# REVIEW BY THE OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS OF THE DEPARTMENT OF ENERGY'S RESPONSES TO KEY TECHNICAL ISSUE AGREEMENTS USFIC.5.02, USFIC.5.04, USFIC.5.12, RT.1.04, RT.2.01, RT.2.03, RT.2.06, RT.2.07, RT.2.08, RT.3.03, AND GEN.1.01 (COMMENTS 41 AND 102) FOR A POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA PROJECT NO. WM-00011

## 1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issue resolution goal during this interim prelicensing period is to ensure 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 prelicensing 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 prelicensing does not prejudge the NRC staff evaluation of the issue during the licensing review. Issues are considered resolved by the NRC staff during prelicensing 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 on a previously resolved issue.

By a letter dated October 2, 2003, DOE submitted a report titled Technical Basis Document No. 11: Saturated Zone Flow and Transport (Bechtel SAIC Company, LLC, 2003a). The DOE responses to twenty-five DOE and NRC key technical issue agreements are contained in appendixes to this report. The NRC reviews of the DOE responses to six of these agreements were conducted previously and staff evaluations and comments were provided to DOE (Reamer, 2004).

This report contains a staff review of DOE responses to ten additional agreements and two staff comments contained in Agreement GEN.1.01. The wordings of the agreement items and brief summaries of information provided by DOE are contained in Section 2.0. Section 3.0 provides NRC evaluations of the DOE responses.

## 2.0 TECHNICAL INFORMATION PROVIDED IN THE DOE AGREEMENT RESPONSES

### 2.1 Agreement USFIC.5.02

Agreement USFIC.5.02 was reached at a meeting, held October 31–November 2, 2000, to discuss the Unsaturated and Saturated Flow Under Isothermal Conditions Key Technical Issue (Reamer, 2000a). The wording of this agreement is as follows.

> USFIC.5.02: "Provide the update to the SZ PMR [Saturated Zone Process Model Report], considering the updated regional flow model. A revision to the Saturated Zone Flow and Transport PMR is expected to be available and will reflect the updated United States Geological Survey (USGS) Regional Groundwater Flow Model in FY 2002, subject to receipt of the model report from the USGS."

Technical Information Provided for Agreement USFIC.5.02

Information relevant to Agreement USFIC.5.02 was previously provided by DOE in a response to Agreement USFIC.5.09 (Ziegler, 2002a). The staff review of Agreement USFIC.5.09 (Schlueter, 2003) resulted in the requests for additional information related to five subject areas: (1) groundwater specific discharge, (2) horizontal hydrologic anisotropy, (3) flow fields for future climate states, (4) comparison of regional and site scale fluxes, and (5) model validation of the site-scale saturated zone flow model. Item 4 is addressed in Appendix D of Bechtel SAIC Company, LLC (2003a). Items 1 and 3 are addressed in a separate letter by Ziegler (2004), which is also reviewed herein as part of the DOE response to Agreement USFIC.5.02. Information pertaining to item 2 has been previously reviewed by NRC and found to be acceptable (Reamer, 2004); item 5 is addressed in the DOE response to Agreement USFIC.5.12, which is reviewed separately in this report.

Bechtel SAIC Company, LLC (2003a, Table D–1) provides a comparison of calculated groundwater fluxes across boundary segments of site-scale saturated zone flow model to the groundwater fluxes calculated for equivalent areas of the 1997 Death Valley regional flow model (D'Agnese, et al., 1997). DOE concludes that this comparison "indicates a reasonable match between the two models within the uncertainty range of the regional model water budget." Bechtel SAIC Company, LLC (2003a, Table D–2) also provides a comparison of groundwater fluxes from the 1997 Death Valley regional model to the updated 2002 version of the Death Valley regional model (D'Agnese, et al., 2002). This latter comparison indicates that the groundwater fluxes in the area of the site-scale model boundaries have changed in the updated regional model. The biggest differences in the 2002 regional model include a significant decrease in inflow across the eastern site-scale model boundary; this difference is attributed to the elimination of a thrust zone that coincides with the southeast corner of the site-scale model. Also, the 2002 regional model shows a switch to significant outflow across the western site-scale model boundary where the 1997 model showed a significant inflow; most of this difference results from a localized change in predicted flow direction across the southwest corner of the site-scale model boundary.

Zeigler (2004, Enclosure 1) provides a summary of how DOE includes uncertainty in groundwater specific discharge in the saturated zone flow and transport abstraction. Specific discharge scaling factors with values that range from 1/30 to 10 are used to develop a set of flow fields for the radionuclide transport abstraction. Eighty percent of the probability distribution for these scaling factors is evenly distributed between values from 1/3 to 3 times the best estimate for specific discharge. Ten percent of the probability is assigned to values between 3 and 10; the remaining 10 percent is assigned to values between 1/30 and 1/3. This range of specific discharge scaling factors is said to be consistent with the uncertainty range developed by the expert elicitation panel for the saturated zone. Additional data from the Alluvial Testing Complex are cited as a basis for weighting most of the probability distribution to the central portion of the range.

Zeigler (2004, Enclosure 2) provides information about potential changes in saturated zone flow during future climate conditions. The effects of climate change are included in performance assessment modeling by scaling the simulated saturated zone breakthrough curves by a factor representative of the future climate state. This approach accounts for increased groundwater specific discharge, but implicitly assumes that flow pathways remain the same. This DOE response to Agreement USFIC.5.02 states that recent field evidence suggests that water table rise in the Yucca Mountain area will be small and will not cause the water table to encounter new hydrostratigraphic units with different flow and transport properties. DOE also cites modeling by D'Agnese, et al. (1999), who used the Death Valley regional flow model to simulate groundwater flow during future potential climate conditions, as evidence that saturated zone flow paths will not change appreciably within the regulatory compliance area during a future climate with increased recharge. The results of the D'Agnese, et al., modeling summarized in the DOE response suggest that the water table rise during the simulated wetter climate ranges from approximately 30 m [100 ft] just south of the compliance boundary to approximately 100 m [330 ft] in the area beneath Yucca Mountain. The groundwater specific discharge calculated for the wetter climate scenario is greater than present-day by approximately a factor of four within the compliance area.

## 2.2 Agreement USFIC.5.12

Agreement USFIC.5.12 was reached at a meeting, held October 31–November 2, 2000, to discuss the Unsaturated and Saturated Flow Under Isothermal Conditions Key Technical Issue (Reamer, 2000a). The wording of this agreement is as follows.

