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U.S. Nuclear Regulatory Commission
ATTN: Mr. James Firth
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Mail Stop 7C–18
Washington, DC 20555

Subject: Transmittal of the Review Report—Review of Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations, Revision 4, Volume II—AI 20.01402.761.105

Dear Mr. Firth:

The purpose of this letter is to transmit "Review of Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations, Revision 4, Volume II", which fulfills AI 20.01402.761.105. The report documents high-level comments by CNWRA staff on Volume II of Revision 4 to the Department of Energy's Repository Safety Strategy (RSS). Two general comments by NRC staff on Revision 3 of the RSS, which were not previously conveyed to DOE, were also included in this report. The format for this report was chosen to match the format of the NRC comments on Revision 3 of the RSS, but the current report does not include a section for specific technical comments.

If you have any technical or programmatic questions about the content of the review report, please contact Dr. Roland Benke at (210) 522-5250 or me at (210) 522-5082.

Sincerely yours,

Gordon Wittmeyer

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Review of Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations, Revision 4, Volume II

The purpose of this report is to document the Center for Nuclear Waste Regulatory Analyses (CNWRA) review of Volume II of Revision 4 of the Department of Energy (DOE) Repository Safety Strategy (RSS) document (CRWMS M&O, 2000a). Volume II of the RSS reports the current status of the DOE postclosure safety strategy for a potential high-level waste repository at Yucca Mountain and (i) describes repository performance, (ii) identifies principle factors of safety, (iii) presents the postclosure safety case, and (iv) states the plans to complete the postclosure safety case in support of site recommendation and license application. This report only documents high-level comments by the CNWRA. The CNWRA comments are presented in two general comment sections. The review of Revision 3 of DOE's RSS (CRWMS M&O, 2000b) by NRC staff was also considered, and comments were compiled from that review and included in a separate section. The CNWRA review of Revision 4 of the RSS also generated comments based on supporting documentation, namely DOE's Total System Performance Assessment (TSPA) Technical Document (CRWMS M&O, 2000c). Aside from the comments from NRC's review of Revision 3, the comments presented in this report do not include NRC staff input.

<u>General Comments</u>

Figure 3-13 compares the performance of the repository with and without backfill. This figure shows almost no temperature effect on the failure time of the waste package or annual dose and implies that the effects of backfill are not significant. However, several potentially significant effects of backfill were not modeled, which could alter the conclusions of the analysis. For example, changes to the dripping or the cladding failure models were not considered. Dripping could be affected by the addition of backfill which would reduce the effectiveness of the capillary barrier associated with the drift openings because of direct contact between the backfill and the top of the drift. Commercial spent nuclear fuel cladding could sustain additional failures due to the long-term exposure to elevated temperatures within the repository. Failure to incorporate such significant changes in the models when conducting sensitivity analyses could result in the failure to identify barriers and processes potentially important to the performance of the repository. It is recommended the DOE document how backfill will affect TSPA models and include those affects into the backfill analyses.

The neutralization analyses for the natural barriers evaluates the capability of these barriers to limit the movement of water or radionuclides. Figure 3-24 presents the effect of neutralizing the unsaturated zone and saturated zones individually and together. Since the effect of neutralizing the saturated zone is small (changes the mean annual dose by less than a factor of two), it appears that the dilution of radionuclides, released from the unsaturated zone, in the saturated zone is not accounted for in the neutralization of the saturated zone. Dilution of radionuclide concentrations by the natural barriers is identified as a waste isolation attribute in Table 4-1 but is not one of the principal factors listed in Table 4-2 on page 4-3. DOE should include dilution in the saturated zone in the defense-in-depth analyses.

Section 4.1.2 discusses the importance of radionuclide solubility in reducing the number of radionuclides considered in the TSPA analyses. Section 4.1.2 states that radionuclide sorption and solubility limits in the unsaturated and saturated zones are significantly more important than is demonstrated by the TSPA calculations, because many radionuclides that are relatively insoluble or highly sorbing were screened out from the analysis. These statements are

confusing since in the Inventory Abstraction Analysis Model Report (CRWMS M&O, 2000d), radionuclides were not screened out from the analysis on the basis of solubility or sorption. Solubility and sorption factors were used solely to group radionuclides, and the radionuclides contributing 95% of the dose from each group were retained for the TSPA analyses. Therefore, including all radionuclides in the dose calculations should not increase the dose by more than 5%. The implication that the solubility limits and retardation in the unsaturated zone could have a significantly greater effect on dose if all radionuclides were considered in the analysis could result in the selection of inappropriate principal factors. The affect of solubility and sorption should be clarified. In addition, the RSS should clarify whether colloidal transport was considered in screening low-solubility radionuclides.

Criticality is screened out on the basis of low probability because the waste package and drip shield restrict the exposure of the waste to water. Because intruding magma could damage some waste packages, thereby permitting water to eventually contact the waste, criticality remains an issue for the igneous activity scenario. DOE should present the results of their criticality analysis from magma intrusion in the RSS. Because human intrusion results in waste package damage, criticality should be included in the human intrusion analyses, and the results should be summarized in the RSS.

