November 17, 2000

Stephan Brocoum, Assistant Manager
Office of Licensing and Regulatory Compliance
U.S. Department of Energy
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SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION/U.S. DEPARTMENT OF ENERGY TECHNICAL EXCHANGE AND MANAGEMENT MEETING ON UNSATURATED AND SATURATED FLOW UNDER ISOTHERMAL CONDITIONS (OCTOBER 31- NOVEMBER 2, 2000)

Dear Mr. Brocoum:

Enclosed are the meeting summary highlights agreed upon during the October 31-November 2, 2000, Technical Exchange and Management meeting between the staff of the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. The main purpose of the meeting was to discuss one of the Key Technical Issues, Unsaturated and Saturated Flow Under Isothermal Conditions (USFIC). The meeting was held in Albuquerque, New Mexico.

If you have any questions regarding this letter, please contact the technical lead for USFIC, Mr. Neil Coleman or the Senior Project Manager for issue closure, Mr. James Andersen. Mr. Coleman can be reached at (301) 415-6615 and Mr. Andersen at (301) 415-5717.

Sincerely,

C. William Reamer, Chief
High-Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: Summary Highlights of NRC/DOE Technical Exchange and Management Meeting on Unsaturated and Saturated Flow Under Isothermal Conditions

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Letter to S. Brocoum from J. Schlueter dated: November 17, 2000

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Summary Highlights of NRC/DOE Technical Exchange and Management Meeting on Unsaturated and Saturated Flow Under Isothermal Conditions

October 31-November 2, 2000
Albuquerque, New Mexico

Introduction and Objectives

This Technical Exchange and Management Meeting on Unsaturated and Saturated Flow Under Isothermal Conditions (USFIC) is one in a series of meetings related to the U.S. Nuclear Regulatory Commission (NRC) key technical issue (KTI) and sufficiency review and the U.S. Department of Energy (DOE) site recommendation decision. Consistent with NRC regulations on prelicensing consultations and a 1992 agreement with DOE, staff-level resolution can be achieved during prelicensing consultation. The purpose of issue resolution is to assure that sufficient information is available on an issue to enable the NRC to docket a proposed license application. Resolution at the staff level does not preclude an issue being raised and considered during the licensing proceedings, nor does it prejudge what the NRC staff evaluation of that issue will be after its licensing review. Issue resolution at the staff level, during prelicensing, is achieved when the staff has no further questions or comments at a point in time regarding how the DOE is addressing an issue. The discussions recorded here reflect NRC's current understanding of aspects of saturated zone (SZ) flow most important to repository performance. This understanding is based on all information available to date which includes limited, focused risk-informed reviews of selected portions of recently provided DOE documents (e.g., Analysis and Model Reports (AMRs) and Process Model Reports (PMRs)). Pertinent additional information could raise new questions or comments regarding a previously resolved issue.

Issues are "closed' if the DOE approach and available information acceptably address staff questions such that no information beyond what is currently available will likely be required for regulatory decision making at the time of any initial license application. Issues are "closed-pending' if the NRC staff has confidence that the DOE proposed approach, together with the DOE agreement to provide the NRC with additional information (through specified testing, analysis, etc.) acceptably addresses the NRC's questions such that no information beyond that provided, or agreed to, will likely be required at time of initial license application. Issues are "open' if the NRC has identified questions regarding the DOE approach or information, and the DOE has not yet acceptably addressed the questions or agreed to provide the necessary 1additional information in a potential license application.

The objective of this meeting is to discuss and review the progress on resolving the remaining subissues within the USFIC KTI (see Attachment 1 for list of subissues covered). Several USFIC subissues relating to the unsaturated zone (UZ) were discussed during a meeting conducted in August 2000. The quality assurance (QA) aspect of this KTI was determined to be outside the scope of the meeting and is being tracked in NRC's ongoing review of DOE's QA program.

Summary of Meeting

At the close of the Technical Exchange and Management Meeting, the NRC staff stated that Subissue 3, 5, and 6 were "closed-pending." Specific NRC/DOE agreements made at the meeting are provided as Attachment 1. The agenda and the attendance list are provided as Attachments 2 and 3, respectively. Copies of the presenters' slides are provided as Attachment 4. Highlights from the Technical Exchange and Management Meeting are listed below.