> USFIC.5.12: "Provide additional supporting arguments for the Site-Scale Saturated Zone Flow model validation or use a calibrated model that has gone through confidence building measures. The model has been calibrated and partially validated in accordance with AP 3.10Q, which is consistent with NUREG–1636. Additional confidence-building activities will be reported in a subsequent update to the Calibration of the Site-Scale Saturated Zone Flow Model AMR, expected to be available during FY 2002."

Technical Information Provided for Agreement USFIC.5.12

The DOE response to Agreement USFIC.5.12 is provided in Appendix D of the Bechtel SAIC Company, LLC (2003a) technical basis document for saturated zone flow and transport. This response contains a brief summary of information used to build confidence in the site-scale saturated zone flow model. The response also cites documentation of the site-scale saturated zone flow model (Bechtel SAIC Company, LLC, 2003b) that contains a more detailed description of model validation activities.

One source of model validation information is data from newly drilled Nye County wells that were not used in the model calibration. Water-level data from these wells (Bechtel SAIC Company, LLC, 2003a, Table D–3) show that residual differences between model-calculated water levels are similar in magnitude to residual errors obtained for wells used in the calibration process. The largest differences between calculated and observed water levels generally occur near hydrogeologic features that result in steep hydraulic gradients.

The DOE response also includes a plot of calculated heads at observation points along projected flow paths as a function of distance along a projected flow path from the potential repository area (Bechtel SAIC Company, LLC, 2003a, Figure D–5). This plot represents a path beginning at Well USW H–6, located on the upstream side of the proposed repository area, and ending at Well NC–EWDP–19P. This plot of calculated head versus distance is compared to a plot of observed heads versus distance. The comparison of plots shows that, along most of the projected flow path from Yucca Mountain, calculated hydraulic gradients are in good agreement with the hydraulic gradients inferred from observed differences in hydraulic heads between well locations.

The DOE response indicates that confidence in model results is also gained from permeability estimates obtained from *in-situ* hydraulic testing of various hydrogeologic units in wells throughout the Yucca Mountain and Nevada Test Site areas.  For most hydrogeologic units, the calibrated permeability values used in the site-scale flow model are within the range of values reported from *in-situ* testing (Bechtel SAIC Company, LLC, 2003a, Figures D–6 and D–7).

The DOE response contains a summary of an analysis of flow paths inferred from groundwater chemistry (Bechtel SAIC Company, LLC, 2003a, Figure D–9).  This analysis of groundwater chemistry indicates that groundwater chemistries can be divided into geochemical groundwater types that trend along generally north-south orientations that are broadly consistent with flow paths predicted by the flow model.

A final model validation activity discussed in the DOE response to Agreement USFIC.5.12 is a model of saturated zone thermal transport (Bechtel SAIC Company, LLC, 2003a, Appendix D). This analysis considered both a conduction-only model and a model of coupled conduction and groundwater advection.  The conduction-only model showed that simulated groundwater temperatures are largely influenced by the thickness of the unsaturated zone.  Higher temperatures corresponded to the relatively thick unsaturated zones under Yucca Mountain in the central model region and under the Calico Hills in the northeastern model region.  The coupled model of heat transport by conduction and groundwater advection used the calibrated thermal properties and boundary conditions obtained from the conduction-only model.  The addition of advection to the thermal model resulted in greater overall residual errors, but reduced bias for simulated temperatures in deeper, higher temperature measurement locations, which were underestimated in the conduction-only model.  This modeling is discussed in greater detail in Bechtel SAIC Company, LLC (2003b, Section 7.4).

2.3 Agreements USFIC.5.04, RT.2.08, and RT.3.03

Agreement USFIC.5.04 was reached at a meeting held October 31–November 2, 2000, to discuss the Unsaturated and Saturated Flow Under Isothermal Conditions Key Technical Issue (Reamer, 2000a):

> USFIC.5.04.  "Provide additional information to further justify the uncertainty distribution of flow path lengths in the alluvium.  This information currently resides in the Uncertainty Distribution for Stochastic Parameters AMR.  DOE will provide additional information, to include Nye County data as available, to further justify the uncertainty distribution of flowpath lengths in alluvium in updates to the Uncertainty Distribution for Stochastic Parameters AMR and to the Saturated Zone Flow and Transport PMR, both expected to be available in FY 2002."

Agreements RT.2.08 and RT.3.03 were reached at a meeting, held December 5–7, 2000, to discuss the Radionuclide Transport Key Technical Issue (Reamer, 2000b).  The wordings of these agreements are as follows:

> RT.2.08.  "Provide additional information to further justify the uncertainty distribution of

flow path lengths in the alluvium. This information currently resides in the Uncertainty Distribution for Stochastic Parameters AMR. DOE will provide additional information, to include Nye County data as available, to further justify the uncertainty distribution of flowpath lengths in alluvium in updates to the Uncertainty Distribution for Stochastic Parameters AMR and to the Saturated Zone Flow and Transport PMR, both expected to be available in FY 2002."

RT.3.03. "Provide additional information to further justify the uncertainty distribution of flow path lengths in the tuff. This information currently resides in the Uncertainty Distribution for Stochastic Parameters AMR. DOE will provide additional information, to include Nye County data as available, to further justify the uncertainty distribution of flowpath lengths from the tuff at the water table through the alluvium at the compliance boundary in updates to the Uncertainty Distribution for Stochastic Parameters AMR and to the Saturated Zone Flow and Transport Process Model Report, both expected to be available in FY 2002."

Notice that the wording of Agreement USFIC.5.04 is identical to Agreement RT.2.08.

Technical Information Provided for Agreements USFIC.5.04, RT.2.08, and RT.3.03

The DOE responses to Agreements USFIC.5.04, RT.2.08, and RT.3.03 are provided in Appendix G of the Bechtel SAIC Company, LLC (2003a) technical basis document for saturated zone flow and transport.

