July 3, 2002

Joseph D. Ziegler, Acting Assistant Manager
Office of Licensing and Regulatory Compliance
U.S. Department of Energy
Yucca Mountain Site Characterization Office
P.O. Box 364629
North Las Vegas, NV 89036-8629

SUBJECT: REVIEW OF DOCUMENTS PERTAINING TO KEY TECHNICAL ISSUE AGREEMENTS

Dear Mr. Ziegler:

During a Technical Exchange and Management Meeting held on October 31-November 2, 2000, the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE) reached agreement on a number of issues within the Unsaturated and Saturated Flow Under Isothermal Conditions (USFIC) Key Technical Issue (KTI). By letters dated April 26 and 30, 2002, DOE provided documents pertaining to two NRC/DOE agreements within this KTI.

In summary, the NRC staff has reviewed the test plan for the Alluvial Testing Complex (ATC) single-well, multiple-well, and laboratory studies as it relates to USFIC Agreement 5.03. Although the NRC staff has comments on the test plan, it believes USFIC Agreement 5.03 is "complete." The NRC staff has also reviewed DOE's water-level data report, which was submitted to partially fulfill USFIC Agreement 5.08. The NRC staff believes that data from well SD-6, which was drilled several years ago and provides key information about hydraulic heads close to the Solitario Canyon Fault, should be incorporated into the analysis of water levels near Yucca Mountain, or a technical basis should be provided as to why it is not applicable. In addition, DOE needs to provide hydrogeologic interpretations for the water levels observed in wells UZ-14, H-5, G-2, WT-6, WT-24, and NC-EWDP-7S. Since DOE still needs to provide an analysis of vertical hydraulic gradients to fulfill this agreement, USFIC Agreement 5.08 will continue to be listed as "partly received."

After you have had the opportunity to review this letter, we will contact you to arrange a meeting to discuss these issues further. Mr. James Andersen is our point of contact for this letter and he can be reached at (301) 415-5717.

Sincerely,
/RA/

Janet R. Schlueter, Chief
High-Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated
cc: See attached distribution list

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Letter to J. Ziegler from J. Schlueter dated July 3, 2002

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**NRC Review of DOE Documents Pertaining to**
**Key Technical Issue Agreements**

The U.S. Nuclear Regulatory Commission (NRC) goal of issue resolution during this interim pre-licensing period is to assure that the U.S. Department of Energy (DOE) has assembled enough information on 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 by the NRC staff during pre-licensing does not prejudge what the NRC staff evaluation of that issue will be after it's licensing review. Issues are resolved by the NRC staff during pre-licensing when the staff has no further questions or comments about how DOE is addressing an issue. Pertinent new information could raise new questions or comments on a previously resolved issue.

This enclosure addresses two NRC/DOE agreements made during a meeting on the Unsaturated and Saturated Flow Under Isothermal Conditions (USFIC) (see NRC letter dated November 17, 2000, which summarized the meeting). By letters dated April 26 and 30, 2002, DOE submitted documents to address USFIC Agreements 5.03 and 5.08. The documents submitted and associated Key Technical Issue (KTI) agreements are discussed below:

**1) Unsaturated and Saturated Flow under Isothermal Conditions Agreement 5.03**

Wording of the Agreement: DOE's outline for collecting data in the alluvium appears reasonable but lacks detail. Provide a detailed testing plan for alluvial testing to reduce uncertainty (for example, the plan should give details about hydraulic and tracer tests at the well-19 complex and it should also identify locations for alluvium-complex testing wells and tests and logging to be performed). NRC will review the plan and provide comments, if any, for DOE's consideration. In support and preparation for this meeting, DOE provided work plans for the Alluvium Testing Complex and the Nye County Drilling Program (FWP-SBD-99-002, Alluvial Tracer Testing Field Work Package, and FWP-SBD-99-001, Nye County Early Warning Drilling Program, Phase II and Alluvial Testing Complex Drilling). DOE will provide test plans of the style of the Alcove 8 plan as they become available. In addition, the NRC Onsite Representative attends DOE/Nye County planning meetings and is made aware of all plans and updates to plans as they are made.