Highlights

1) Opening Comments

DOE stated that the intent of the meeting is to reach agreement on the current status and path forward for each of the USFIC subissues (see "Saturated Zone Flow Under Isothermal Conditions" presentation given by Claudia Newbury). Following the August 2000 meeting on the UZ issues (Subissue 1, 2, 3, 4, and part of 6), the NRC stated that Subissues 1 and 2 are closed, Subissue 3 is open, Subissue 4 and part of 6 (that relate to UZ) is "closed-pending." During this meeting, DOE stated that its presentation would focus on confirmatory and additional information, data, and analyses identified by the NRC during the April 2000 Technical Exchange, the August Technical Exchange, and subsequent discussions. DOE stated that it felt that the details provided during the current meeting would be the basis for NRC to list Subissues 3, 5, and the SZ portion of 6 as "closed-pending."

2) Technical Discussions - USFIC Subissue #3, Present-Day Shallow Groundwater Infiltration

A summary of the current status of resolution was presented (see "Present-Day Shallow Infiltration" presentation given by James Houseworth). Subissue #3, Acceptance Criterion (AC) #3, was reopened by the NRC at the August 2000 Technical Exchange because the DOE estimates of shallow infiltration were revised downward since the Total System Performance Assessment - Viability Assessment (TSPA-VA) and NRC believes sufficient justification was not provided.

DOE provided the basis to resolve the present-day shallow infiltration subissue, AC #3. A draft plan to address NRC concerns included three elements: (1) developing an upper-bound infiltration case based on the Monte-Carlo analysis for the glacial-transition climate. The upper-bound will be based on the 90th percentile case from the Monte Carlo analysis and new weighting factors for the lower bound, mean, and upper bound cases will be based on the documented methodology (Analysis of Infiltration Uncertainty Analysis and Model Report: ANL-NBS-HS-000027); (2) developing upper-bound infiltration cases for the monsoon and modern climates by proportional scaling based on the average infiltration ratio between the upper bound and mean cases for the glacial-transition climate; and (3) incorporating the new infiltration maps and weighting factors into the models that support Total System Performance Assessment - License Application.

The NRC expressed concern that revised weighting factors for upper bound infiltration may be too low. DOE responded that the recalculated weighting factors only changed about 30 percent for upper bound infiltration. The DOE stated that the modern day infiltration was not affected

using the scaling from the glacial-transition climate. DOE stated, based on its recollection, that the recalculated infiltration rates are approximately 53 mm/yr for glacial-transition and 30 mm/yr for the monsoon climate. The DOE was asked by the NRC how well the infiltration model represents modern climate, considering the neutron data, temperature data, chloride mass balance, and the calcite data. The DOE believes the current climate is reasonably well covered with the model. There are some minor issues with the site data that could change the current infiltration rate a few millimeters per year, but that is within the uncertainty ranges. DOE stated the spatial distribution covered in the model matches the conceptual model implemented in the mathematical model. NRC questioned if the model values are reasonable for the repository block area. DOE stated the model is best represented for the repository block area. NRC staff asked for an explanation why there was apparently a large change (i.e. reduction) in the infiltration since the TSPA-VA was issued. DOE provided three reasons for the changes: (1) the temperature representation was inadequate in the VA infiltration model and has since been fixed; (2) improvements were made to the evaporation-transpiration parameters along with calibration improvements; and (3) the bedrock geology was updated which caused a change in the spatial distribution of the permeability parameters. The NRC raised some issues with the consistency of the Alcove 1 permeability measurements with the model parameters and the lack of justifications for the Analysis of Infiltration Uncertainty AMR Table 4-1 distributions. A representative from the USGS stated the majority of the new Yucca Mountain infiltration data is or will be published outside of the project and committed to provide the NRC with the references. The NRC emphasized the need to provide the technical basis for the Table 4-1 distributions, and specifically noted that bedrock permeability estimates need to be reconciled with observations from the Alcove 1 and Pagany Wash experiments.

The NRC agreed with the approach of the Monte-Carlo analysis and the use of the 90th percentile. The NRC and DOE reached two agreements in this area (see Attachment 1). The NRC stated that these agreements supercede the three agreements reached during the August 2000 meetings. With these two new agreements, the NRC stated that Subissue #3 could be listed as “closed-pending.”

3) Technical Discussions - USFIC Subissue #6, Matrix Diffusion (Saturated Zone Aspects)

A summary of the current status of resolution was presented (see “Subissue 6, Acceptance Criterion 2: Matrix Diffusion, Saturated Zone Aspects” presentation given by Al Aziz Eddebbarh). DOE identified the NRC information needs from Revision 2 of the USFIC Issue Resolution Status Report (IRSR), the April 2000 KTI technical exchange, and subsequent NRC/DOE discussions. DOE stated that it would provide the basis for resolving matrix diffusion in the saturated zone.