As currently conceptualized by DOE, the calculated total flow path length from beneath the repository to the compliance boundary varies from approximately 19.5 to 22 km [12.1 to 13.7 mi], depending on source location and the degree of horizontal anisotropy of permeability in the volcanic rock units. Uncertainty in the proportion of this flow path that occurs in alluvial material is considered in two ways. First, the abstraction includes alternative sets of flow paths that are computed using a range of values to account for uncertainty in the horizontal anisotropy of volcanic tuff permeability. Flow paths computed with a high value of horizontal anisotropy take a more direct southerly route and transition into alluvium farther south and closer to the compliance boundary. Second, an alluvium uncertainty zone is included in the abstraction to account for uncertainty in the position of the interface between volcanic tuff and valley-fill alluvium. The tuff–alluvium transition area is incorporated in the particle-tracking transport simulations for total system performance assessment as a trapezoidal region with a maximum north-south extent of approximately 10 km [6.21 mi] and an east-west extent of approximately 5 km [3.1 mi]. The northern and western boundaries of the alluvium uncertainty zone are varied in the performance assessment abstraction to account for uncertainty in the location where flow paths transition from volcanic tuff to alluvium. The result of this combined consideration of uncertainties is the lengths of flow paths in alluvium considered in the performance assessment abstraction vary from approximately 1 to 10 km [0.62 to 6.2 mi], depending on the stochastically selected combination of anisotropy and alluvium uncertainty zone parameters.

The DOE response also provides information on the uncertainty of horizontal anisotropy of permeability in the volcanic tuff aquifer, which affects the location at which flow paths transition from tuff to alluvium. The response provides a figure showing calculated flow paths for horizontal anisotropy ratios of 0.05, 0.2, 1.0, 5.0, and 20, overlain on a map that also shows the location of the alluvium uncertainty zone. This map makes it clear that it is the northern and western boundaries of the alluvial basin that are of interest to defining the geometry of the tuff alluvium transition.

## 2.4 Agreement RT.1.04

Agreement RT.1.04 was reached at a meeting, held December 5–7, 2000, to discuss the Radionuclide Transport Key Technical Issue (Reamer, 2000b). The wording of this agreement is as follows:

> RT.1.04: "Provide sensitivity studies on $K_d$ for plutonium, uranium, and protactinium to evaluate the adequacy of the data. DOE will analyze column test data to determine whether, under the flow rates pertinent to the Yucca Mountain flow system, plutonium sorption kinetics are important to performance. If they are found to be important, DOE will also perform sensitivity analyses for uranium, protactinium, and plutonium to evaluate the adequacy of $K_d$ data. The results of this work will be documented in an update to the Analysis and Model Report Unsaturated Zone and Saturated Zone Transport Properties available to the NRC in FY 2002."

Technical Information Provided for Agreement RT.1.04

The DOE response to Agreement RT.1.04 is provided in Appendix J of the Bechtel SAIC Company, LLC (2003a) technical basis document for saturated zone flow and transport, with supplemental information provided in Bechtel SAIC Company, LLC (2003c, Attachment IV). The DOE response contains a brief summary of analyses of plutonium column transport tests and kinetic sorption behavior. Protactinium and uranium are not considered in the analyses. Plutonium was selected for detailed study because plutonium sorption kinetics are slower than the sorption kinetics of other radionuclides in the Yucca Mountain inventory (Bechtel SAIC Company, LLC, 2003a, Appendix J). The column transport tests, sorption reaction rates, and estimated advection times in the saturated zone are used to calculate Damköhler numbers (*Da*). Damköhler numbers represent the ratio of advection timescale to the timescale of sorption and can provide a basis for evaluating which timescale dominates the system. If the reaction time is much faster than the transport time, the calculated *Da* is large, and the assumption of local equilibrium is valid (Bechtel SAIC Company, LLC, 2003a, Appendix J). A sample calculation provided in Bechtel SAIC Company, LLC (2003c, Attachment IV) indicates that the *Da* is large under the conditions in which the Yucca Mountain sorption experiments were performed and under typical Yucca Mountain geochemical conditions. DOE concludes that the study demonstrates the kinetics of plutonium sorption are relatively unimportant for plutonium and that the assumption of local equilibrium can be used when evaluating transport of plutonium in the saturated zone. Moreover, because plutonium sorption kinetics were slower than those of other sorbing radionuclides, kinetic limitations of sorption reactions do not need to be considered when predicting the transport of radionuclides through the saturated zone (Bechtel SAIC Company, LLC, 2003a, Appendix J).

## 2.5 Agreement RT.2.01

Agreement RT.2.01 was reached at a meeting, held December 5–7, 2000, to discuss the Radionuclide Transport Key Technical Issue (Reamer, 2000b). The wording of this agreement is as follows:

> RT.2.01. "Provide further justification for the range of effective porosity in alluvium, considering possible effects of contrasts in hydrologic properties of layers observed in wells along potential flow paths. DOE will use data obtained from the Nye County Drilling Program, available geophysical data, aeromagnetic data, and results from the Alluvial Testing Complex testing to justify the range of effective porosity in alluvium, considering possible effects of contrasts in hydrologic properties of layers observed in wells along potential flow paths. The justification will be provided in the Alluvial Testing Complex report due in FY 2003."

Technical Information Provided for Agreement RT.2.01

The DOE response to Agreement RT.2.01 is provided in Appendix H of Bechtel SAIC Company, LLC (2003a). The response discusses the practical limitations of obtaining information regarding alluvium effective porosity using field-scale pump and tracer testing at the Alluvial Testing Complex as planned. Because testing at the Alluvial Testing Complex was not available, an alternative approach was developed to derive needed information from literature values, expert opinion, laboratory testing, and single-hole tracer test results. DOE argues that there is sufficient understanding of alluvium in general to conclude that the alluvium effective porosity is adequately characterized. The response provides results of the single-hole tracer test and compares that value to effective porosity distributions developed from other sources. The measured value at the single-hole tracer test falls within the DOE-proposed distribution of effective porosity. DOE concludes that the proposed distribution adequately bounds the range of effective porosity in the saturated alluvium.

## 2.6 Agreement RT.2.03

Agreement RT.2.03 was reached at a meeting held December 5–7, 2000, to discuss the Radionuclide Transport Key Technical Issue (Reamer, 2000b). The wording of this agreement is as follows:

> RT.2.03. "Provide a detailed testing plan for alluvial testing (the ATC and Nye County Drilling Program) 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 the October/November 2000 Saturated Zone meeting, DOE provided work plans for the Alluvial 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. The plan will be amended to include laboratory testing. In addition, the NRC On Site Representative attends DOE/Nye County planning meetings and is made aware of all plans and updates to plans as they are made."