NRC Review: In response to Radionuclide Transport (RT) Agreement 2.03 and USFIC Agreement 5.03, DOE provided a test plan (Reimus and Umari, 2002) for the Alluvial Testing Complex (ATC) single-well, multiple-well, and laboratory studies. This material was sent under a cover letter dated April 30, 2002. The following review pertains to USFIC Agreement 5.03. The staff's review of RT Agreement 2.03 will be documented in a separate letter. The test plan includes:

(1) Details about the hydraulic and tracer tests at the Nye well-19 complex and identifies locations for alluvium-complex testing wells and tests;
(2) A limited discussion of preliminary results from geochemical sampling, single- and multiple-well hydraulic tests, and single-well tracer tests that have already been conducted at the ATC; and
(3) Pre-test calculations and predictions for multiple-well tracer tests.

Beyond a generalized lithology (stratigraphy) diagram of boreholes EWDP-19D1 and NC-EWDP-19P, the test plan provides no details or analyses of logging performed during or after borehole construction.

Borehole logging conducted by Nye County staff and contractors during construction included geophysical (e.g., gamma, density, temperature, resistivity), and caliper logging. The test plan provides no indication of how or whether this information will be used in the overall characterization of alluvium hydrostratigraphy, or in the interpretation of hydraulic and tracer testing. Based on discussions with DOE on June 27, 2002, it is the NRC staff's understanding that DOE will use this information in analyzing tests at the ATC and will document those analyses in documentation for a possible license application.

A preliminary composite transmissivity estimate of 300 $ft^2$/day for alluvium is given for well NC-EWDP-19D. A preliminary hydraulic conductivity estimate of 0.7 ft/day for three of the four isolated intervals in well NC-EWDP-19D is also given in the test plan; this translates to an alluvium permeability of approximately 0.25 darcy. It should be noted that Nye County consultants have reported significantly greater permeability estimates for alluvium at the ATC site. For example, at the January 29, 2002, Nuclear Waste Technical Review Board meeting, Dave Cox of Questa Engineering Corporation presented a composite transmissivity estimate of 4,000 $ft^2$/day, and a permeability estimate of 2.3 darcy for well NC-EWDP-19D1, and permeabilities of 2.1 and 2.3 darcy, for adjacent wells 19-IM1 and 19-IM2, respectively. The order-of-magnitude differences between U.S. Geological Survey and Nye County alluvium permeability estimates likely result from different analytical approaches. These differences should either be reconciled or treated as a parameter uncertainty for the final characterization and interpretation of testing results at the ATC. Based on discussions with DOE on June 27, 2002, it is the NRC staff's understanding that the technical basis for alluvium permeability will be included in documentation for a possible license application.

Additional Information Needed: None at this time.

Status of Agreement: USFIC Agreement 5.03 is "Complete."

References

Reimus, P. and M.J. Umari. "Test Plan for Alluvial Testing Complex—Single-well, Multiple-well, and Laboratory Studies." SITP-02-SZ-003 REV 01 ICN 1. North Las Vegas, NV: Bechtel SAIC. April, 2002.

**2) Unsaturated and Saturated Flow under Isothermal Conditions Agreement 5.08**

Wording of the Agreement: Taking into account the Nye County information, provide the updated potentiometric data and map for the regional aquifer, and an analysis of vertical hydraulic gradients within the site scale model. DOE will provide an updated potentiometric map and supporting data for the uppermost aquifer in an update to the Water-Level Data Analysis for the Saturated Zone Site-Scale Flow and Transport Model AMR expected to be available in October 2001, subject to receipt of data from the Nye County program. Analysis of vertical hydraulic gradients will be addressed in the site-scale model and will be provided in the

Calibration of the Site-Scale Saturated Zone Flow Model AMR expected to be available during FY 2002.

NRC Review: In partial fulfillment of USFIC Agreement 5.08, DOE provided a revised Analysis/Model report (AMR), Water-Level Data Analysis for the Saturated Zone Site-Scale Flow and Transport Model, Rev. 01. DOE noted that available information from the Nye County Early Warning Drilling Program (EWDP) was included in the AMR. The water-level data and potentiometric-surface map generated in this AMR will be used by the DOE to calibrate the saturated zone site-scale flow model. The potentiometric surface defines an upper boundary of the site-scale flow model and also provides information regarding the magnitude and direction of lateral groundwater flow within the flow system. The EWDP was initiated as part of the Nye County Nuclear Waste Repository Project Office (NWRPO), Yucca Mountain Oversight program. The hydrologic information from these wells aids in establishing the groundwater flow patterns and provides constraints for the groundwater flow model. Other wells that have been updated in the AMR include USW WT-24 and UE-25 J-11. The AMR also includes a table with the vertical hydraulic gradients in the model area, which will provide additional flow-model calibration targets.

