

THE U.S. NUCLEAR REGULATORY COMMISSION OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS REVIEW OF THE U.S. DEPARTMENT OF ENERGY'S KEY TECHNICAL ISSUE AGREEMENT RESPONSES RELATED TO THE POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA: UNSATURATED AND SATURATED ZONE FLOW UNDER ISOTHERMAL CONDITIONS 5.05 AND RADIONUCLIDE TRANSPORT 2.09

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issue resolution goal during this interim pre-licensing period is to ensure the U.S. Department of Energy (DOE) has assembled enough information about a given issue for NRC to accept a license application for review. Resolution by the NRC staff during pre-licensing does not prevent anyone from raising any issue for NRC consideration during the licensing proceedings. Also, and just as important, resolution of an issue by NRC during pre-licensing does not prejudice the NRC staff evaluation of the issue during the licensing review. Issues are resolved by the NRC staff during pre-licensing when the staff have no further questions or comments about how DOE is addressing an issue. Pertinent new information could raise new questions or comments about a previously resolved issue.

By letter dated October 2, 2003, DOE submitted a report, "Technical Basis Document No. 11: Saturated Zone Flow and Transport" (Bechtel SAIC Company, LLC, 2003). The DOE responses to 25 DOE/NRC key technical issue (KTI) agreements are contained in appendixes to this report. Appendix B of the report provides the combined DOE responses to Agreements Unsaturated and Saturated Zone Flow Under Isothermal Conditions (USFIC) 5.05 and Radionuclide Transport (RT) 2.09.

2.0 KTI AGREEMENTS

Appendix B of Bechtel SAIC Company, LLC (2003) provides the combined DOE responses to Agreements USFIC.5.05 and RT.2.09. Agreement USFIC.5.05 was reached at a meeting held October 31–November 2, 2000, to discuss the USFIC KTI (Reamer, 2000a). Agreement RT.2.09 was reached at a meeting held December 5–7, 2000, to discuss the RT KTI (Reamer, 2000b). These two agreements are worded identically as follows.

USFIC.5.05 and RT.2.09: "Provide the hydrostratigraphic cross sections that include the Nye County data. DOE will provide the hydrostratigraphic cross sections in an update to the Hydrogeologic Framework Model for the Saturated Zone Site-Scale Flow and Transport Model AMR expected to be available during FY 2002, subject to availability of the Nye County data."

The DOE responded to the agreements with a report (Ziegler, 2002) that contained hydrostratigraphic and geologic cross sections. The NRC reviewed this report, which resulted in USFIC.5.05 Additional Information Needed (AIN)–1, RT.2.09 AIN–1, and seven additional comments (Schlueter, 2002). The AINs are identical and worded as follows.

USFIC.5.05 and RT.2.09 AIN–1: "DOE should provide hydrostratigraphic cross sections containing NYE County data in the forthcoming revised Hydrogeologic Framework Model AMR or separate report. NRC staff suggests the revised report also address the

Enclosure

two comments for corrected information and the seven comments for additional information needs previously discussed in the staff comments of this review.”

The seven additional comments (Schlueter, 2002) relating to the AINs are briefly outlined next.

- 1) The cross sections provided in the initial DOE letter report (Ziegler, 2002) are insufficient to reduce the uncertainties in groundwater flow and transport.
- 2) The initial DOE letter report (Ziegler, 2002) presents hydrogeologic cross sections that were extracted from a hydrogeologic framework model 2002, yet no reference is provided for the updated model. Furthermore, it is unclear if the revised hydrologic framework model will be used to update the site-scale saturated flow model.
- 3) The initial DOE letter report fails to provide information and discussion about the technical basis for identification of the volcanic tuff units.
- 4) The initial DOE letter report fails to provide the technical basis for identification of the geologic and hydrologic units found in the Nye County wells.
- 5) The technical basis is not provided for how the referenced geophysical data were used to develop stratigraphic information in the cross sections.
- 6) The initial DOE letter report fails to provide the technical basis for how data from geologic maps and cross sections were used to develop stratigraphic information in the Nye County cross sections.
- 7) The lithologic identifications, specifically the units Tgeg1–Tgeg6, found in the initial DOE letter report are unique to the Nye County cross sections without consideration of existing geologic information and nomenclature. Furthermore, many of the similarly aged units have been identified and mapped in surrounding bedrock exposures (Murray, et al., 2002), and it is unclear whether previously identified lithologic units have been renamed or new lithologic units are being proposed.