Information relevant to Agreement RT.2.03 was previously provided by DOE in a letter report (Ziegler, 2002b). The staff review of the test plan (Schlueter, 2002) resulted in the following request for additional information for Agreement RT.2.03.

> "The purpose of the testing is to support the development of a conceptual model of groundwater flow and radionuclide transport in saturated alluvium south of Yucca Mountain, and to quantify flow and transport parameters. The distance between wells is less than 30 meters. The parameters used in performance assessment are applied to cells 500 meters on a side. Provide the justification for the use of parameter values, determined at one scale (30 meters between drill holes of the ATC test), in the total system performance assessment model that uses a different scale."

Technical Information Provided for Agreement RT.2.03

The DOE response to Agreement RT.2.03 AIN–1 is provided in Appendix H of Bechtel SAIC Company, LLC (2003a) and is supplemented with supporting information provided in two other documents by Bechtel SAIC Company, LLC (2003a, Appendix I; 2003c, Attachment III). The DOE response argues that although monitoring wells used in field-scale testing may be relatively closely spaced, the testing impacts a much larger area and can yield results on the order of several square kilometers. Several methods used by DOE to address upscaling are provided. These methods include (i) using probability distributions constructed from a variety of information sources and refined by parameter estimates from field-scale tests, (ii) obtaining insights into scaling by comparing laboratory and field-scale parameter estimates and appropriately extrapolating laboratory-scale information as needed, and (iii) using geostatistical methods to refine probability distributions and provide additional insight into scaling phenomena (Bechtel SAIC Company, LLC, 2003a, Appendix H). In Bechtel SAIC Company, LLC (2003a, Appendix I; 2003c, Attachment III), DOE provides results of geostatistical analyses that suggest a 500-m (1,640 ft) grid size adequately accounts for smaller scale heterogeneities and the probability distributions used in the saturated zone flow and transport abstraction adequately account for uncertainty in parameter estimates from smaller scale field tests.

## 2.7 Agreements RT.2.06, RT.2.07, and GEN.1.01 (Comments 41 and 102)

Agreements RT.2.06 and RT.2.07 were reached at a meeting held December 5–7, 2000, to discuss the Radionuclide Transport Key Technical Issue (Reamer, 2000b). The wordings of these agreements are as follows:

> RT.2.06. "If credit is taken for retardation in alluvium, the DOE should conduct $K_d$ testing for radionuclides important to performance using alluvium samples and water compositions that are representative of the full range of lithologies and water chemistries present within the expected flow paths (or consider alternatives such as testing with less disturbed samples, use of samples from more accessible analog sites (e.g., 40-mile Wash), detailed process level modeling, or other means). DOE will conduct $K_d$ experiments on alluvium using samples from the suite of samples obtained from the existing drilling program; or, DOE will consider supplementing the samples available for testing from the alternatives presented by the NRC. This information will be documented in an update to the SZ In Situ Testing AMR, available in FY 2003. $K_d$ parameter distributions for TSPA will consider the uncertainties that arise from the experimental methods and measurements."

RT.2.07. "Provide the testing results for the alluvial and laboratory testing. DOE will provide testing results for the alluvial field and laboratory testing in an update to the SZ In Situ Testing AMR available in FY 2003."

Agreement GEN.1.01 was reached at a meeting held September 18–19, 2001, to discuss the Range of Thermal Operating Temperatures (Reamer, 2001). The wordings of Comments 41 and 102 for Agreement GEN.1.01 are as follows:

GEN.1.01 (Comment 41). "The new Np sorption coefficient distribution for the saturated zone used in the uncertainty analysis needs further analysis. Any future adoption of this distribution in TSPA will require a technical basis consistent with agreements RT.1.05 and RT.2.10."

GEN.1.01 (Comment 102). "The DOE states in Section 12 (p. 12-4) that 'new data from column and batch experiments have been used to define the $K_d$s estimate for neptunium-237.' Previous work used uranium $K_d$ values to characterize the $K_d$ values for neptunium-237. Has this been improved by using neptunium studies?"

Technical Information Provided for Agreements RT.2.06, RT.2.07, and GEN.1.01 (Comments 41 and 102)

The DOE initially responded to Comments 41 and 102 of Agreement GEN.1.01 as documented in the following text from Reamer (2001).

DOE Initial Response to GEN.1.01 (Comment 41). "Alluvium $K_d$ distributions are based on data obtained using EWDP–3S water and alluvium from saturated zone 3S, 9Sx, and 2D. However, DOE acknowledges that 3S water was contaminated with a polymer / surfactant used during well development. The effect of this polymer / surfactant on $K_d$ values is being investigated by conducting additional experiments using alluvium samples and water from Nye County EWDP well locations along Fortymile wash, which were drilled without using polymer or surfactant additives. These locations are essentially along the projected SZ flow pathway from the proposed repository. The technical basis for sorption coefficients will be provided consistent with the cited agreements for data used in any potential license application."

DOE Initial Response to GEN.1.01 (Comment 102). "$K_d$ values obtained directly from neptunium sorption measurements are superior to assuming that uranium $K_d$ values also apply to neptunium. A description of column and batch Neptunium 237 experiments and results will be provided in the next revision of the transport properties report, per KTI agreements RT.1.05 and 2.10."

DOE provided additional information to respond to Comments 41 and 102 of Agreement GEN.1.01 and a combined response to Agreements RT.2.06 and RT.2.07 in Appendix K of Bechtel SAIC Company, LLC (2003a). The information provided presents a summary of results of numerous laboratory experiments designed to determine sorption coefficients in saturated alluvium for important radionuclides such as neptunium, uranium, iodine, and technicium. The experimental objectives were to (i) evaluate the potential of the saturated alluvium to retard radionuclides, (ii) study chemical reaction mechanisms between the radionuclides and alluvium, and (iii) estimate sorption and transport parameters for use in predictive models. Results of chemical analyses of saturated zone waters, mineralogical and surface area analyses of alluvial sediments, and batch and column sorption experiments are presented. DOE also provides results of experiments that evaluate the effects of pH, ionic strength, kinetics, mineral content, and surface area on the sorption behavior of radionuclides, including neptunium. DOE concludes that the range of conditions and samples considered in the experiments is representative of the saturated alluvium.

