Subissue #3 - Model Abstraction ENG 4.2.1

Tracking # ENG 4.2.1

Comment On page 1-38 a description is provided that states, "The conceptualization of diffusion resulted in very small diffusive releases (drip rate required substantiation)." What information became available to result in the substantial changes to the conceptualization of diffusive releases?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The abstraction for the diffusion coefficient in the TSPA-Site Recommendation [CRWMS M&O 2000ar] is based on the following information that was not incorporated into the TSPA-Viability Assessment [DOE 1998]:

The free water diffusion coefficient for all radionuclides is based on the self-diffusivity of water, 2.299 x 10-5 cm2/sec (Mills 1973, Table III). The self-diffusivity of water provides a bounding value for all radionuclides of interest to performance assessment (CRWMS M&O 2000bg, Section 6.4.1.1).

The dependence of the diffusion coefficient on porosity and saturation (CRWMS M&O 2000bg, Section 6.4.1.2) is based on the experimental data of Conca and Wright (1992) for a variety of granular materials, including crushed tuff from Yucca Mountain. A statistical analysis (CRWMS M&O 2000b) produced an excellent fit to Conca and Wright's data using a power law dependence on moisture content (Archie's law).

The diffusion coefficient is corrected for temperature variation (CRWMS M&O 2000bg, Section 6.4.1.3).

This approach represents the diffusion coefficient as a function of porosity, saturation, and temperature for the TSPA-Site Recommendation. The abstraction for the TSPA-Viability Assessment is a function of saturation only.

References: DOE. 1998. Total System Performance Assessment. Volume 3 of Viability Assessment of a Repository at Yucca Mountain. DOE/RW-0508. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19981007.0030.

CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Conca, J.L. and Wright, J. 1992. "Diffusion and Flow in Gravel, Soil and Whole Rock." Applied Hydrogeology, 1, 5-24. Hanover, Germany: Verlag Heinz Heise GmbH. TIC: 224081.

CRWMS M&O 2000bg. EBS Radionuclide Transport Abstraction. ANL-WIS-PA-000001 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001204.0029.

CRWMS M&O 2000. Invert Diffusion Properties Model. ANL-EBS-MD-000031 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000912.0208.

Mills, R. 1973. "Self-Diffusion in Normal and Heavy Water in the Range 1-45(." The Journal of Physical Chemistry, 77, (5), 685-688. Washington, D.C.: American Chemical Society. TIC: 246404.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction ENG 4.4.1

Tracking # ENG 4.4.1

Comment In DOE's abstraction of radionuclide transport through the EBS, transport through the invert is dominated by diffusion in the time before advective fluxes are significant (CRWMS M&O, 2000a). Retardation is conservatively neglected under advective transport. Under diffusive transport, the diffusion coefficient employed is adjusted for porosity and water saturation in the invert; an analogous term is used for colloidal transport. DOE analyses show sensitivity of the timing of dose curves to this model (CRWMS M&O, 2000a) and the RSS identifies the invert as a significant barrier (CRWMS M&O, 2000b). Because retardation is not assumed under advective transport, invert barrier performance is related to the diffusive transport model. It appears that the invert diffusive transport model is sensitive to the exponential term applied to water saturation, which is itself highly uncertain. DOE has not shown that model uncertainty with respect to saturation in the invert has been accounted for in sensitivity studies.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O." Repository Safety Strategy." TDR-WIS-RL-000001 Revision 04 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The formulation for diffusion coefficient in the TSPA-Site Recommendation model directly accounts for uncertainty. The diffusion coefficient in a partly saturated, porous medium, D, is given by:

D = Do × (phi)^1.3 × s^1.849 × 10^[ND(a=0, sigma=0.223)] (the symbol ^ is used to denote exponentiation)

where Do is the free water diffusion coefficient, phi is the porosity, s is the saturation, and ND is a normal distribution with mean of zero and standard deviation, sigma, of 0.223 (Equation 6.4.1-11). The normal distribution spans the range of variability in the diffusivity measurements by Conca and Wright (1992) for a variety of granular materials, including crushed tuff. This normal distribution is sampled for each realization of the TSPA-Site Recommendation model, providing a direct representation of the uncertainty in the experimental data.

Reference: CRWMS M&O 2000bg. EBS Radionuclide Transport Abstraction. ANL-WIS-PA-000001 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001204.0029.

Conca, J.L. and Wright, J. 1992. "Diffusion and Flow in Gravel, Soil, and Whole Rock." Applied Hydrogeology, 1, 5-24. Hanover,

Germany: Verlag Heinz Heise GmbH. TIC: 224081.

Agreement Number TSPAI.3.17

Agreement DOE will provide an uncertainty analysis of the diffusion coefficient governing transport of dissolved and colloidal radionuclides through the invert. The analysis will include uncertainty in the modeled invert saturation. The uncertainty analysis will be documented in the EBS Radionuclide Transport Abstraction AMR, ANL-WIS-PA-000001, expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction ENG 4.4.2

Tracking # ENG 4.4.2

Comment The abstraction process may result in elimination of important uncertainty/variability in NFE model output. For example, on page 37 the highest and lowest waste package temperatures are listed as 316 and 235 C. However, the temperatures for the bin-averages resulted in 292 and 274 C. A demonstration is needed that the abstraction process is not eliminating important uncertainty and variability.

References CRWMS M&O. "Abstraction of NFE Drift Thermodynamic Environment and Percolation Flux AMR." ANL-EBS-HS-000003 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Potential waste package temperature variability is not eliminated during the thermal-hydrologic abstraction process. The thermal-hydrologic abstraction parses the process-level thermal-hydrologic data into 5 discrete infiltration rate ranges (see section 5.1.1 of the referenced AMR). Each raw temperature curve is placed into one of 5 bins until all curves have been placed. From there, a bin weighted average waste package temperature is computed for each of the bins as a function of the entries in a bin. This "average" curve is passed to TSPA as an abstracted TH result. This result is shown in Figure 26 in CRWMS M&O 2000c (Figure 33 in CRWMS M&O 2000d). Additionally, the maximum waste package temperature curve (that is found in a bin) and the minimum max waste package temperature curve (found in a bin) are also passed to TSPA. This is shown in Figure 24 (for the mean infiltration rate case only) in CRWMS M&O 20000c (Figure 30 in CRWMS M&O 2000d). This same procedure is followed for the low, mean, and high infiltration flux cases. Therefore, the TSPA model receives from the thermal-hydrologic abstraction, the maximum waste package temperature curve, the temperature curve with the minimum max, and a bin averaged waste package temperature based on the bin entries. This same procedure followed for every infiltration bin for all flux cases.

The 316 and 235 C are the extreme cases. Since Figure 26 in the Near Field Abstraction Analysis/Model Report (CRWMS M&O 2000c) only shows the plot for the mean infiltration flux case, the 316 C is not shown. However, the abstraction searches the entire population of parameters within a bin, thus finding the hi max and lo max and feeds these values to TSPA. Although not plotted, all of the data was passed to TSPA.

Reference: CRWMS M&O 2000c. Abstraction of NFE Drift Thermodynamic Environment and Percolation Flux. ANL-EBS-HS-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000504.0296.

CRWMS M&O 2000d. Abstraction of NFE Drift Thermodynamic Environment and Percolation Flux. ANL-EBS-HS-000003 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001206.0143.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction ENG 4.4.3

Tracking # ENG 4.4.3

Comment In the description of the colloid release abstraction in the TSPA-SR model report (CRWMS M&O, 2000a, page 326), it does not appear proper to say that Condition B is 1 if Ionic_Str_CDSP is greater than "either" of the two calculated values. The value to compare with is dependent on the pH range (see Fig 11 of CRWMS M&O, 2000b). Ionic strength may be below one calculated value and above another, and still be in the region of stability. The way Condition B is described ("either"), a combination of Condition A and Condition B both being 1 is not sufficient to be in the zone of instability.This potential inconsistency may be related to CNWRA staff's inability to reproduce results on FeOx colloid concentration in the TSPA-SR colloid model verification discussion (CRWMS M&O, 2000a, page 332, paragraph 3).

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, NV. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Waste Form Colloid-Associated Concentration Limits: Abstraction and Summary." ANL-WIS-MD-000012 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b

DOE Response The NRC has asked about an apparent discrepancy in the stepwise procedure that has been programmed into GoldSim to calculate FeOx stability. As the reviewer points out, pH is important in this determination, but this parameter is already accounted for in the calculation. At each time step in the GoldSim calculations, ionic strength (I) and pH derived from in package chemistry calculations are supplied as input (Equations 6-5 and 6-6 on p. 326 of the TSPA-Site Recommendation model report, CRWMS M&O aq) and the code then determines whether [pH, I] plots above or below either of the two "slanting" lines in Figure 11.

The text in the TSPA-Site Recommendation report on colloid model verification (CRWMS M&O, 2000ar, page 332, paragraph 3) is conceptually correct as currently written, but minor word changes will be made in the next revisions to the document to clarify implementation the of I and pH in the stepwise procedure that calculates FeOx stability.

References: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01.

Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

CRWMS M&O 2000ba. Waste Form Colloid-Associated Concentrations Limits: Abstraction and Summary. ANL-WIS-MD-000012 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000525.0397.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction ENG 4.4.4

Tracking # ENG 4.4.4

Comment Discussions of colloid release abstraction implementation (CRWMS M&O, 2000, pages 328 and 333) appear to imply that any Pu or Am removed from a waste cell by irreversible attachment is then subtracted from the amount available to be removed as a soluble species. This does not seem conceptually consistent with the model of irreversible attachment. Radionuclide irreversibly attached to colloids should not reduce the amount in solution. This is potentially significant to the modeled masses released.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response GoldSim calculates the quantities of chemical constituents made available from the degradation of the waste form and components in the waste package. This calculation is executed for each time step in a "mixing cell" subcomponent of the TSPA model report (CRWMS M&O 2000aq). The TSPA calculations partition the chemical constituents into aqueous and precipitated phases. The concentrations in the aqueous phase, as well as in the solid phase(s), are determined according to calculated aqueous chemical conditions, solubility limits, reactions, etc. Pu and Am are also partitioned into waste form colloids (irreversibly attached) which are generated from high level waste glass degradation. The basis for this apportioning is an established relationship based on experimental data. The Pu and Am assigned to the waste form colloids are subtracted from the total Pu and Am quantities in the mixing cell, and not from the Pu and Am calculated for the aqueous phase. The very small quantities of Pu and Am that are in solution and irreversibly attached to the waste form colloids do not materially affect the determination of aqueous species and precipitation of solid phases in the geochemical calculations.

Evolution of Near Field agreement 3.5 addresses the bounding concentration of Pu in solution and a Container Life and Source Term agreement 3.5 addresses solubility limits.

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction ENG 4.4.5

Tracking # ENG 4.4.5

Comment Modeled concentrations of waste form, FeOx, and groundwater colloids during release are extremely sensitive to small shifts in pH and/or ionic strength (CRWMS M&O, 2000a, pages 331-332). The fact that modeled Pu (Am) colloidal concentration drops over three orders of magnitude during one time step, then recovers nearly all that drop in the next time step because of rapid pH change, raises concerns about sensitivity to small uncertainties in modeled pH and ionic strength. A small shift across the line on figure 12 in CRWMS M&O (2000b) can cause this factor of 1000 change in concentration.The concentration of FeOx colloids is either 1 mg/L or 0.001 mg/L; there are no transitional values (CRWMS M&O, 2000a, figure 6-144). A slight shift on the plot of Fig 11 in CRWMS M&O (2000b) can cause this large change in FeOx colloids available for sorbing radionuclides.Groundwater colloid concentration suffers from the same extreme sensitivity to pH as for waste form colloids. The situation is potentially worse, because the minimum and maximum values range over a factor of 10,000 (CRWMS M&O, 2000a, page 332).

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Waste Form Colloid-Associated Concentration Limits: Abstraction and Summary." ANL-WIS-MD-000012 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response DOE agrees with NRC's observation that colloid concentration (and stability) can be extremely sensitive to relatively small shifts in pH and/or ionic strength (I). This phenomenon is experimentally observed and can be attributed as much to actual colloid behavior as to the random selection of pH and I parameters from stochastic distributions during the modeling procedure. For example, experimental data from Argonne National Laboratory, and elsewhere (CRWMS M&O 2001k, Section 6.2.1.3), indicate that smectite and iron-(hydr)oxide colloid stability tends to decrease drastically above ionic strengths of about 0.05M. DOE is currently conducting further literature reviews and interactions with investigators of iron-(hydr)oxide colloid phenomena to obtain a larger data set for iron-(hydr)oxide colloid concentrations. These additional data will improve the model, however, under the current TSPA model (CRWMS M&O 2000aq) colloid behavior will remain "abrupt" over certain small ranges of pH and ionic strength.

Calculation of groundwater colloid concentration is based on a compilation of colloid concentrations in groundwaters from many different geologic and hydrologic environments. DOE is currently updating the groundwater colloid database to include additional

data specific to the Yucca Mountain region.

References: CRWMS M&O, Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00.

CRWMS M&O 2001k, Waste Form Colloid-Associated Concentration Limits: Abstraction and Summary, ANL-WIS-MD-000012 REV 00 ICN01.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction ENG 4.TT.1

Tracking # ENG 4.TT.1

Comment Pages 404. An explanation is needed of what physical processes are causing the strong variation in the release curves from the EBS, such as for Pu-239.

References CRWMS M&O. "Total-System Performance Assessment (TSPA) Model for the Site Recommendation." TDR-WIS-PA-000002 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The variations are a numerical discretization issue caused by chain decay in the particle tracker, and specifically the decay of discrete particles of the parent radionuclide Am-243. The code was optimized to minimize this discrete behavior for as many chains as possible, but some residual "discreteness" remained for a few radionuclides, such as Pu-239 and U-233. Since there was an upper limit on the number of particles that could be injected into the Unsaturated Zone model based on process size and RAM availability, using a very, very large number of particles to resolve the variations was not possible. The maximum number was used while still remaining within these constraints.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ 1.2.1

Tracking # UZ 1.2.1

Comment There are insufficient data to support the use of a distributed-parameter, water-balance plug flow approach for net infiltration. Infiltration is a highly nonlinear process. The effect of capillarity on infiltration and percolation is neglected by the INFIL; it is not clear that the coarse vertical grid spacing would offset the neglect of capillarity. Use of a Richards equation-based solution as a comparison to the water-balance plug flow approach is needed, particularly over the repository where thin soils and bare bedrock dominate the land cover. In addition, corroborating data do not support the results from the INFIL model: chloride mass balance represents a lower bound; temperature and neutron probe data suggest a higher average is supported. The non-uniqueness of the calibration process for parameters in the INFIL model leads to large uncertainty.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Distributed-Parameter, Water-Balance

DOE believes that the distributed-parameter, water-balance plug flow approach (aka bucket model) for net infiltration is justified for representing the spatial variability of net infiltration as a function of topography, soil properties, soil depth, bedrock, climate, and surface water re-distribution. However, to demonstrate confidence in the approach, DOE will consider investigating the high uncertainty in net infiltration estimates through comparison with a Richards equation approach. The uncertainty is believed to be due to the coarse vertical resolution and possible over-simplification of physical process with respect to infiltration.

INFIL Model Uncertainty

Uncertainty in infiltration is included in the process-level models and in TSPA. This is captured through the lower and upper bounds for infiltration identified in the process model analyses and the distribution of mean infiltration identified in the infiltration uncertainty analysis.

Reference: Audit Observer Inquiry No. M&O-APR-01-02-02, dated February 9, 2001, for ANL-NBS-HS-000032.

Agreement Number TSPAI.3.18

Agreement DOE will provide a technical basis that the water-balance plug-flow model adequately represents the non-linear flow processes represented by Richard's equation, particularly over the repository

where there is thin soil. The technical basis will be documented in an update to the Simulation of Net Infiltration for Modern and Potential Future Climates AMR, ANL-NBS-HS-000032. The AMR is expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 1.3.1

Tracking # UZ 1.3.1

Comment It is not clear that the evapotranspiration model adequately represents the conditions during future climates at YM. Overestimates of evapotranspiration would lead to underestimates of shallow infiltration. Adjustments of vegetation cover and rooting depth for potential future climates are not supported by data. In addition, it is not clear if the temperature data from geographic analog sites (Arizona and Washington) reflect conditions expected at YM, specifically, the effect of radiation differences on temperature.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Preliminary model sensitivity analysis in the Analysis of Infiltration Uncertainty Analysis/Model Report (CRWMS M&O 2000bi) indicated that the model sensitivity to the vegetation cover term is low, based on most net infiltration occurs during the winter and early spring when potential evapotranspiration is low. Thus, doubling or halving vegetation cover only changes daily evapotranspiration by a small amount.

A more important source of uncertainty than vegetation cover is the root density term for the lower soil layers. There is no data on vegetation cover or rooting depths. One method of addressing the effects of vegetation on infiltration during future climates is to calibrate the model using study areas representative of the analog sites.

References: CRWMS M&O 2000bi. Analysis of Infiltration Uncertainty. ANL-NBS-HS-000027 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000525.0377.

USGS 2001. Simulation of Net Infiltration for Modern and Potential Future Climates. ANL-NBS-HS-000032 REV 00 ICN 01. Denver, Colorado: U.S. Geological Survey. ACC: MOL.20010405.0002.

Audit Observer Inquiry No. M&O-APR-01-02-01, dated February 9, 2001, for ANL-NBS-HS-000033.

Agreement Number TSPAI.3.19

Agreement DOE will provide justification for the use of the evapotranspiration model, and justify the use of the analog site temperature data. The justification will be documented in an update to the Simulation of Net Infiltration for Modern and Potential Future Climates AMR, ANL-NBS-HS-000032, and the Future Climate Analysis AMR, ANL-NBS-GS-000008. The AMRs are expected to be available to NRC in FY

2003.

Subissue #3 - Model Abstraction UZ 1.3.2

Tracking # UZ 1.3.2

Comment Without access to the data, it is difficult to assess the reasonableness of 100-yr synthetic meteorologic records used to calculate shallow infiltration for the mean modern climate, lower bound modern climate, and upper bound modern climate. These data sets need to be analyzed to determine if sufficient annual, multi-year, and decadel oscillations in precipitation are reflected in the meteorological inputs. Initially, DOE maintained that the synthetic records were an intermediate data set, therefore, it would not be included in the technical database available to NRC. The concern is that under-representation of climate variability leads to underprediction of shallow infiltration.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The 100-year synthetic meteorological records used for infiltration calculations are being compiled.

Agreement Number TSPAI.3.20

Agreement DOE will provide data supporting the synthetic meteorologic records (specifically, data files 4JA.s01 and Area12.s01). These data files will be provided to NRC September 2001.

Subissue #3 - Model Abstraction UZ 1.5.1

Tracking # UZ 1.5.1

Comment The effect of lateral surface or near-surface flow on net infiltration may be underestimated. The watershed calibrations are constrained by 2 rainfall-runoff events, thus leaving parameterization highly uncertain. Recent integration of data from the ECRB and ESF into the net infiltration analysis suggested an underestimation of net infiltration beneath wash channels in the repository footprint, particularly for potential future climates.

References Flint, L. "Distribution of Water Potential Measured with Heat Dissipation Probes in Underground Volcanic Tuffs." Paper at Geological Society of America meeting November 13-17. Reno, Nevada: Geological Society of America. 2000.

DOE Response The net infiltration model as documented in the Simulation of Net Infiltration for Modern and Future Potential Climates (USGS 2001) is considered to provide an adequate representation of the areal distribution of net infiltration at spatial scales and over time durations for the intended application of the model (i.e., to provide an upper boundary condition for the site-scale unsaturated zone flow and transport model).

Sensitivity studies in the Unsaturated Zone Flow Models and Submodels (CRWMS M&O 2000bj) Analysis/Model Report looked at Chloride using two independent methods. Both methods indicated that spatial variability is not important.

References: USGS 2001. Simulation of Net Infiltration for Modern and Potential Future Climates. ANL-NBS-HS-000032 REV 00 ICN 01. Denver, Colorado: U.S. Geological Survey. ACC: MOL.20010405.0002.

CRWMS M&O 2000bj. UZ Flow Models and Submodels. MDL-NBS-HS-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0527.

Audit Observer Inquiry No. M&O-APR-01-02-03, dated February 9, 2001, for ANL-NBS-HS-000032.

Agreement Number TSPAI.3.21

Agreement DOE will demonstrate that effects of near surface lateral flow on the spatial variability of net infiltration are appropriately considered in an update to the Simulation of Net Infiltration for Modern and Potential Future Climates AMR (ANL-NBS-HS-000032) and UZ Flow Models and Submodels AMR (MDL-NBS-HS-000006). These AMRs are expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 2.3.1

Tracking # UZ 2.3.1

Comment Page 3-32 (CRWMS M&O, 2000). An assessment is needed of the potential error involved with using a hydrologic property set obtained by calibrating a model on current climate conditions and using that model to forecast flow for future climate conditions. In addition, an assessment of the applicability of this property set for thermohydrology models is needed.

Page 3-52 (CRWMS M&O, 2000). Similar issue but with respect to the use of the active fracture model for thermohydrological processes.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response (CRWMS M&O 2000ar, page 3-32)

Test predictions for field tests (such as Alcove 8 - Niche 3) will be conducted at higher flow rates that are expected to encompass flow behavior representative of future climates. Modeling predictions for these tests will be compared with testing results, which should validate the potential error of using property sets calibrated under present-day climate for future climates. These predictions will be in revisions to the referenced Analysis/Model Reports.

(CRWMS M&O 2000ar, page 3-52)

DOE has modeled the Drift Scale Test using property sets for the active fracture model for thermohydrologic processes. Comparisons between the Drift Scale Test results and model predictions have been performed. The test results validate the model. The results will be documented in the Drift-Scale Coupled Processes thermohydrologic Analysis/Model Report (CRWMS M&O 2000o).

References: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

CRWMS M&O 2000bj. UZ Flow Models and Submodels. MDL-NBS-HS-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0527.

CRWMS M&O 2000bk. Radionuclide Transport Models Under Ambient Conditions. MDL-NBS-HS-000008 REV 00. Las Vegas,

Nevada: CRWMS M&O. ACC: MOL.19990721.0529.

CRWMS M&O 2001j. Seepage Calibration Model and Seepage Testing Data. MDL-NBS-HS-000004 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010122.0093.

CRWMS M&O 2000o. Drift-Scale Coupled Processes (DST and THC Seepage) Models. MDL-NBS-HS-000001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0523.

Agreement Number TSPAI.3.22

Agreement DOE will provide an assessment or discussion of the uncertainty involved with using a hydrologic property set obtained by calibrating a model on current climate conditions and using that model to forecast flow for future climate conditions. This assessment will be documented in the UZ Flow Models and Submodels AMR, MDL-NBS-HS-000006, expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 2.3.2

Tracking # UZ 2.3.2

Comment Current DOE results suggest the Paintbrush Tuff is a barrier to episodic infiltration as a result of diffusion into the matrix. However, independent modeling "demonstrates that heterogeneity of rock properties is a primary source of uncertainty in the spatial and temporal distribution of unsaturated flow through fractured rock and reveals development of preferential pathways and flow focusing, both of which can have significant consequences on the performance of waste disposal facilities constructed in unsaturated, fractured rocks." Technical basis is needed that heterogeneity within hydrostratigraphic units is not an important source of uncertainty.

References CRWMS M&O. "Unsaturated Zone Flow and Transport Model Process Model Report".TDR-NBS-HS-000002, Revision 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. 2000.
Illman, W.A. and D. Hughson. "Numerical Modeling of Unsaturated Flow in Thick Vadose Zones of Fractured Rocks." Presentation at the Spring 2001 Meeting of the American Geophysical Union.

DOE Response It is expected that the overall behavior of site-scale flow and transport processes is determined mainly by relatively large-scale heterogeneities associated with the geologic stratification of the mountain. Stratification and faulting, which places units with highly different properties against each other, are the major heterogeneities within the unsaturated zone at Yucca Mountain. Within the same geologic unit, hydrological properties are relatively uniformly distributed because of the intra-strata homogenization induced by the tuff depositional environments. In the geology-based, deterministic approach, subunits are defined within the major hydrogeologic units to capture variability in the vertical stratification. Within these subunits, important lateral heterogeneity can be accounted for by defining lateral boundaries, differentiating areas with significant differences in hydrological properties.

The complexity of a heterogeneity model needs to be consistent with the availability of the data. More complicated models introduce larger degrees of uncertainties in rock property estimations when data are limited. The layered approach is also supported by field observations, such as the relatively uniform matrix water saturations within a given layer. Flow and transport models based on a layered approach can be relatively easily calibrated with multiple data sets and provide a means to incorporate a significant amount of the available site data.

It is straightforward to upscale using inverse modeling when a layered approach is employed (CRWMS M&O 2000aw, Section 3.4.1.4.4).

DOE agrees that it is important to investigate the effects of smaller-scale heterogeneity. Larger-scale heterogeneity is captured in the flow and transport models in terms of hydrogeologic unit stratification and structure, and major faults. Some aspects of smaller scale heterogeneity were investigated and reported in the Supplemental Science and Performance Analysis, Volume 1 (BSC 2001e). DOE is considering future work that addresses heterogeneity in the PTn (FY02) and in the CHn (FY03 and FY04). The PTn analysis will be used to address Unsaturated and Saturated Flow under Isothermal Conditions agreement 4.4.

References: CRWMS M&O 2000aw. Unsaturated Zone Flow and Transport Model Process Model Report. TDR-NBS-HS-000002 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000831.0280.

BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

Agreement Number TSPAI.3.23

Agreement DOE will evaluate spatial heterogeneity of hydrologic properties within hydrostratigraphic units and the effect this heterogeneity has on model results of unsaturated flow, seepage into the drifts and transport. This evaluation will be documented in the UZ Flow Models and Submodels AMR, MDL-NBS-HS-000006, Radionuclide Transport Models under Ambient Conditions, MDL-NBS-HS-000008, and Seepage Models for PA Including Drift Collapse AMR, MDL-NBS-HS-000002, expected to be available to NRC in FY 2003. DOE will also provide a technical basis for the assessment that bomb-pulse Cl-36 found below the PTn can be linked to a negligible amount of fast flowing water. The technical basis will be documented in the UZ Flow Models and Submodels AMR , MDL-NBS-HS-000006, expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 2.3.3

Tracking # UZ 2.3.3

Comment There are insufficient water potential and geochemical data to support the flow fields predicted by the 3D UZ site-scale model in the CHn, Prow Pass, and Bullfrog units below the repository. Of particular concern is the estimated fraction of water that may travel significant distances through permeable nonwelded vitric tuff matrix versus the fraction that may be laterally diverted atop layers of low-permeability zeolitized or moderate to densely welded tuff to fast pathways to the water table (e.g., through faults). The focus of this concern is areas where no perched water is predicted, and in unsaturated zones in the lower CHn, Prow Pass, and Bullfrog units below the perched water. In addition, a basis should be presented for the use of current hydraulic properties, rather than thermally perturbed properties; specifically, zeolitization of the nonwelded, nonaltered Tptpv1, Tptb1, and upper Tac may be caused by the thermal pulse. Note also that statistics of flow percent in faults versus matrix and fractures that are relevant to the entire 3D UZ site-scale model domain may not reflect flow regimes below the repository footprint.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Uncertainty in the Calico Hills flow model will be addressed through sensitivity studies for unsaturated zone radionuclide transport under a range of potential Calico Hills flow conditions. This will be addressed in the revisions to Unsaturated Zone Flow Models and Submodels (CRWMS M&O 2000bj), Radionuclide Transport Models under Ambient Conditions (CRWMS M&O 2000bk), and in Analysis of Geochemical Data for Unsaturated Zone (BSC 2001h).

The Unsaturated Zone Flow Models and Submodels (CRWMS M&O 2000bj) Analysis/Model Report will be updated to include the flow path and flow field for moisture tension and geochemical data. Documentation of the analysis is an extension of Unsaturated and Saturated Flow under Isothermal Conditions agreement 4.5 and related Radionuclide Transport agreement 1.1.

References: (future revisions)

CRWMS M&O 2000aw. Unsaturated Zone Flow and Transport Model Process Model Report. TDR-NBS-HS-000002 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000831.0280.

CRWMS M&O 2000bk. Radionuclide Transport Models Under Ambient Conditions. MDL-NBS-HS-000008 REV 00. Las Vegas,

Nevada: CRWMS M&O. ACC: MOL.19990721.0529.

CRWMS M&O 2000bj. UZ Flow Models and Submodels. MDL-NBS-HS-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0527.

BSC 2001h. Analysis of Geochemical Data for the Unsaturated Zone. ANL-NBS-HS-000017 REV 00 ICN 01. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010405.0013.

Agreement Number TSPAI.3.24

Agreement DOE will provide an analysis of available geochemical and hydrological data (water content, water potential, and temperature) used for support of the flow field below the repository, particularly in the Calico Hills, Prow Pass, and Bullfrog hydrostratigraphic layers. The analyses will demonstrate that potential bypassing of matrix flow pathways below the area of the proposed repository, as opposed to the entire site-scale model area, is adequately incorporated for performance assessment, or provide supporting analyses that the uncertainties are adequately included in the TSPA. These analyses will be documented in the UZ Flow Models and Submodels AMR, MDL-NBS-HS-000006, In-Situ Field Testing of Processes AMR, ANL-NBS-HS-000005,, and Calibrated Properties Model AMR, MDL-NBS-HS-000003, expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 2.3.4

Tracking # UZ 2.3.4

Comment Results of subsurface seepage and tracer studies, including the Passive Cross Drift Hydrologic test, Alcove 8-Niche 3 tests, and Niche 5 test, need to be documented to provide validation of or a basis for revising the TSPA seepage abstraction and associated parameter values (e.g., flow focusing factor, van Genuchten alpha for fracture continuum).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See also response to 1.b. The flow model accounts for measurements from boreholes and tunnels. Future revisions to the referenced Analysis/Model Reports will document:

- data used for calibration
- conflicting results from the different methodologies
- tests results

The associated Unsaturated and Saturated Flow under Isothermal Conditions agreements for seepage are 4.1a), 4.1 b); 4.2; 4.3 and 6.3 for seepage. Radionuclide Transport agreement 3.4 will address the units below the repository. The results of the agreements will be documented in future revisions to the referenced Analysis/Model Reports.

References (future revisions):

CRWMS M&O 2000bl. In Situ Field Testing of Processes. ANL-NBS-HS-000005 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000504.0304.

CRWMS M&O 2001j. Seepage Calibration Model and Seepage Testing Data. MDL-NBS-HS-000004 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010122.0093.

CRWMS M&O 2000bk. Radionuclide Transport Models Under Ambient Conditions. MDL-NBS-HS-000008 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0529.

Agreement Number TSPAI.3.25

Agreement DOE will utilize field test data (e.g., the Passive Cross Drift Hydrologic test, the Alcove 8 - Niche 3 tests, the Niche 5 test, and other test data) to either provide additional confidence in or a basis for revising the TSPA seepage abstraction and associated parameter values (e.g., flow focusing factor, van Genuchten alpha for fracture continuum, etc.), or provide technical basis for not

using it. This will be documented in Seepage Calibration Model and Seepage Testing Data AMR, MDL-NBS-HS-000004, expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 2.3.5

Tracking # UZ 2.3.5

Comment The site-scale UZ flow model for TSPA is not calibrated using the most recent in situ measurements of saturations and water potentials.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The flow model accounts for measurements from boreholes and tunnels. Current measurements of moisture tension and saturation are in good agreement with the model. Revisions to the Unsaturated Zone flow model Analysis/Model Reports will incorporate the recent in-situ measurements.

References (future revisions):

CRWMS M&O 2000bm. Analysis of Hydrologic Properties Data. ANL-NBS-HS-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0519.

CRWMS M&O 2000bn. Calibrated Properties Model. MDL-NBS-HS-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0520.

CRWMS M&O 2000bj. UZ Flow Models and Submodels. MDL-NBS-HS-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0527.

Agreement Number TSPAI.3.26

Agreement DOE will calibrate the UZ flow model using the most recent data on saturations and water potentials, and document the sources of calibration data and data collection methods. The results will be documented in the Calibrated Properties Model AMR (MDL-NBS-HS-000003) expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 2.5.1

Tracking # UZ 2.5.1

Comment Page 143 (CRWMS M&O, 2000). A discussion is provided of perched water bodies. Information is needed on what the model is producing with respect to perched water bodies for example (How do the modeled perched water body ages compare to the dated ages of observed perched water bodies? Would perched water bodies be expected to have the same ages for future climate conditions as they do now? Do perched water bodies drain and what is the impact on dose?).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Treatment of perched water for the flow model is discussed in Unsaturated Zone Flow Models and Submodels Analysis/Model Report (CRWMS M&O 2000bj). The perched water conceptual model and calibration are discussed in sections 6.2.2 and 6.2.3. See pages 65, 66, and 67 for flow results.

The Analysis of Base-Case Particle Tracking Results of the Base-Case Flow Fields Analysis/Model Report (CRWMS M&O 2000bo,Section 6.2.2) discusses the effects of different perched water models on unsaturated zone transport.

Water does drain through, as well as along, perched water bodies in the unsaturated zone flow model. Therefore, these effects are included in the TSPADOSE calculations.

Comparison of transport for alternative perched water models is documented in the Analysis of Base-Case Particle Tracking Results of the Base-Case Flow Fields Analysis/Model Report, (CRWMS M&O 2000bo, Section 6.2.2). The sensitivity study suggests that residence time for transport along more extensive perched water bodies is slower than vertical transport to the water table. However, the overall differences in transport times are not large.

Flow models assumed steady state resident times for perched water bodies. Transients in the fracture system resulting from climate change are expected to propagate through the unsaturated zone in 100's of years (less than 1000 years). Climate change periods and the regulatory time period are long compared with the transient time period, therefore the neglect of transient flow due to climate change is reasonable.

References: CRWMS M&O 2000bj. UZ Flow Models and Submodels. MDL-NBS-HS-000006 REV 00. Las Vegas, Nevada:

CRWMS M&O. ACC: MOL.19990721.0527.

CRWMS M&O 2000bo. Analysis of Base-Case Particle Tracking Results of the Base-Case Flow Fields (ID: U0160). ANL-NBS-HS-000024 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000207.0690.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ 2.TT.1

Tracking # UZ 2.TT.1

Comment There is a lack of transparency pertaining to the presented parameter histories.

References CRWMS M&O. "Abstraction of NFE Drift Thermodynamic Environment and Percolation Flux AMR." ANL-EBS-HS-000003 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The parameter time-histories are given to specifically illustrate in the Near Field Abstraction Analysis/Model Report (CRWMS M&O 2000c) the potential thermohydrologic variability infiltration bin average thermohydrologic variability associated with the infiltration rate uncertainty (low, mean, and high infiltration flux cases) specified future climates repository design issues such as repository center and edge effects and other issues, such as different waste package types.

The time-histories specifically indicate that for the thermohydrologic process-model assumptions, such as conceptual flow model, boundary conditions, etc (as described in the Multiscale Analysis/Model Report [CRWMS M&O 2000ag]), these are the thermohydrologic distributions for temperature, relative humidity, etc, that are made available for TSPA (and other downstream models).

Furthermore, the actual thermohydrologic abstraction data passed to TSPA either for further abstraction and/or direct use is specifically given in Tables 3 and 4 in the Near Field Abstraction Analysis/Model Report. TSPA thermohydrologic data is used in direct process model results or infiltration rate bin averaged and is described in the downstream models that apply the abstracted thermohydrologic data as inputs. The illustrated time-histories shown in the Analysis/Model Report give an idea as to what is being passed/implemented into the downstream models including the TSPA model.

References: CRWMS M&O 2000c. Abstraction of NFE Drift Thermodynamic Environment and Percolation Flux. ANL-EBS-HS-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000504.0296.

CRWMS M&O 2000ag. Multiscale Thermohydrologic Model. ANL-EBS-MD-000049 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001208.0062.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and

Subissue #3 - Model Abstraction UZ 2.TT.2

Tracking # UZ 2.TT.2

Comment Water densities are used inconsistently to model evaporation.

References CRWMS M&O. "Multiscale Thermal Hydrologic Model Abstraction AMR." ANL-EBS-MD-000049. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The abstracted average invert evaporation rate used a constant water density of 1000 kg/m3. Section 6.3.10 in the Multiscale Analysis/Model Report (CRWMS M&O 2000ag) utilized both a constant water density and a temperature dependent water density to compute the average evaporation rate at the top of the drip shield surface. The constant water density used in the drip shield calculation was 983.19 kg/m3, not 1000 kg/m3. However, Figure 53 in the Multiscale Analysis/Model Report indicates that the difference in evaporation rate at the drip shield surface was not very sensitive to the choice of water density temperature dependence (e.g., approximately 500 years after waste emplacement, both evaporation response curves, temperature dependent and constant density, are the same).

In the drip shield calculations for evaporation rate, the water densities used in the calculations varied by about 4% (from 25°C to about 100°C) in accordance with Figure 53. No differences in the evaporation rates are noted after about 500 years. Subsequently, the difference between the invert water density and the drip shield water density was actually less than 2%, thus indicating that the choice in water densities (in this range 2-4% difference) will not affect the evaporation rates.

Based on the above, the choice of water density used to calculate the evaporation rate is not dependent on the value selected in the 25°C to 100°C range (CRWMS M&O 2000ag, Figure 53, for the drip shield evaporation rate).

Reference: CRWMS M&O 2000ag. Multiscale Thermohydrologic Model. ANL-EBS-MD-000049 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001208.0062.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ 2.TT.3

Tracking # UZ 2.TT.3

Comment What is the water mass flux balance used above, at, and below the repository horizon in the TSPA (CRWMS M&O, 2000)?

References CRWMS M&O. "Total-System Performance Assessment (TSPA) Model for the Site Recommendation." TDR-WIS-PA-000002 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Mass balances are based on mass conservation equations in the flow calculations.

The unsaturated zone flow fields are mass balanced. Any seepage that enters and then exits the drifts would be assumed to be a small perturbation that does not disturb the steady state flow fields.

The conceptual model for water flow within the drift accounts for the various possible flow paths (e.g., some water flows around the drip shield, some flows through the drip shield and around the waste package, and some flow through the drip shield and through the drip shield). The effects of the drift in perturbing the water flow (for example, the "shadow zone" below the drift) are not taken into account, but the approximations made are conservative (i.e., account for increased flux because of thermally mobilized water above the drift, no credit for thermal dryout, no credit for drift shadow zone).

Agreement Number TSPAI.3.27

Agreement DOE will provide an overview of water flow rates used in the UZ model above and below the repository, in the Multi-Scale Thermohydrologic Model (MSTHM), in the seepage abstraction, and in the in drift flow path models, to ensure appropriate integration between the various models. This will be documented in the TSPA for any potential license application expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 3.5.1

Tracking # UZ 3.5.1

Comment Page 3-30 (CRWMS M&O, 2000). "Field observations suggest limited interaction between the fractures and matrix." A comparison is needed that the abstraction and implementation of matrix diffusion in the TSPA model is consistent with the field observations.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Existing field observations concerning fracture-matrix interaction do not provide much constraint on the range of potential behavior. Further field testing is being conducted in the Alcove 8/Niche 3 tests. The results of these tests will be analyzed and implemented in TSPA.

Alcove 1 tracer tests indicate that matrix diffusion plays an important role in tracer transport behavior. The Alcove 1 tracer tests are in documented in Section 6.8.1 of the Unsaturated Zone Flow Models and Submodels Analysis/Model Report (CRWMS M&O 2000bj) and the following sections of the Unsaturated Zone Process Model Report Sections 2.2.2.2.3; 3.7.4.4; 3.11.11.1.

Another observation in section 3.8.2 of the Unsaturated Zone Process Model Report (CRWMS M&O 2000aw) suggests matrix diffusion is important is the uniform geochemical signature in pore water of the TSw.

References: CRWMS M&O 2000bj. UZ Flow Models and Submodels. MDL-NBS-HS-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0527.

CRWMS M&O 2000aw. Unsaturated Zone Flow and Transport Model Process Model Report. TDR-NBS-HS-000002 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000831.0280.

Agreement Number TSPAI.3.28

Agreement DOE will provide independent lines of evidence to provide additional confidence in the use of the active fracture continuum concept in the transport model. This will be documented in Radionuclide Transport Models under Ambient Conditions AMR (MDL-NBS-HS-000008) and UZ Flow Models and Submodels AMR (MDL-NBS-HS-000006) expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ 3.TT.1

Tracking # UZ 3.TT.1

Comment Page 433 (CRWMS M&O, 2000). An explanation is needed of what physical processes are causing the strong variation in the release curves from the UZ, such as for Pu-239.

References CRWMS M&O. "Total-System Performance Assessment (TSPA) Model for the Site Recommendation." TDR-WIS-PA-000002 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The variations are a numerical discretization issue caused by chain decay in the particle tracker, specifically the decay of discrete particles of the parent radionuclide Am-243. The code was optimized to minimize this discrete behavior for as many chains as possible, but some residual "discreteness" remained for a few radionuclides, such as Pu-239 and U-233. Since there was an upper limit on the number of particles that could be injected into the unsaturated Zone model based on process size and RAM availability, using a very, very large number of particles to resolve the variations was not possible. The maximum number was used while still remaining within these constraints.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ 3.TT.2

Tracking # UZ 3.TT.2

Comment The AMR describes in general terms how FEHM and resulting data will be implemented, but does not include detail about implementation into GoldSim. Data resulting from this AMR will be used in the UZ Flow and Transport PMR and the TSPA-SR.

References CRWMS M&O. "Abstraction of Flow Fields for RIP." ANL-NBS-HS-000023 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Total System Performance Assessment Model for Site Recommendation (CRWMS M&O 2000aq, Section 6.3.6) describes the implementation of FEHM into GoldSim.

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ 3.TT.3

Tracking # UZ 3.TT.3

Comment Matrix diffusion in the UZ has emerged, somewhat surprisingly, as a significant natural barrier for attenuation of potential radionuclide releases. This increased importance seems to have come after the incorporation of the active-fracture concept into the transport model. The integration of active fracture concept within the transport abstraction is not transparent.

References CRWMS M&O. "Unsaturated Zone Flow and Transport Model PMR." TDR-NBS-HS-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
CRWMS M&O. "Particle Tracking Model and Abstraction of Transport Processes AMR." ANL-NBS-HS-000026 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The active fracture model is a flow focusing model that results in reduced fracture-matrix area (and increased flowing fracture-spacing). The geometric interpretation of the Active Fracture Model is transferred directly to the matrix diffusion transport model.

The Alcove 8 test results will be documented in the In-Situ Field Testing of Processes, Analysis/Model Report (CRWMS M&O 2000bl).

The differences found in matrix diffusion in radionuclide transport calculations for the TSPA-Viability Assessment and TSPA-Site Recommendation models are primarily due to the differences in calibrated model parameters including the fracture-matrix interaction factors. In the TSPA-Viability Assessment, a constant fracture-matrix interaction factor was calibrated for each hydrogeologic model unit. For TSPA-Site Recommendation, the active fracture model was used in which the fracture-matrix interaction factor is a function of the effective fracture water saturation.

The fracture-matrix interaction factors are different in the Site Recommendation model due to changes in other hydrologic parameters for TSPA-Viability Assessment versus TSPA-Site Recommendation such as permeability and van Genuchten alpha. This has lead to differences in the fracture-matrix reduction factors in TSPA-Site Recommendation compared with TSPA-Viability Assessment.

A more complete description of how the active fracture model is integrated with the transport model will be given in an update to the Radionuclide Transport Models under Ambient Conditions Analysis/Model Report.

Subissue #3 - Model Abstraction UZ 3.TT.3

References: (future revisions)

CRWMS M&O 2000bl. In Situ Field Testing of Processes. ANL-NBS-HS-000005 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000504.0304.

CRWMS M&O 2000bk. Radionuclide Transport Models Under Ambient Conditions. MDL-NBS-HS-000008 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990721.0529.

Agreement Number TSPAI.3.29

Agreement DOE will provide verification that the integration of the active fracture model with matrix diffusion in the transport model is properly implemented in the TSPA abstraction. This verification will be documented in the Particle Tracking Model and Abstraction of Transport Processes, ANL-NBS-HS-000026, expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ.Ltr.1.b

Tracking # UZ.Ltr.1.b

Comment The ongoing and planned testing under agreement USFIC.4.01 are a reasonable approach for a licensing application with the following comments:

i. Consider a mass balance of water for alcove 8/Niche 3 cross over test.
ii. Monitor evaporation during all testing.
iii. Provide the documentation of the test plan for the Passive Cross Drift Hydrologic test.
iv. Provide the NRC with any Cross Drift seepage predictions that may have been made for the Passive Cross Drift Hydrologic test.
v. Provide documentation of the results obtained and the analysis for the Passive Cross Drift Hydrologic test. This documentation should include the analysis of water samples collected during entries into the Cross Drift (determination whether the water comes from seepage or condensation).
vi. Provide documentation of the results obtained and the analysis for the Alcove 7 test. This documentation should include the analysis of water samples collected during entries into Alcove 7 (determination whether the water comes from seepage or condensation).
vii. Provide the documentation of the test plan for the Niche 5 test.
viii. Provide documentation of the results obtained and the analysis for the Niche 5 test.
ix. Provide documentation of the results obtained and the analysis for the Systematic Hydrologic Characterization test.
x. Provide documentation of the results obtained and the analysis for the Niche 4 test.
xi. Provide documentation of the results obtained from the calcite filling test. Include interpretation of the observed calcite deposits found mostly at the bottom of the lithophysal

References

DOE Response Test plans and pre-test predictions will be made available as they are developed.

Exceptions:

vi. [Original NRC comment] Provide the documentation of the test plan for the Alcove 7 test
(vi) [DOE response] Test plan for Alcove 7 is not needed since test is near completion.

xiii. [Original NRC comment] Provide documentation of the results

obtained from the Comparison of Continuum and Discrete Fracture Network Models modeling study. Alternatively, provide justification of the continuum approach at the scale of the seepage model grid.
(xiii) [DOE response] This is a modeling issue that is not related to testing. An agreement on the comparison of continuum versus discrete fracture seepage models is not needed because this is ongoing work.

xiv. [Original NRC comment] Provide documentation of the results obtained from the Natural Analogs modeling study. The study was to apply conceptual models and numerical approaches developed from Yucca Mountain to natural analog sites with observations of seepage into drifts, drift stability, radionuclide transport, geothermal effects and preservation of artifacts.
(xiv) [DOE response] This is a modeling issue that is not related to testing. An agreement on the comparison of continuum versus discrete fracture seepage models is not needed because this is ongoing work.

Agreement Number

Agreement The following statement by DOE was considered adequate to the NRC, and was recorded under Attachment 3 of the Summary Highlights of NRC/DOE Technical Exchange and Management Meeting on Total System Performance Assessment and Integration, August 6-10, 2001.

Unsaturated and Saturated Flow Under Isothermal Conditions, Agreement Modifications and Additions:

1) A mass balance of water for the Alcove 8/Niche 3 test has been considered, but is not feasible due to the size of the collection system that would be required. A collection system to obtain a mass balance is being developed for the Niche 5 test. (i)
2) Evaporation will be monitored for all tests where evaporation is a relevant process. (ii)
3) Test plans for Niche 5 and the Cross Drift Hydrologic tests are expected to be available to NRC FY 2002. (iii, viii)
4) The Cross Drift seepage predictions will be documented in the Seepage Calibration Model and Seepage Testing Data AMR (MDL-NBS-HS-000004) expected to be available to NRC by FY 2003. (iv)
5) DOE will document the results for the tests identified above (except calcite filling observations) in the In-Situ Field Testing of Processes AMR (ANL-NBS-HS-000005) expected to be available to NRC in FY 2003. (v, vi, vii, ix, x)
6) Results of the calcite filling observations will be documented in Analysis of Geochemical Data for the Unsaturated Zone (ANL-NBS-HS-000017) and the UZ Flow Models and Submodels (MDL-NBS-

HS-000006) expected to be available to NRC FY 2003. (xi)

Subissue #3 - Model Abstraction UZ.Ltr.1.c

Tracking # UZ.Ltr.1.c

Comment Provide the analysis of geochemical and hydrological data (water content, water potential, and temperature) used for support of the flow field below the repository, particularly in the Calico Hills, Prow Pass and Bullfrog hydrostratigraphic layers. Demonstrate that potential bypassing of matrix flow pathways below the area of the proposed repository, as opposed to the entire site-scale model area, is adequately incorporated for performance assessment.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See [response to comment] UZ.2.3.3 above.

Agreement Number TSPAI.3.24

Agreement DOE will provide an analysis of available geochemical and hydrological data (water content, water potential, and temperature) used for support of the flow field below the repository, particularly in the Calico Hills, Prow Pass, and Bullfrog hydrostratigraphic layers. The analyses will demonstrate that potential bypassing of matrix flow pathways below the area of the proposed repository, as opposed to the entire site-scale model area, is adequately incorporated for performance assessment, or provide supporting analyses that the uncertainties are adequately included in the TSPA. These analyses will be documented in the UZ Flow Models and Submodels AMR (MDL-NBS-HS-000006), In-Situ Field Testing of Processes AMR (ANL-NBS-HS-000005), and Calibrated Properties Model AMR (MDL-NBS-HS-000003) expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction UZ.Ltr.1.d

Tracking # UZ.Ltr.1.d

Comment The NRC staff does not believe that the agreement USFIC.5.04 needs to be rewritten; however, it would like to confirm that the effects of water table rise on groundwater flux will be addressed in the two documents cited by DOE for this agreement.

References

DOE Response The effects of water table rise on groundwater flux will be addressed in the Saturated Zone Flow and Transport Process Model Report (CRWMS M&O 2000an) and the Uncertainty Distribution for Stochastic Parameters Analysis/Model Report (CRWMS M&O 2000at) as part of Unsaturated and Saturated Flow under Isothermal Conditions agreement 5.4.

References: (future revisions)

CRWMS M&O 2000an. Saturated Zone Flow and Transport Process Model Report. TDR-NBS-HS-000001 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001102.0067.

CRWMS M&O 2000at. Uncertainty Distribution for Stochastic Parameters. ANL-NBS-MD-000011 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0328.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ.Ltr.3.a

Tracking # UZ.Ltr.3.a

Comment The UZ AMR U0010, Simulation of Net Infiltration for Modern and Potential Future Climates (U.S. Geological Survey, 2000), notes that the simulation results using three synthetic meteorological data sets are averaged for the lower, mean and upper bound estimates of net infiltration. The NRC is interested in obtaining two of the three synthetic meteorological data sets; 4AJ.s01 and Area12.s01.

References U.S. Geological Survey. "Simulation of Net Infiltration for Modern and Potential Future Climates." Las Vegas, Nevada: U.S. Geological Survey. 2000.

DOE Response See [response to comment] UZ1.3.2 above.