A summary of the current status of resolution was presented and DOE stated that: (1) the C-wells conservative and reactive tracer tests demonstrated that models that incorporate matrix diffusion provide more reasonable fits to the tracer-experiment data than those that assume a single continuum; and (2) the matrix sorption coefficients that fit the data for the lithium tracer in the C-wells reactive tracer experiment agreed well with the values in laboratory sorption tests.

The NRC asked what the recovery was for the tests. The DOE stated it was 50% for the conservative tracers, 15-16% for lithium, and 1% for the microspheres. The NRC expressed

concern that the loss of tracers from these field tests could be used as an indication of uncertainty associated with the modeling of transport in fractured rock. DOE responded that tracers may have entered the matrix but were not recovered in the wells. Also, more of the tracers would have been recovered had the test been run longer. The NRC questioned the ability to scale a laboratory test and 30 meter field test to the site scale model using 500 meter grid spacing. DOE believes the scale effects are captured with treatment of matrix diffusion properties in TSPA. The NRC asked why the field tests were not used for the model diffusivity coefficients, instead of the laboratory data. The DOE stated the field tests served to constrain matrix diffusion parameters and the field tests agree with the laboratory data. The DOE is confident in the results of the tracer tests because several tracers were used in two stratigraphic horizons in the saturated zone which captured several hydraulic regimes. The NRC questioned why there was a gap in the observed and simulated data and notes that the slope of the tails on a log-log plot should be -1.5 (based on work by Mathew Becker, State University of New York - Buffalo, presented to the Spring 2000 American Geophysical Union meeting). DOE stated that was an issue with partial recirculation creating a weak dipole field. There are three parameters used in the TSPA as input to the matrix diffusion abstraction. They are effective diffusion coefficients, spacing of flowing intervals, and fracture porosity. The DOE stated that for each simulation run, all radionuclides were assigned the same effective diffusion coefficients. There is currently no matrix diffusion modeled in the alluvium portion of the saturated zone flow path, because the alluvium is considered for modeling purposes as a continuous porous medium.

The NRC agreed that the tests demonstrate that matrix diffusion exists in the SZ tuffs. The NRC noted that matrix diffusion is a proposed mechanism that affects radionuclide transport and additional questions may be raised on this subject in the Radionuclide Transport Technical Exchange. The DOE agreed to provide documentation for the C-well testing and to use field testing data or provide justification that data from the laboratory test is consistent with data from field tests.

As a result of the additional discussions, the NRC stated that of the three agreements made during the August 2000 meeting, the first agreement needed to be modified to include SZ , the second one could be closed, and the third remained the same. In addition, the NRC and DOE reached an additional agreement concerning the C-well testing (see Attachment 1 for list of open and closed agreements). With the remaining three agreements, the NRC stated that Subissue #6 could be listed as “closed-pending.”

4) Technical Discussion - USFIC Subissue #5, Saturated Zone Ambient Flow Conditions and Dilution Processes

In the opening summary (see ”Saturated Zone Flow Under Isothermal Conditions“ presentation given by Claudia Newbury), DOE stated that there are 10 acceptance criteria (excluding QA), all of which are considered to be either closed or closed-pending by the DOE. DOE then identified the NRC information needs from Revision 2 of the USFIC IRSR, the April 2000 KTI technical exchange, and subsequent NRC/DOE discussions. DOE then addressed these needs during discussions of each acceptance criteria.

<u>Presentations and Discussion Pertaining to AC #1</u>

In its discussion of AC #1, Conceptual Flow and Data Uncertainties, DOE described its approach to treat horizontal anisotropy in volcanic units, how SZ specific discharge is discretized for incorporation in TSPA, and how other uncertain parameters are incorporated in TSPA based on Monte Carlo simulations. DOE concluded that documentation needed for AC #1 is provided in the SZ PMR and supporting AMRs and that conceptual model and data uncertainty will be refined as additional site data becomes available.