## 3.0 NRC EVALUATION AND COMMENT

The following sections provide a discussion of the relevance of the agreements to repository performance, followed by NRC reviews of the agreement responses organized according to the applicable review methods in the Yucca Mountain Review Plan (NRC, 2003). The five generic review methods described in the Yucca Mountain Review Plan are: (i) Model Integration, (ii) Data and Model Justification, (iii) Data Uncertainty, (iv) Model Uncertainty, and (v) Model Support. The agreement responses reviewed in this report pertain to these review methods:

- The DOE response to Agreement USFIC.5.02 contains information related to Data Uncertainty and Model Uncertainty.
- The DOE response to Agreement USFIC.5.12 contains information related to Model Support.
- The DOE-combined response to Agreements RT.2.08, RT.3.03. and USFIC.5.04 provides information related to both Data and Model Justification and Data Uncertainty.
- The DOE combined response to Agreements RT.1.04, RT.2.07, and GEN.1.01 (Comments 41 and 102) contains information related to Data and Model Justification.
- The DOE response to Agreement RT.2.03 AIN–1 contains information related to Data Uncertainty.
- The DOE combined response to Agreements RT.2.01 and RT.2.06 contains information related to Data and Model Justification and Data Uncertainty.

### 3.1 Relevance to Repository Performance

The saturated zone is listed as a principal factor in total system performance, chiefly as a component of defense in depth (CRWMS M&O, 2000). Revision 4.0 of CRWMS M&O (2000) describes the degree of radionuclide sorption on mineral surfaces within the rock matrix of the tuff aquifer system and in the alluvial aquifer system as the most important process affecting the ability of the saturated zone to act as a natural barrier by attenuating and delaying potentially released radionuclides. Independent NRC performance assessment sensitivity analyses have also concluded that retardation in the saturated zone is important, based on much higher modeled doses that result from analyses in which the saturated zone was excluded from the model (NRC, 1999; Mohanty, et al., 2002). In particular, neptunium retardation has been shown to have a significant effect on dose calculations (NRC, 1999).

These and other risk insights pertaining to radionuclide transport in the saturated zone indicate that the most important aspects are those related to sorption in the saturated alluvium, matrix diffusion in the fractured volcanic tuff, and colloid-facilitated radionuclide transport. The potential delay of radionuclides in the saturated alluvium is primarily controlled by the magnitude of sorption on alluvial minerals and the effective porosity of the alluvium, which also is important for determining travel time of nonsorbing radionuclides. Radionuclide transport in fractured volcanic tuff is retarded through diffusion of radionuclides from the flowing fractures into the porous tuff matrix, where radionuclides may be sorbed. NRC has ranked alluvium sorption as having a high significance to waste isolation and has ranked diffusion and subsequent sorption of radionuclides in the tuffs as having medium significance to waste isolation. Agreements RT.1.04, RT.2.03 AIN–1, RT.2.06, RT.2.07, and GEN.1.01 (Comments 41 and 102) all pertain to the development and technical bases for sorption parameters. Agreement RT.2.01 pertains to the determination and technical bases for the effective porosity of alluvium.

Agreement USFIC.5.02 pertains to uncertainty in groundwater fluxes in the site-scale saturated zone flow model. Groundwater flux was not specifically ranked in the NRC risk insights baseline initiative (NRC, 2004), but its relevance to repository performance lies in the fact that groundwater travel time from the potential repository area to the compliance boundary is directly proportional to the groundwater flux along the flow paths.

Agreement USFIC.5.12 pertains to obtaining additional lines of evidence to support the results of the site-scale saturated zone flow model. This category of information does not directly affect repository performance, but it is necessary to provide confidence in repository performance predictions.

Agreements RT.2.08, RT.3.03, and USFIC.5.04 pertain to justification of the uncertainty distribution for flow distances in tuff and alluvium considered in the DOE performance assessment abstraction for saturated zone flow and transport. Based on the results of the NRC risk insights baseline initiative (NRC, 2004), saturated alluvium transport distance is considered to be of medium significance to waste isolation, and retardation in saturated alluvium is considered to have high significance to waste isolation. These risk insights reflect the fact that the efficacy of the saturated zone as a natural barrier to radionuclide migration, as presently conceptualized, relies almost entirely on retardation of radionuclides within the alluvial portion of saturated zone flow paths.

## 3.2 Data and Model Justification

At the time Agreements RT.2.08, RT.3.03, and USFIC.5.04 were reached, there were no published borehole data for the area extending south of Well UE–25 JF#3 to the compliance boundary. This data gap made it difficult to characterize the area in which saturated zone flow and transport paths transition from volcanic tuff to alluvium. The information provided in the DOE response indicates that the addition of Wells NC–EWDP–10S, NC–EWDP–22S, and NC–EWDP–19D has helped to justify the treatment of uncertainty in the location of the tuff–alluvium interface in the abstraction of saturated zone flow and transport. The constraints provided by these additional well data indicate that the saturated zone flow paths through the alluvium should comprise between 1 to 10 km [0.62 to 6.2 mi] of the total flow distance to the compliance boundary, depending on the effect of horizontal anisotropy on flow paths and the location at which the flow paths transition from tuff to alluvium. The uncertainty distribution for horizontal anisotropy assigned 90 percent probability to a value of greater than 1 for the ratio of north-south to east-west permeability, so that the majority of flow path lengths in the alluvium were generally less than 6 km.  The DOE response to Agreements RT.2.08 and USFIC.5.04 provides adequate information to justify the treatment of uncertainty in alluvium flow path distances.

Agreement RT.3.03 is similar to Agreements RT.2.08 and USFIC.5.04, except that it refers to uncertainty in the flow distance traveled in volcanic tuff rather than alluvium.  DOE has evaluated uncertainty in flow paths through the tuff aquifer by analyzing and quantifying uncertainty in the horizontal anisotropy of permeability in the saturated volcanic tuffs.  The information on horizontal anisotropy provided in the DOE response to Agreement USFIC.5.04 is consistent with the previously reviewed information (Bechtel SAIC Company, LLC, 2003a, Appendix E), which staff consider to adequately bound the range of uncertainty for horizontal anisotropy (Reamer, 2004).  High values of north-south oriented anisotropy ratios result in modeled flow paths that take a more direct southerly route away from the proposed repository footprint and, as a result, tend to stay in the volcanic formations longer by skirting the western edge of the tuff–alluvium transition zone.  Thus, the DOE response to Agreement RT.3.03 provides adequate information to justify the treatment of uncertainty in volcanic tuff flow path distances.