3.0 TECHNICAL INFORMATION PROVIDED IN DOE’S AGREEMENT RESPONSE

The DOE responded to the Agreement and the seven comments in Agreements USFIC.5.05 AIN–1 and RT.2.09 AIN–1 in Appendix B (Bechtel SAIC Company, LLC, 2003). Specifically, Appendix B provides additional information needed to address the NRC concerns raised by Schlueter (2002) that DOE provide properly constructed hydrostratigraphic cross sections incorporating current Nye County data found in the hydrogeologic framework model (HFM). The additional information provided by DOE acknowledges the request for additional information (Schlueter, 2002); however, a self-assessment by Bechtel SAIC concluded that errors and inconsistencies do not affect the HFM2002. Therefore, DOE claims it will not correct the errors unless the material is used in the Licensing Application.

The DOE responses to the USFIC.5.05 and RT.2.09 AIN-1 comments are briefly outlined next.

- 1) Additional information obtained from the Nye County Early Warning Drilling Program borehole lithologies and aeromagnetic studies reduces uncertainties in the tuff-alluvium contact.
- 2) The HFM2002 was developed as a result of data from new Nye County Early Warning Drilling Program boreholes and supports the HFM2001 (U.S. Geological Survey, 2001) used for the performance assessment for the license application.
- 3) The technical basis for identification of the tuff units is available in selected references of Ziegler (2002) and the detailed lithologic logs of Nye County Early Warning Drilling Program boreholes.
- 4) The technical basis for identifying lithostratigraphic units in the Nye County Early Warning Drilling Program boreholes is found in selected references of Ziegler (2002).
- 5) A data package was developed displaying the spatial position of data used in creating the Nye County cross sections. Ziegler (2002) provides a discussion how geophysical data were used to constrain the top of the Paleozoic strata.
- 6) Hydrostratigraphic cross sections were drawn or revised from regional geologic maps and cross sections.
- 7) Lithographic identifications are not unique to the Nye County cross sections and are based on lithostratigraphic descriptions from Wahl, et al. (1997), Buesch, et al. (1996), and the lithologic log from NC-EWDP-2DB (Spengler, 2001).

4.0 NRC EVALUATION AND COMMENTS ON DOE'S RESPONSES TO THE USFIC.5.05 AND RT.2.09 AGREEMENTS

4.1 Relevance of KTI Agreements USFIC.5.05 and RT.2.09 to Repository Performance

The technical goals of Agreements USFIC.5.05 and RT.2.09 are to provide hydrostratigraphic cross sections that include the Nye County data in an update to the Hydrogeologic Framework Model. The relevance of these agreements to repository performance is to develop a defensible technical basis for hydrostratigraphic interpretations in saturated zone flow models of Fortymile Wash. Agreements USFIC.5.05 and RT.2.09 were ranked as having "low risk significance" in Attachment 3 of Travers (2003), although the information requested by these agreements and AIN-1 bear on the technical bases that support medium and high significant aspects of two integrated subissues (ISI). These are saturated alluvium transport distance in the Flow Paths in the Saturated Zone ISI and retardation in the saturated alluvium in the Radionuclide Transport in the Saturated Zone ISI.

4.2 Staff Evaluation of KTI Agreements USFIC.5.05 and RT.2.09

The DOE response to AIN-1 Comment 1 describes the use of lithologies from Nye County boreholes and aeromagnetic studies to help reduce uncertainties in tuff-alluvium contact and

groundwater flow and transport properties. The DOE indicates that these new data sources have been used to update the HFM for the Yucca Mountain area. In addition, DOE provided revised geologic cross sections (Spengler and Dickerson, 2003). Staff conclude that these cross sections provide a depiction of the location of stratigraphic units at a scale which can be useful to build confidence in the understanding of groundwater flow and transport.