Agreement Number

Agreement This comment was discussed under comment UZ1.3.2. DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ.Ltr.3.b

Tracking # UZ.Ltr.3.b

Comment The NRC is interested in how the results of the Passive Cross Drift Hydrologic and Alcove 8 - Niche 3 Cross-over tests were used to validate or modify the values used for the flow focussing factor in the seepage model for performance assessment. In addition, the NRC is interested in the justification for the van Genuchten alpha for fracture continuum, (f) parameter.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See [response to comment] UZ2.3.4 above

Agreement Number

Agreement This comment was discussed under comment UZ2.3.4. DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ.Ltr.3.c

Tracking # UZ.Ltr.3.c

Comment The NRC is interested in additional justification on how fracture continuum properties (i.e., porosity, spacing, aperture) for the unsaturated transport model are calculated and how the active-fracture concept is integrated into these parameter values. The discussion should show that the matrix diffusion and active fracture models are properly integrated.

References CRWMS M&O. "Unsaturated Zone Flow and Transport Model PMR." TDR-NBS-HS-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
CRWMS M&O. "Particle Tracking Model and Abstraction of Transport Processes AMR." ANL-NBS-HS-000026 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See [response to comment] UZ 3.TT.3 above

Agreement Number

Agreement This comment was discussed under comment UZ 3.TT.3. DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction UZ.Ltr.3.d

Tracking # UZ.Ltr.3.d

Comment The NRC is interested in an update to the calibrated unsaturated zone flow model using the most recent matrix saturation and water potential data that suggest the rock mass is wetter than previous core-sample saturation measurements have indicated.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See [response to comment] UZ2.3.5 above

Agreement Number

Agreement This comment was discussed under comment UZ2.3.5. DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction SZ 2.3.1

Tracking # SZ 2.3.1

Comment Calculation of the Kc parameter, used to simulate reversible colloid attachment during SZ transport by lowering the radioelement Kd, involves a term for colloid concentration in the water (CRWMS M&O, 2000a). The concentration adopted-0.03 mg/L-is claimed to be "for conservatism, the highest observed or expected colloid concentration" (CRWMS M&O, 2000b). However, this concentration is well below the maximum values used in release models for waste form (5 mg/L) and iron (hydr)oxide (1 mg/L) colloids derived from the EBS (CRWMS M&O, 2000c).

References CRWMS M&O. "Uncertainty Distribution for Stochastic Parameters." ANL-NBS-MD-000011. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002. Revision 00. Las Vegas, Nevada. 2000b.
CRWMS M&O. "Waste Form Colloid-Associated Concentration Limits: Abstraction and Summary." ANL-WIS-MD-000012. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000c.

DOE Response Measurements of natural colloid concentrations in groundwater are more representative of colloid stability in equilibrium with far-field geochemical conditions than are estimates of colloid concentrations at the waste form.

Sensitivity and uncertainty analyses for the Supplemental Science and Performance Analysis (BSC 2001e) include an evaluation of colloid facilitated transport that considers uncertainty in the colloid concentrations in groundwater. This analysis effectively evaluates the impact of a broader range of values (as high as 0.3 mg/L) for the colloid concentrations on the simulated dose rates in TSPA-Site Recommendation (CRWMS M&O 2000aq).

References: BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, NV: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number TSPAI.3.30

Agreement DOE will provide the technical basis for the contrasting concentrations of colloids available for reversible attachment in the engineered barrier system and the saturated zone. The sensitivity

analyses planned in response to RT Agreement 3.07 will address the effect of colloid concentration on the Kc parameter. The technical basis will be documented in the Waste Form Colloid Associated Concentration Limits: Abstractions and Summary, ANL-WIS-MD-000012, in FY 2003. The Kc parameter will be updated as new data become available from the Yucca Mountain region in the Uncertainty Distribution for Stochastic Parameters AMR, ANL-NBS-MD-000011, in FY2003.

Subissue #3 - Model Abstraction SZ 2.3.2

Tracking # SZ 2.3.2

Comment Five FEPs concerning possible chemical effects on radionuclide transport properties are stated to be included in TSPA to the extent that uncertainty ranges in Kd bound the effects (CRWMS M&O, 2001). These FEPs are:
2.2.08.01.00-Groundwater chemistry/composition in UZ and SZ;
2.2.08.02.00-Radionuclide transport in a carrier plume;
2.2.08.03.00-Geochemical interactions in the geosphere;
2.2.08.06.00-Complexation in the geosphere;
2.2.09.01.00-Microbial activity in geosphere.
The issue common to these five included FEPs is that DOE has not adequately demonstrated that uncertainty distributions bound the possible variations in Kd in the saturated zone below Yucca Mountain (CRWMS M&O, 2000a,b). To support a licensing decision, documentation is necessary to determine how DOE developed the TSPA transport parameter distributions.

References CRWMS M&O. "Features, Events, and Processes in SZ Flow and Transport. ANL-NBS-MD-000002 Revision 01." Las Vegas, Nevada: CRWMS M&O. 2001.
CRWMS M&O. "Uncertainty Distribution for Stochastic Parameters." ANL-NBS-MD-000011 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Unsaturated Zone and Saturated Zone Transport Properties." ANL-NBS-HS-000019 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response Documentation of the justification for uncertainty distributions for radionuclide sorption coefficients will be revised. This comment is addressed in the existing Radionuclide Transport agreements 2.10 and 1.5.

Agreement Number TSPAI.3.31

Agreement DOE will reexamine the FEPs, currently included in the performance assessment, that may lead to temporal changes in saturated zone hydrochemistry. If the DOE determines that these FEPs can be excluded, the results will be documented in the FEP Saturated Zone Flow and Transport AMR, ANL-NBS-MD-000002, in FY 2003. If the DOE determines that these FEPs cannot be excluded from the performance assessment, the DOE will evaluate the effects of temporal changes in the saturated zone chemistry on radionuclide concentrations and will document this evaluation in above mentioned AMR.

Subissue #3 - Model Abstraction SZ 2.4.1

Tracking # SZ 2.4.1

Comment On page 3-174 the transport times for C-14 range from 100 years to greater than 100,000 years. This result appears to be non-physical and brings into question the representation of variability/uncertainty. The proposed dose standard is based on peak of the mean dose.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response There is a misprint in the text of the TSPA-Site Recommendation REV 00 ICN01. The statement should be that transport times for C-14 vary from less than 100 years to greater than 10,000 years among the realizations. These results reflect a relatively large aggregate uncertainty in the transport of C-14 in the saturated zone, but are not "non-physical".

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.3.32

Agreement DOE will provide the technical basis that the representation of uncertainty (i.e., lack-of-knowledge uncertainty) in the saturated zone does not result in an underestimation of risk when propagated to the performance assessment. A deterministic case from Saturated Zone Flow Patterns and Analyses AMR (ANL-NBS-HS-000038) will be compared to TSPA analyses. The comparison will be documented in the TSPA for any potential license application expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction DIRECT 1.1.1

Tracking #	DIRECT 1.1.1
Comment	DOE has not yet assembled the information relating to the potential for volcanic disruption of the waste package needed for a potential license application, and DOE does not yet have a reasonable approach to do so by the time of license application. Available information shows that variations in the amount of HLW disrupted during extrusive and intrusive igneous events can affect significantly the probability-weighted doses to the proposed critical group.
References	CRWMS M&O. "Dike Propagation Near Drifts." ANL-WIS-MD-000015 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2001a. CRWMS M&O. "Igneous Consequence Modeling for the TSPA-SR." ANL-WIS-MD-000017. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2001b.
DOE Response	This item was discussed at the Igneous Activity Technical Exchange, June 21-22, 2001.
Agreement Number	
Agreement	

Subissue #3 - Model Abstraction DIRECT 1.1.2

Tracking #	DIRECT 1.1.2
Comment	While the text was updated to reflect the "backfill" to "no-backfill" design change, the model and analysis were not modified to account for this design change.
References	CRWMS M&O. "Dike Propagation Near Drifts." ANL-WIS-MD-000015. Revision 00 and Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2001.
DOE Response	This item was discussed at the Igneous Activity Technical Exchange, June 21-22, 2001.
Agreement Number	
Agreement	

Subissue #3 - Model Abstraction DIRECT 1.1.3

Tracking # DIRECT 1.1.3

Comment This AMR uses a pre-VA design to estimate thermal loads and implications on rock mechanics and the thermal-mechanical evolution of the stress states (pp. 15-16, Figs. 2 and 3, p. 49). Since these stress states are used to predict a possible redirection of an ascending dike, the implications are risk-significant. A consistent design and thermal load should be used.

References CRWMS M&O. "Dike Propagation Near Drifts." ANL-WIS-MD-000015. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The Analysis/Model Report (CRWMS M&O 2000l) cites previous work, which was based on the pre-Viability Assessment design thermal loads, to provide support for the concept of principal stress rotation. The referenced calculation is used to make the point at issue, which is a change or rotation in the stress conditions during the thermal period. The conceptual finding from the cited work indicate that the rotation of principal stress direction remains valid even for thermal loads that differ from the pre-Viability Assessment design.

The Analysis/Model Report (CRWMS M&O 2000l) uses the findings in a conceptual or qualitative sense in development of a decision tree (Figure 1). One of the decision points is whether a dike is intruding into an ambient or thermally perturbed stress environment. The findings are used quantitatively for the plots presented in Figures 2 and 3 to demonstrate the possible magnitude of the change. The magnitude of the stress rotation, the duration of the thermal period, and the distinction between thermal and non-thermal periods are not further considered within the igneous-related TSPA models. For these reasons, citation of the previous work is consistent with the findings presented in the TSPA-Site Recommendation (CRWMS M&O 2000ar).

If the rotation of stress or drift stress conditions are quantitatively considered in future igneous consequence work, the magnitude and direction of the stress rotation with time will be reconsidered and based on the design and thermal load assumptions consistent with the inputs developed for use in the corresponding TSPA.

References: CRWMS M&O 2000l. Dike Propagation Near Drifts. ANL-WIS-MD-000015 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001213.0061.

CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Subissue #3 - Model Abstraction DIRECT 1.1.3

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DIRECT 1.TT.1

Tracking # DIRECT 1.TT.1

Comment This AMR uses a 600 C drift wall temperature (p. 36) to calculate a sample magma solidification time. What is the basis for this value? Is it dependent on thermal load?

References CRWMS M&O. "Dike Propagation Near Drifts." ANL-WIS-MD-000015. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The drift wall temperature was assumed to be 600 degrees C to be consistent with the conduction calculation for cooling of the pyroclastic material in the previous section of the Analysis/Model Report (CRWMS M&O 2000l, "Pyroclastic Flow"). This calculation indicated the drift wall temperature, based on the thermal power available and conducted away into the rock. The assumed value is also consistent with the available literature as cited and described in Section 5.2 of the Analysis/Model Report. Thermal loading effects from emplaced waste were considered secondary with respect to this assumption.

Note that the calculated duration leads to the bounding assumption for the models that packages in contact with the magma are significantly damaged and provide no further protection. Therefore, changes in the exact value of the wall temperature, unless they were sufficient to reduce the "hot soak" duration to a few hours or days (which is not a credible condition), would not lead to a different assumption.

Reference: CRWMS M&O 2000l. Dike Propagation Near Drifts. ANL-WIS-MD-000015 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001213.0061.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DIRECT 2.2.1

Tracking #	DIRECT 2.2.1
Comment	The TSPA model abstraction for incorporation of waste particles into erupting magma makes use of unsupported assumptions related to the size distribution of particles.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	This item was discussed at the Igneous Activity Technical Exchange, June 21-22, 2001.
Agreement Number	
Agreement	

Subissue #3 - Model Abstraction DIRECT 2.TT.1

Tracking # DIRECT 2.TT.1

Comment The dose pathways for direct release scenario are discussed on p. 3-206 (CRWMS M&O, 2000). Inhalation and ingestion have been considered, but external exposure from contaminated ash on the ground surface was not listed.

DOE should clarify in TSPA-SR whether ground surface exposure was considered.

See DOSE2.TT.3 (identical comment)

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response This item was discussed at the Igneous Activity Technical Exchange, June 21-22, 2001.

Agreement Number

Agreement

Subissue #3 - Model Abstraction DOSE 1.1.1

Tracking # DOSE 1.1.1

Comment Climate change is considered in other model abstractions to assess repository performance, but DOE does not consider the impact of climate change on projected well pumping withdrawals. Climate change could reduce groundwater withdrawals without impacting the lifestyle of the critical group. A wetter, cooler climate could reduce groundwater extraction and therefore reduce the volume of water available for dilution. Reduced dilution could result in an increased effective dose.

References CRWMS M&O. "Analysis Model Report -- Groundwater Usage by the Proposed Farming Community." ANL-NBS-MD-000006. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Saturated Zone Flow and Transport PMR." TDR-NBS-HS-000001. Revision 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response An evaluation has been performed that takes into account the annual estimate of precipitation (during the growing and irrigation season) both at the present and in future climate conditions and uses these data to predict groundwater usage from alfalfa evapotranspiration estimates. The evaluation is documented in Section 13.3.5 in the Supplemental Science and Performance Analysis, Volume 1.

Reference: BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 1.2.1

Tracking # DOSE 1.2.1

Comment The analysis of groundwater usage by the proposed farming community is based on 1990 census data which may not reflect current conditions in the YM region.

References CRWMS M&O. "Analysis Model Report -- Groundwater Usage by the Proposed Farming Community." ANL-NBS-MD-000006. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a. CRWMS M&O. "Saturated Zone Flow and Transport PMR." TDR-NBS-HS-000001. Revision 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The annual groundwater usage distribution cited in the Groundwater Usage Analysis/Model Report (CRWMS M&O 2000w) was based on State published data of land use and irrigation in Amargosa Valley (Attachment II to cited Analysis/Model Report) and not census data. The agricultural groundwater users in Amargosa Valley were used to represent the parent distribution from which the 15 to 25 farms based on the preamble to the proposed 10 CFR 63.

Annual water usage used in the TSPA-Site Recommendation was not based on any census data. The 1990 census data were used in an alternate water usage model based on per population usage rather than per farm usage. The calculations substantiate/support the conservative water usage estimates, but did not use the census data.

Reference: CRWMS M&O 2000w. Groundwater Usage by the Proposed Farming Community. ANL-NBS-MD-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000407.0785.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 1.2.2

Tracking # DOSE 1.2.2

Comment DOE addresses conservatism and identifies those parameters to which its model are sensitive. However, the data used to develop model parameters are limited and appear insufficient. For example, the agricultural water usage data used to support the model are based on one year of data. Although these data represented the most recent data available at the time the analyses were performed, the DOE has not demonstrated that agricultural water usage data for this year are representative of annual water usage in the region. Furthermore, DOE has not presented any basis for the nominal distribution used to select parameter values for their model.

References CRWMS M&O. "Groundwater Usage by the Proposed Farming Community." ANL-NBS-MD-000006. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Saturated Zone Flow and Transport PMR." TDR-NBS-HS-000001. Revision 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The annual groundwater usage was based on a single year of state published data and is therefore subject to some uncertainty due to temporal variation. DOE will consider including the assessment of multiple year data. There is likely to be a high correlation of usage from one year to the next, so it may be difficult to obtain statistically independent annual usage estimates on which to base unbiased estimates.

The annual groundwater usage distribution in the Groundwater Usage Analysis/Model Report (CRWMS M&O 2000w) was based on State published data of land use and irrigation in Amargosa Valley (CRWMS M&O 2000w, Attachment II). The agricultural groundwater users in Amargosa Valley were used to represent the parent distribution from which the 15 to 25 farms based on the preamble to the proposed 10 CFR 63.

Reference: CRWMS M&O 2000w. Groundwater Usage by the Proposed Farming Community. ANL-NBS-MD-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000407.0785.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 1.TT.1

Tracking # DOSE 1.TT.1

Comment Improved transparency required to determine if DCFs are consistently used in TSPA and preclosure calculations. In Section 6.4 of (CRWMS M&O, 2000) it is stated that: "Worst case solubility values, provided as part of the code, representing the most conservative conditions for radionuclides under consideration, were used for this analysis." The comparison was clearly made with the worst case DCFs, but it was unclear if the worst case DCFs are consistent with the DCFs used in the TSPA and preclosure dose calculations.

References CRWMS M&O. "Dose Conversion Factor Analysis: Evaluation of GENII-S Dose Assessment Methods AMR." ANL-MGR-MD-000002. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The dose conversion factors are consistent. The dose conversion factors for some radionuclides are available as a function of solubility class. Because of the possibility of complex chemistry with the attendant difficulties of defining the species as a function of time in the biosphere, the most conservative values for the dose conversion factors were used. In the case of pre-closure releases, there is a possibility that the chemical species of the release are better known. In this case it may be possible to justify the use of smaller and more realistic dose conversion factors.

Reference: CRWMS M&O 1999a. Dose Conversion Factor Analysis: Evaluation of GENII-S Dose Assessment Methods. ANL-MGR-MD-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991207.0215.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 2.1.1

Tracking # DOSE 2.1.1

Comment Scenarios in which high concentrations of radionuclides may be found on the ground surface should include a check to ensure the concentration of radionuclides leaching out of the surface soil does not exceed the solubility limit of the radionuclide.

References CRWMS M&O. "Evaluate Soil/Radionuclide Removal by Erosion and Leaching." ANL-NBS-MD-000009. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response In the case of contaminated groundwater, the TSPA-Site Recommendation predicted radionuclide concentrations calculations in soils even after build-up due to continuing irrigation are many orders of magnitude below solubility limits. This may not be the case for contaminated ash deposition (i.e., significant amounts of relatively insoluble species e.g., oxides may be present). In this scenario, the major pathway is inhalation, primarily arising from resuspension of contaminated ash from locations remote from irrigated areas. For this release scenario, credit for leaching should not be taken.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 2.2.1

Tracking # DOSE 2.2.1

Comment The analysis would be strengthened by the use of site-specific Kd values instead of generic values from Sheppard and Thibault (1990) because these values can vary significantly due to variations in soil pH and other soil characteristics.

References CRWMS M&O. "Evaluate Soil/Radionuclide Removal by Erosion and Leaching." ANL-NBS-MD-000009. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Kd values appropriate for the soil at Amargosa Valley were used. A sensitivity study was performed and documented in Section 13.3.3 in the Supplemental Science and Performance Analysis (BSC 2001e) that evaluated the effect on Biosphere DOSE Conversion Factors of using a distribution of partition coefficients, for several radionuclides identified in the TSPA analyses as important DOSE contributors. The range of Kds was taken from International Atomic Energy Agency Technical Report No. 364 (IAEA 1994). Estimated increases in the mean value of the Biosphere DOSE Conversion Factors distributions, as the result of sampling over the possible variations in the Kd values, were by a factor of 1.4 and 1.3 for iodine and neptunium, respectively, and by a factor of 4.9 for technetium (Table 13.3-9). For the high Kd value Pu has such a protracted build-up time (24,000 years) that the limit is determined by the erosion rate (several hundred years).

References: IAEA 1994. Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments. Technical Report Series No. 364. Vienna, Austria: International Atomic Energy Agency. TIC: 232035

BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

Agreement Number TSPAI.3.33

Agreement DOE will provide justification that the Kd values used for radionuclides in the soil in Amargosa Valley are realistic or conservative for actual conditions at the receptor location. The justification will be provided in Evaluate Soil/Radionuclide Removal by Erosion and Leaching AMR (ANL-NBS-MD-000009) or other document expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction DOSE 2.2.2

Tracking # DOSE 2.2.2

Comment Additional data are needed to support the assumption that the concentration of resuspended particles returns to background values within 10 years of the cessation of an igneous event. This concern is focused on the sustainability of elevated mass loadings over thicker tephra deposits.

References CRWMS M&O. "Input Parameter Values for External and Inhalation Radiation Exposure Analysis." ANL-MGR-MD-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response This item was discussed at the Igneous Activity Technical Exchange meeting (21/22 Jun 01).

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Igneous Activity Technical Exchange, June 21-22, 2001.

Subissue #3 - Model Abstraction DOSE 2.3.1

Tracking # DOSE 2.3.1

Comment The mixing of temporal variability and parameter uncertainty in the development of the mass loading above a tephra deposit is confusing and will only provide correct results if other time-dependent processes do not result in a significant change in the concentration of radionuclides in the soil over the 10-year period over which the temporal averaging is being performed.

References CRWMS M&O. "Input Parameter Values for External and Inhalation Radiation Exposure Analysis." ANL-MGR-MD-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response This item was discussed at the Igneous Activity Technical Exchange meeting (21/22 Jun 01).

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Igneous Activity Technical Exchange, June 21-22, 2001.

Subissue #3 - Model Abstraction DOSE 2.3.2

Tracking # DOSE 2.3.2

Comment Sampling from a loguniform distribution between the nominal mass load representing a thin deposit and the average mass load for a thick deposit assumes that the average mass load over the first 10 years following an event is directly proportional to the thickness of the deposit.

References CRWMS M&O. "Input Parameter Values for External and Inhalation Radiation Exposure Analysis." ANL-MGR-MD-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response This item was discussed at the Igneous Activity Technical Exchange meeting (21/22 Jun 01).

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Igneous Activity Technical Exchange, June 21-22, 2001.

Subissue #3 - Model Abstraction DOSE 2.4.1

Tracking # DOSE 2.4.1

Comment The particle transport model of radionuclide leaching out of the surface soil has not been investigated for its effect on TSPA results.

References CRWMS M&O. "Evaluate Soil/Radionuclide Removal by Erosion and Leaching." ANL-NBS-MD-000009. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The current approach does not include radionuclide removal from soil by colloidal transport. The model uses the partition coefficient (Kd) to quantify radionuclide removal from top soil by leaching from over watering to avoid salt build up that would affect production efficiency. This approach assumes that only soluble contaminants can be removed by leaching. Suspended solids (colloids) are assumed to remain in the soil where they are available for plant uptake and resuspension and subsequent inhalation. The neglect of an additional loss mechanism is conservative.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 2.5.1

Tracking # DOSE 2.5.1

Comment DOE has not provided support to justify that the mass loading model does not underestimate the concentration of radionuclides in the air.

References CRWMS M&O. "Evaluate Soil/Radionuclide Removal by Erosion and Leaching." ANL-NBS-MD-000009. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response This item was discussed at the Igneous Activity Technical Exchange meeting (21/22 Jun 01).

Agreement Number

Agreement Igneous Activity Technical Exchange, June 21-22, 2001.

Subissue #3 - Model Abstraction DOSE 2.TT.1

Tracking # DOSE 2.TT.1

Comment It is not clear whether these long irrigation periods are realistic, since consideration of factors such as build up of salts, plant toxicity levels, and effect of periods of no irrigation are not documented.

References CRWMS M&O. "Abstraction of BDCF Distributions for Irrigation Periods." ANL-NBS-MD-000007. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response As noted in responses to DOSE 3.1.4 and 3.2.6, the prior irrigation periods are used as a calculational tool, to ensure that the equilibrium radionuclide concentration in soil is achieved.

The saturated radionuclide concentration in soil is a conservative approach to calculate dose after mitigation erosion (CRWMS M&O 2001q). The method of derivation of irrigation periods is described in detail in the Nominal Performance Biosphere Dose Conversion Factor Analysis Analysis/Model Report (CRWMS M&O 2001h).

References: CRWMS M&O 2001q. Abstraction of BDCF Distributions for Irrigation Periods. ANL-NBS-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010201.0027.

CRWMS M&O 2001h. Nominal Performance Biosphere DOSE Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 2.TT.2

Tracking # DOSE 2.TT.2

Comment Leaching values for carbon and cesium used in the Disruptive Event Biosphere Dose Conversion Factor AMR (CRWMS M&O, 2000a) are inconsistent with the Evaluate Soil/Radionuclide Removal by Erosion and Leaching AMR (CRWMS M&O, 2000b). The former AMR cites a calculation package instead of the later AMR.

References CRWMS M&O. "Analysis Model Report -- Disruptive Event Biosphere Dose Conversion Factor Analysis." ANL-MGR-MD-000003 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.

CRWMS M&O. "Evaluate Soil/Radionuclide Removal by Erosion and Leaching." ANL-NBS-MD-000009 Revision 00B. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response Disruptive Event Biosphere Dose Conversion Factor Analysis Analysis/Model Report (CRWMS M&O 2000m) used preliminary leaching factors received via input transmittal (DTN SN9912T0512299.001), as noted in Section 4.1 of the report. These values were subsequently revised. Revision 01 of the Disruptive Event Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001n) uses leaching factors documented in the Evaluate Soil/Radionuclide Removal by Erosion and Leaching Analysis/Model Report (CRWMS M&O 2000r).

References: CRWMS M&O 2000m. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000303.0216.

CRWMS M&O 2001n. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

CRWMS M&O 2000r. Evaluate Soil/Radionuclide Removal by Erosion and Leaching. ANL-NBS-MD-000009 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000310.0057.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 2.TT.3

Tracking # DOSE 2.TT.3

Comment The dose pathways for direct release scenario are discussed on p. 3-206 in TSPA-SR (CRWMS M&O, 2000). Inhalation and ingestion have been considered, but external exposure from contaminated ash on the ground surface was not listed. TSPA-SR should clearly state whether ground surface exposure was considered.

Note: Same comment as Direct2.TT.1.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Prior irrigation periods are used as a calculational tool to ensure that the equilibrium radionuclide concentration in soil is achieved. The saturated radionuclide concentration in soil is a conservative approach to calculate dose after mitigation erosion (CRWMS M&O 2001q). The method of derivation of irrigation periods is described in detail in the Nominal Performance Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001h).