Agreement RT.1.04 pertains to column transport experiments that indicate the sorption kinetics of plutonium, protactinium, and uranium affected experimental results.  If kinetic effects are important on larger scales, the effects could potentially impact the estimates of sorption coefficients, which are based on assumptions of equilibrium sorption conditions.  Risk insights that suggest sorption in the geosphere is particularly effective at delaying the potential release of plutonium to the accessible environment are also based on assumptions of equilibrium sorption.  Agreement RT.1.04 was developed from a concern that sorption data for plutonium, protactinium, and uranium were not sufficient to support the equilibrium assumption.  The DOE response to Agreement RT.1.04 focuses on plutonium and does not present studies of the potential effect of kinetics on protactinium or uranium sorption.  This DOE approach seems reasonable because the sorption kinetics of plutonium are observed to be slower than for other radionuclides and because risk insights suggest that neither protactinium nor uranium sorption is important to waste isolation.  The DOE sensitivity study presented in the response calculates Damköhler numbers that indicate the timescale of the kinetic effects of plutonium reaction is fast relative to the timescale of potential plutonium transport in the geosphere.  The results suggest that the assumption of local equilibrium is adequate for the radionuclide transport abstraction.  The DOE response provides sufficient information to conclude that necessary information relevant to concerns regarding the kinetics of plutonium, protactinium, and uranium sorption will be available for review of a potential license application.

Agreement RT.2.01 was developed based on a concern that data were not sufficient to justify the parameters used to represent effective porosity in the saturated alluvium.  When combined with specific discharge, the effective porosity is important in determining the average linear groundwater velocity.  Risk insights and sensitivity studies (Bechtel SAIC Company, LLC, 2003c) indicate that the uncertainties in specific discharge have a much greater effect on saturated zone travel times than do the uncertainties in effective porosity.  The staff recognizes the compensating effects of effective porosities on retardation factors and average linear velocities.  Cutting the porosity in half, doubles the average linear velocity but also approximately doubles the retardation factor. Dividing the average linear velocity by the retardation factor yields transport distances that are similar. This could be the cause for this lack of sensitivity. A preferential pathway, where potential sorbing sites are unavailable to radionuclide contaminated water, is a more important feature than effective porosity. Reducing the effective porosity just makes the sorbing flowpath more rock dominated.

The DOE response to Agreement RT.2.01 provides a discussion of why tests to measure alluvium effective porosity have been limited to one single-hole tracer test and presents additional information based on geophysical tests, literature reviews, and nonsite-specific studies to support the estimated range of alluvium effective porosity used in the saturated zone flow and transport abstraction. The single value determined from the field test falls within the estimated effective porosity distribution, but is at the low end of the distribution and represents a value near the lower 5 percent of sampled values. This observation contradicts the statement made concerning RT2.03 AIN-1 that "... most of the probability distributions tend to be conservative in that the field-derived parameters fall into the less conservative end of the distribution" (H-7). Although the distribution may be skewed to higher values than supported by the single test, the information provided in the DOE response to Agreement RT.2.01 is sufficient to conclude that necessary information regarding alluvium effective porosity will be available for review of a potential license application.

Risk insights indicate that the potential retardation of moderately sorbing radionuclides, specifically neptunium, in the saturated alluvium has high significance to waste isolation. Agreements RT.2.06, RT.2.07, and GEN.1.01 Comments 41 and 102 are directly related to concerns that sufficient data and technical bases be available to justify alluvium sorption parameters for neptunium and other radionuclides. The DOE response to Agreements RT.2.06 and RT.2.07 presents results of numerous laboratory experiments and analyses of alluvium sediment and water samples that evaluate alluvium characteristics and sorption values in alluvium for iodine, neptunium, technetium, and uranium. While the laboratory and analytical data presented are adequate to meet the intent of Agreement RT.2.07, the conclusion of the DOE response that the number and type of alluvium water and sediment samples adequately represent the range of lithologies and water chemistries along the expected flow paths is only marginally supported. Fortunately, modeling and analyses of additional sorption experiments presented in Bechtel SAIC Company, LLC (2003c, Attachment I) provide additional confidence that the probability distribution for neptunium sorption values in alluvium represents the expected range based on variation in alluvium lithology and water chemistry. Based on the information provided in the DOE response, there is a reasonable basis to conclude that sufficient information will be available to review aspects of a license application relevant to alluvium sorption characteristics.

### 3.3 Data Uncertainty

One topic addressed by Agreement USFIC.5.02 is the uncertainty in groundwater specific discharge. This uncertainty results from the combined uncertainties in the calibrated flow model permeabilities and in the prescribed boundary and recharge conditions that lead to the distribution of groundwater flow throughout the model domain. The DOE response indicates that specific discharge uncertainty is addressed in the saturated zone flow abstraction by developing steady-state flow fields using a range of scaling factors for permeability values and recharge rates. Scaling all permeability and recharge rates by the same factor results in proportional increases or decreases in specific discharge while maintaining the same model calibration. Previously, the abstraction of saturated zone flow paths used scaling factors of 1/10, 1.0, and 10, based on a range of estimates from the Saturated Zone Flow and Transport Expert Elicitation (CRWMS M&O, 1998). The current abstraction approach is revised to use specific discharge scaling factors of 1/30, 1/3, 1.0, 3.0, and 10 (Bechtel SAIC Company, LLC, 2003c, Table 6–8). This current approach spans a somewhat larger range of uncertainty but focuses 80 percent of the probability distribution on values from 1/3 to 3.0. This revision to the range of uncertainty is supported by recent tracer testing at the Alluvial Testing Complex. The DOE response to Agreement USFIC.5.02 provides sufficient documentation of the basis for the range and distribution considered for specific discharge uncertainty in the DOE performance assessment abstraction. The DOE response also sufficiently addresses the additional information related to data uncertainty requested by NRC in the review of Agreement USFIC.5.09 (Schlueter, 2003; see also “item 1" mentioned in Section 2.1 of this report).