The discussion following this presentation focused on the appropriate degree of anisotropy for the site-scale saturated zone model, on proper calibration of the model, and on the use of alternative conceptual models. DOE stated that the isotropic case is really anisotropic given the discrete features, such as faults, included in the site-scale model. NRC asked if the calibration was based on the isotropic or anisotropic case. DOE replied that calibration was performed with the isotropic case and noted that only a small, on average 1 meter head change was observed when using the anisotropic model. DOE stated that bulk permeability was preserved between isotropic and anisotropic models. NRC asked whether an anisotropy ratio greater than 5:1 was possible. DOE stated that it is possible, and that more analysis is needed. NRC noted that the uncertainty is very large, with a range that could spread from an isotropic model to a highly anisotropic model. DOE stated it would consider a wider range of horizontal anisotropy. NRC stated that it expects to see documentation of relevant C-well test analysis. NRC observed that a 10:1 vertical anisotropy is used in the DOE model. DOE stated that the model lacked the resolution to capture all vertical structural features.

NRC inquired about the use of alternative conceptual models. DOE stated that isotropic and anisotropic models are considered different conceptual models. NRC raised the question whether flow to the carbonate aquifer should be considered. DOE stated that hydraulic head and water chemistry data suggest there is a potential for upward flow from the carbonate aquifer to the tuffs, and that south of Yucca Mountain, flow is from tuff to alluvium. DOE stated that the process of model calibration successively eliminated alternative conceptual models. NRC stated that head data alone is not sufficient to establish a flow path. Linda Lehman (Consultant for the State of Nevada) suggested that temperature data should be considered when calibrating the model. DOE stated that geochemical and temperature data are important. Geochemical data are consistent with the model. NRC stated that model calibration includes the use of the regional model, which has been criticized. DOE replied that the regional model is only used to obtain boundary conditions for the site-scale model. NRC asked for an agreement to revise the site-scale SZ model when the updated regional model is finalized.

Presentations and Discussion Pertaining to AC #5

In its discussion of AC #5, Estimates of Key Hydrologic Parameters, DOE stated that it planned to address four issues: (1) the hydraulic conductivity and effective porosity for saturated valley fill at 20-km and in the data gaps to the south of Yucca Mountain, (2) the plan to fill the data gap north of the Washburn well and 19D complex, (3) the plans to obtain porosity data in the valley fill, using geophysical methods, and (4) the plans for tracer tests at the Alluvium Testing Complex, along with detailed stratigraphy and results of aquifer tests in the complex. Following the DOE presentation, the NRC questioned how DOE was going to extrapolate the testing data to 500 meters (the size of the grid blocks in the model) given that the test covered distances less than 100 meters. DOE stated that the transport model is grid independent, therefore, no numerical dispersion would occur.

The NRC stated that it was pleased to see predictions for the single-well tests and questioned how the tracer recovery would affect the usability of these tests. DOE stated that by using multi-tracer tests, the results are good and not as sensitive to recovery, even for the low amount of recovery in the C-wells. DOE suggested the need for obtaining core from Nye County bore holes to use in laboratory flow and transport experiments that will help better define field testing parameters for the alluvial tracer tests. After further discussions, the NRC stated that it needed additional information on the DOE testing plans for the alluvium studies.

Presentations and Discussion Pertaining to AC #2

Nye County, Nuclear Waste Repository Office, presented the Nye County Early Warning Drilling Program. Topics included delineation of flow paths, Phase II progress, Preliminary Findings, and Phase III plans. Nye County cautioned that the material in the presentation was preliminary. More than a dozen wells are completed and four are in progress. Nye County reported that "water levels are looking up" because several of the wells have upward gradients and that the depth to groundwater was shallower than expected at the paleodischarge site. Details were presented for well NC-EWDP-2DB, temperature profiles, conceptual compartments in Amargosa Desert, spinner survey, gravity data, and structural complexities. Nye County was concerned the DOE is using the regional model for input into the site-scale model. The DOE stated there is consistency in fluxes. Nye County discussed its plans to acquire water rights. They have applied for 33,000 acre feet of water rights which is under evaluation by the State Engineer. Nye County discussed the upcoming sequence of drilling and testing.

Linda Lehman, a consultant for the State of Nevada, presented an interpretation of the saturated zone with regards to temperature and structural interpretation. Ms. Lehman stated the flow fields near Yucca Mountain may not be connected. The DOE stated they are currently running a flow model which incorporates thermal effects.

DOE then provided the basis for closure of this subissue. DOE stated the subissue should be closed because (1) DOE has appropriately delineated saturated zone flow paths and is further refining the flow path delineation through additional Fiscal Year 2001 work; and (2) the DOE, in cooperation with Nye County, is conducting an extensive investigation of the stratigraphy of the saturated zone to define the transition of the water table from tuff to valley fill. Existing uncertainty is incorporated in the performance assessment.