External exposure was not considered in the eruption phase dose factors, which are described on page 3-206 (CRWMS M&O 2000ar). These dose factors were not used to calculate doses in the TSPA-Site Recommendation. Instead they were only used in sensitivity studies. Biosphere Dose Conversion Factors for the transition phase used in the TSPA-Site Recommendation analysis for a volcanic eruption included inhalation, ingestion and external exposure.

During the volcanic eruption, only inhalation pathway was considered because for all radionuclides, except 137Cs, external exposure from the ground is insignificant when compared with the inhalation pathway, as can be verified by examining the results of pathway analysis (CRWMS M&O 2001n, Tables 16-20). For the overall external exposure from volcanic eruption, the exposure during the eruption phase (which, on the average, lasts only 8 days) is negligible compared with the exposure during the transition phase. The Biosphere Dose Conversion Factors for the transition phase were calculated for one-year exposure because of the relative duration of these phases. In addition, during the transition phase, 100% of the available activity is already deposited on the ground resulting in the highest external exposure, as opposed to the eruption phase when the deposition is in progress.

The reason that ingestion was included was based on the assumption that the intake of two thirds of the activity (large particles) is through the ingestion pathway. The recent model

considers that the intake of all airborne particles occurs through the inhalation.

Per Igneous Activity 2-15, DOE will clarify that external exposure from high level waste contaminated ash, in addition to inhalation and ingestion was considered in TSPA. DOE will include in the clarification the consideration of external exposure during indoor occupancy times, or provide a basis for dwelling shielding from outdoor gamma emitters in a subsequent revision to the Input Parameter Values for External and Inhalation Radiation Exposure Analysis/Model Report (CRWMS M&O 2000ad) or equivalent document.

References: CRWMS M&O 2001q. Abstraction of BDCF Distributions for Irrigation Periods. ANL-NBS-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010201.0027.

CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

CRWMS M&O 2001n. Disruptive Event Biosphere DOSE Conversion Factor Analysis. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

CRWMS M&O 2000ad. Input Parameter Values for External and Inhalation Radiation Exposure Analysis. ANL-MGR-MD-000001 REV 01 ICN 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001122.0005.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 2.TT.4

Tracking # DOSE 2.TT.4

Comment No reference was provided on p. 3-210 in TSPA-SR (CRWMS M&O, 2000a) to the basis for the assumption that the total suspended particle load is 3 times higher than the mass load.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Input Parameter Values for External and Inhalation Radiation Exposure Analysis AMR." ANL-MGR-MD-000001 Revision 01 ICN 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The assumption is documented in scoping calculation for the Biosphere Dose Conversion Factors. However, this assumption was not used in the recent version, as explained in DIRECT2.TT.1

Reference: CRWMS M&O 2000av. Scoping Calculation for Volcanic Eruption Biosphere Dose Conversion Factors. CAL-MGR-MD-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000809.0358.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.1.1

Tracking # DOSE 3.1.1

Comment The Disruptive Event Biosphere Dose Conversion Factor Analysis AMR (CRWMS M&O, 2000) does not discuss how the analysis of disruptive event BDCFs would be affected by climate change. Climate change was included in the revised FEP analysis only for the nominal case.

References CRWMS M&O. "Disruptive Event Biosphere Dose Conversion Factor Analysis." ANL-MGR-MD-000003 Revision 00. 2000.

DOE Response This item was discussed at the Igneous Activity Technical Exchange meeting (21/22 Jun 01).

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Igneous Activity Technical Exchange, June 21-22, 2001.

Subissue #3 - Model Abstraction DOSE 3.1.2

Tracking # DOSE 3.1.2

Comment In Figure 1 of the Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR (CRWMS M&O, 2000c), the food transfer factors presented for the reasonable representation are not the same as those used in other reports (CRWMS M&O, 2000a; CRWMS M&O, 2000b). Differences up to a factor of 540 were found.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factors, Analysis Model Report." ANL-MGR-MD-000009 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Design Basis Event Frequency and Dose Calculation for Site Recommendation." CAL-WHS-SE-000001 Revision 01. Las Vegas, Nevada: CRWMS M&O. 2000b.
CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR. ANL-MGR-MD-000010 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000c.

DOE Response The difference by a factor of 540 is for carbon, for which an incorrect leaching coefficient was initially developed. This value was used in the Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis (CRWMS M&O 2000aj).

Subsequently, the leaching coefficients were revised, which resulted in the change of the value for carbon and other radionuclides. The later reports (e.g., Non-Disruptive Event Biosphere Dose Conversion Factors, Analysis Model Report [CRWMS M&O 2000ai]) used the corrected values, hence the difference.

References: CRWMS M&O 2000aj. Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis. ANL-MGR-MD-000010 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000420.0074.

CRWMS M&O 2000ai. Non-Disruptive Event Biosphere Dose Conversion Factors. ANL-MGR-MD-000009 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000307.0383.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.1.3

Tracking # DOSE 3.1.3

Comment In the Inventory Abstraction AMR (CRWMS M&O, 2000b), the screening arguments for exclusion of a couple of radionuclides in the human intrusion analyses were insufficient.

Example 1:
Insufficient basis was provided to exclude 241Pu. To account for human intrusion as early as 100 yr after the placement of waste, 137Cs, 90Sr, and 63Ni were added to the radionuclides considered for the nominal TSPA-SR analysis. For 10-yr-old, average-pressurized water reactor SNF after 100 yr in the repository (i.e., a total decay time of 110 yr), 137Cs and 90Sr account for the majority of the activity. Although 241Pu can be present in SNF with more activity than the included 63Ni, 241Pu was excluded from the human intrusion scenario.

Example 2:
Insufficient basis was provided to exclude 151Sm. For longer times (~500-1,000 yr), the inventories of 151Sm and 63Ni become more important and their activities remain nearly equal. The inhalation DCF for 151Sm is more than two orders of magnitude larger than for 63Ni, and the ingestion DCF for 151Sm is only slightly less (less than a factor of 1.5 smaller) than that for 63Ni (U.S. Environmental Protection Agency, 1988). Because the inventories of 63Ni and 151Sm tend to be similar during a 1,000-yr period, there appears to be insufficient basis provided to screen out 151Sm and yet consider 63Ni for the human intrusion scenario.

Example 3:
Insufficient basis was provided to exclude the long-lived radionuclide 59Ni. Even for a hypothetical human intrusion event at 100 yr after repository closure, the technical bases for radionuclide screening must be valid for much longer times, associated with the radionuclide travel times to the critical group.

References

CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.

CRWMS M&O. "Inventory Abstraction AMR." ANL-WIS-MD-000006 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

U.S. Environmental Protection Agency. "Limiting Values of Radionuclide Intake And Air Concentration and Dose Conversion Factors for Inhalation, Submersion, And Ingestion. Federal Guidance Report 11." EPA-520/1-88-020. Washington, DC: EPA. 1988.

DOE Response The NRC claims insufficient basis for screening 241Pu, 151Sm,

and 59Ni. For 241Pu and 151Sm, the NRC points out that these radioisotopes are potentially more important than 63Ni, which was screened in. However, 63Ni was only mistakenly included in the first iteration of the Inventory Abstraction Analysis/Model Report (CRWMS M&O 2000ae). In ICN 01, 63Ni was correctly screened out (CRWMS M&O 2000bs). Hence, 63Ni cannot be used to argue that other radioisotopes with potentially larger Biosphere DOSE Conversion Factors should be included as well.

The Inventory Abstraction Analysis/Model Report, will be revised to take into account NRC's critique in the Container Life and Source Term IRSR Rev. 3 (NRC 2001); for example, screening factors that account for biological transport will be used for screening radioisotopes in future revisions of the Analysis/Model Report. With this and other modifications, perhaps 241Pu, 151Sm, and 59Ni will be found to be important; however, if past analysis can be used as a guide, 241Pu, 151Sm, and 59Ni were included in TSPA-93 and TSPA-95 (Leigh and Rechard 2001) and found to be unimportant.

References: CRWMS M&O 2000ae. Inventory Abstraction. ANL-WIS-MD-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000414.0643.

CRWMS M&O 2000bs. Inventory Abstraction. ANL-WIS-MD-000006 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001130.0002.

BSC 2001i. Inventory Abstraction. ANL-WIS-MD-000006 REV 00 ICN 02. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010416.0088.

NRC 2001. Issue Resolution Status Report Key Technical Issue: Container Life and Source Term. Rev. 3. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: MOL.20010418.0048.

Leigh, C. and Rechard, R.P.. "Radioisotope Inventory for TSPA-SR", Proceedings of the 9th International High-Level Radioactive Waste Management Conference (IHLRWM), April 29-May 3, 2001, Alexis Park Resort, Las Vegas, Nevada. La Grange, Illinois: American Nuclear Society. ACC: MOL.20010313.0012.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.1.4

Tracking # DOSE 3.1.4

Comment The prior irrigation times contained within the referenced document (CRWMS M&O, 1999) were inconsistent with those used in the Non-Disruptive Event Biosphere Dose Conversion Factors AMR. For both the reasonable and bounding representations, the Input Request for Biosphere Dose Conversion Factors (BDCFs) to be Used in the TSPA-SR listed prior irrigation times for elements (Cs, Ni, Sr, and Mo) not contained within the AMR, and the AMR analyzed elements (Am, Ac, and Th) not contained within the referenced document. For those elements contained within both documents, the prior irrigation times for the reasonable representation did not agree for Pu-240, and the prior irrigation times for the bounding representation did not agree for C-14, U-232, Pu-238, Pu-239, and Pu-240.

References Review of: Non-Disruptive Event Biosphere Dose Conversion Factors AMR (ANL-MGR-MD-000009 Revision 00)
CRWMS M&O. 1999. Input Request for Biosphere Dose Conversion Factors (BDCFs) to be Used in the TSPA-SR (Input Tracking Number PA-R&E-99251.R, ACC: MOL.19990819.0070.

DOE Response The prior irrigation times from the Dose Conversion Factors used in the TSPA-Site Recommendation input transmittal were calculated based on leaching coefficients only, while those used in the Non-Disruptive Event Biosphere Dose Conversion Factors Analysis/Model Report (CRWMS M&O 2000ai) included radionuclide decay.

Although prior irrigation periods are not site nor receptor specific inputs, they are parametric tools used in the Biosphere Dose Conversion Factor abstraction to incorporate soil removal by erosion (with a characteristic time of a few hundred years). The final Biosphere Dose Conversion Factor abstraction does not depend on which specific irrigation periods were used, as long as the trend in the Biosphere Dose Conversion Factor behavior with the duration of the prior irrigation can be observed. Therefore, the lack of agreement pointed out by the reviewer has no effect on the Biosphere Dose Conversion Factor values.

The revised Section 6.3.2 in the Nominal Performance Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001h) addresses the derivation of the prior irrigation periods.

References: CRWMS M&O 2000ai. Non-Disruptive Event Biosphere Dose Conversion Factors. ANL-MGR-MD-000009 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000307.0383.

CRWMS M&O 2001q. Abstraction of BDCF Distributions for Irrigation Periods. ANL-NBS-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010201.0027.

CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

CRWMS M&O 1999d. Input Request for Biosphere Dose Conversion Factors (BDCFs) to be Used in the Total System Performance Assessment for Site Recommendation. Input Request PA-R&E-99251.R. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990819.0070.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.1.5

Tracking # DOSE 3.1.5

Comment In the example pathway contribution for Am-243 on page II-8 of the Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR (CRWMS M&O, 2000; Figure 3 of Attachment II) were substantially different to those for Am-243 contained in the Attachment I compact disc file, /Ndesden_5/Pathway/Ndepat_6.xls.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR." ANL-MGR-MD-000010 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The purpose of the example presented in Attachment II (CRWMS M&O 2000aj) was to show the mechanics of the pathway calculations using a spreadsheet routine. This specific example used the data from Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis (CRWMS M&O 2000bt), hence the difference. Although DOE agrees that the data from the report in question could have been used, the purpose of the attachment was not compromised by using some other numerical values.

References: CRWMS M&O 2000aj. Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis. ANL-MGR-MD-000010 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000420.0074.

CRWMS M&O 2000bt. Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis. ANL-MGR-MD-000004 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000418.0826.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.2.1

Tracking # DOSE 3.2.1

Comment DOE selection criteria for parameters includes selection based on the appearance of a parameter in more than half of the documents reviewed. DOE interprets this to represent consensus among the scientific community that the parameter is the best available data. This selection criteria is subject to manipulation and/or bias based on the initial selection and number of reviewed reports. The approach has no technical basis when the reason for frequent selection/use by the referenced reports is not known or provided.

References CRWMS M&O. " Environmental Transport Analysis." ANL-MGR-MD-000007 Revision 00. Las Vegas, Nevada: CRWMS M&O. 1999a.

CRWMS M&O. "Transfer Coefficient Analysis." ANL-MGR-MD-000008 Revision 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. 1999b.

DOE Response The selection criteria include several items, not just one "more than half" as indicated in the comments. Due to lack of site-specific data, generic data were used. All data were initially selected to be applicable to the Yucca Mountain biosphere model. The cited data were all from reputable sources, including NRC Guidance (Regulatory Guide, and NUREG/CR), National Labs' reports (Oak Ridge, PNL, Sandia, Argonne, and EPRI), and international sources (IAEA and AECL). The documents provide the comprehensive reviews of related parameters and/or completed radiation DOSE assessment. To refine the initially selected data, the selection criteria were created and used.

The bases for parameter selections were included in the referenced documents. Because the parameter values were selected using compilations of data produced by reputable organizations, the original technical reports were not evaluated from the perspective of their technical merits. Instead, data selection was invoked based on the premise that the technical evaluation had been performed by the data compilers. Where possible, the parameter values were selected such that they were applicable to the environmental conditions at Yucca Mountain region, such as the soil type and pH. If such specific values were unavailable, generic ones were used.

References: CRWMS M&O 1999b. Environmental Transport Parameters Analysis. ANL-MGR-MD-000007 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991115.0238.

CRWMS M&O 1999e. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000413.0692.

Subissue #3 - Model Abstraction DOSE 3.2.1

Agreement Number TSPAI.3.34

Agreement For the radionuclides that dominate the TSPA dose, DOE will provide the technical basis for selection of radionuclide or element specific biosphere parameters (except for Kds which are addressed in TSPAI 3.33) that are important in the BDCF calculations (e.g. soil to plant transfer factors). The technical basis will be documented in the Transfer Coefficient Analysis AMR (ANL-MGR-MD-000008) or other document and is expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction DOSE 3.2.2

Tracking # DOSE 3.2.2

Comment Rationale for not using site specific studies for transfer coefficients that data have not been collected and is expensive/time consuming appears to ignore EPA research on the Nevada Test Site and possibility to show relevance of the few important coefficients using available information.

References CRWMS M&O. "Transfer Coefficient Analysis." ANL-MGR-MD-000008 Revision 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. 1999.

DOE Response The Environmental Protection Agency research on the Nevada Test Site was not available to the author when the report was written. Procedurally, cited literature must be publicly available, as these documents may be in the public reading room. However, the applicability of the research will be reviewed in future and will be documented in a subsequent revision of the Analysis Model Report -- Transfer Coefficient Analysis (CRWMS MYO 1999e).

Reference: CRWMS M&O 1999e. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000413.0692.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.2.3

Tracking # DOSE 3.2.3

Comment The AMR Transfer Coefficient Analysis (CRWMS M&O, 1999a) incorrectly states an NRC contractor report reflects the NRC position. Example: Justification for use of GENII-S code inappropriately includes CNWRA use. The depth and types of analyses conducted to prepare for review of a license application (e.g., CNWRA use) are different than what may be required to support a license application.

References CRWMS M&O. "Transfer Coefficient Analysis." ANL-MGR-MD-000008 Revision 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. 1999a.
CRWMS M&O. "Environmental Transport Analysis." ANL-MGR-MD-000007 Revision 00. Las Vegas, Nevada: CRWMS M&O. 1999b.

DOE Response The incorrect statements have been removed from the latest revisions to these documents, and will not be used in the future.

References: CRWMS M&O 2000bu. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001016.0005.

CRWMS M&O 2001r. Environmental Transport Parameter Analysis. ANL-MGR-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010208.0001.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.2.4

Tracking # DOSE 3.2.4

Comment The selected value for inhalation exposure time is based on average value for U. S. citizens age 18 to 64. No rationale is provided for excluding adults over age 64. It also appears possible that the average member of a farming community would spend more time outdoors than the average American.

References CRWMS M&O. "Input Parameter Values for External and Inhalation Radiation Exposure Analysis." ANL-MGR-MD-000001. Las Vegas, Nevada: CRWMS M&O. 1999.

DOE Response Inhalation exposure time was based primarily on the assumed occupation (farming) of the critical group members. Their work-related inhalation exposure time amounted to 2000 - 3,120 hours per year and was unrelated to age. The recreational component of the inhalation exposure time (827 hours per year) was based on the results of a nation-wide survey for adults 18-64 years old. Recreational exposure time for people older than 64 years is about 3% higher than that for those in the 18-64 years age bracket. Considering that people 18-64 years old account for 61.8 % of the US population, while people older than 64 years old constitute 12.7% of the population (KiplingersForecasts.com), inclusion of people over 64 would only result in the 0.6% increase in the recreational exposure time. Considering that the recreational exposure time accounts for less than 25% of the total time spent outdoors, the effect of including recreational exposure time of people over 64 years old would result in a negligible increase (about 0.04%) in the mean inhalation exposure time for the critical group.

The critical group is composed of farmers, who because of the nature of their work, spend more time outdoors (CRWMS M&O 2000ad, Sections 6.2 and 6.4) than an average American and more than the average Amargosa Valley resident.

Reference: CRWMS M&O 2000ad. Input Parameter Values for External and Inhalation Radiation Exposure Analysis. ANL-MGR-MD-000001 REV 01 ICN 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001122.0005.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.2.5

Tracking # DOSE 3.2.5

Comment Applicability of beryllium data for determination of crop interception fraction for all radionuclides was not sufficiently discussed in the Identification of Ingestion Exposure Parameters AMR (CRWMS M&O, 2000a). Although based on beryllium, a single distribution for the crop interception fraction would be applied for all radionuclides. The analysis included a comparison between the interception fractions of iodine and beryllium, but further justification is needed to ensure that the interception fractions for beryllium will not likely be exceeded for other radionuclides. The crop interception fraction has been shown to be a significant parameter for most of the radionuclides considered in the sensitivity analyses for non-disruptive events (CRWMS M&O. 2000b).

References CRWMS M&O. " Identification of Ingestion Exposure Parameters AMR." ANL-MGR-MD-000006 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O."Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis." ANL-MGR-MD-000010 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The crop interception fraction was derived based on a series of studies done by the Hoffman et al. The experiment was conducted using two radionuclides, Be-7 and I-131. However, the type of radionuclide used in this study, was less significant than the ionization of the atoms. In this study beryllium was in form of cations (positive ions, +2) while iodine was in form of anions (negative ions, -1).

The study established the empirical equation to estimate the crop interception fraction, which depends on crop type, crop yield, irrigation methods, irrigation rate, and the type of ions present in the water. The study showed that interception is higher for cations than anions, due to the mainly negative charge on leaf surface.

Most radionuclides in groundwater form various complexes and their molecules are either positively (cations) or negatively (anions) charged. Because of the negative charge on the leaves, the interception fraction for the negative beryllium ion is assumed to serve as a conservative estimate of the interception fraction for other radionuclides of interest. In addition, small molecules, like those of beryllium, will tend to stick better to leaf surfaces than large molecules, such as NpO_2^+.

References: Hoffman, F.O.; Frank, M.L.; Blaylock, B.G.; von Bernuth, R.D.; Deming, E.J.; Graham, R.V.; Mohrbacher, D.A.; and Waters, A.E. 1989. Pasture Grass Interception and Retention of

(131) I, (7)BE, and Insoluble Microspheres Deposited in Rain. ORNL-6542. Oak Ridge, Tennessee: Oak Ridge National Laboratory. TIC: 237241.

Hoffman, F.O.; Thiessen, K.M.; and Rael, R.M. 1995. "Comparison of Interception and Initial Retention of Wet-Deposited Contaminants on Leaves of Different Vegetation Types." Atmospheric Environment, 29, (15), 1771-1775. New York, New York: Pergamon Press. TIC: 243593.

Hoffman, F.O.; Thiessen, K.M.; Frank, M.L.; and Blaylock, B.G. 1992. "Quantification of the Interception and Initial Retention of Radioactive Contaminants Deposited on Pasture Grass by Simulated Rain." Atmospheric Environment, 26A, (18), 3313-3321. New York, New York: Pergamon Press. TIC: 243594.

Agreement Number TSPAI.3.35

Agreement DOE will provide additional justification to support that the assumed crop interception fraction is appropriate for all radionuclides that dominate the TSPA dose and does not result in underestimations of dose. The justification will include the impacts of electrostatic charge and particle size on the interception fraction. This justification will be documented in Identification of Ingestion Exposure Parameters (ANL-MGR-MD-000006) or other document expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction DOSE 3.2.6

Tracking # DOSE 3.2.6

Comment While other parameters are assigned distributions that are sampled or fixed values, the prior irrigation time parameter has been grouped into six periods in the Non-Disruptive Event Biosphere Dose Conversion Factors AMR. For a given period (except for period 1 where a prior irrigation time of 0 yr was assigned for all radionuclides), different values of prior irrigation time were assigned to individual radionuclides.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factors AMR." ANL-MGR-MD-000009 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response As noted in the DOSE 3.1.4 response, the prior irrigation time periods are used as a calculational tool to determine the equilibrium Biosphere Dose Conversion Factor values (CRWMS M&O 2001q; CRWMS M&O 2001s). The exact numerical value is not required as long as they cover most of the period during which activity in soil builds up until the equilibrium conditions (steady-state) are reached. The time periods necessary for the equilibrium in soil to be achieved are different for different radionuclides. It is about a single year for mobile radionuclides such as technetium-99, and on the order of thousands of years, for the isotopes of thorium, if soil erosion is not considered. In the build-up analysis (CRWMS M&O 2001q) erosion has been considered.

Section 6.3.2 of the Nominal Performance Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001h) addresses the derivation of the prior irrigation periods.

References: CRWMS M&O 2001q. Abstraction of BDCF Distributions for Irrigation Periods. ANL-NBS-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010201.0027.

CRWMS M&O 2001s. Distribution Fitting to the Stochastic BDCF Data. ANL-NBS-MD-000008 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010221.0148.

CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.2.7

Tracking # DOSE 3.2.7

Comment The Non-Disruptive Event Biosphere Dose Conversion Factors AMR (CRWMS M&O, 2000a) provides the supporting data for the Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR (CRWMS M&O, 2000b). However, the Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR included two radionuclides, 90Sr and 137Cs, which were not included in the Non-Disruptive Event Biosphere Dose Conversion Factors AMR.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factors AMR." ANL-MGR-MD-000009 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis AMR." ANL-MGR-MD-000010 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The two radionuclides cited were identified too late to be included in the referenced Analysis/Model Report. REV 00 of the Analysis/Model Report (CRWMS M&O 2000ai) concerned the nominal scenario, while the two additional radionuclides were considered for human intrusion. The Biosphere Dose Conversion Factors were generated in a calculation but were available for the sensitivity study as documented in the Non-Disruptive Event Biosphere DOSE Conversion Factor Sensitivity Analysis Analysis/Model Report (CRWMS M&O 2000aj).

These two relatively short-lived radionuclides were added after the Non-Disruptive Event Biosphere DOSE Conversion Factors Analysis/Model Report (CRWMS M&O 2000ai) was completed. Calculation of the Biosphere Dose Conversion Factors for 90Sr and 137Cs is documented in the calculation report (CRWMS M&O 2000bv). The Non-Disruptive Event Biosphere DOSE Conversion Factor Sensitivity Analysis Analysis/Model Report (CRWMS M&O 2000aj) applies the Biosphere Dose Conversion Factors developed in both reports.

References: CRWMS M&O 2000aj. Non-Disruptive Event Biosphere Dose Conversion Factor Sensitivity Analysis. ANL-MGR-MD-000010 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000420.0074.

CRWMS M&O 2000ai. Non-Disruptive Event Biosphere Dose Conversion Factors. ANL-MGR-MD-000009 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000307.0383.

CRWMS M&O 2000bv. Biosphere Dose Conversion Factors for Reasonably Maximally Exposed Individual and Average Member of

Critical Group. CAL-MGR-MD-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000306.0251.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.3.1

Tracking # DOSE 3.3.1

Comment Uncertainty in Soil leaching factors supplied to GENII-S code is accounted for by running a reasonable case (probabilistic) and a bounding case (deterministic). The AMR is unclear as to how the uncertainty is accounted for in the TSPA modeling to fully account for data uncertainty.

References CRWMS M&O. "Disruptive Event Biosphere Dose Conversion Factor Analysis." ANL-MGR-MD-000003 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Uncertainty in soil leaching has not been accounted for in the TSPA-Site Recommendation analyses. Additional evaluation of the uncertainty resulting from using a fixed value of leaching coefficient is presented in Section 13.3.4 in the Supplemental Science and Performance Analysis, Vol.1 (BSC 2001e).

The bounding case was not used as compounded conservatism assumptions provided unrealistically large Biosphere Dose Conversion Factors. Volume 1 contains a sensitivity study of this parametric uncertainty in leaching. GENII-S cannot sample from the leaching parameter. A more integrated model that will allow stochastic sampling from the available Kd distributions is being proposed for any potential License Application.