Page 7 of the AMR states that "This revision of the potentiometric surface represents an alternate concept from that presented in Rev 00 ICN 01 of this report (USGS 2001) of the northern part of Yucca Mountain, which has been termed the 'large hydraulic gradient area' (Ervin et al., 1994, p. 7). This concept assumes that water levels in boreholes USW G-2 and UE-25 WT #6 represent perched conditions and are not representative of the regional potentiometric surface."

Wells drilled during Phase III of the Nye County EWDP program have not been included in this AMR. These wells include NC-EWDP-10S, NC-EWDP-22S, and NC-EWDP-18P. These wells provide data in a region of uncertainty associated with groundwater flow. Based on discussions with DOE, it is the NRC staff's understanding that these and other Nye County wells will be included in future water table maps and analyses for model calibration or validation. It is also the NRC staff's expectation and understanding that this information will be provided as it becomes available, and will be included in documentation for a possible license application.

Well SD-6, located at the western margin of the potential repository block, was drilled several years ago in proximity to the Solitario Canyon Fault zone. Hydrologic data from SD-6 were omitted from the water-level AMR and need to be provided by DOE.

The most significant difference between the analysis presented in this AMR (Rev 01) and the previous AMR (Rev 00 ICN 01) is in the portrayal of the large hydraulic gradient (LHG) area north of Yucca Mountain. This is based on the assumption that wells USW G-2 and UE-25 WT #6 are perched (Assumption 5.1.4). By not using the data from those two boreholes, the LHG is reduced from about 0.11 (Tucci and Burkhardt 1995, p. 9) to between 0.06 to 0.07, and the potentiometric contours are more widely spaced. There is some uncertainty associated in assuming whether water levels reported represent perched conditions or not. For example Flint et al. (2001) propose a conceptual model of a "semiperched system that consists of an unconfined water body, which has a high water level, above a confined water body, which has a low water level, and is separated by a low-permeability zone that is completely saturated." This conceptual model uncertainty should be incorporated in future analyses, or an evaluation

should be provided to explain why the effect of this uncertainty on predicted flow paths from Yucca Mountain is not significant.

The AMR states that professional judgment was used to determine whether water-level altitudes represent perched-water conditions in the area north of Yucca Mountain with an apparent steep hydraulic gradient (wells G-2 and WT-6). The NRC staff note that there are insufficient data available to unequivocally prove whether these wells are perched or not. The AMR cites Czarnecki et al. (1997) as providing a rationale for treating wells G-2 and WT-6 as representing perched water. However, Czarnecki's rationale was also considered by panelists on a DOE sponsored expert elicitation on the saturated zone (Geomatrix, 1998). Three of these experts recommended that additional well drilling be done in the zone of the large hydraulic gradient to reduce uncertainty and determine whether an extensive zone of perched water was present. DOE drilled well WT-24 and found it did not represent perched water. DOE also treats UE-29a#2, located northeast of well WT-6, as representing a regional water level. These facts, and data on the stratigraphy and water chemistry of deep well G-2, could be interpreted to mean that both G-2 and WT-6 represent the regional potentiometric surface, with little influence of perched water on the groundwater elevations. Rather than cite Czarnecki, et al. (1997), which pre-dates the drilling of WT-24, DOE needs to provide an updated interpretation of water levels in well G-2 and WT-6, and for the large hydraulic gradient, based on new data from WT-24.

In the water-level AMR, well NC-EWDP 7S is assumed to reflect perched water due to the anomalously high water levels. The AMR states that "...no other hydrogeologic explanation other than perched conditions is plausible for this location." No other basis is provided by DOE. The groundwater elevation in this well would be consistent with the presence of a fault zone, or some other zone of contrasting permeability, downgradient from well NC-EWDP 7S. In an alternative conceptual potentiometric map developed at CNWRA, (Hill et al., 2002), NC-EWDP 7S was used to develop a potentiometric map that will be used in the calibration of an independent Site Scale Saturated Zone Model (Winterle, et al., 2002). These differing data interpretations illustrate an uncertainty in the analysis and resulting conceptual model development. It is recommended that DOE either conduct modeling analyses for alternative conceptual models assuming both perched or non-perched conditions at the various "assumed perched wells," or present an evaluation to show whether the differences between these alternative conceptual models are relevant to flow paths from Yucca Mountain. The NRC staff expects this information to be included in documentation for a possible license application.