Discussion followed DOE's presentation. The NRC suggested other methods to evaluate interpretations of the bore hole stratigraphy, such as age dating of cuttings, or palynology. The DOE agreed the methods could be used, but has no plan to use them because the model is not sensitive to the information. The NRC asked the DOE to justify the statistical model of uncertainty for the length of the saturated zone flow path in alluvium. The DOE stated that there is no evidence for a specific stochastic distribution other than a uniform distribution, which is the least biased.

Presentations and Discussion Pertaining to AC #3

In its presentation of AC #3, Moderate and Large Hydraulic Gradient, DOE reported on the drilling and testing of wells WT-24 and SD-6. DOE acknowledged NRC's earlier request, that related data should be provided and analyzed, and stated that information from this testing would be incorporated in the Technical Data Management System and considered in preparing updated AMRs and PMRs. DOE also stated that individual borehole reports would no longer be developed. DOE reported on water bearing features and water depths measured in these wells. DOE stated that AC#3 should be closed, mainly based on the fact that the hydraulic gradients are represented in the SZ flow and transport model.

NRC asked whether the 840 meter water elevation in WT-24 represents the regional water table. NRC also asked if there was a plan to deepen well SD-6 to test the moderate hydraulic gradient. DOE stated that 100% of the well test objective for SD-6 was not achieved, but that the tests provided a good source of information, and allowed testing of alternative conceptual models that have a significant impact. NRC asked which models were tested. DOE replied that, for example, large hydraulic gradient models were also considered. NRC asked whether tests yielded average transmissivity estimates. DOE replied that tests were not analyzable due to the rapid drawdown, and that they had faced difficulties drilling well SD-6. NRC recommended testing other wells. NRC asked when detailed test reports will be available. DOE replied that information is distributed among pertinent AMRs. NRC stated that some of this information is not yet published. NRC will continue to evaluate data such as water chemistry, mineralogy, stratigraphy, and hydraulic testing as it becomes available.

Presentations and Discussion Pertaining to AC #4

In its presentation of AC #4, Potentiometric Maps, DOE described an updated potentiometric map of the regional uppermost aquifer, and stated that infiltration, evapotranspiration, spring discharges, and pumping estimates are included in the regional model.

NRC commented that the head data is applied to a single, uppermost aquifer, and that the large head gradients may suggest that the aquifer is not well connected, which could require the fitting of several maps. The NRC also stated that its published interpretations of the SZ are found in Revision 2 of the USFIC IRSR. DOE replied that they have tried to develop potentiometric surface maps of lower aquifers, but given the limited data, were unsuccessful. The Nye County data may help in future analysis. NRC asked whether constant head values were used as model input. A Nye County representative questioned whether water levels are really composite heads, rather than representing discrete intervals. DOE stated that water level data are not always useful for contouring, but are used directly in model calibration at the depth of measurement. NRC suggested that the analysis start with the description of a flow net, development of potentiometric maps for each aquifer, and then calibration of corresponding models. However, the NRC also commented that the current approach may be appropriate. DOE replied that they needed to address all parts of this AC.

Presentations and Discussion Pertaining to AC #6

In its discussion of AC #6, Mathematical Groundwater Models, DOE stated that it has used mathematical groundwater models: (1) that incorporate site-specific climatic and subsurface information; (2) that are reasonably calibrated and reasonably represent the physical system;

(3) whose fitted aquifer parameters compare reasonably well with observed site data; (4) whose implicitly or explicitly simulated fracturing and faulting are consistent with the data in the 3D geologic framework model (GFM); (5) whose abstractions are based on initial and boundary conditions consistent with site-scale modeling and the regional model of the Death Valley groundwater flow system. DOE has used mathematical groundwater models whose abstractions of the groundwater models for use in PA simulations use the appropriate spatial and temporal averaging techniques.

The DOE's presentation included a discussion of the hydrogeologic framework model (HFM) which provides the fundamental geometric framework for development of a site-scale three-dimensional groundwater flow and transport model. The DOE stated the framework provides a basis for the mathematical model which incorporates site-specific subsurface information and will continue to be updated. The regional model is also being revised.