Reference: BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

Agreement Number TSPAI.3.36

Agreement DOE will document the methodology used to incorporate the uncertainty in soil leaching factors into the TSPA analysis. This will be documented in Nominal Performance Biosphere Dose Conversion Factor Analysis AMR (ANL-MGR-MD-000009), Disruptive Event Biosphere Dose Conversion Factor Analysis (ANL-MGR-MD-000003) or other document expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction DOSE 3.4.1

Tracking # DOSE 3.4.1

Comment The approach used to propagate uncertainty in BDCFs for the biosphere abstraction in the TSPA SR model introduces unnatural correlation (e.g.,samples from radionuclie-specific BDCF distributions are correlated to the Np-237 BDCF distribution and no justification for this approach is provided). Biosphere factors that influence the magnitude of BDCFs vary by radionuclide and the justification for the selected approach is not self evident. Failure to maintain vectors from initial GENII-S BDCF modeling leads to inconsistencies in sampled biosphere/critical group parameters across radionuclides when resampling in TSPA SR model.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000002. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000aq. (p. 439).

DOE Response GENII-S is unable to consider the correlation between the equivalent parameters for multiple radionuclides. It also cannot track the results of such correlation.

Most of the time, there is only one dominant radionuclide in which case correlation has no effect. For the limited time where there are two or more radionuclides contributing to dose, the Biosphere Dose Conversion Factor correlation is assumed to be unity (Rn#1 to Np to Rn#2). A distribution of dose with the correct mean value is obtained. The distribution is wider than it would have been if the correlation had been less than unity.

Agreement Number TSPAI.3.37

Agreement DOE will provide a quantitative analysis that the sampling method including the correlations between BDCFs utilized by the TSPA code to abstract the GENII-S process model data adequately represent the uncertainty and variability and correlations for the biosphere process model. This will be documented in Nominal Performance Biosphere Dose Conversion Factor Analysis AMR, ANL-MGR-MD-000009, Disruptive Event Biosphere Dose Conversion Factor Analysis, ANL-MGR-MD-000003, or other document expected to be available to NRC in FY 2003. Results of these analyses will be documented in the TSPA for any potential license application expected to be available to NRC in FY 2003.

Subissue #3 - Model Abstraction DOSE 3.5.1

Tracking # DOSE 3.5.1

Comment It is unclear how DOE will show that GENII-S is a valid model for the Yucca Mountain system.The AMR includes a comprehensive description of other AMRs that rely on the GENII-S code and also identifies AMRs that provided input to the validation analysis. The validation of GENII-S focuses on investigation the bases for the conceptual model and verifying that the mathematical model is performing as intended, but no discussion is provided of the scientific bases for the mathematical model.

References CRWMS M&O. " Abstraction of BDCF Distributions for Irrigation Periods." ANL-NBS-MD-000007. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

CRWMS M&O. "Evaluation of the Applicability of Biosphere Related Features, Events, and Processes." ANL-MGR-MD-00001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Biosphere model validation is presented as attachments to Disruptive Event Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001n) and Nominal Performance Biosphere DOSE Conversion Factor Analysis (CRWMS M&O 2001h). Additional model validation is in progress in accordance with the model validation corrective action report.

References: CRWMS M&O 2001n. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

CRWMS M&O 2001h. Nominal Performance Biosphere DOSE Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.1

Tracking # DOSE 3.TT.1

Comment The AMR references supporting AMRs. The AMR does not identify where generated data will be used, but does indicate that the output will be used to develop BDCFs.

References CRWMS M&O. "Identification of the Critical Group (Consumption of Locally Produced Food and Tap Water)". ANL-MGR-MD-000005. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Procedurally, Analysis/Model Reports must cite the source of all data used. The Data Tracking Number of the data generated is identified. Any user requiring the data generated can get the data from the Technical Data Management System by the Data Tracking Number.

Regarding the biosphere modeling, the Biosphere Process Model Report (CRWMS M&O 2000bw) described relationship between the Analysis/Model Reports contributing to the final output of the model. Note that the Process Model Report shows the interrelationship of input and outputs of applicable Analysis/Model Reports.

Reference: CRWMS M&O 2000bw. Biosphere Process Model Report. TDR-MGR-MD-000002 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000620.0341.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.2

Tracking # DOSE 3.TT.2

Comment More references should be made to other documents that contain related analyses. Irrigation with contaminated ground water is the only deposition process considered in this AMR. The ingestion analyses within this AMR did not include root uptake. Neither deposition from airborne releases nor effluents from preclosure operations nor ash deposition and remobilization were addressed in this AMR. It would be helpful if the appropriate documents that account for these processes and factors be referenced within this AMR. In addition, it appears that food washing and crop retention fraction after food washing has not been sufficiently discussed in this AMR.

References CRWMS M&O. "Identification of Ingestion Exposure Parameters." ANL-MGR-MD-000006. Revision 00. Las Vegas, Nevada: CRWMS M&O 2000.

DOE Response The Identification of Ingestion Exposure Parameters Analysis/Model Report has a very limited scope. This Analysis/Model Report is one of many that develop input parameters for the biosphere model implementing code, GENII-S. It does not, in itself document any analyses of radionuclide transport to plants. Parameters for the root uptake were developed in another model input, Transfer Coefficient Analysis. Input parameters related to retention fraction for various crops are documented in another the Environmental Transport Analysis. The model uses many different parameters, which are documented in several input Analysis/Model Reports.

Food processing, which results in removal of radionuclides from edible parts of crops, was not included in the biosphere model. This is a conservative approach. GENII-S does not allow the user to include food processing.

Biosphere Process Model Report (CRWMS M&O 2000bw) explains the relationship between and scope of work for each Analysis/Model Report.

Deposition of radionuclides from the preclosure operations is outside the scope of the postclosure analysis.

The issues of ash deposition and remobilization were addressed at the Igneous Activity Technical Exchange 21/22 June 2001.

References: CRWMS M&O 2000bw. Biosphere Process Model Report. TDR-MGR-MD-000002 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000620.0341.

CRWMS M&O 2000y. Identification of Ingestion Exposure Parameters. ANL-MGR-MD-000006 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000216.0104.

CRWMS M&O 2000bu. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001016.0005.

CRWMS M&O 2001r. Environmental Transport Parameter Analysis. ANL-MGR-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010208.0001.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.3

Tracking # DOSE 3.TT.3

Comment This AMR concludes with a summary tabulation consisting of BDCFs for each radionuclide and prior irrigation time, but it is unclear how the information from the six prior irrigation periods will be used in the total system performance analyses.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factors." ANL-MGR-MD-000009. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Information developed in the Non-Disruptive Event Biosphere Dose Conversion Factors Analysis/Model Report (CRWMS M&O 2000ai) was not used directly in the TSPA. The Biosphere Dose Conversion Factors used in TSPA are documented in the Distribution Fitting to the Stochastic BDCF Data (CRWMS M&O 2001s) and the Abstraction of BDCF Distributions for Irrigation Periods (CRWMS M&O 2001q).

References: CRWMS M&O 2000ai. Non-Disruptive Event Biosphere Dose Conversion Factors. ANL-MGR-MD-000009 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000307.0383.

CRWMS M&O 2001s. Distribution Fitting to the Stochastic BDCF Data. ANL-NBS-MD-000008 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010221.0148.

CRWMS M&O 2001q. Abstraction of BDCF Distributions for Irrigation Periods. ANL-NBS-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010201.0027.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.4

Tracking # DOSE 3.TT.4

Comment Improvements should be made in the documentation of data acquisition and traceability.

References CRWMS M&O. "Abstraction of BDCF Distributions for Irrigation Periods." ANL-NBS-MD-000007. Revision 00. 2000.

DOE Response Biosphere Process Model Report (CRWMS M&O 2000bw) explains the relationship between Analysis/Model Reports, and scope of work for each Analysis/Model Report in which a well-defined analysis or model is presented. It is redundant to explain them in each individual supporting Analysis/Model Report.

Reference: CRWMS M&O 2000bw. Biosphere Process Model Report. TDR-MGR-MD-000002 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000620.0341.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.5

Tracking # DOSE 3.TT.5

Comment The AMR states that no assumptions were used for the analysis, yet numerous assumptions, implicit or otherwise, are made throughout the report. Some example assumptions include: (i) that parameter value selections made from literature sources or GENII-S default values are appropriate for the Yucca Mountain region, (ii) that fraction of roots in upper soil is one, and (iii) that 1/2 of forage is stored and 1/2 of forage is fresh for beef and dairy cattle consumption.

References CRWMS M&O. "Environmental Transport Analysis." ANL-MGR-MD-000007. Las Vegas, Nevada: CRWMS M&O. 1999.

DOE Response In a subsequent revision of the Analysis/Model Report, Environmental Transport Analysis, DOE will ensure that all major assumptions are listed in the Assumption section In addition, DOE will cite where the assumptions are documented and used.

Reference: CRWMS M&O 1999b. Environmental Transport Parameters Analysis. ANL-MGR-MD-000007 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991115.0238.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.6

Tracking # DOSE 3.TT.6

Comment AMR is unclear how soil to plant transfer factors were combined when a food group value was needed yet the source data applied to a number of specific crops (e.g., arithmetic or geometric mean etc). AMR is also unclear how it was determined which plants were most likely to be planted in a farmers garden. The AMR states fish is not an important pathway w/ no justification or reference to support.

References CRWMS M&O. "Transfer Coefficient Analysis." ANL-MGR-MD-000008. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 1999.

DOE Response The initially selected transfer coefficients were based on the reputable sources, including NRC Guidance (Regulatory Guide, and NUREG/CR), National Lab's reports (Oak Ridge, PNL, Sandia, Argonne, and EPRI), and international sources (IAEA and AECL).

The documents provide the comprehensive reviews of related parameters and/or completed radiation dose assessment.

There were no specific crops for each group data, and no specific information on crop grown in the farmer garden.

The process of the transfer factor selection, and grouping is documented in Transfer Coefficient Analysis (CRWMS M&O 1999e, 2000bu).

Ingestion of fish was included in REV 01 of the Nominal Performance Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001h) and it turned out to be a significant pathway for carbon-14.

References: CRWMS M&O 1999e. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000413.0692.

CRWMS M&O 2000bu. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001016.0005.

CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and

Subissue #3 - Model Abstraction DOSE 3.TT.6

Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.7

Tracking # DOSE 3.TT.7

Comment AMR ambiguously defines conservatism as "...a value that would lead to a higher dose."

References CRWMS M&O. "Transfer Coefficient Analysis." ANL-MGR-MD-000008. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 1999.

DOE Response The Analysis/Model Report definition of conservatism will be clarified in the next.

Reference: CRWMS M&O 1999e. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000413.0692.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.8

Tracking # DOSE 3.TT.8

Comment Some areas in this AMR were unclear.
Example 1: The AMR is unclear on how "period of prior irrigation" values were derived for the analysis. The AMR states that the parameters were based on the soil leaching factor and half life but provides no additional information. No explanation is provided why this parameter varies by radionuclide.
Example 2: The AMR includes an assumption that model, mathematical model, numerical solution, and computer model uncertainty is negligible and cites a code validation exercise in another AMR (Non-disruptive Event BDCF) as the basis. The cited AMR does not contain the referenced model validation analysis results nor provides any indication on where to find it.

References CRWMS M&O. "Distribution Fitting to the Stochastic BDCF Data." ANL-NBS-MD-000008. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response For Example 1 in cited the Analysis/Model Report (CRWMS M&O 2000n), these values are simply input data. The Analysis/Model Report Rev 01 (CRWMS M&O 2001h) documenting Biosphere Dose Conversion Factor generation, discusses this period selection. The prior irrigation time was calculated in Biosphere Dose Conversion Factor Analysis/Model Report (CRWMS M&O 2000ai). The data provided as input for each radionuclide consisted of a set of 150 stochastic realization. The distribution of the data was assumed to capture uncertainties in the data generation process.

The Nominal Performance Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2001h, Section 6.3.2) addresses the derivation of the prior irrigation periods.

For Example 2, biosphere model validation is presented as attachments to ANL-MGR-MD-000003 Rev 01 and ANL-MGR-MD-000009 Rev 01. Additional model validation is in progress. Code validation is an ongoing activity, and status of the validation activity was reported in the Analysis/Model Report.

References: CRWMS M&O 2000n. Distribution Fitting to the Stochastic BDCF Data. ANL-NBS-MD-000008 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000517.0258; MOL.20000601.0753.

CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

CRWMS M&O 2000ai. Non-Disruptive Event Biosphere Dose Conversion Factors. ANL-MGR-MD-000009 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000307.0383.

CRWMS M&O 2001n. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.9

Tracking # DOSE 3.TT.9

Comment Transfer factors used in the AMR (Table 3) do not match values in the cited source report (Analysis Model Report -- Transfer Coefficient Analysis, ANL-MGR-MD-000008 REV 00).

References CRWMS M&O. "Disruptive Event Biosphere Dose Conversion Factor Analysis." ANL-MGR-MD-000003. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response It was verified that transfer factors used in the Disruptive Event Biosphere Dose Conversion Factor Analysis (CRWMS M&O 2000m) match the values in Rev 00 of the Transfer Coefficient Analysis (CRWMS M&O 1999g).

Transfer factors used in Table 3 of the Analysis/Model Report (CRWMS M&O 2000m) are the same as the source report (CRWMS M&O 1999g) and were changed when the document was updated. Updated data was used in the Analysis Model Report, Disruptive Event Biosphere DOSE Conversion Factor Analysis. (CRWMS M&O 2001n).

References: CRWMS M&O 2000m. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000303.0216.

CRWMS M&O 1999g. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991115.0237.

CRWMS M&O 1999e. Transfer Coefficient Analysis. ANL-MGR-MD-000008 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000413.0692.

CRWMS M&O 2001n. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.10

Tracking # DOSE 3.TT.10

Comment 1) In section 6.12.(5), Radionuclides Present, discusses the dependency of interception fraction on the particle charge (e.g., for cations and anions), but it was unclear how this information was included in the analysis.
2) It appears that the determination of yield and growing time for hay and forage are inconsistent. The estimated effective yield for hay and forage was based on alfalfa and "other hay" production, while the growing time for hay and forage was based only on alfalfa. An explanation for why this approach was taken should be added.
3) The basis for applying a single distribution to the crop irrigation time for all of the leafy vegetables should be enhanced.

References CRWMS M&O. "Identification of Ingestion Exposure Parameters." ANL-MGR-MD-000006. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response For comment No. 1, please see response to DOSE 3.2.5.

Regarding comment No. 2, the discrepancy has been corrected in REV 01 of the Nominal Performance Biosphere DOSE Conversion Factor Analysis (CRWMS M&O 2001h, Attachment III).

Regarding comment No. 3, it is not possible in GENII-S to use more than one distribution for the crop irrigation time for leafy vegetables.

A subsequent revision of the Analysis/Model Report will directly address the NRC comments.

Reference: CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.11

Tracking # DOSE 3.TT.11

Comment The AMR contains a table of input parameters for BDCF calculations. This is a very useful table, however, it uses data tracking numbers rather than AMRs to link to source data. A link to AMRs would facilitate NRC review since we could easily locate the reports where the parameters are discussed. The present AMR approach has segmented the BDCF input into a large number of separate AMRs which increases difficulty/time to find the bases for specific parameter values.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factors." ANL-MGR-MD-000009. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Revision 01 of this report (CRWMS M&O 2001h, Table 1) links input data to individual Analysis/Model Reports. Procedurally, input data refer to Reference Information Base item or Data Tracking Number, instead of Analysis/Model Report. The cross-link could be found from Reference Information Base item or Data Tracking Number.

Reference: CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.12

Tracking # DOSE 3.TT.12

Comment The selected value for soil exposure time is based on the assumption the individual is not exposed when indoors. This is true for many radionuclides due to shielding provided by the house. However, this is not true for high energy gamma emitters (the only radionuclides where direct exposure is significant pathway). This is particularly true for the direct release scenario where the house would be surrounded by deposited ash. Staff were unable to locate the argument for exclusion of this exposure pathway.

References CRWMS M&O. " Input Parameter Values for External and Inhalation Radiation Exposure Analysis." ANL-MGR-MD-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 1999.

DOE Response This item was discussed at the Igneous Activity Technical Exchange, June 21-22, 2001. The parameter value has been updated in the revision of AMR (CRWMS M&O 2000ad). External exposure was not considered in indoors in a direct way. Most radionuclides considered in the postclosure assessment are not strong gamma emitters, therefore do not contribute significantly to the exposure indoors. Strong gamma emitters like cesium-137 are relatively short lived and will not contribute to the dose at times greater than a few hundred years.

In addition, for groundwater release scenario, external exposure during the period of time spent outdoors was calculated using home (lawn) irrigation rate of, on the average, 74 inches, which is about twice the average irrigation rate for the crops. This results in the higher radionuclide concentration in the lawn soil than that for agricultural land, and, consequently, higher external exposure. This approach is conservative, because the receptor does not spend all of his outdoor time on the lawn, and more than compensates for not considering external exposure while indoors.

Reference: CRWMS M&O 2000ad. Input Parameter Values for External and Inhalation Radiation Exposure Analysis. ANL-MGR-MD-000001 REV 01 ICN 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001122.0005.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Igneous Activity Technical Exchange, June 21-22, 2001.

Subissue #3 - Model Abstraction DOSE 3.TT.13

Tracking # DOSE 3.TT.13

Comment In addition to the data sets, the corresponding AMRs that include discussions of the parameter value selections should be referenced within the Non-Disruptive Event Biosphere Dose Conversion Factors AMR. For example, the animal product consumption rates for the Reasonable Representation and Bounding calculations were presented in Tables 1 and 2, respectively, with their data sources. However, no connection was made from the data sources to the AMRs that provide the justification for the parameter value selection.

References CRWMS M&O. "Non-Disruptive Event Biosphere Dose Conversion Factors." ANL-MGR-MD-000009. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Revision 01 of this report (CRWMS M&O 2001h, Table 1) links input data to individual Analysis/Model Reports. Procedurally, input data refer to Reference Information Base item or Data Tracking Number, instead of Analysis/Model Report. The cross-link could be found from Reference Information Base item or Data Tracking Number. Revision 1 considers only the reasonable representation cases.

Reference: CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction TSPA001

Tracking # TSPA001

Comment There are a number of positive examples in the documentation related to transparency and traceability. However, there are some areas that need improvement. In particular, there are numerous examples where the discussion in a summary section or an individual abstraction section is inconsistent with other sections or the actual TSPA-model. In particular, there are contradictory statements about the role of environmental variables in the corrosion models. The summation of the inconsistencies makes it difficult for the reviewers to identify what is being done in some parts of the TSPA-model. Two specific areas where transparency and traceability were lacking were (1) the abstraction of colloid modeling and (2) The use of WAPDEG in modeling the failure of the engineered barrier system.

See list of examples that follow (labeled TSPA001.Ex1, etc.) for details.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response DOE agrees that improvement on transparency and traceability of the documents can be made. Activities to improve transparency and traceability include:

a. Update review procedures with emphasis on vertical slice, e.g., by chapter and between documents to improve consistency.

b. Improve/update the documents as mentioned in the specific examples noted by the NRC

c. Conduct vertical slice review for consistency. (currently ongoing)

d. Develop additional transparency tools, such as
- flow chart of model
- data source flow to model
- additional graphics

e. Provide for additional reviews
- International Peer Review Panel
- internal review teams
- technical editors

DOE also will revisit the (1) the abstraction of colloid modeling and (2) the use of Waste Package Degradation Model in modeling the failure of the engineered barrier system.

The following TSPA examples are categorized as follows:

CAT 1. Clarification required primarily in terms of rewording text. Limited additional work required.

CAT 2. Clarification and additional analysis required. Additional analyses or plots required to fully clarify the point.

CAT 3. Not the scope of the document. Some of the comments ask for more than the model document is intended to serve. For example, additional TSPA analyses in the model document that indicates the significance of the component to long term DOSE. These should be referred to the other documents.

CAT 4. Not used.

CAT 5. Correction required to the text.

CAT 6. Provide abstraction defensibility of the abstraction utilized.

CAT 7. No change required. Suggestions for transparency/traceability may not require any changes.

CAT 8. NRC points out a few instances where we have obtained transparency, or provided abstraction defensibility.

Agreement Number

Agreement DOE general response addressing transparency and traceability during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction TSPA001.Ex1

Tracking # TSPA001.Ex1

Comment Page 3-93: The level of detail provided about the coupling of the in-package chemistry model to the degradation rates is excellent. This allows the reviewer to understand what was done.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response No response required (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex2

Tracking # TSPA001.Ex2

Comment Page 2-20: "The Alloy-22 layer degrades only in the presence of liquid water, i.e. when water drips directly on the waste package." If this statement were correct, then only 13% of the waste packages should fail in the TSPA-SR model.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will correct the text. (CAT 5, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex3

Tracking # TSPA001.Ex3

Comment Page 2-20: There is a lengthy discussion of items that can cause variability in the corrosion rates. Later in the document (pages 3-82, 4-7, 5-12), it is stated that the degradation rates are insensitive to environmental conditions except when relative humidity increases above a threshold value. A clarification of which statements are accurate is needed and the inaccurate statements removed. If the environmental parameters influence the general corrosion rates, it would be useful to provide plots to illustrate the effects.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will correct the text. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex4

Tracking # TSPA001.Ex4

Comment Page F2-20: The figure shows temperature, RH, drip/no-drip, and chemical conditions supplying input to the waste package degradation model. Based on the later descriptions, only temperature/RH are used and they only define the initial conditions. A clarification is needed.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the inputs to the Figure. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex5

Tracking #	TSPA001.Ex5
Comment	Page 3-34: The water travel time for the fraction of flow that occurs in faults would be a useful addition to the results.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	No change is required. (CAT 7, see DOE Response to TSPA001)
Agreement Number	
Agreement	See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex6

Tracking # TSPA001.Ex6

Comment Page 3-43: "The environments are important to the potential repository performance to the extent that they help determine degradation rates of the engineered barrier components ..." This statement does not appear to describe the corrosion model abstraction accurately.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response It is agreed that the corrosion model abstractions do not have degradation rates that depend on environmental conditions. It should be noted that the general corrosion initiation criteria is based on the temperature-dependent deliquescence points of an assumed always present surface layer of a sodium nitrate salt film. The localized corrosion initiation criteria are based on in-drift chemical conditions (the pH). The general corrosion rates used are derived from weight-loss measurements in several solutions with compositions that are considered bounding. The chemical modeling done in support of TSPA provides some of the basis for the assumption that the solution compositions used is bounding. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex7

Tracking #	TSPA001.Ex7
Comment	Page 3-65: From the paragraph at the top of the page, it is difficult to tell what is in the model and what is not in the model.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	DOE will clarify the text. (CAT 1, see DOE Response to TSPA001)
Agreement Number	
Agreement	See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex8

Tracking # TSPA001.Ex8

Comment Page 3-66, 3.3.4.2.2: "Knowledge of water compositions on the drip shield is required to predict drip shield corrosion." While in theory this is correct, the current drip shield corrosion values are abstracted independently of chemistry.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex9

Tracking # TSPA001.Ex9

Comment Page 1-46: "Use engineered components to tailor the environmental variables (i.e., temperature, relative humidity, seepage flux to be as benign as possible." This is a good concept but it is unclear how it has been done. If the drift spacing is called an engineered component then maybe this would be true, but typically engineered components are referring to waste packages, drip shields, tunnel support, etc.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex10

Tracking # TSPA001.Ex10

Comment Page 3-84: The reader would benefit from identification of the fraction of cracks that start and then stop.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response In the Waste Degradation Model, once stress corrosion cracking initiates cracks continue to grow to failure. No cracks start and then stop in the Waste Degradation Model. The statement quoted refers to a general description of the slip-dissolution model. (CAT 2, see DOE Response to TSPA001)

Reference: CRWMS M&O 2000az. WAPDEG Analysis of Waste Package and Drip Shield Degradation. ANL-EBS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001208.0063.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex11

Tracking #	TSPA001.Ex11
Comment	Page 350: The flux-splitting algorithm was not used for the drip-shield as implied in the documentation.
References	CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	DOE will clarify the text. (CAT 1, see DOE Response to TSPA001)
Agreement Number	
Agreement	See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex12

Tracking # TSPA001.Ex12

Comment Page 3-100: The term "coupling" is used at the bottom of 3.5.2 to mean linkage or something else. Coupling implies a more complex solution than what is done.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text by changing "coupling" to "linkage". (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex13

Tracking # TSPA001.Ex13

Comment Page 3-101: A comparison of the output values generated with the stochastic model, such as water flux into the failed containers, with the values selected to develop the conceptual model (3.5.2.1), would be useful to help judge the adequacy of the approach.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The comparison between assumed flux based on TSPA-Viability Assessment and values calculated in TSPA-Site Recommendation was performed. The much lower range of flux values calculated in TSPA-Site Recommendation into the waste package where used in the second iteration of the TSPA-Site Recommendation. See In-Package Chemistry for Waste Forms (BSC 2001g) for more discussion on flux values. (CAT 2, see DOE Response to TSPA001)

References: DOE (U.S. Department of Energy) 1998. Total System Performance Assessment. Volume 3 of Viability Assessment of a Repository at Yucca Mountain. DOE/RW-0508. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19981007.0030.

BSC 2001g. In-Package Chemistry for Waste Forms. ANL-EBS-MD-000056 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010322.0490.

CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex14

Tracking # TSPA001.Ex14

Comment Page 3-104, Third paragraph: The discussion is very good and an appropriate amount of detail is put here. However, more information showing the comparison would be very useful to the reader.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE believes the text provided is sufficient for this report since this report is not intended to fully justify the models used. Rather the Analysis/Model Reports provide this justification. DOE plans to provide more figures comparing the model with data in the Analysis/Model Reports which should provide adequate support for the statements. (CAT 2, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex15

Tracking # TSPA001.Ex15

Comment Page 3-81: The last sentence of the second paragraph under 3.4.1.1 implies that in-package chemistry is an input to the waste package degradation model. Considering that WAPDEG is run up front it is unclear how this is done. It is also unclear what information is passed to TSPA.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex16

Tracking # TSPA001.Ex16

Comment Page 198: The top paragraph is misleading. It implies that chemistry information at 400 locations is abstracted when in fact little chemistry information is abstracted to the corrosion models.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex17

Tracking # TSPA001.Ex17

Comment Page 40,Table 4: This is a good table for the reader but it also may be a source of confusion as to what is used/important in the TSPA-SR model and what is simply a capability of the TSPA-SR model but is never really activated (chemistry and waste package/drip shield corrosion).

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify Table 4-1 (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex18

Tracking # TSPA001.Ex18

Comment Page 104: Figure 6-21 is somewhat misleading because WAPDEG is run up front and only passes information to GoldSim, so it should be in the first group of codes.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify Figure 6-21 (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex19

Tracking # TSPA001.Ex19

Comment Page 109: It is unclear if any strongly sorbing radionuclides were modeled through the saturated zone and how they would contribute to very long time DOSEs.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The Analysis/Model Report (CRWMS M&O 2000at, Section 6.10) discusses the sorption coefficients that are modeled in the saturated zone site scale model. Analysis/Model Report (CRWMS M&O 2000bx) discusses the simulated radionuclide mass breakthrough curves, Section 6.3.2. (CAT 3, see DOE Response to TSPA001)

References: CRWMS M&O 2000at. Uncertainty Distribution for Stochastic Parameters. ANL-NBS-MD-000011 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0328.

CRWMS M&O 2000bx. Input and Results of the Base Case Saturated Zone Flow and Transport Model for TSPA. ANL-NBS-HS-000030 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0330.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex20

Tracking # TSPA001.Ex20

Comment Page 113: It would be helpful if each of the items described as key attributes to the repository system could be better quantified in terms of their significance to risk. In order for the NRC to perform a risk-informed review, it is necessary to have a clear and convincing identification of those components that are risk-significant.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Analyses quantifying the contribution of particular attributes to overall risk have not yet been conducted. We believe that it is not part of the scope of Total-System Performance Assessment Model for the Site Recommendation. (CAT 3, see DOE Response to TSPA001)

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex21

Tracking # TSPA001.Ex21

Comment Page 128: It would be useful to prepare a plot of the release rate of the gap and bulk-fuel radionuclides versus the flow-focusing factor for all realizations to determine if the maximum risk occurs at an intermediate value.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response This evaluation has not yet been conducted; however, it will be considered for the future work. The measure of risk is the mean annual DOSE. In the current calculational model, sensitivity of the mean annual DOSE to the flow focusing factor could be evaluated in a straightforward way. (CAT 3, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex22

Tracking # TSPA001.Ex22

Comment Page 555: The arrows for the curves in Figure 6-245 and 6-247 are backwards.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will correct the Figures. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex23

Tracking # TSPA001.Ex23

Comment Page 183: A statement to the effect that "[t]he resulting pH and concentration of dissolved solids are key parameters in determining the waste package and drip shield..." does not accurately reflect how the corrosion model is actually implemented in TSPA. The pH values are used only to examine whether or not localized corrosion occurs, which is never the case. Please clarify this statement.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the statement. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex24

Tracking # TSPA001.Ex24

Comment Page 1-32: It is stated that the iterative process of performance assessment reduces uncertainty in the forecasted performance of the potential repository. A historical comparison of past performance assessments would be useful to support this assertion.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The treatment of uncertainty in earlier assessments is not the same as the treatment today. For example, initial performance assessments (TSPA-91 and TSPA-93) were deterministic. Therefore, a comparison of quantified uncertainties has not been performed. (CAT 2, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex25

Tracking # TSPA001.Ex25

Comment Page 237: Talks about 1600 different histories for thermodynamic variables (temperature, RH, etc.), which is different from what is mentioned elsewhere.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Per NRC Clarification, this comment does not need to be addressed.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex26

Tracking # TSPA001.Ex26

Comment Page 250: We understand the need for an overview, but the current one is misleading. Many factors are listed, but only some of them are actually connected to one another (e.g. chemistry variables).

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex27

Tracking # TSPA001.Ex27

Comment Page 252: "The actual waste package corrosion rate is randomly sampled from the range bounded by these high and low values." This statement implies that there is a dependence of waste package corrosion rate on pH. We are not aware that the data demonstrate this conclusion. Maybe just a language clarification needed.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex28

Tracking # TSPA001.Ex28

Comment Page 4-8: An excellent discussion of how things are working is provided on this page.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response No response required (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex29

Tracking # TSPA001.Ex29

Comment Page 406: It would be useful to show a plot comparing the results for the three-dimensional model to those for the pipe model. This information would help give NRC assurance that the models were operating correctly.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Analysis/Model Report (CRWMS M&O 2000bx) Figure 25 compares results from the 3-D and 1-D models (CAT 2, see DOE Response to TSPA001)

Reference: CRWMS M&O 2000bx. Input and Results of the Base Case Saturated Zone Flow and Transport Model for TSPA. ANL-NBS-HS-000030 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0330.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex30

Tracking # TSPA001.Ex30

Comment Page II-21: Equations II-2a, II-2b, II-4, and II-5 are all incorrect in the document.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will correct the text. (CAT 5, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex31

Tracking # TSPA001.Ex31

Comment Page 148. The paragraph should clearly identify that the near-field environment outputs are being used by other models. As currently stated, there is a discrepancy with other statements made about model implementation.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response It is agreed that the corrosion model abstractions do not have degradation rates that depend on environmental conditions. It should be noted that the general corrosion initiation criteria is based on the temperature-dependent deliquescence points of an assumed always present surface layer of a sodium nitrate salt film. The localized corrosion initiation criteria are based on in-drift chemical conditions (the pH). The general corrosion rates used are derived from weight-loss measurements in several solutions with compositions that are considered bounding. The chemical modeling done in support of TSPA provides some of the bases for the assumption that the solution compositions used are bounding.

In addition, chemical conditions are used in GoldSim to calculate upper caps on radionuclide concentrations in the invert. Wording can be clarified in revisions to document. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex32

Tracking # TSPA001.Ex32

Comment Page 3-123, second paragraph under 3.5.5.4: The explanation for why 237Np solubility does not appear to have a significant influence on the uncertainty of the DOSE needs further clarification.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The importance of a parameter is primarily a function of the range of uncertainty of the parameter. While the overall potential variation is greater for TSPA-Site Recommendation than used before, this potential variation of 237Np solubility is a combination of the range that occurs in commercial spent nuclear fuel and codisposed packages and the range before and after 1000 yr after breach of the packages. (See Figure 2. in Y. Chen and R.P. Rechard). The DOSE in the TSPA-Site Recommendation is dominated by the 237Np released from the commercial spent nuclear fuel 1000 years after breach of the package. This particular range in uncertainty of 237Np is much narrower than the range used for TSPA-95 and TSPA-Viability Assessment. Hence, the importance of 237Np is less in TSPA-Site Recommendation. (CAT 2, see DOE Response to TSPA001)

Note: DOE has not "settled" on the "best" uncertainty to use for 237Np. For the PA work accomplished to support the Supplemental Science and Performance Analysis, the uncertainty for 237Np solubility was again greatly increased.

Reference: Chen, Y. and Rechard, R.P. 2001. "Dissolved Concentration Component of Waste Form Degradation Model in TSPA-SR." Proceedings of the 2001 International High-Level Radioactive Waste Management Conference, April 29 -May 3, 2001, Las Vegas, Nevada. La Grange, IL: American Nuclear Society.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex33

Tracking #	TSPA001.Ex33
Comment	Page 4-40: The second paragraph provides a qualitative example that corrosion doesn't depend at all on water.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	Per NRC Clarification, this comment does not require a response.
Agreement Number	
Agreement	See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex34

Tracking # TSPA001.Ex34

Comment Page 5-11: The last statement on the page is inaccurate or inconsistent with the description of flux-splitting provided earlier in the document.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex35

Tracking # TSPA001.Ex35

Comment Page F5-12 (Figure 5.1-12): It would be useful to present a plot of the probability density function of the dissolution rate for commercial spent nuclear fuel along with this figure. This would clarify why dissolution rate was identified as a sensitive parameter.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will add a probability distribution function plot to the figure. (CAT 2, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex36

Tracking # TSPA001.Ex36

Comment Pages EF-5 and following: Many of these figures have puzzling connections that need to be explained, such as the connection of General Corrosion and Localized Corrosion of the Waste Package Outer Barrier to the AMR for Environments on the Surfaces of those engineered systems. Without identification of the information passed, transparency and traceability is more hindered than improved.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the Figures. (CAT 1, see DOE Response to TSPA001)

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA001.Ex37

Tracking # TSPA001.Ex37

Comment Page 3-173: The presentation of curves using median values may be misleading for overall system performance. The stochastic behavior of the saturated zone should be represented in order to appropriately risk-inform. Probability density functions of travel times for important radionuclides developed considering the full stochastic behavior of the saturated zone would be appropriate.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Analysis/Model Report (CRWMS M&O 2000bx) presents simulated unit breakthrough curves from 100 stochastic realizations, for the radionuclides considered, Figures 12 - 19. (CAT 2, see DOE Response to TSPA001)

Reference: CRWMS M&O 2000bx. Input and Results of the Base Case Saturated Zone Flow and Transport Model for TSPA. ANL-NBS-HS-000030 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0330.

Agreement Number

Agreement See Agreement statement under TSPA001.

Subissue #3 - Model Abstraction TSPA002

Tracking # TSPA002

Comment An appropriately rigorous methodology has not been utilized for model abstraction simplifications and selection of "conservative" parameter distributions, conceptual models, or modeling approaches.

In addition to integration of various abstractions into the TSPA, DOE needs an integrated and consistent approach in other areas of the performance assessment. The system-model, or even individual abstractions, rapidly become too complex. Human intuition cannot be relied on to make accurate decisions consistently.

For complex, nonlinear models embodied into the TSPA, it may be impossible to determine the effect of a parameter a priori. Because of the interactions at the system-level, some intermediate outputs may have a maximum impact on risk for some intermediate value rather than at its bounds. For example, if ionic strength affected both colloid stability and cladding corrosion, it is possible that minimizing ionic strength in order to maximize colloid stability may not result in maximizing risk (due to lessor cladding corrosion).

See list of examples that follow (labeled TSPA002.EX1, etc.) for details.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS- PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response Several activities will support improvement in this area. Additional documentation and training will be provided
a. Systematize/characterize abstraction process.
b. Systematize/characterize selection of conservatism in components.
c. Provide more guidance for abstractions in procedures, such as in AP3.10Q.

DOE will evaluate and define approaches to deal with:
a. Evaluating non-linear models as to what is their most conservative settings
b. Dealing with the "complexity" issue in the TSPA model
c. Including some "basis" slides from the Analysis/Model Reports as Appendix.

Subissue #3 - Model Abstraction TSPA002

The following TSPA examples are categorized as follows:

CAT 1. Clarification required primarily in terms of rewording text. Limited additional work required.

CAT 2. Clarification and additional analysis required. Additional analyses or plots required to fully clarify the point.

CAT 3. Not the scope of the document. Some of the comments ask for more than the model document is intended to serve. For example, additional TSPA analyses in the model document that indicates the significance of the component to long term DOSE. These should be referred to the other documents.

CAT 4. Not used.

CAT 5. Correction required to the text.

CAT 6. Provide abstraction defensibility of the abstraction utilized.

CAT 7. No change required. Suggestions for transparency/traceability may not require any changes.

CAT 8. NRC points out a few instances where we have obtained transparency, or provided abstraction defensibility.

Agreement Number TSPAI.3.38

Agreement DOE will develop written guidance in the model abstraction process for model developers so that (1) the abstraction process, (2) the selection of conservatism in components, and (3) representation of uncertainty, are systematic across the TSPA model. These guidelines will address: (1) evaluation of non-linear models when conservatism is being utilized to address uncertainty, and (2) utilization of decisions based on technical judgement in a complex system. These guidelines will be developed, implemented, and be made available to the NRC in FY 2002.

Subissue #3 - Model Abstraction TSPA002.Ex1

Tracking # TSPA002.Ex1

Comment Page 3-57: It is unclear that the neglect of the dry-out effect is conservative with respect to near-field chemistry or temperatures.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Dryout (by ventilation) during the preclosure period is neglected. This ultimately results in lower near-field/engineered barrier system temperatures since the thermal conductivity in the rock is effectively the wet thermal conductivity (higher than dry), thus resulting in higher heat transfer rates away from the repository horizon. It is true that neglecting dryout may or may not result in a conservative condition for temperature. However, it can be argued that this effect on final DOSE, either conservative or nonconservative, does not matter. Two cases can be considered.

In the case of lower early time temperatures being adverse to DOSE, this is the current method of calculation and, if it occurs, this influence would be captured within the limitations of modeling assumptions and/or conceptual model usage (particularly associated with the corrosion models).

In the case of higher early time temperatures, it can be argued that high early time temperatures have been applied in the current analysis. It is noted that the much higher rock temperatures associated with full power heating (e.g., initial postclosure period) and rock dryout did not adversely affect the corrosion models. Therefore, even if preclosure ventilation host rock dryout would have been included (and hence caused engineered barrier system/near-field temperatures to be higher due to a lower host rock thermal conductivity), it is unlikely that the (higher) temperatures during this short time period (50 years) would be any greater than those being used immediately after repository closure. The high temperatures immediately after closure don't adversely affect the corrosion models (and hence DOSE). Therefore, an assumed condition of lower temperatures for the first 50 years does not impact DOSE.

More moisture left in the model is expected to result in earlier appearance of water with dissolved constituents on engineered barrier system materials such as the drip shield or waste, resulting in potential for earlier radionuclide release. (CAT 2, see DOE Response to TSPA002)

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA002.Ex2

Tracking # TSPA002.Ex2

Comment Page 5-32: Using the 5th or 95th values might not capture the highest DOSE or sensitivity, because for some processes the worst case might be somewhere in the middle of the distribution rather than at its bounds.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The use of 5th and 95th percentile values in the one-off sensitivity analysis implicitly assumes a monotonic relationship between the uncertain input and the model output. For most processes, this is indeed the case, i.e., the worst outcome can be traced to extreme values of the underlying parameters. As part of the screening for the one-off analyses, the TSPA-Site Recommendation analysts examined the nature of the input-output relationship. When it was felt that extreme behavior may not be reflected by 5th and 95th percentile parameter values (e.g., solubility of secondary mineral phases), alternative conceptual/parametric models were used to stress the system. Such analyses have been documented in Section 5.2 of the TSPA-Site Recommendation report. (CAT 2, see DOE Response to TSPA002)

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA002.Ex3

Tracking # TSPA002.Ex3

Comment Page 3-86: It is unclear that DOE considered combined effects such as chemistry+radiolysis+coupled electrochemical processes when evaluating whether a process can cause a shift in potential large enough to initiate localized corrosion.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA002)

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA002.Ex4

Tracking # TSPA002.Ex4

Comment Page 3-59: It is unclear that forcing seepage is conservative with respect to near-field chemistry or temperatures.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Earlier appearance of water in the drift, although all effects are less clear in this case.

There is currently not a direct process-level link between emplacement drift seepage and predicted engineered barrier system temperatures. The multiscale thermo-hydrological process-level model treats the emplacement drift as a capillary barrier that does not allow seepage moisture to enter the drift during the simulation. Some preliminary studies have been performed using selected submodels of the multiscale thermo-hydrological model to determine the influence of seepage water on the in-drift temperatures and relative humilities. (CAT 2, see DOE Response to TSPA002)

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA002.Ex5

Tracking # TSPA002.Ex5

Comment Page 1-5: DOE stated that some abstractions have very little detail eliminated, while others are simplified greatly. NRC staff were unable to determine where guidance is provided to project staff to ensure a consistent approach is taken for the abstraction process (much simplification vs. little). The criteria to be applied to determine the amount of simplification are likely subjective.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA002)

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA002.Ex6

Tracking # TSPA002.Ex6

Comment Page 251: It is unclear how a "conservative" abstraction is selected when the chemistry model outputs can impact so many system components.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response For degradation of cladding, commercial spent nuclear fuel. High level waste, solubility, and colloids generation are all greater at low pH values; (only colloid solubility decreases as pH decreases). Hence, for the time period where pH was low, a bounding low value was chosen. (CAT 2, see DOE Response to TSPA002)

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA002.Ex7

Tracking # TSPA002.Ex7

Comment Page 3-60: It is unclear that setting preclosure RH artificially high is conservative with respect to near-field chemistry or temperatures.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response High relative humidity promotes earlier appearance of water with dissolved constituents on engineered barrier system materials such as the drip shield or waste, resulting in potential for earlier radionuclide release.

Since rock dryout during preclosure is not included in the models, the in-drift relative humidity is made artificially high during the 50 year preclosure period. Temperatures and relative humidity are dynamically calculated by the multiscale thermo-hydrological model. Therefore, if moisture removal would have been modeled during the preclosure period, the resultant temperatures would be higher (see above), relative humidity lower. However, an assumed high relative humidity (results from not removing moisture during preclosure) during this 50 year period was deemed to be a more conservative response for potential corrosion since it requires higher relative humidity values to initiate. (CAT 2, see DOE Response to TSPA002)

Agreement Number TSPAI.3.38

Agreement See Agreement statement under TSPA002.

Subissue #3 - Model Abstraction TSPA003

Tracking # TSPA003

Comment Inadequate basis is provided for the simplifications utilized for some model abstractions.

We recognize that it is intractable to represent all of the spatial and temporal uncertainty and variability, as well as conceptual model uncertainty in the overall TSPA-model. The abstraction process is typically a simplification of process-model results into a form that represents an appropriate amount of uncertainty/variability, while allowing a computationally efficient solution.

A number of instances have been identified where inadequate justification has been provided for the amount of information retained by the abstraction. In particular, DOE needs to justify the simplifications used with consideration of all affected subsystems or models. The risk-significance of the models or subsystems will determine the degree of support needed for the simplifications.

See list of examples that follow (labeled TSPA003.EX1, etc.) for details.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response As NRC has recognized, it is intractable to represent all of the spatial and temporal uncertainty and variability, as well as conceptual model uncertainty in the overall TSPA-model. DOE acknowledges the comment. We believe that adequate technical basis has been provided for the simplification utilized for model abstractions. Please see our responses to all of the specific examples identified by NRC as inadequate justification.

In TSPA-License Application, documentation of the simplifications will be updated per TSPA002 activities. The justification will be provided to show that the simplification appropriately represents the necessary processes. The following TSPA examples are categorized as follows:

CAT 1. Clarification required primarily in terms of rewording text. Limited additional work required.

CAT 2. Clarification and additional analysis required. Additional analyses or plots required to fully clarify the point.

CAT 3. Not the scope of the document. Some of the comments ask for more than the model document is intended to serve. For example, additional TSPA analyses in the model document that indicates the significance of the component to long term DOSE. These should be referred to the other documents.

CAT 4. Not used.

CAT 5. Correction required to the text.

CAT 6. Provide abstraction defensibility of the abstraction utilized.

CAT 7. No change required. Suggestions for transparency/traceability may not require any changes.

CAT 8. NRC points out a few instances where we have obtained transparency, or provided abstraction defensibility.

Agreement Number TSPAI.3.38

Agreement DOE will document the simplifications utilized for abstractions per TSPAI.3.38 activities for all future performance assessments. Justification will be provided to show that the simplifications appropriately represent the necessary processes and appropriately propagate process model uncertainties. Comparisons of output from process models to performance assessment abstractions will be provided, with the level of detail in the comparisons commensurate with any reduction in propagated uncertainty and the risk significance of the model. The documentation of the information will be provided in abstraction AMRs in FY 2003.

Subissue #3 - Model Abstraction TSPA003.Ex1

Tracking #	TSPA003.Ex1
Comment	Pages 167: It is unclear whether inputs for the thermo-hydro-chemical model came from the TSPA or from the process model.
References	CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	DOE will clarify the text. (CAT 1, see DOE Response to TSPA003)
Agreement Number	TSPAI.3.39
Agreement	See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex2

Tracking # TSPA003.Ex2

Comment Page 360: Because of the strong dependence of diffusivity in the invert on liquid saturation, you should provide the technical basis that it is appropriate to represent the invert as one mixing cell and to not consider heterogeneities in the engineered materials.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The representation of the invert as one mixing cell is a reasonable simplification for two reasons. First, the saturation in the invert is essentially uniform, as explained below, so there is no need to represent this heterogeneity. Second, a one cell representation for the invert provides a conservative calculation of diffusive transport through the invert in comparison to multiple cells through the invert.

An analysis was performed with the NUFT computer code to evaluate the saturation gradients in the invert during the recent evaluation of unquantified uncertainties for the Nuclear Waste Technical Review Board. The new analysis is documented in Section 10.3.3.3.3 of Volume I of the Supplemental Science and Performance Analysis (BSC 2001e). This analysis considers a low-temperature operating mode for the latest engineered barrier system design. The grid for the simulation is finer than that used for typical calculations with the multiscale thermal-hydrologic model in order to provide more resolution in the invert. The NUFT calculation predicts essentially constant saturation in the invert underneath the drip shield, demonstrating that the saturation beneath the waste package is essentially constant (uniform). In this case, the use of a volume-averaged saturation for the invert provides acceptable accuracy for calculating the effect of saturation on the diffusion coefficient. (CAT 6, see DOE Response to TSPA003)

Reference: BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex3

Tracking # TSPA003.Ex3

Comment Page 184: Technical basis is needed for the "subset of combinations" that were used in the chemistry modeling.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The "subset of combinations" used for the lookup tables that constitute the response surface span the entire range used in the TSPA. Interpolation was used to obtain values between the values in the tables. (CAT 6, see DOE Response to TSPA003)

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex4

Tracking # TSPA003.Ex4

Comment Page 183: "...abstracted to representative constant values..." We are not aware of the criteria used to interpret whether the process model was an appropriate abstraction. Also, we do not know what you mean by a "representative constant value", and whether the simplification you employed eliminates significant amounts of uncertainty and variability.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Discussion of the appropriateness of the abstraction and uncertainty are in Abstraction of Drift-Scale Coupled Processes (CRWMS M&O 2000b). As stated in that document, "Section 6.1 provides the details of the thermal-hydrologic-chemical abstraction of water chemistry and gas-phase composition adjacent to the drift wall. It provides a tabulation of the abstracted time-histories of the aqueous species concentrations, pH, and CO2 component concentration in the gas phase. In addition, Section 6.1 contains a discussion of the uncertainty in these values based on the differences in the thermal-hydrologic-chemical results from the other infiltration flux cases." (CAT 6, see DOE Response to TSPA003)

Reference: CRWMS M&O 2000b. Abstraction of Drift-Scale Coupled Processes. ANL-NBS-HS-000029 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000525.0371.

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex5

Tracking # TSPA003.Ex5

Comment Page 372: DOE needs to demonstrate that heterogeneities in the flow paths are adequately captured by the abstraction; i.e., releasing from the unsaturated zone to four random points in the saturated zone. It is unclear whether the peak mean DOSE will be larger if the releases are distributed over the total flow area to the saturated zone or to four discrete points.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The horizontal placement of the point source in each of the four source regions is varied stochastically from realization to realization, reflecting uncertainty in the location of leaking waste packages and transport pathways in the unsaturated zone. This is described in more detail in the Section 6.2.2 of the Analysis/Model Report (CRWMS M&O 2000bx) (CAT 6, see DOE Response to TSPA003)

Reference: CRWMS M&O 2000bx. Input and Results of the Base Case Saturated Zone Flow and Transport Model for TSPA. ANL-NBS-HS-000030 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0330.

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex6

Tracking # TSPA003.Ex6

Comment Pages 167 and 170: DOE should provide further clarification of the temporal variability of the thermohydrology parameters and the significance of the variation considering the large time-step used in the TSPA model. It is unclear how the model is constructed so that processes operating at faster time constants than the model time steps are captured. Figure 6-41 illustrates the point; it shows that the temperature responds very dynamically in the first 500 years. If a 500-year timestep was used in the TSPA simulation, it is unclear how the dynamic response of this process would be captured. We suggest at least a few test cases using smaller time steps to demonstrate sensitivity.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Efforts are made to ensure time steps are not too long to prevent resolution of system dynamics. The time step is generally tested as a part of model implementation. For example, such testing helped identify appropriate times steps for the early period when temperatures are changing and for the periods when the climate transitions occur. (CAT 2, see DOE Response to TSPA003)

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex7

Tracking # TSPA003.Ex7

Comment Page 118: There is inadequate justification that representing seepage threshold by three levels (low, medium, and high) captures the contribution from the tails of the distribution, especially on the upper side.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response To resolve this issue, we propose to use the 90th percentile infiltration case identified in the Monte-Carlo analysis for the upper-bound infiltration map of the glacial transition climate. Parameters from this case will be used in the infiltration model to calculate the upper-bound infiltration map. Using this in the infiltration weighting scheme the weights for lower bound, mean and upper bound infiltration cases will be recalculated. The upper bound infiltration cases for the monsoon and modern climates will be computed by the ratio of the spatial average infiltration for the upper bound infiltration map to the mean infiltration map for the glacial transition climate multiplied by the mean infiltration map for the monsoon and modern climates. These new infiltration maps will be incorporated into the process model calculations that are used to support TSPA and the new weighting factors will be used directly for TSPA sampling. (CAT 6, see DOE Response to TSPA003)

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex8

Tracking # TSPA003.Ex8

Comment Page 118: There is inadequate technical basis provided that it is unimportant to represent uncertainty in the infiltration map at each climate state.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Performing an uncertainty analysis of infiltration for the other climate states is included in the Unsaturated and Saturated Flow under Isothermal Conditions agreement 3.1. The resolution for representing uncertainty is described in the response to the second NRC Comment for Model-Page118. (CAT 6, see DOE Response to TSPA003)

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex9

Tracking # TSPA003.Ex9

Comment Page 107: Engineered barrier system environment section. TSPA uses an equilibrium batch reactor in simulation of the engineered barrier system environments. There is inadequate technical basis provided that the simplification is appropriate to represent the dynamic processes.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The statement that an equilibrium batch reaction calculations were used is an oversimplification. As stated in the In Drift Precipitates/Salts Analysis (CRWMS M&O 2000bz), "The conceptual model is that boiling and evaporation of water within the drift will cause dissolved solids in the water to concentrate and precipitate. The degree of vaporization of H2O and precipitation of salts and minerals may change with time as conditions change. The precipitates that form will depend on the temperature, gas fugacities, vaporization rate, seepage rate, and seepage composition."..."The Precipitates/Salts model was developed to simulate the conceptual model."