The DOE combined response to Agreements RT.2.08, RT.3.03, and USFIC.5.04 provides a summary of how the performance assessment abstraction includes data uncertainty in the location where flow paths transition between volcanic tuff and alluvium. Supporting documentation was also available for staff review (Bechtel SAIC Company, LLC, 2003c, Section 6.5.2.2). Staff agree that uncertainty in the northern extent of the alluvium uncertainty zone is bounded by the location of Well UE–25 JF#3 in which the water table is below the tuff–alluvium contact, and by Well NC–EWDP–10S in which the water table is above the tuff–alluvium contact. Consistent with this observation, the northern portion of the alluvial uncertainty zone extends from just south of Well UE–25 JF#3 to just north of Well NC–EWDP–10S. The geometry of the western edge of the tuff–alluvium transition is constrained by Wells NC–EWDP–10S, NC–EWDP–22S, and NC–EWDP–19D. These wells form a south-southwest trending line in which the water table is above the tuff–alluvium contact. Consistent with data from these wells, the western portion of the alluvial uncertainty zone begins just west of the line defined by these wells. Outcrops of volcanic bedrock to the west constrain the western edge of the alluvial uncertainty zone. The information provided by DOE adequately addresses those aspects of Agreements RT.2.08, RT.3.03, and USFIC.5.04 related to uncertainty of flow path lengths in alluvium.

Agreement RT.2.01 was developed based on concerns that the uncertainty in alluvium effective porosity was not adequately represented by the probability distribution for alluvium effective porosity included in the saturated zone flow and transport abstraction. The DOE response to Agreement RT.2.01 provides information to support the range and shape of the probability distribution for alluvium effective porosity. Risk insights and sensitivity studies (NRC, 2004) indicate that the performance of the potential repository is not significantly impacted by uncertainties in alluvium effective porosity. The DOE response to Agreement RT.2.01 provides sufficient information to conclude that adequate information regarding uncertainty in alluvium effective porosity will be available for review of a potential license application.

Agreement RT.2.03 AIN–1 was developed to address concerns that transport parameter estimates and uncertainties based on laboratory and field-scale tests were not adequately represented by the 500-m (1,640 ft) grid size of the DOE saturated zone flow and transport abstraction. The DOE response to Agreement RT.2.03 AIN–1 provides a list of methodologies used by DOE to appropriately consider the effects of differences in scale between laboratory experiments, field tests, and model abstractions. Additional information provided in Bechtel SAIC Company, LLC (2003a, Appendix I), which considers the effects of scale and sorption coefficient heterogeneity in the transport model abstraction, also indicates DOE adequately considers upscaling issues. The DOE response provides information to conclude that necessary information will be available to review transport parameter uncertainties associated with upscaling in a potential license application.

Agreement RT.2.06 was developed in part based on concerns that the variation in alluvium sorption properties would not be adequately represented by the range of conditions included in experiments to determine alluvium sorption properties. Because risk insight activities indicate that sorption in the saturated alluvium is of high significance to waste isolation, it is important that probability distributions for alluvium sorption properties and the experiments on which the distributions are based appropriately represent the range of alluvium water chemistries and lithologies. The DOE response to Agreement RT.2.06 provides information regarding the range of experimental conditions and alluvium properties considered. Recent data from sonic coring samples collected from the Early Warning Drilling Program Well NC–EWDP–19PB suggest that mineralogical and grain-size properties of the alluvium may be different from those measured using cutting samples from well drilling. The DOE response also indicates that water chemistries used in alluvium sorption experiments were limited. However, the staff considers that the DOE response provides sufficient information to review a potential license application.

### 3.4 Model Uncertainty

One topic addressed by Agreement USFIC.5.02 is the model uncertainty related to changes in saturated zone flow that could result from a climate-induced water table rise. Potential water table rise on the order of a few tens of meters, as inferred by the Lathrop Wells diatomite deposits, would likely have only a small effect on saturated zone flow patterns. Such effects might include changes in locations where the water table transitions from the tuff to the alluvial aquifer. DOE documentation of the site-scale flow model contains an analysis in which the flow model was adapted to include the effects of estimated water table rise (Bechtel SAIC Company, LLC, 2003b, Section 6.4.5). The adapted model suggests that greater portions of alluvium would be present below the water table along potential flow paths in the event of a water table rise. Greater flow distance through alluvium instead of volcanic tuff would slow transport of radionuclides; thus, not including water table rise in the flow model abstraction can be considered conservative from this perspective. DOE also cites modeling by D'Agnese, et al. (1999), who used the Death Valley regional flow model to simulate groundwater flow during future potential climate conditions, as evidence that saturated zone flow paths will not change appreciably within the regulatory compliance area during a future climate with increased recharge. In addition, the DOE analysis includes an assessment of the effect of water table rise on groundwater specific discharge and concludes that the maximum estimated water table rise could result in approximately a factor of four increase in groundwater specific discharge. This estimate is consistent with the use of a specific discharge scaling factor of 3.9 in the performance assessment abstraction to account for the glacial transition climate state. Based on the analyses provided by DOE, the exclusion of water table rise from the flow model abstraction is justified. An analysis of potential water table rise using an independently developed site-scale saturated flow model by Winterle (2003) also showed that a rise in the water table ranging from nearly 150 m [500 ft] under the potential repository footprint to 30 m [100 ft] near the compliance location did not significantly affect groundwater flow paths from Yucca Mountain. Thus, the information provided by DOE adequately addresses the aspects of Agreement USFIC.5.02 related to saturated zone flow during future, wetter climate conditions.

Another model uncertainty related to Agreement USFIC.5.02 is the question of whether boundary groundwater fluxes in the site-scale saturated zone flow model are consistent with the groundwater fluxes in the updated 2002 Death Valley regional groundwater flow model (D'Agnese, et al., 2002). The DOE site-scale flow model uses the earlier 1999 Death Valley regional model (D'Agnese, et al., 1999) to provide calibration targets for boundary segments of the site-scale model. Agreement USFIC.5.02 was reached to address the concern that the site-scale model should also be updated if groundwater fluxes in the updated regional model are significantly different from the earlier regional model. Information provided in the DOE response indicates there are areas corresponding to the site-scale model boundaries in which significant differences exist between the calculated groundwater fluxes of the previous and the updated regional models. It appears, however, that the most significant differences are localized in areas corresponding to the southwest and southeast corners of the site-scale model boundary that are not likely to significantly affect groundwater fluxes or pathways between Yucca Mountain and the compliance boundary. Groundwater specific discharge along flow paths from Yucca Mountain appears to be mainly influenced by the permeability of hydrogeologic units and the effects of structural features on the hydraulic gradients within the model. Thus, recalibration of boundary fluxes in the site-scale model to better match the updated regional model would not likely have a significant effect on the groundwater specific discharge and flow paths considered in the performance assessment abstraction. Staff, therefore, conclude that the DOE response to Agreement USFIC.5.02 adequately addresses questions regarding the differences in groundwater fluxes from the updated Death Valley regional model. The DOE response also sufficiently addresses the additional information related to model uncertainty requested by NRC in the review of Agreement USFIC.5.09 (Schlueter, 2003; see also “items 3 and 4" mentioned in Section 2.1 of this report).