The DOE presented the basis of resolution for the numerical flow model. The basis for resolution stated that DOE has developed a numerical flow model that adequately incorporates site data, that is reasonably calibrated, and reasonably represents the physical system. The DOE suggested the flow model has a lower upward gradient than observed at well P-1 but is consistent with the flow direction. The DOE stated the models will be updated with new information to further reduce uncertainty. The NRC asked if more work will be done on the HFM. The DOE stated the framework model will be updated to include available Nye County data. The NRC asked several questions regarding the analysis of alternative conceptual models and the propagation of such models through performance assessment. NRC requested that the alternative conceptual models be discussed in the PMR. The DOE stated they incorporate alternative conceptual models in TSPA only if they impact flow pathlines and flux changes that are important to performance. NRC expressed concerns in the HFM AMR regarding the boundary between the GFM and areas to the south which presented problems in correlating geologic units in faults and maintaining unit thickness. DOE stated that the HFM is being updated to include new data. The NRC questioned the model permeabilities which fall outside of field or lab data. The DOE agreed that some fall outside the data ranges but they focused on the permeabilities that affect TSPA runs. The NRC asked the DOE if permeabilities along the Solitario Canyon Fault could be revised to permit additional flow from Crater Flat into the regional deep aquifer beneath Yucca Mountain. The NRC indicated that in this way, the model can be used to evaluate alternate conceptual flow models. The DOE indicated this alternative model could be evaluated. The DOE stated the model has good resolution and allows for short run times. Priority was given in the model to those features with the greatest impacts to performance assessment. In response to the DOE's presentation, the NRC stated that the removal of the east-west barrier (corresponding to the large hydraulic gradient) would not likely cause major changes in the SZ site-scale model output since this parameter was assigned a low composite scaled sensitivity of 0.2. The DOE agreed.

The DOE stated that the averaged calibrated water level error of 16 meters is small in comparison to the entire thickness of the model. The NRC stated that the comparison should only include the thickness of the aquifer in which the measured vs. simulated hydraulic heads are compared, not the entire thickness of the model. The NRC stated that the PMR referred to the recharge as a candidate for use as a calibration parameter. The DOE clarified that the recharge rate is redistributed as it is applied from the regional model onto the site-scale model, but is not a calibrated parameter. The NRC pointed out that the difference between the SZ site-

scale model inflow and outflow, which represents recharge, varied substantially from the regional model recharge rate. In response to an NRC question concerning the southern boundary condition, the DOE stated that no actual pumping occurs within the model boundaries. The NRC stated that two of the three criteria used for model validation justification were data used to develop or calibrate the model. The DOE agreed. The NRC further stated that, at present, the site-scale model can not be considered fully validated. The NRC and DOE discussed using NUREG-1636, "Regulatory Perspectives on Model Validation in High-Level Radioactive Waste Management Programs: A Joint NRC/SKI White Paper," as guidelines. DOE noted that the site-scale AMR acknowledged that the model was only partially validated and that confidence building activities would continue as the model matures.

Presentations and Discussion Pertaining to AC #8

In its discussion of AC #8, Dilution, DOE stated that it would address this AC using the particle tracking based transport methodology. DOE's discussion included the key features of the particle tracking model, code verification simulations, the treatment of dilution, and ongoing model development. NRC questioned the dispersivity values. DOE stated the values assumed in each specific realization are constant, but vary by realization. DOE and NRC discussed fracture spacing, both for the no-sorption and with-sorption cases. The NRC stated that the issue of dilution and the particle tracking based transport methodology will be discussed again during the Radionuclide Transport Technical Exchange, but at this point, it did not need any NRC/DOE agreements.

With regarding to AC #7, Wellbore Dilution, DOE stated that no additional credit for any wellbore dilution specifically due to well pumping is taken in the TSPA. Therefore, DOE stated this AC should be closed.

Presentations and Discussion Pertaining to AC #9

In its discussion of AC #9, Potential Effects on the Saturated Zone Flow System, DOE stated that its basis for closure was the investigation of secondary mineral deposits that have been interpreted by others as providing evidence that potential geothermal processes and seismicity modified the ambient flow system and the alternative models resulting from this interpretation. The DOE expects the fluid inclusion study to confirm the validity of their conclusions that there has not been geothermal upwelling in the repository horizon. The DOE acknowledged the ongoing University of Nevada - Las Vegas (UNLV) studies of fluid inclusions as a test of the geothermal hypothesis. The DOE said they will evaluate results of the UNLV fluid inclusion study when they are available. DOE feels that based on interim reports these results are not expected to change conclusions previously drawn regarding geothermal and seismic effects on the water table.