The precipitates/Salts model consists of a low relative humidity model and a high relative humidity model. Those two models are linked at 85% relative humidity.

"In the low relative humidity salts model, seepage water enters a specified location within the drift where it is subjected to evaporation processes. This location is called a "reactor" in this document.

"The EQ3/6 high relative humidity model is used in two modes, a simple evaporation mode and a mode that simulates both flow-through and evaporation simultaneously. The first mode is used to predict the simple evolution of a given solution as water evaporates. The second mode is used to predict the evaporative evolution of a constant incoming seepage." (CAT 6, see DOE Response to TSPA003)

Reference: CRWMS M&O 2000bz. In-Drift Precipitates/Salts Analysis. ANL-EBS-MD-000045 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000512.0062.

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex11

Tracking # TSPA003.Ex11

Comment Page 129: The seepage uncertainty parameter is randomly sampled from 0 to 1 and is not considered data. It seems that if it is representing uncertainty but no data exists to support its selection, then DOE should favor the value that produces the largest risk.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The random number from 0 to 1 is only necessary because the parent triangular distributions for seepage uncertainty are evaluated in the seepage dynamically linked library (DLL - a subroutine external to GoldSim) rather than in GoldSim itself. These parent distributions are based on data (see Table 6-4, p. 125). If the triangular distributions were in GoldSim itself, then GoldSim would utilize exactly the same method of using a uniform random number surrogate for sampling the seepage uncertainty distributions. (CAT 7, see DOE Response to TSPA003)

Agreement Number TSPAI.3.39

Agreement See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA003.Ex12

Tracking #	TSPA003.Ex12
Comment	Page 182: On the electronic figure (6-65), it looks like that even for median value simulations, there is significant underprediction of peak temperatures.
References	CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	DOE will clarify the Figure. (CAT 1, see DOE Response to TSPA003)
Agreement Number	TSPAI.3.39
Agreement	See Agreement statement under TSPA003.

Subissue #3 - Model Abstraction TSPA004

Tracking # TSPA004

Comment As part of the model development process it is necessary to verify that the model is calculating properly, validate that an appropriate model has been developed for the problem being examined, and complete analyses to explain the detailed functioning of the model. The DOE has provided information on all three of these topics in the TSPA-SR documentation. Support for the process model results abstracted in the TSPA was lacking. The DOE has issued a Corrective Action Report (CAR) BSC-01-C-001 dated 5/3/01 that found "the area of model validation is considered to be a significant condition adverse to quality." The CAR indicates that 18 of 24 Analysis Model Reports (AMR's) were inadequately validated, including eight that were not validated at all. In general, the DOE did not present comparisons of the process model output to the abstractions used in the TSPA. Also, as the CAR indicates, the other methods deemed acceptable to develop support for process models were not satisfied.

See list of examples labeled TSPA004.Ex1, TSPA004.Ex2, etc. for additional details.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response DOE will provide comparisons of process model output to the abstractions used in the TSPA. A root cause analysis for Corrective Action Report (BSC-01-C-001) is being performed. This comment seems more applicable for Analysis/Model Report model and abstraction validation, not for TSPA model abstractions. The following TSPA examples are categorized as follows:

CAT 1. Clarification required primarily in terms of rewording text. Limited additional work required.

CAT 2. Clarification and additional analysis required. Additional analyses or plots required to fully clarify the point.

CAT 3. Not the scope of the document. Some of the comments ask for more than the model document is intended to serve. For example, additional TSPA analyses in the model document that indicates the significance of the component to long term DOSE. These should be referred to the other documents.

CAT 4. Not used.

CAT 5. Correction required to the text.

CAT 6. Provide abstraction defensibility of the abstraction utilized.

CAT 7. No change required. Suggestions for transparency/traceability may not require any changes.

CAT 8. NRC points out a few instances where we have obtained transparency, or provided abstraction defensibility.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #3 - Model Abstraction TSPA004.Ex1

Tracking # TSPA004.Ex1

Comment Page 421: We expect that the pipe model has an analytical solution that can be verified. We also believe that the more-complex models should be compared to simple models to provide model support.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The Analysis/Model Report (CRWMS M&O 2000bx), Section 6.5.2, discusses the 1-D model validation. (CAT 2, see DOE Response to TSPA004)

Reference: CRWMS M&O 2000bx. Input and Results of the Base Case Saturated Zone Flow and Transport Model for TSPA. ANL-NBS-HS-000030 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000526.0330.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex2

Tracking # TSPA004.Ex2

Comment Page F3-23: Model support is needed for the percolation flux modeling results, such as comparison to the ECRB observations or other natural systems.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE has quantitative support for the levels of percolation flux used in the unsaturated zone flow model from hydrological (water saturation and potential), geochemical (Cl and Sr), temperature, and mineralogical (calcite) measurements. For seepage, model predictions have been compared with seepage testing at Niche 3650 and seepage studies conducted during systematic characterization of the Enhanced Characterization of the Repository Block. (CAT 6, see DOE Response to TSPA004)

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex3

Tracking #	TSPA004.Ex3
Comment	Page 3-149: A comparison of the unsaturated zone results from this abstraction with basic information about fractures and flow should be provided for adequate model support.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	DOE will consider providing in tabular form, a comparison between infiltration rates and water flow travel times. (CAT 6, see DOE Response to TSPA004)
Agreement Number	TSPAI.4.05, TSPAI.4.06
Agreement	See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex4

Tracking # TSPA004.Ex4

Comment Page 3-117: In order for the reader to agree with the assertion that the corrosion of Zircalloy in boiling seawater and geothermal solutions provides adequate model support, a comparison of the corrosion rates of Zircalloy in those environments and a comparison of those environments to the ionic strength solutions of the other solutions would be appropriate.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE intends to document the technical basis for the assertion that the corrosion of Zircalloy in boiling seawater and geothermal solutions provides adequate model support in the Waste Form Degradation Process Model Report (CRWMS M&O 2000by) and Cladding Analysis/Model Report (CRWMS M&O 2001t). (CAT 2, see DOE Response to TSPA004)

Reference: CRWMS M&O 2000by. Waste Form Degradation Process Model Report. TDR-WIS-MD-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000713.0362. (future revision)

CRWMS M&O 2001t. Clad Degradation - Summary and Abstraction. ANL-WIS-MD-000007 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010214.0229.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex5

Tracking # TSPA004.Ex5

Comment Page 3-114: Is the frequency of 1.1E-6/yr for cladding failure due to severe seismic activity a modeled result? If so, what is the model support for this result?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify the text. (CAT 1, see DOE Response to TSPA004)

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex6

Tracking # TSPA004.Ex6

Comment Page 3-107 (last paragraph under Basis for High-level Radioactive Waste Glass Degradation Model): The description is for a comparison of a model to other models. A comparison of models to models is a questionable method to develop model support.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The Analysis/Model Report on high level waste glass degradation explains that the model for glass degradation in humid air was based on drip tests on Savannah River glass. DOE will add sentence "The better model, in turn, was based on drip tests using results from high level waste glass." (CAT 6, see DOE Response to TSPA004)

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex7

Tracking #	TSPA004.Ex7
Comment	Page 3-73: Technical basis is needed for the pH values applied below 85% RH.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	The EQ3/6 database and code are now being further developed to make pH predictions at far lower values of relative humidity. Extrapolation of values from 85% relative humidity to lower values was chosen in lieu of any other rational approach. The duration of relative humidity below 85% is relatively short compared with the period of performance. (CAT 6, see DOE Response to TSPA004)
Agreement Number	TSPAI.4.05, TSPAI.4.06
Agreement	See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex8

Tracking # TSPA004.Ex8

Comment Page 3-61: DOE needs to address more thoroughly the observation: "The use of the simplified THC model results for the abstraction is based on the fact that it reproduces more accurately the observed changes to water and gas compositions in the drift-scale heater test..." Specifically, we are concerned by the fact that the field data show better agreement with the abstraction than with the process model, which may be anecdotal rather than real.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The "simplified model" and the "complex model" are both process-level models (run with TOUGHREACT), not abstractions. The main difference is that the "complex model" has more trace constituents. In CRWMS M&O 2000cc, the simplified process-level model better matches the results of the drift-scale heater test, therefore, it was used as the basis for the thermal-hydrologic-chemical abstraction in TSPA, i.e., the "simplified" process-level model was further simplified (abstracted) for use in TSPA. (CAT 7, see DOE Response to TSPA004)

Reference: CRWMS M&O 2000cc. Near Field Environment Process Model Report. TDR-NBS-MD-000001 REV 00, ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001005.0001.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex9

Tracking # TSPA004.Ex9

Comment Page 424: "...it can be concluded that the SZ component model is verified." DOE should provide the technical basis that demonstrates the approach taken satisfies the requirements for model verification.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The intent of this statement is not to verify the sub-component model, but to show that the saturated zone site-scale model is correctly implemented in the TSPA model and working as intended. The specific Analysis/Model Reports (CRWMS M&O 2000ca, 2000cb), flow and transport respectively, discuss model verification. (CAT 6, see DOE Response to TSPA004)

References: CRWMS M&O 2000ca. Calibration of the Site-Scale Saturated Zone Flow Model. MDL-NBS-HS-000011 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000825.0122.

CRWMS M&O 2000cb. Saturated Zone Transport Methodology and Transport Component Integration. MDL-NBS-HS-000010 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000824.0513.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex10

Tracking # TSPA004.Ex10

Comment Page 191: The pH and ionic strength should also be checked at time periods between calculational switch points.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The current model switches in-package water chemistry at times chosen to represent the dynamics of the chemistry evolution. It would be straightforward to provide finer resolution on these switches. However, the effect of doing so would not be very important in the calculational construct. The evolution of chemistry within each waste package is not tracked. Instead, an average chemistry is used to represent performance of groups of waste packages. Since the waste packages within a group fail at very different times, this averaging means that fine details of the changes in chemistry after the time of package failure are blurred over. Consequently, finer resolution on the chemistry changes is not likely to change the calculated DOSE rate very much. (CAT 2, see DOE Response to TSPA004)

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex11

Tracking # TSPA004.Ex11

Comment Page 120: The paragraph basically shows that the Infiltration_Scenario parameter was implemented correctly at the local, limited basis. The technical basis for evaluating the Infiltration_Scenario implementation on a limited basis was not provided. In particular, the Infiltration_Scenario is listed as being utilized by UZ flow fields, thermohydrology, and seepage and is described as being linked to 137 other parameters.

References CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Verification that the correct value of Infiltration_Scenario is used in the various submodels is generally described in the subsection of the Model Document devoted to that submodel. These subsections are referred to on p. 120. For example, see Table 6-6 (CRWMS M&O 2000aq, Section 6.3.1.2) for the value of Infiltration_Scenario used in the seepage submodel. If additional proof is needed, the GoldSim model file can be opened and the external links for Infiltration_Scenario can be followed individually to each place that the parameter is used. (CAT 6, see DOE Response to TSPA004)

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex12

Tracking #	TSPA004.Ex12
Comment	Page 50, #7: It doesn't appear that points on which experts disagree have been discussed in the documentation, as implied by the comment. It is unclear how the DOE has handled these issues in the TSPA.
References	CRWMS M&O. "Total System Performance Assessment Model for Site Recommendation." TDR-WIS-PA-000001. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	DOE will clarify the text. (CAT 1, see DOE Response to TSPA004)
Agreement Number	TSPAI.4.05, TSPAI.4.06
Agreement	See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex13

Tracking #	TSPA004.Ex13
Comment	Page 4-6: Model support is needed for the glacial transition climate or monsoon climate ratios of infiltration to precipitation.
References	CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.
DOE Response	See the response to NRC Comment for Page 3-37. If the technical basis is sufficient to support the model calculations of infiltration for future climates (NRC Comment for Page 3-37) then DOE considers it is sufficient to support the computed ratios of infiltration to precipitation for future climates. (CAT 6, see DOE Response to TSPA004)
Agreement Number	TSPAI.4.05, TSPAI.4.06
Agreement	See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction TSPA004.Ex14

Tracking # TSPA004.Ex14

Comment Page 3-37: The conceptual model for infiltration is based on field studies at Yucca Mountain under current climate conditions. Technical basis is needed that the same infiltration model will apply under future climate conditions, which are roughly 94% of the 10,000 year compliance period.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The infiltration model has been compared with alternative methods for estimating infiltration over a range of precipitation corresponding to wetter future climates. These comparisons include the Maxey-Eakin method and the chloride mass balance method. These comparisons support the conclusion that the net infiltration model is appropriate for estimating the spatial distribution of net infiltration at Yucca Mountain. (CAT 6, see DOE Response to TSPA004)

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement See Agreement statement under TSPA004.

Subissue #3 - Model Abstraction General.TT.1

Tracking # General.TT.1

Comment Table D.1-1 defines the subissues of the NRC Key Technical Issues (KTIs), when the NRC structure is shifting from KTIs to Integrated Subissues (ISIs).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Table D.1-1 is a synopsis of the TSPAI Issue Resolution Status Report Key Technical Issue (NRC 2000) and their related Subissues. The relationship between NRC Integrated Subissues and Key Technical Issue subissues is in Table D.1-2. Table D.1-1 will be deleted in the next revision of TSPA-Site Recommendation.

Reference: NRC 2000. Issue Resolution Status Report Key Technical Issue: Total System Performance Assessment and Integration. Rev. 3. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 249045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction General.TT.2

Tracking # General.TT.2

Comment Table B-1 of the Repository Safety Strategy, REV04 presents process model factors. Table D.1-3 of TSPA-SR presents process model reports and process model factors. The list of process model factors (for the nominal case) do not match between the two documents. Specifically, a process model factor, equivalent to "EBS(invert) degradation and performance" (from Table B-1 of the RSS), was not apparent in Table D.1-3 of TSPA-SR. Similarly, process model factors, equivalent to "In-Package Environments" and "Changes to SZ Flow" (from Table D.1-3 of TSPA-SR), were not apparent in Table B-1 of the RSS.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

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

DOE Response DOE agrees that Table D.1-3 should be same with Table B-1 of Repository Safety Strategy Rev. 4 (CRWMS M&O 2001i). DOE will verify the accuracy of the information in Table D.1-3 and update it as necessary.

Reference: CRWMS M&O 2001i. Repository Safety Strategy: Plan to Prepare the Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations. TDR-WIS-RL-000001 REV 04 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010329.0825.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction General.TT.3

Tracking # General.TT.3

Comment It seems that it would be more helpful if the IRSR tracking database, described in Appendix D of TSPA-SR (CRWMS M&O, 2000), included the content of the IRSR (i.e., the comments and how they have been addressed) in addition to listing the acceptance criteria from the TSPAI IRSR (NRC, 2000).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

NRC. "Issue Resolution Status Report. Key Technical Issue: Total System Performance Assessment and Integration." Revision 3. Washington, DC: NRC. 2000.

DOE Response In the next revision to TSPA-Site Recommendation, references and content of the Issue Resolution Status Report database will be removed from Appendix D. Considering the impending release of the Yucca Mountain Review Plan, DOE does not believe that it is prudent to update Appendix D since the acceptance criteria may change in the Review Plan.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #3 - Model Abstraction General.TT.4

Tracking # General.TT.4

Comment The contents of Table E-1 seemed to have missed the intent implied by the title to Appendix E called "Analyses Model and Data Traceability". The reader likely will assume that the information in the table will provide a way to trace the source of input data through the TSPA system; however, the poorly formatted and confusing information is more useful for tracking document contents through the system than data items. Consider the data input item of a geologic layer thickness in the unsaturated zone. The "Reference Document" column could be scanned to locate possible locations of the data. For example ,"Abstraction of Flow Fields for RIP", Abstraction of Drift Seepage", and Draft of "MR Abstraction of NFE Drift Thermodynamic Environment and Percolation Flux". With an educated guess one might select the "Abstraction of Flow Fields for RIP," but there is no verification in the Table that the data actually exists in this document or any other. Indeed, the data may not exist in any of the documents listed.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will consider updating Table E-1 to add another layer to identify the type of information that will be fed into the models.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-H2.1

Tracking # J-H2.1

Comment Assumptions made in the analysis of the effects of human intrusion do not appear to be justified or appropriate based on proposed 10 CFR Part 63.

Specific Examples:
- Volume and chemistry of drilling fluids are ignored in analysis: Sufficient support is not provided for ignoring the impact of these aspects on the human intrusion scenario analyses.

- Rate of infiltration is unaffected by the presence of the borehole: The technical basis for this assumption used for the human intrusion scenario analyses is neither transparent nor traceable.

- Cladding in the penetrated WP is perforated due to the event, but not completely failed. The cladding still needs to unzip, which can take a very long time.

- The properties of the rubblized borehole (porosity, fluid saturation, and dispersivity) are represented by the matrix properties of a UZ fault.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The human intrusion analysis was formulated using the nominal case scenario. Unsaturated Zone and Engineered Barrier System components were replaced to produce a simplified representation of the human intrusion scenario as specified in the proposed !0 CFR Part 63 (64 FR 8640) and 40 CFR 197 (66 FR 32074). Human intrusion scenario inputs will be re-evaluated following promulgation of final Environmental Protection Agency, NRC, and DOE rules.

References:

64 FR 8640. Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain, Nevada. Proposed rule 10 CFR Part 63. Readily available.

66 FR 32074. 40 CFR Part 197, Public Health and Environmental Radiation Protection Standards for Yucca Mountain, NV; Final Rule. Readily available.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and

Subissue #4 - Overall Performance Objective J-H2.1

Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-H2.2

Tracking # J-H2.2

Comment The results of the human intrusion analyses do not appear to be consistent with other models in the TSPA.

Examples:
- The peak expected dose resulting from human intrusion is shown to occur approximately 200 years after the single WP is breached by drilling. This result suggests that the travel time in the saturated zone is extraordinarily short. Elsewhere in the TSPA-SR Technical Document it appears that the 3D SZ model predicts a median travel time for unretarded carbon-14 of about 600 years while for slightly retarded technetium-99, the median travel time is around 1000 to 1500 years. These findings seem inconsistent.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See above response to J-H2.1.

For the specific example shown, this may be due to comparison of a mean peak dose from the TSPA HI calculation (Figure 4.4-11) to breakthrough curves calculated using median inputs to the 3D Saturated Zone model (Figure 3.8-18). Note that the mean HI dose is strongly dominated by the early breakthroughs. The TSPA median HI dose peaks after 10,000 years, consistent with retardation of Np and Pu. The probabilistic breakthrough curves shown in Figure 3.8-19 provide insight into the distribution of breakthrough curves that contribute to the distribution of dose curves.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.1

Tracking # J-O3.1

Comment DOE appears to be weighting the results of alternative conceptual models without an appropriate technical basis for the weighting factor used.

Specific Examples:
Igneous dike propagation model identifies two alternatives: (i) the dike either centralizes above the repository due to flow into the drifts; or (ii) the dike centralizes randomly along the drift length. Without any technical basis, each of these alternatives is weighted by 50%.

Seepage uncertainty parameter is randomly sampled from 0 to 1 without any justification for selecting a value less than 1.

Information on the correlation of Kds among different UZ units is limited, but the most conservative model is neither identified nor selected.

The anisotropic and isotropic alternative conceptual models for saturated zone flow are weighted equally without a technical basis.

References CRWMS M&O. "Dike Propagation near drifts." ANL-WIS-MD-000015. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
CRWMS M&O. "Igneous Consequence Modeling for the TSPA-SR." ANL-WIS-MD-000017. Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.
CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000. Pages 129 and 398.
CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Page 3-163.

DOE Response DOE agrees that weighting for alternative conceptual models should be appropriately justified. Note that in some cases (e.g. seepage) the distribution has been chosen to capture uncertainty, and it is not always clear a priori which end of the distribution is more conservative. The DOE has therefore included the full uncertainty in the analysis to allow determination of sensitivity.

Seepage Uncertainty - The seepage uncertainty parameter does not represent alternative conceptual models, but rather the uncertainty in the hydrologic properties around the drifts. This uncertainty is discussed in detail in the seepage-abstraction Analysis/Model Report (CRWMS M&O 2001o)

Unsaturated Zone Kds - The Kd measurements and abstraction

are done in terms of rock type, not stratigraphic unit. This is appropriate because it is the rock chemistry (i.e., mineral abundances, etc.) that will determine the Kd.

Saturated Zone Anistropy - Given the lack of any additional basis for assigning probability weights to alternative conceptual models of horizontal anisotropy, the least biased approach is to assign equal weights to the two alternatives.

Reference: CRWMS M&O 2001o. Abstraction of Drift Seepage. ANL-NBS-MD-000005 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010309.0019.

Agreement Number TSPAI.4.01

Agreement DOE will document the methodology that will be used to incorporate alternative conceptual models into the performance assessment. The methodology will ensure that the representation of alternative conceptual models in the TSPA does not result in an underestimation of risk. DOE will document the guidance given to process-level experts for the treatment of alternative models. The implementation of the methodology will be sufficient to allow a clear understanding of the potential effect of alternative conceptual models and their associated uncertainties on the performance assessment. The methodology will be documented in the TSPA-LA methods and assumptions document in FY02. The results will be documented in the appropriate AMRs or the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.2

Tracking # J-O3.2

Comment The treatment of alternative conceptual models in the DOE sensitivity and uncertainty analysis is not clear.

DOE briefly mentions alternative conceptual models only as an example in the TSPA-SR Technical Document (page 5-9): "An example of a parameter with this effect is neptunium solubility (see Section 5.2.4.2). An example of a conceptual model that might have this effect is the dual-porosity UZ transport model, which may result in faster transport than a dual continuum model."

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Where a particular conceptual model is technically justified, there is no requirement to consider more conservative alternatives. DOE will clarify the incorporation of alternative conceptual models in the next revisions to the Analysis/Model Reports.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.3

Tracking # J-O3.3

Comment Inappropriate characterization of data uncertainty may affect the results of calculated repository performance even if the mean of the distribution is reasonable. Selecting too wide of an uncertainty band may dilute the risk by spreading the peak dose in time, thereby reducing the peak value. Selecting too narrow of an uncertainty band may underestimate peak dose during the compliance period by delaying dose beyond the regulatory period of interest. DOE needs to discuss what, if any, analyses that they have used to provide confidence that their choice of parameter distributions is appropriate and will not lead to risk dilution by reducing the peak expected annual dose.

Specific Examples
Use of uniform distributions for the Kd value for several radionuclides (Am, Pu, Ra, Pb, Pa, Sn) gives equal probability to all values, which is likely not appropriate. A more biased distribution could increase peak dose by reducing the spread in travel times.

Selection of non-zero lower value for distributions of Kds for Pu, Pb, Ra, and Sn without an appropriate technical basis may inappropriately delay doses beyond compliance period.

Lower values in uncertainty bands for the stress intensity factor (Ki) include values below 0, which have no risk significance. This may inappropriately dilute risk.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Figure 3.4-11.

DOE Response Parameter distributions utilized in the TSPA model are documented in the TSPA model report (CRWMS M&O 2000aq) or in the supporting Analysis/Model Reports. For the TSPA-License Application, the documentation of the selection of parameter distributions and associated impact on peak expected annual dose will be enhanced.

Kd Distributions - Uncertainty distributions for Kd values are based on statistical analyses of data in most cases. Additional justification for uncertainty distributions will be included in revision of existing documentation, as covered by an existing Radionuclide Transport agreements 2.10, 1.5).

Stress Intensity Factor - The stress intensity factor (KI) could become negative depending on the stress state and crack geometry. Negative stress intensity factor values included in the

uncertainty range do not have any impact on the waste package performance because no stress corrosion cracks grow with the stress intensity factor less than zero. As a result, DOE does not believe that this results in any dilution of risk.

DOE will provide a plot of Pu Kd vs. distribution function.

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.4

Tracking # J-O3.4

Comment The 10,000-year water residence time in the WP does not appear to be consistent with the assumption that diffusion in the WP is instantaneous.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Page 4-8, first paragraph.

DOE Response Diffusion out of the waste package is not instantaneous because of the relatively small area available for diffusion. Later on as the hole becomes larger, diffusion does increase.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.5

Tracking # J-O3.5

Comment DOE has not demonstrated that the results of all of their analyses are stable with respect to the number of realizations performed in the simulations. For example, submodels such as BDCFs and saturated zone transport transfer functions are developed from a limited number of realizations, which is not increased for tests of the stability of the results.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response TSPA-Site Recommendation model results have been determined to be stable only with respect to their inputs. For postclosure, the analyses focussed on stability for the first 10,000 years. Multiple replicate TSPA runs are being considered to provide additional insight regarding stability of model results.