The DOE response to AIN-1 Comment 2 indicates that data from the Nye County boreholes area and reinterpretation of geophysical data from the northern area of the site were used to update the HFM2002. The DOE notes there are differences between the HFM2002 and the HFM1999 models, including changes to the discretization and to the extent of the Crater Flat group. Specifically, the Crater Flat group is more continuous to the north and west in the HFM2002, which results in a high-permeability path at the water table up gradient from Yucca Mountain because of the relatively high permeability in the Crater Flat group. The DOE notes existing geologic information described by Wahl, et al. (1997), Buesch, et al. (1996), and the data report for NC-EWDP-2DB (Spengler, 2001) was considered when developing the HFM2002. Staff note, however, the Wahl, et al. (1997) digital geologic map database does not contain written descriptions of geologic units, and the Buesch, et al. (1996) report about the nomenclature of volcanic stratigraphy does not include the relevant hydrogeologic units beneath the alluvial basin beneath Fortymile Wash. The technical basis for development of the hydrogeologic units in the HFM2002 model is, therefore, not apparent from the information provided by DOE. Although the HFM2002 version of the HFM for Yucca Mountain may represent the most recently completed data interpretations, staff understand that an earlier version of the HFM (U.S. Geological Survey, 2001) was used as the basis for developing the saturated zone flow model that will be used to support the performance assessment for a license application. As such, staff recognize that hydrostratigraphic interpretations based on the HFM2002 model can only support or confirm the hydrostratigraphic interpretation used in developing the flow and transport model for performance assessment.

The DOE response to AIN-1 Comment 3 referred staff to the initial June 28, 2002, letter report (Ziegler, 2002) and the lithostratigraphic descriptions of Nye County Early Warning Drilling Program boreholes. The staff evaluation of supporting documentation and revised cross sections reveals no significant problems that affect the HFM2002. However, review of the lithostratigraphic descriptions of Nye County Early Warning Drilling Program boreholes reveals no consistent diagnostic properties used to identify individual tuff units. For example, the lithostratigraphic log for EWDP-19D1 (Spengler, 2001) denotes, "nomenclature of lower volcanic units and Tertiary sedimentary strata, for the most part, follows that found in Wahl, et al. (1997)." Although the nomenclature adopted for the cross sections is that of Wahl, et al. (1997), it is unclear how the tuff units in the Nye County boreholes were identified, considering the lack of detailed petrographic and trace element data for tuff units in Wahl, et al.

The DOE response to AIN-1 Comment 4 referred staff to the initial June 28, 2002, letter report (Ziegler, 2002). Analysis of the references in this report reveals the stratigraphic units identified in the Nye County Early Warning Drilling Program boreholes (Spengler, 2001) are based on lithostratigraphic descriptions from Wahl, et al. (1997) and Buesch, et al. (1996). Wahl, et al. and Buesch, et al., however, lack detailed lithostratigraphic descriptions for the majority of hydrogeologic units identified in the Nye County cross sections. Specifically, the Buesch, et al. (1996) report about the nomenclature of volcanic tuffs contains detailed petrographic and lithostratigraphic descriptions of the Tiva Canyon Tuff and the Topopah Spring Tuff, yet lacks detailed descriptions of other units found in the Fortymile Wash area. Although the technical

basis for identification of the lithostratigraphic units is still unclear, staff recognize that an earlier version of the HFM (U.S. Geological Survey, 2001) was used for the saturated zone flow model. Subsequently, the current stratigraphic interpretations in HFM2002 are used as support of the previous saturated zone flow model.