The degree of reliance on barriers for radionuclide containment is described for 100,000 yr. The significance of a barrier, however, is specific to the period of interest. Therefore, the degree of reliance on a barrier for radionuclide isolation should be presented separately for below and above the 10,000 yr regulatory period of interest.

Several possible combinations of barriers, such as mixed components of natural and engineered systems, have not been considered. For instance, the combination of the natural system above the repository and the dripshield has not been considered in the barrier analyses. To enable staff to better understand barrier capability, it is suggested that the barrier analyses consider combinations between those natural and engineered barriers that are most important to safety.

General Comments Relating to Supporting Documentation

Table 6.3-1 of the TSPA Technical Document (CRWMS M&O, 2000c) establishes a correlation between barriers and the process model factors. Section 5.3 of the same document identifies the barriers that are considered in the robustness analysis. Sections 3.2 and 3.4 of the RSS (CRWMS M&O, 2000a) also identify degraded and neutralized barrier analyses. However, the discussion of these barriers, in several instances, includes process model factors such as water usage, biosphere dose conversion factors, and backfill. For a reviewer to adequately understand DOE's identification and linkage of barriers to their contribution to postclosure performance, a clear distinction between the discussion on process model factors and barriers is recommended.

DOE has appropriately described the uncertainty associated with the model parameters representing barriers in the degraded barrier analysis (DBA). However, because a barrier neutralization calculation is omitted from the TSPA Technical Document (CRWMS M&O, 2000c), the details of the analysis are not available for evaluation. It is recommended that DOE document the details of the neutralized barrier analyses so they may be referenced in the RSS.

Results from the DBA indicate that the described capabilities are consistent with the results from the TSPA. However, there appears to be inconsistency in the treatment of combinations of barriers. For example, the combination of barriers treated in the RSS (CRWMS M&O, 2000a) under DBA is different from those examined in the barrier neutralization analysis (BNA). Similarly, the combinations of barriers presented in the TSPA Technical Document (CRWMS M&O, 2000c) are different from the combinations presented in the RSS (CRWMS M&O, 2000a) for DBA and BNA. Therefore, it is difficult to compare DBA and BNA approaches to assess uncertainty treatment and degree of reliance placed on barriers for radionuclide isolation. It is recommended that consistent combinations of barriers be used in degraded and neutralized barrier analyses.

In several cases, barrier redundancy overshadows the description of the degree of reliance on individual barriers. As an example, while the combination of drip shield and waste package is considered in the BNA, it has been omitted from the DBA in the RSS (CRWMS M&O, 2000a) and the TSPA Technical Document (CRWMS M&O, 2000c). The presence of the dripshield in the degraded waste package analysis masks the impact of early waste package failure. While this analysis (i.e., in the presence of drip shield) shows the protective ability of the drip shield after waste package failure or vice versa, the protective ability of the individual barriers over 10,000 years is not clear. Analysis with the removal of redundant barriers would enhance understanding of the protective ability of the waste package.

The RSS (CRWMS M&O, 2000a) discusses both DBA and BNA. However, DOE's TSPA Technical Document (CRWMS M&O, 2000c) provides information to support only the DBA. The main purpose of the DBA is to explore whether degradation of a barrier within the range of parametric uncertainty results in significant increase in mean annual dose estimate, and not to determine the total contribution of the barrier to the estimate of the mean annual dose. The DBA analysis serves only to investigate the relative importance of uncertainty in the performance of the barrier with respect to meeting the postclosure performance objective and to evaluate doses from low probability events. The DBA analysis is limited by the TSPA models. A more complete assessment of the system and the individual barrier capability requires consideration of both model and data uncertainty, which may be achieved using BNA.

<u>Comments Compiled from NRC's Review of Revision 3 of the RSS</u>

For the neutralization analyses described on page 3-21, the "other factors are the same as in the base-case analysis." The determinations of principal factors and evaluation of defense in depth and multiple barriers based on mean-value simulations in the neutralization analyses (instead of simulations that fully sample the other factors) is inappropriate. Simulations that involve full parameter sampling should be used to determine the principal factors and quantify the defense in depth.

Principal factors were stated on page 4-1 to be those factors essential to the demonstration of postclosure safety. The evaluation for site suitability considers a wider range of factors. Simplification is acceptable only if the fully-coupled processes are understood and if sufficient justification is provided. The selection of the principal factors should be supported with discussions of (i) limitations in the current TSPA models, (ii) parameter uncertainties, and (iii) parameter defensibility. As stated in the conclusions on page 8-1, the uncertainty analyses are not complete. Therefore, the principal factors should be reconsidered with the final uncertainty characterizations.

References

CRWMS M&O. 2000a. *Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations.* TDR-WIS-RL-000001 REV 04 ICN 01. Las Vegas, Nevada: CRWMS M&O.

CRWMS M&O. 2000b. *Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations.* TDR-WIS-RL-000001 REV 03. Las Vegas, Nevada: CRWMS M&O.

CRWMS M&O. 2000c. *Total System Performance Assessment for the Site Recommendation.* TDF-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O.

CRWMS M&O. 2000d. *Inventory Abstraction.* ANL-WIS-MD-000006 REV 00. Las Vegas, Nevada: CRWMS M&O.