assumptions are not met, the review may require independent staff evaluations

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of engineering flood protection measures and the potential impacts of any water impoundments that could be sited at elevations above portals for shafts, ramps, or tunnels.

2.0 REVIEW STRATEGY

2.1 Acceptance Review

To determine whether this section of the Department of Energy's (DOE's) license application is acceptable for docketing, the staff will determine whether the information submitted is consistent with that identified in the corresponding section of the Regulatory Guide "Format and Content for the License Application for the High-Level Waste Repository" (FCRG).

Before the receipt of the license application, the staff will have conducted pre-licensing reviews of DOE's program, including technical reviews and quality assurance reviews and audits. The staff will have documented its concerns, resulting from these pre-license application reviews, as open items. Some of these open items, referred to as objections to license application submittal, may be critical to the staff's license application review, because lack of acceptable DOE resolution would prevent NRC from conducting a meaningful review. Therefore, as part of its Acceptance Review for docketing, the staff will evaluate how significant any unresolved objection to license application submittal is to the effective conduct of licensing activities, using the criteria given in Section 3.1 of this review plan.

2.2 Compliance Review

2.2.1 Safety Review

This regulatory requirement topic is limited to considering DOE's demonstration, through appropriate investigations, of the potential for surface-water flooding of the underground facility. It is not concerned with future flooding of the repository due to a rise of the water table, which is covered in Section 3.2.2.11 ("PAC: Potential for the Water Table to Rise and Inundate a Repository") of the license application. Flooding due to future or existing perched water bodies is covered in Section 3.2.2.12 ("PAC: Perched Water Bodies"). Section 3.2.5 (Assessment of Compliance with Criteria for Integrated Analyses of Combinations of Favorable Conditions and Potentially Adverse Conditions) will examine compliance with 10 CFR 60.122 (a)(2). The effectiveness of seals and other engineering measures to preclude post-closure flooding of the geologic repository will be addressed in various sections of Chapter 3.2 ("Siting Criteria"), Section 4.3 ("Assessment of Compliance with Design Criteria for Shafts and Ramps"), and Section 5.4 ("Assessment of Engineered Barrier System Compliance with Performance Objectives"). Findings under this review plan will provide input to review plans 4.2, 4.3, and 4.4.

In conducting the *Safety Review*, the reviewer will, as a minimum, determine the adequacy of the data and analyses presented in the license application to support DOE's demonstrations regarding 10 CFR 60.21(c)(1)(ii) (A) (B), and (F) as they relate to 10 CFR 60.122(c)(1) (see Appendix F of the LARP for applicable text). The specific aspects of the license application on which the reviewer will focus are discussed below. The Acceptance Criteria are identified in Section 3 of this review plan. Specifically, DOE should have: (1) assessed whether and to what extent this PAC is present (i.e., the potential for flooding of the geologic repository operations area (GROA) underground facility); (2) evaluated the extent to which the presence of this PAC may have been underestimated or undetected taking into account the degree of resolution achieved by the investigations; (3) assured that the lateral and vertical extent of field

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data collection is sufficient to support items (1) and (2); and (4) further evaluated the information presented under items (1) and (2), using assumptions and analysis methods that encompass the ranges of all relevant parameters.

The reviewer will also evaluate the support for DOE models that are used to assess the presence or absence of the potential to flood the GROA underground facility. Analyses and models that are used to predict the preclosure flooding shall be supported with 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 whether DOE used: (1) analyses that are sensitive to evidence of the potential for flooding the GROA underground facility; and (2) assumptions that are not likely to underestimate its effects. In general, the reviewer will assess the adequacy of DOE's investigations for evidence of this PAC, 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).

To conduct an effective review, the reviewer will rely on staff expertise and independently acquired knowledge, information, and data in addition to that provided by DOE in its license application. The reviewer should focus on additional data which can refine knowledge of this PAC, and should acquire, as necessary, additional information to confirm the resolution capabilities of the methodologies. The reviewer must acquire a body of knowledge regarding these and other critical considerations in anticipation of conducting the *Safety Review* to assure that DOE's submittal is sufficient in scope and depth to provide the information necessary for resolution of the concerns.

RATIONALE FOR REVIEW STRATEGY

Not Applicable.

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APPLICABLE REGULATORY REQUIREMENTS FOR EACH TYPE OF REVIEW

Type 1

- 10 CFR 60.21(c)(1)(ii)(A)
- 10 CFR 60.21(c)(1)(ii)(B)
- 10 CFR 60.21(c)(1)(ii)(F)
- 10 CFR 60.122(c)(1)

Type 3

- 10 CFR 60.122(c)(1)

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6.0 REFERENCES

References for Rationales

Glancy, P. A., 1994. "Evidence of Prehistoric Flooding and the Potential for Future Extreme Flooding at Coyote Wash, Yucca Mountain, Nye County, Nevada." Open File Report 92-458. United States Geological Survey: Denver, CO: 31.

Nuclear Regulatory Commission. 1983. Disposal of high-level radioactive wastes in geologic repositories: final rule. *Federal Register*: 48(120): 28,194-28,229.

References for Review Strategies

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.]