The DOE response to AIN-1 Comment 5 referred staff to the initial June 28, 2002, letter report (Ziegler, 2002) and a supplementary data package (Spengler and Dickerson, 2003). The supplementary data package includes the spatial position and references for all geophysical, structural, and stratigraphic data used to identify features and units in the Nye County cross sections. Analysis of the gravity profiles and depth-to-basement line used to constrain the top of the Paleozoic surface reveals that geophysical methods were misused. The depth-to-basement line was derived from a depth-to-basement map of the Death Valley region from Blakely and Ponce (2001). The depth-to-basement method has a number of inherent limitations, and Blakely and Ponce (2001) suggest, "...caution should be exercised when using these results at a scale greater than about 1:500,000." Because the revised Nye County cross sections were constructed at a scale of 1:25,000, it is unlikely the depth-to-basement method would aid in constraining the top of the Paleozoic surface.

Independent staff analysis attempted to verify the geologic validity of the cross sections through structural restoration and geophysical modeling. Extensional structural restoration of the Nye County cross sections failed to reveal major structural problems. Furthermore, forward gravity modeling using gravity stations from Ponce, et al. (2001) produced gravity-derived cross sections that identified the major structural features but failed to identify the numerous high-angle faults with little vertical offset. Based on these analyses, staff conclude the Nye County cross sections are one of many viable geologic interpretations.

The DOE response to AIN-1 Comment 6 referred staff to the revised geologic cross sections in the two-poster sheet format (Spengler and Dickerson, 2003). Plate 1 displays regional maps that depict the Nye County boreholes, geologic maps that display outcrops, and structures relevant to each cross section. Staff conclude the new information provided in the table of Plate 1 is sufficient to explain the use of regional geologic data in cross section construction.

The DOE response to AIN-1 Comment 7 states that lithologic identifications units used in these cross sections are not unique and that existing geologic information was considered. DOE notes that six marker beds are traceable between boreholes and denote them as subunits of Tge (Tgeg1-Tgeg6). Staff still are concerned, however, that there remains insufficient information to categorically rename previously identified lithologic units. Staff cannot find any published information that explicitly reclassifies or renames the lower Miocene and upper Oligocene strata.

5.0 SUMMARY

The DOE response to AIN-1 provides only a portion of the necessary information requested to complete this agreement. In particular staff note that:

- The DOE response addresses information needs described in NRC Comments 1 and 6.

- The DOE response does not address the information needs described in Comments 2, 3, and 4. However, those information requests may now be moot because DOE has indicated that the flow modeling results from HFM2002 are only used to support results obtained from its previous HFM (U.S. Geological Survey, 2001). Grid spacings in this earlier version of the framework model are too coarse to be affected by different interpretations of the geologic cross sections.
- The DOE response to the information need in Comment 5 concerned a data package was developed displaying the spatial position of data used in creating the Nye County cross sections. However, because the revised Nye County cross sections were constructed at a relatively coarse scale, it is unlikely the depth to basement method would aid in constraining the top of the Paleozoic surface.
- The DOE response to the information needs in Comment 7 is neither traceable or transparent. The DOE response points staff to previously published U.S. Geological Survey reports and papers. However, those previously published documents do not appear to contain the information that DOE cites by reference.

The NRC staff has reviewed DOE's KTI agreement responses provided in Appendixes A–I of Technical Basis Document No. 11 (Bechtel SAIC Company, LLC, 2003) to determine if sufficient information on these technical agreement items will be available for review of a potential license application. The overall significance to waste isolation of the remaining comments listed above and the independent analyses of the staff, coupled with additional information obtained by Nye County in the Early Warning Drilling Program, indicate that sufficient information will exist at the time DOE plans to submit a license application for staff to make a safety evaluation with respect to the topics covered by these agreements. On this basis, and notwithstanding new information that could raise new questions or comments concerning the preceding agreements, DOE has provided sufficient information to satisfactorily address these agreements. However, DOE should be mindful that, if the units described in Comment 7 are important to performance, the Staff recommends that, in any License Application, DOE provide the information supporting the identification of the Tge units in the Nye County cross sections.

6.0 REFERENCES

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