DOE's updated potentiometric surface map has variable contour intervals that aid in a better description of the groundwater flow regime. If future revisions are to be made to the water-level AMR, it is recommended that the contour interval should be reduced, where sufficient data are available, to represent the flow in the low and moderate hydraulic gradient areas.

Page 28 of the AMR states that "...an area termed the 'moderate hydraulic gradient' is associated with the area adjacent to the Solitario Canyon fault..." However, wells H-5 and UZ-14 are east of the fault and have heads from 775 to 779 m, similar to heads in wells just west of the fault. No hydrogeologic explanation is given in the AMR. We consider this to be a significant omission because model calibration could be strongly affected by lateral and vertical head differences in proximity to the repository footprint. One way to address this concern would be to include a discussion of wells H-5, UZ-14, and the Solitario Canyon Fault in the "Calibration

of the Site-Scale Saturated Zone Flow Model" AMR." As previously agreed under USFIC Agreement 5.08, that AMR will be provided by DOE in the near future.

Additional Information Needed:

(1) Incorporate data for well SD-6, which was drilled several years ago (DOE, 1999) and provides key information about hydraulic heads close to the Solitario Canyon Fault, into the analysis of water levels near Yucca Mountain and provide the analysis for NRC review. The same data given in tables in the water-level AMR for other wells should be provided for SD-6.

(2) Provide a hydrogeologic interpretation for the high heads observed in wells UZ-14 and H-5.

(3) Provide an updated hydrogeologic interpretation for groundwater elevations in wells G-2 and WT-6 (i.e., wells that define the large hydraulic gradient) based on newly available data from well WT-24.

(4) Provide the basis for assuming that the water level in well NC-EWDP-7S represents perched water.

Status of Agreement: As USFIC Agreement 5.08 still requires DOE to provide the analysis of vertical hydraulic gradients in the Calibration of the Site-Scale Saturated Zone Flow Model AMR, this agreement will be listed as "Partly Received." DOE should provide the requested information above (i.e., "additional information needed") in the AMR or another document. An update of the water-level AMR is not required for this purpose.

References

Czarnecki, J.B.; Faunt, C.C.; Gable, C.W.; and Zyvoloski, G.A. 1997. Hydrogeology and Preliminary Three-Dimensional Finite-Element Ground-Water Flow Model of the Site Saturated Zone, Yucca Mountain, Nevada. Milestone SP23NM3. Denver, Colorado: U.S. Geological Survey. 1997.

DOE, 1999. Site Characterization Progress Report, Yucca Mountain, Nevada, Number 20.

Ervin, E.M., R.R. Luckey, and D.J. Burkhardt, *Revised Potentiometric-Surface Map, Yucca Mountain and Vicinity, Nevada*, USGS Water-Resources Investigations Report 93-4000, Denver, CO, U.S. Geological Survey, 1994.

Flint, A.L., L.E. Flint, E.M. Kwicklis, G.S. Bodvarsson, and J.M. Fabryka-Martin. "Hydrology of Yucca Mountain, Nevada." *Reviews of Geophysics*, Vol. 39, No. 4: pp. 447–470. 2001.

Geomatrix, Saturated Zone Flow and Transport Expert Elicitation Project [for Yucca Mountain], WBW 1.2.5.7, prepared for U.S. Dept. of Energy by Geomatrix Consultants, Inc., San Francisco, CA, January 1998.

Hill, M., J. R. Winterle and R. Green. "Revised Site-Scale Potentiometric Surface Map For Yucca Mountain, Nevada", San Antonio, Texas: CNWRA. 2002.

Tucci, Patrick, and Burkhardt, D.J., 1995, Potentiometric-Surface Map, 1993, Yucca Mountain and Vicinity, Nevada: U.S. Geological Survey Water-Resouces Investigations Report 95-4149.

Winterle, J.R., M.E. Hill, and C. Manepally. “Concepts of Saturated Zone Modeling for Development of a Site-Scale Groundwater Flow Model for Yucca Mountain.” San Antonio, Texas: CNWRA. 2002.