## 3.5 Model Support

The information provided by DOE in response to Agreement USFIC.5.12 provides comparisons of model results to site data not used in the calibration process. Of the more recent Nye County water level data presented in the DOE agreement response, only Wells NC–EWDP–19D and NC–EWDP–19P have the joint distinctions that they were not used in the initial model calibration and are both located in the area of most likely flow paths from Yucca Mountain. These two wells monitor deep and shallow portions of the alluvial aquifer, at essentially the same location. The observed water level reported for Well NC–EWDP–19D is 0.4 m [1.3 ft] greater than the calculated water level; the difference is 5.7 m [19 ft] for Well NC–EWDP–19P.

In this DOE comparison of hydraulic gradients contained in the DOE response to Agreement USFIC.5.12, five of the six wells used to plot water levels along the projected flow path also were used in the model calibration. Although most of these wells were used to calibrate hydraulic heads at specific points within the model, there was no effort to calibrate differences in calculated heads to match the observed differences in heads along the flow pathway. Thus, the knowledge that the modeled hydraulic gradients along projected flow paths are in good agreement with the gradients inferred from well observations provides an additional measure of confidence in the model results beyond that gained by achieving a good model calibration.

For most hydrogeologic units, the calibrated permeability values used in the site-scale flow model are within the range of values reported from *in-situ* testing. This consistency is to be expected because, while *in-situ* permeability estimates were not used as calibration targets, they were used to guide the constraints placed on the range of permeability values considered. The only new permeability estimates reported in the DOE agreement response are those obtained from the Alluvial Testing Complex at Well NC–EWDP–19D. The calibrated model permeability for alluvium at this location was an order of magnitude greater than the permeability estimated from a single-hole test and was 19 percent greater than the permeability estimated from a cross-hole test at this location. In general, the permeability estimate from the larger scale cross-hole test can be considered more reliable for estimating aquifer permeability at the scale of flow model grid, and this value is reasonably consistent with the calibrated model value. Additionally, the fact that the calibrated permeability value is greater than the estimates from the Alluvial Testing Complex would conservatively favor higher estimates of groundwater specific discharge and velocity.

The summary of hydrochemical data trends presented in the DOE agreement response suggests that groundwaters from the Crater Flat, Yucca Mountain, and Jackass Flat areas appear to converge in the Northern Amargosa Valley area. This interpretation is broadly consistent with flow path predictions that result from the saturated zone flow model. It should be recognized, however, that there are many uncertainties related to source water chemistries, groundwater–rock interactions, groundwater mixing, and geochemical evolution that cannot be fully considered in such analyses.

The thermal modeling presented in the DOE response indicates that observed groundwater temperature patterns are controlled significantly by the thickness of the unsaturated zone. This result is consistent with independent modeling by Painter, et al. (2003), who concluded surface topography significantly controls temperature patterns near the water table surface. This observation does little to improve confidence in the groundwater flow paths and specific discharge calculated with the saturated zone flow model. Interestingly, residual errors in matching temperature observations increased after coupling groundwater advection to the thermal conduction model. This increase in error might seem to suggest that groundwater flow rates predicted by the flow model are not validated by the temperature data. In actuality, however, the reason for the increased residual error is that groundwater flow was coupled to a previously calibrated conduction-only model and the thermal properties and boundary conditions were never recalibrated after including advective processes. Hence, as currently developed, the coupled model of thermal conduction and advection neither validates nor invalidates groundwater flow fields predicted by the DOE saturated zone flow model. As noted in the DOE response, an ideal approach for providing explicit constraints on groundwater flow fields would be to perform a joint calibration of the saturated zone flow model using both measured temperature and water-level data. DOE notes, however, that this approach has not been possible because of excessive computer run times required by such a joint calibration approach.

It can be seen that many of the lines of evidence provided as model support by DOE have significant uncertainties. While no single line of evidence provides definitive support for the site-scale saturated zone flow model, the body of supporting evidence, when combined with the generally adequate characterization of hydraulic gradients and hydrogeologic properties in the area, provides a sufficient level of confidence that the DOE model abstraction adequately incorporates the range of uncertainty in saturated zone flow paths and specific discharges.

Staff conclude that the information provided by DOE in response to Agreement USFIC.5.12 provides an adequate summary of information used to provide model support. The DOE response also sufficiently addresses the additional information related to model support requested by NRC in the review of Agreement USFIC.5.09 (Schlueter, 2003; see also “item 5" mentioned in Section 2.1 of this report).

## 4.0 SUMMARY

NRC staff evaluated DOE responses to 10 key technical issue agreements and 2 of the comments raised in Agreement GEN.1.01. These agreement responses are contained in appendices to Bechtel SAIC Company, LLC (2003a) and other supporting documents. The specific agreements evaluated were USFIC.5.02, USFIC.5.04, USFIC.5.12, RT.1.04, RT.2.01, RT.2.03, RT.2.06, RT.2.07, RT.2.08, RT.3.03, and GEN.1.01 (Comments 41 and 102). NRC staff conclude that the information provided by DOE to address these agreements and comments is responsive to the original staff concerns.

## 5.0 STATUS OF THE AGREEMENTS

The NRC staff has reviewed DOE's responses to Agreements USFIC.5.02, USFIC.5.04, USFIC.5.12, RT.1.04, RT.2.01, RT.2.03, RT.2.06, RT.2.07, RT.2.08, RT.3.03, and GEN.1.01 (Comments 41 and 102). Based on our review of the information provided, NRC staff considers these agreements and comments complete and have no further questions at this time. Although these agreements are considered complete, please note that NRC will make its final determination on any issues relevant to licensing during review of the LA.

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