Discussion followed DOE's presentation. The NRC asked about possible alternative thermal sources at the site that could explain the fluid inclusion results. The DOE stated possible other sources include the residual heat from the Timber Mountain volcanism or detachment faulting. The USGS representative stated that the greatest abundance in calcite/opal minerals occurs beneath the Drill Hole Wash. NRC asked the significance of this observation. USGS responded that this suggests significant deep infiltration at this location and questioned the assumptions used in the UZ flow models. The NRC also asked about sources of calcite in fault

zones. The DOE position is that the fault zone calcite came from surface infiltration because there is no plausible mechanism for seismic pumping to raise the water table 2000 feet. The NRC asked about the status of carbon-14 dating of organic carbon in groundwater. The DOE said the results from samples collected in Amargosa may be available in the next three months.

As a result of additional discussions, NRC and DOE reached 14 agreements for Subissue #5 (see Attachment 1). With these 14 agreements, the NRC stated that Subissue #5 could be listed as ”closed-pending”.

5) Total System Performance Assessment

DOE offered a brief discussion following a question on sensitivity analysis in TSPA. NRC asked how, given the long life of the engineered barrier, can the contributions of the natural barriers be properly estimated. DOE answered that, if waste packages are not expected to fail before 10,000 years, then performance studies of longer duration should be carried out. DOE stated that, although not a realistic scenario, neutralization of the engineered barrier has been simulated. In addition, analysis of “degraded” and “enhanced” barriers in TSPA simulate realistic behavior of the system. DOE stated that this would allow a better estimate of the performance of natural barriers. DOE stated that failure of the engineered barrier system is also included in the human intrusion scenario, as well as in the disruptive igneous case. NRC asked if related results could be presented at the Radionuclide Transport Technical Exchange. DOE answered that this was possible, but needed to be planned for.

6) Features, Events, and Processes

The DOE presented Features, Events, and Processes (FEPs) in Saturated Zone Flow and Transport. The objective of the presentation was to describe the upcoming revision to the Saturated Zone Features, Events, and Processes Analysis and Model Report. Two new secondary FEPs will be added and additional documentation of the secondary FEPs will be included in the revised AMR.

Discussion followed the presentation. NRC asked whether any screening results were changed since Rev. 00. DOE answered that a few previously excluded FEPs are now included. The DOE explained the process of excluding low consequence FEPs using either qualitative or quantitative arguments based on TSPA runs. The NRC asked the DOE for the definition and screening process of several specific FEPs, including microbial activity, wells, and water table rise. Each of these FEPs was explained by the DOE and will be defined in the upcoming AMR. The DOE explained to Nye County that the water management FEP does not include potential changes to future groundwater appropriations due to the regulatory requirements. The State of Nevada asked how the water conducting features FEP was included in the DOE models. The DOE stated that they captured these features with the flowing interval spacing parameter and the horizontal anisotropy. NRC commented that the provided table of FEPs screening results was very useful, and asked to get a similar presentation at future technical exchanges. The DOE agreed to provide the revised Saturated Zone Features, Events, and Processes Analysis and Model Report.

7) Public Comments

None

C. William Reamer	Dennis R. Williams
Deputy Director	Deputy Assistant Manager
Division of Waste Management	Office of Licensing & Regulatory Compliance
Nuclear Regulatory Commission	Department of Energy

Summary of the Resolution of the Key Technical Issue on Unsaturated and Saturated Flow Under Isothermal Conditions

Subissue #	Subissue Title	Status	121NRC/DOE Agreements
3	Present-Day Shallow Groundwater Infilitration	Closed-Pending	1) Provide the documentation sources and schedule for the Monte Carlo method for analyzing infiltration. DOE will provide the schedule and identify documents expected to contain the results of the Monte Carlo analyses in February 2002. 2) Provide justification for the parameters in Table 4-1 of the Analysis of Infiltration Uncertainty AMR (for example, bedrock permeability in the infiltration model needs to be reconciled with the Alcove 1 results/observations. Also, provide documentation (source, locations, tests, test results) for the Alcove 1 and Pagany Wash tests. DOE will provide justification and documentation in a Monte Carlo analyses document. The information will be available in February 2002.

5	Saturated Zone Ambient Flow Conditions and Dilution Processes	Closed-Pending	1) The NRC believes that the incorporation of horizontal anisotropy in the site scale model should be reevaluated to ensure that a reasonable range for uncertainty is captured. The data from the C-wells testing should provide a technical basis for an improved range. As part of the C-wells report, DOE should include an analysis of horizontal anisotropy for wells that responded to the long-term tests. Results should be included for the tuffs in the calibrated site scale model. DOE will provide the results of the requested analyses in C-wells report(s) in October 2001, and will carry the results forward to the site-scale model, as appropriate. 2) Provide the update to the SZ PMR, 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 (reference item 9).

5	Saturated Zone Ambient Flow Conditions and Dilution Processes (Cont.)		3) 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 On Site Representative attends DOE/Nye County planning meetings and is made aware of all plans and updates to plans as they are made. 4) 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.

5	Saturated Zone Ambient Flow Conditions and Dilution Processes (Cont.)		5) Provide the hydro-stratigraphic 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. 6) Provide a technical basis for residence time (for example, using C-14 dating on organic carbon in groundwater from both the tuffs and alluvium). DOE will provide technical basis for residence time in an update to the Geochemical and Isotopic Constraints on Groundwater Flow Directions, Mixing, and Recharge at Yucca Mountain, Nevada AMR during FY 2002. 7) Provide all the data from SD-6 and WT-24. Some of this data currently resides in the Technical Data Management System, which is available to the NRC and CNWRA staff. DOE will include any additional data from SD-6 and WT-24 in the Technical Data Management System in February 2001.

5	Saturated Zone Ambient Flow Conditions and Dilution Processes (Cont.)		8) 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. 9) Provide additional information in an updated AMR or other document for both the regional and site scale model (for example, grid construction, horizontal and vertical view of the model grid, boundary conditions, input data sets, model output, and the process of model calibration). The updated USGS Regional Groundwater Flow Model is a USGS Product, not a Yucca Mountain Site Characterization Project product. It is anticipated that this document will be available in September 2001. DOE believes that the requested information is now available in the current version of the Calibration of the Site-Scale Saturated Zone Flow Model AMR and will be carried forward in future AMR revisions.

5	Saturated Zone Ambient Flow Conditions and Dilution Processes (Cont.)		10) Provide in updated documentation of the HFM that the noted discontinuity at the interface between the GFM and the HFM does not impact the evaluation of repository performance. DOE will evaluate the impact of the discontinuity between the Geologic Framework Model and the Hydrogeologic Framework Model on the assessment of repository performance and will provide the results in an update to the Hydrogeologic Framework Model for the Saturated-Zone Site-Scale Flow and Transport Model AMR during FY 2002. 11) In order to test an alternative conceptual flow model for Yucca Mountain, run the SZ flow and transport code assuming a north-south barrier along the Solitario Canyon fault whose effect diminishes with depth or provide justification not to. DOE will run the saturated zone flow and transport model assuming the specified barrier and will provide the results in an update to the Calibration of the Site-Scale Saturated Zone Flow Model AMR expected to be available during FY 2002. 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.

5	Saturated Zone Ambient Flow Conditions and Dilution Processes (Cont.)		13) Provide the evaluation of the ongoing fluid inclusion studies (for example, UNLV, State of Nevada, and USGS). DOE's consideration of the fluid inclusion studies will be documented in an update to the Saturated Zone Flow and Transport PMR expected to be available in FY 2002, subject to availability of the studies. 14) Provide the updated SZ FEPs AMR. DOE will provide the updated Features, Events, and Processes in Saturated Zone Flow and Transport AMR in February 2001.

6	Matrix Diffusion	Closed-Pending	1) The DOE will provide the final sensitivity analysis on matrix diffusion (for UZ) in the TSPA-SR, Rev. 0. Due date: December 2000. The saturated zone information will be available in TSPA-SR, Rev.1, expected to be available in June 2001. 2) The DOE will provide the final detailed testing plan for Alcove 8. The testing plan will be provided by August 28, 2000. The NRC staff will provide comments, if any, no later than two weeks after receiving the testing plan. DOE provided the testing plan on August 29, 2000, the NRC staff provided comments on September 15, 2000, therefore this agreement is closed. 3) The DOE will complete the Alcove 8 testing, taking into consideration the NRC staff comments, if any, and document the results in a DOE-approved AMR, due date: May 2001. 4) Provide the documentation for the C-wells testing. Use the field test data or provide justification that the data from the laboratory tests is consistent with the data from the field tests. DOE will provide the C-wells test documentation and will either use the test data or provide a justified reconciliation of the lab and field test data in C-wells document(s) in October 2001.