Biosphere Dose Conversion Factors - Testing was not used to demonstrate Biosphere Dose Conversion Factors stability. This testing would be more appropriate post-Site Recommendation and DOE recognizes that additional work is required to demonstrate stability of the results in TSPA-License Application.

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number TSPAI.4.03

Agreement DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.6

Tracking # J-O3.6

Comment DOE has not presented justification that the model results appropriately address variability (e.g., fom the level of discretization within the system). For example, DOE should demonstrate that results are stable with respect to the number of infiltration bins, number of climate states, number of thermohydrology bins, and time step size.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Spatial and temporal variability and discretization apply at all scales of all of the process-level and abstraction models, and the TSPA model. The level of discretization/variability used in the models represents an optimization that strives to achieve the greatest amount of variability within the constraints of available scientific data and available computational resources. For example, the five thermo-hydrological/infiltration bins represent a discretization of the source term behavior that is a compromise between modeling the source term releases at each individual waste package environment (total of about 12,000) versus assuming an average behavior for the entire repository. The four saturated zone source regions represent a similar compromise. Studies indicate that little difference in repository behavior would be expected using either one source saturated zone region or four saturated zone source regions (CRWMS M&O 2000ar, Figure 4.1-18). Chapter 3 includes discussions of uncertainty and variability as implemented in the various TSPA submodels. Variability ranges used in the models represent a combination of scientific data and judgement, generally biased toward conservatism when specific data is lacking.

Number of infiltration bins - The infiltration bins are used to divide the waste packages into groups for purposes of calculating radionuclide mobilization, release, and transport within the Engineered Barrier System. It is not possible to model all 11,770 waste packages individually. However, the following observations apply:

(1) The infiltration bins used (0-3 mm/yr, 3-10 mm/yr, 10-20 mm/yr, 20-60 mm/yr, and 60+ mm/yr during the glacial-transition climate) cover a wide range of infiltration, and therefore do capture important aspects of the effects of infiltration variability.

(2) The TSPA results have been found not to be particularly sensitive to infiltration (see Section 5.2.1.1 of the TSPA-Site Recommendation technical report). Thus, including greater detail in its TSPA implementation would not be expected to have a great

effect.

Number of climate states - The climate states, including their number and properties (e.g., precipitation, temperature, etc.), are justified in detail in the future-climate Analysis/Model Report (USGS 2000b).

Number of thermohydrology bins - The thermal-hydrology results are binned according to the infiltration bins that are discussed above.

Timestep size - Timestep size in the total system model was conducted to optimize: (1) convergence (timestep size and substep size), (2) result file size and the amount of data that could be saved within the Windows NT 2GB limit, and (3) computational time. The first constraint forces smaller timesteps, while the latter two constraints force larger timesteps. The timestep sizes used in the TSPA-Site Recommendation model (CRWMS M&O 2000aq) are small enough to capture the key changes in the system (e.g., the climate oscillations), but large enough to allow storage of key data from a multiple-realization, million-year simulation using currently available computational resources. The internal substep used for convergence of the model allows the much larger timesteps (e.g., 500 years) to cycle as low as 1 month in order to attain convergence. Further internal substep reductions, e.g., on the order of hours, do not give noticeably different results. Sensitivity studies on timestep size and substep size in GoldSim will be available for the TSPA-License Application.

References: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

USGS 2000b. Future Climate Analysis. ANL-NBS-GS-000008 REV 00. Denver, Colorado: U.S. Geological Survey. ACC: MOL.20000629.0907.

CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number TSPAI.4.04

Agreement DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of

the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7

Tracking # J-O3.7

Comment The TSPA code is not properly verified, such that there is confidence that the code is correctly modeling the physical processes in the repository system. The TSPA code needs to be verified by the time of a License Application (if one is submitted). See Comment TSPA004. NRC Clarification: The proposed rule at 10 CFR 63.114(g) requires that the DOE provide the technical basis for the models used in the Total System Performance Assessment (TSPA). The technical basis includes appropriate efforts to ensure the quality of the code results, where verification and validation are integral to assuring the quality of code results. Verification ensures that software performs properly prior to its use for the intended purpose. The verification process should demonstrate that(i) the models used have been adequately tested for calculational correctness with all relevant data together with associated uncertainties; (ii) a well-defined and rational assessment procedure has been followed; and (iv) results have been fully disclosed and subjected to QA and review procedures. The verification process encompasses (i) tests that provide evidence of correct and successful implementation of algorithms, as appropriate, and (ii) bench-marking or comparative testing against results from other software for cases where accuracy of the code or the correctness of the code cannot judged otherwise, because there is no analytical method to use for comparison. Verification must be clearly distinguished from model validation. Model validation (e.g., conceptual or mathematical) deals with the conceptual basis of the model used for representing the real system. Therefore, model validation is a demonstration of suitability of a model to accurately represent a stipulated component (e.g., waste package) or aspect (e.g., heat flow) of a real system. Whether the processes are properly formulated mathematically and parameterized following accepted theories (or if a new theory is used [e.g., the active fracture model] then is this new theory tested), numerical schemes used have acceptable convergence properties, dimensionality (space and time) is appropriate, etc. are part of model validation. The validation of the TSPA model, which is essentially an abstracted model or a combination of models, has a special requirement that the simplification introduced does not cause optimistic biases in the results.

References

DOE Response Code verification and model validation are accomplished through DOE's Quality Assurance procedures. AP-SI.1Q is used for code verification and AP-3.10Q is used for model validation.

Examples of model verification and validation methods include:

° Software verifications by the developer (Golder)

° Input to TSPA model checked to ensure that the input is used for its intended purpose and is working appropriately

° Intermediate and expected value results checked to ensure subsystem linkages and overall system performance are performing properly

Corrective action reports have been initiated to assess recent discrepancies identified with software and model verification and validation. In addition, root cause analyses have been initiated to identify systemic causes of the discrepancies and programmatic improvements, if necessary. Periodic updates on the root cause findings and corrective actions are being reported in accordance with the DOE Management Plan for TSPA Quality Issues.

References: AP-3.10Q, Rev. 2, ICN 4. Analyses and Models. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010405.0009.

AP-SI.1Q, Rev. 3, ICN 1, ECN 1. Software Management. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010705.0239.

CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Brocoum, S.J. Letter from S.J. Brocoum to W. Reamer, Total System Performance Assessment Quality Issues, dated July 6, 2001.

Agreement Number TSPAI.4.05, TSPAI.4.06, TSPAI.4.07

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation

procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

TSPAI.4.07
DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification — all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex1

Tracking # J-O3.7.Ex1

Comment In the TSPA-SR Technical Document (CRWMS M&O 2000), the DOE presented various levels of analyses to demonstrate the verification of selected aspects of the performance assessment model. However, the verification was not sufficiently comprehensive; carrying the calculations forward to step through different parts of the model in larger segments would provide a more robust verification of the TSPA code.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response In a future revision of the TSPA model report, DOE will provide additional documentation regarding the TSPA modules and their integration into the overall TSPA.

Agreement Number TSPAI.4.07

Agreement DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex2

Tracking # J-O3.7.Ex2

Comment DOE has issued a Corrective Action Request (CAR) BSC-01-C-001 on model validation. The condition described in the CAR is that the DOE requirements for model validation (AP-3.10Q) have not been consistently implemented, which places the validation status of the TSPA model in question.

References AP-3.10Q, Rev. 2, ICN 4. Analyses and Models. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010405.0009.

DOE Response Model validation and its impact on TSPA results is within the scope of Corrective Action Report BSC-01-C-001.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex3

Tracking # J-O3.7.Ex3

Comment It is not clear that validation of the corresponding detailed model truly validates the abstracted model for the span over which the abstracted model has been applied (e.g., whether the simplified model is appropriate over the full range of conditions for which the model is used, including the treatment of coupled phenomena).

References

DOE Response Model validation is within the scope of Corrective Action Report BSC-01-C-001. Process and abstracted models will be validated. DOE understands that abstracted models must honor process models and that process models must be representative.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex4

Tracking # J-O3.7.Ex4

Comment DOE has collected field and laboratory data to support detailed hydrologic calculations from which abstractions were made when representing the data in tabular form. Whether the data that support the original model also support the abstracted model (in the form of tabular data) has not been investigated consistently throughout the document. Also, objective comparisons have not been made for all the constituent models to validate the parameters and/or the abstraction. Lack of validation (i.e., objective comparison) of the colloidal transport model with the C-wells Alluvium Testing Complex results (although the model is based on such data) is one example.

References

DOE Response Model validation is within the scope of Corrective Action Report BSC-01-C-001. Process and abstracted models will be validated. DOE understands that abstracted models must honor process models and that process models must be representative.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex5

Tracking # J-O3.7.Ex5

Comment A peer review is not a substitute for objective confidence building measures such as comparison with field data, laboratory data, or natural analogs. Although field investigations and natural analogs may not present the whole spectrum of information needed to validate the TSPA model, comparisons against field investigations and natural analogs may be used to provide objective support that a large portion (i.e., multiple components) of the TSPA model is validated. If, however, a peer review is used to help validate the TSPA code, the peer review should be documented with an appropriate level of detail to allow an independent assessment of its value in the validation process.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response AP3.10Q allows validation by peer review. DOE understands that use of field investigations or natural analogs is preferred, if available.

Reference: AP-3.10Q, Rev. 2, ICN 4. Analyses and Models. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010405.0009.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex6

Tracking # J-O3.7.Ex6

Comment There are several instances where DOE has validated results by comparing with NRC calculations. While DOE may use NRC's published work in light of its technical merit, the NRC results do not necessarily reflect a regulatory position. If DOE chooses to use NRC results to support their technical findings, it is the sole responsibility of the DOE to provide validation for such results.

References

DOE Response DOE will not use NRC calculations as the sole line of evidence. Instead, NRC calculations will be used as corroborating evidence.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex7

Tracking # J-O3.7.Ex7

Comment There appears to be some confusion in the understanding of validation and verification. Although Section 6.5 of the TSPA-SR Model Report (CRWMS M&O 2000aq) is titled "Model Validation," the discussion only pertains to software verification. From those parts of the report where validation is discussed in its proper sense, it appears that validation is only partially done. For example, DOE has performed validation of the conceptual model for the biosphere, but they have not applied the same validation procedures to the mathematical model of the biosphere (GENII-S). No attempts have been made to validate the model to show the mathematical model accurately represents the physical system.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will clarify Section 6.5 (CRWMS M&O 2000aq) to distinguish between model verification and model validation. Biosphere model validation (includes GENII-S) is presented in attachments to CRWMS M&O 2001n and CRWMS M&O 2001h. Additional model validation is in progress in accordance with the corrective action reports on software and model validation.

References: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

CRWMS M&O 2001n. Disruptive Event Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010125.0233.

CRWMS M&O 2001h. Nominal Performance Biosphere Dose Conversion Factor Analysis. ANL-MGR-MD-000009 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20010123.0123.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06

Subissue #4 - Overall Performance Objective J-O3.7.Ex7

DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex8

Tracking # J-O3.7.Ex8

Comment There is no indication that DOE has conducted tests that systematically verify the operations of the TSPA-SR model (CRWMS M&O 2000) to ascertain that the code is functioning properly over the full range of conditions being modeled. Sufficient tests have not been conducted for the code to be relatively error free. The verification of the TSPA model (as it is implemented using GoldSim and the associated codes called through dynamically linked libraries [DLLs]) does not appear to satisfy the intent of systematic verification.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response In a future revision of the TSPA model report, DOE will provide additional documentation regarding the TSPA modules and their integration into the overall TSPA.

Agreement Number TSPAI.4.07

Agreement DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex9

Tracking # J-O3.7.Ex9

Comment DOE has the elements of verification in their TSPA-SR and supporting documents. However, rigorous verification of the modules and the full code has either not been conducted, not been adequately reported, or is not yet available for review. The description of the verification in Section 6.5 (CRWMS M&O 2000aq) is not adequate. A specific verification plan was not found, and the verification was not uniform across the document.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response See above response to J-O3.7.

Agreement Number TSPAI.4.07

Agreement DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex10

Tracking # J-O3.7.Ex10

Comment Sufficient rationale was not provided to describe why verification of the median value results is an appropriate verification for a model that relies on stochastic simulations. There is no indication that verification of the TSPA model behavior included stochastic simulation of the model, sensitivity analyses, or uncertainty importance analyses. These analyses provide insights into whether the code is computing properly near the extremes of the input value ranges.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response TSPA-Site Recommendation model results have been determined to be stable only with respect to their inputs. For postclosure, the analyses focussed on stability for the first 10,000 years. Multiple replicate TSPA runs are being considered to provide additional insight regarding stability of model results.

Reference: CRWMS M&O 2000aq. Total System Performance Assessment (TSPA) Model for Site Recommendation. MDL-WIS-PA-000002 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001226.0003.

Agreement Number TSPAI.4.07

Agreement DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex11

Tracking # J-O3.7.Ex11

Comment An extensive GoldSim error log file was generated by execution of the "median value" file by the DOE. DOE documents do not discuss the significance of the warnings and errors in the GoldSim error log file.

References

DOE Response The impact of run log error messages is assessed by the analysts to determine their effect on model results. The run log errors will be documented in future revisions of the TSPA model report. Specific concerns regarding GoldSim errors have been addressed in the DOE Management Plan. See also above response to J-O3.7.

Agreement Number TSPAI.4.07

Agreement DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex12

Tracking # J-O3.7.Ex12

Comment Although DOE states that no abstractions in the PA model operate outside of their intended ranges, the NRC review found models being utilized outside the range of conditions for which the abstractions were developed.

References

DOE Response See above response to J-O3.7. Specific concerns regarding range of conditions for a given model have been addressed in the DOE Management Plan.

Agreement Number TSPAI.4.05, TSPAI.4.06, TSPAI.4.07

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

TSPAI.4.07
DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex13

Tracking # J-O3.7.Ex13

Comment Inputs and outputs to process-level models were verified with hand calculations. The NRC review of several hand calculations has identified various errors.

References

DOE Response See above response to J-O3.7. Specific concerns regarding use of hand calculations have been addressed in the DOE Management Plan.

Agreement Number TSPAI.4.07

Agreement DOE's software qualification requirements are currently documented in procedure AP SI.1Q which is under review for process improvement as part of software CAR-BSC-01-C-002. During its review of AP SI.1Q, DOE will consider: 1) the procedure it would follow to conduct a systematic and uniform verification - all areas of a code analyzed at a consistent level, 2) the process it would follow to ensure correct implementation of algorithms, and 3) the process it would follow for the full disclosure of calculations and results. DOE will document compliance with the improved process in the verification documentation required by AP SI.1Q. Software qualification record packages for the affected programs will be available for NRC review in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.7.Ex14

Tracking # J-O3.7.Ex14

Comment NRC believes that to demonstrate model validation, DOE should present the validation of the conceptual basis for the model. This should include: (i) proper mathematical formulation of the processes and correct parameterization following accepted theories (or if a new theory is used (e.g., the active fracture model) then is this new theory tested), (ii) acceptable convergence properties of numerical schemes, and (iii) appropriate dimensionality (in space and time).

DOE has the elements of model validation in their documents supporting the TSPA-SR Technical Document (CRWMS M&O 2000). However, a model validation plan does not appear to exist. Rigorous model validation at the system level has either not been conducted or has not been adequately reported.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Model validation is within the scope of Corrective Action Report BSC-01-C-001. Successful validation of conceptual as well as mathematical models will be ensured. See above response to J-O3.7.

Agreement Number TSPAI.4.05, TSPAI.4.06

Agreement TSPAI.4.05
DOE will document the process used to develop confidence in the TSPA models (e.g., steps similar to those described in NUREG-1636). The detailed process is currently documented in the model development procedures that are being evaluated for process improvement in response to the model validation corrective action report CAR-BSC-01-C-001. The upgraded model validation procedures will be available for NRC review in FY 2002.

TSPAI.4.06
DOE will document the implementation of the process for model confidence building and demonstrate compliance with model confidence criteria in accordance with the applicable procedures. This will be documented in the respective AMR revisions and made available to NRC in FY 2003.

Subissue #4 - Overall Performance Objective J-O3.8

Tracking # J-O3.8

Comment Throughout section 5 of the TSPA-SR Technical Document, the discussions on the method, data analyses, and model verification information appear to be mixed. For example, the general discussion on sensitivity and uncertainty analysis briefly touches on model sensitivity. However, the section does not appear to have any treatment or analysis of model uncertainty.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Section 5, Page 5-6.

DOE Response Section 5 (CRWMS M&O 2000ar) discusses uncertainty and sensitivity in model results, conditional on the distributions assigned to model inputs, rather than discussing uncertainty in those distributions, which may be the point of the comment.

DOE will clarify Section 5 in the next revision of the document.

Uncertainty in the model inputs for TSPA is captured in probability distributions. Discussion of the basis for these probability distributions is, in general, outside the scope of the TSPA technical report.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.9

Tracking # J-O3.9

Comment Section 5 of the TSPA-SR Technical Document gives an appearance that the section is more geared toward depicting the power of analysis the method(s) and has less emphasis on the analysis of results from sensitivity and uncertainty analysis.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Section 5, Page 5-6.

DOE Response DOE will clarify Section 5 (CRWMS M&O 2000ar) in the next revision of the document to emphasize results from sensitivity and uncertainty analyses.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.10

Tracking # J-O3.10

Comment Sensitivity and uncertainty analysis was emphasized on only one or two parameters, giving an appearance that only one or two parameters are important. It is not clear what quantitative cutoff value (e.g., R square loss, etc.) was used to determine that not more than one or two parameters could be important.
The influence of important parameters and models, identified through sensitivity and uncertainty analyses, on the performance assessment results should be described.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a. Section 5.

DOE Response In Section 5 (CRWMS M&O 2000ar, F5-1 through F5-21), most of the uncertainty importance analyses included 3 or 4 important parameters, the only exception being Figure 5.1-19, which had 2 important parameters. The selection of these was based on an uncertainty importance factor cutoff of 0.10, which corresponds to an R-squared loss in the range between 0.07-0.09. Tables of uncertainty importance factors have been developed that show the clusters of unimportant parameters. These tables were not included for reasons of brevity in the current TSPA-SR report. DOE will include these tables in future revisions to better explain the uncertainty importance results.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.11

Tracking # J-O3.11

Comment Section 5 of the TSPA-SR Technical Document (Page 5-8) states, "In most cases, the sensitivity to individual parameters is examined by setting a parameter to its 5th and 95th percentile values. This choice keeps most of the range that is considered defensible. The 5th and 95th percentiles are used rather than the entire range (i.e., 0th and 100th percentiles) because in some cases there is a very long tail out to extremely unlikely parameter values. The 5th and 95th percentile values are at the level that they are unlikely, but not so unlikely as to be unreasonable." This does not explain why choice of 95th and 5th percentiles are more appropriate and reasonable than, say, 99.9th and 0.1th percentiles.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a. Section 5, Page 5-8.

DOE Response The "one-off" sensitivity analyses are conducted to provide insight into model sensitivity to specific parameter values. They do not provide insight into the appropriate value of expected annual dose for regulatory decision making. The basis for the choice of the 5th and 95th percentiles is as stated, and there does not appear to be any need to choose alternative values for this type of analysis.

Agreement Number

Agreement Written DOE response by the DOE was deemed not satisfactory; however, DOE response during discussions at Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.12

Tracking # J-O3.12

Comment Section 5 of the TSPA-SR Technical Document (Page 5-9) states, "...uncertainty analyses based on dose rate as the metric necessarily deal only with those radionuclides that pass through the potential repository system. Those that are retained, for example the majority of the uranium, cannot influence these types of analyses. Thus, a case can be made that the relatively immobile waste form itself (comprised mostly of uranium) is the most important part of the system, rather than the waste package."

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a. Section 5, Page 5-9.

DOE Response DOE will clarify Section 5 (CRWMS M&O 2000ar) in the next revision of the document. The discussion of important aspects of the overall system will be enhanced to incorporate this topic of the waste form, and it's own immobile characteristics, being an important aspect of the overall system performance.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.13T

Tracking # J-O3.13T

Comment While the object oriented approach of the Goldsim software provides connections among modules, it is still difficult to get a clear picture of how process models are working in an integrated fashion within the TSPA model.

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response TSPA will continue to attempt to provide clearer descriptions of the modeling system. Appendix E describes the integration of the TSPA models, but will be clarified in the next revision of the document.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.14T

Tracking # J-O3.14T

Comment Uncertainty and variability does not appear to have been described adequately for all submodels. Although each TSPA submodel has an associated description of uncertainty and variability, it is difficult to draw a clear picture of where uncertainty was considered or the rationale for not describing it. For example, description of uncertainty in thermal properties could not be found in any of the documents. The TSPA-SR Technical Document (CRWMS M&O 2000a) only indicates, "information on thermal properties and processes has come from laboratory tests and from a series of in situ thermal tests in the ESF at Yucca Mountain (CRWMS M&O 2000b, Section 3.6)". Specific discussions of how uncertainty in thermal conductivity was handled in the TSPA, could not be found.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Near Field Environment Process Model Report." TDR-NBS-MD-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response The uncertainty in thermal conductivities was not considered in the TSPA-Site Recommendation thermohydrologic process level submodels. Only the mean thermal conductivities were used in the models that fed TSPA-Site Recommendation (CRWMS M&O 2000ar). Sensitivity studies are planned in the potential License Application time frame to investigate the sensitivity of thermohydrologic process model results to uncertainty of the thermal conductivities in the host units.

To improve transparency and traceability, DOE will consider consolidating and providing additional detail regarding the treatment of uncertainty and variability in the next revision of the TSPA Technical Report.

References: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.15T

Tracking # J-O3.15T

Comment In the presentation TSPA-SR Technical Document (CRWMS M&O 2000a), sometimes 10E-6 and other times 10E-5 mrem/yr has been used as the smallest vaule for displaying dose as a function of time.

In the sensitivity analysis, a value of 10E-5 mrem/year is used as a cutoff below which the response is considered negligible. Has there been any analysis done to ensure that this cutoff value is not partly responsible for zero dose in various figures until much after 10,000 years?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.

DOE Response Cut-off values on the y-axis of dose plots have been chosen for readability and clarity--scales of interest vary from plot to plot.

DOE has verified in TSPA-Site Recommendation (CRWMS M&O 2000ar) that no nominal realizations showed waste package failure before 10,000 years.

References: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement Written DOE response by the DOE was deemed not satisfactory; however, DOE response during discussions at Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.16T

Tracking # J-O3.16T

Comment The TSPA-SR Technical Document (CRWMS M&O 2000a) specifies that it is difficult to quantify the bias introduced through the use of conservative assumptions. Since the developer knows what is conservative, he/she must, conversely, know what is non-conservative and therefore should be able to at least bound the bias.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Page 4-3, paragraph 2.

DOE Response Bias introduced through the use of conservative assumptions has been addresses on a component-by-component basis in the Supplemental Science and Performance Analysis Volumes 1 and 2 (BSC 2001e, 2001f).

Note, however, that the developer of inputs does not know, a priori, what the effect of bias will be on system-level performance because of coupled and nonlinear effects within the system model.

References: BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

BSC 2001f. FY01 Supplemental Science and Performance Analyses, Volume 2: Performance Analyses. TDR-MGR-PA-000001 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010724.0110.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-O3.17

Tracking # J-O3.17

Comment Demonstration of the convergence of the LHS methods as implemented in the TSPA should be more technically robust. Simple graphical demonstration of the increased "stability" of the expect annual dose versus time curve as more realizations are conducted should be bolstered by discussions of how the variance of the variance in the peak of the mean dose decreases as the number of realizations is increased.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE will use appropriate statistical approaches to investigating the stability of the mean in future revisions of the TSPA document. (Note that the approach suggested here, of examining changes in the variance in the peak of the mean with changing sample size, may not be the only approach considered.).

TSPA-Site Recommendation Section 4.1.4 (CRWMS M&O 2000ar) shows the probability results for the mean, 5th and 95th percentiles. For 100, 300, and 500 realizations, the results appear to be stable. As an alternative approach consideration will be given to performing additional comparisons (e.g., T-tests) to demonstrate confidence in the limits. Additional calculations will be done as part of the next major update to TSPA-Site Recommendation to demonstrate stability of results.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.4.03

Agreement DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective J-O4.1

Tracking # J-O4.1

Comment Two alternative designs are considered: Backfill and a low temperature operating mode.

-The minimal effect of backfill on dose for volcanism does not appear to completely capture the reduction in the number of waste packages contacted by magma

-Bases of assumptions used for incorporation of a low temperature operating mode into TSPA are not adequately supported.

-It is not apparent from the analysis of the low temperature mode how uncertainties in the thermal regime and thermal effects on performance are reduced.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Alternative Design section, Page 4-36--4-40.

DOE Response The technical justification for the intrusive damage model was addressed at the Igneous Technical Exchange, June 2001. TSPA results appropriately capture effects consistent with that input.

Low temperature operating mode uncertainties are being examined through Supplemental Science and Performance Analysis and will be addressed in more detail at the Auguts 2001, Operating Range Technical Exchange.

Agreement Number

Agreement

Subissue #4 - Overall Performance Objective J-TT1.1

Tracking # J-TT1.1

Comment Section 5 of the TSPA-SR Technical Document (Page 5-19) states: "Figure 5.2-14 shows the mean dose rate from the base case compared to a case with no matrix diffusion in the UZ and also compared to a case where the UZ anion and cation matrix diffusion coefficients were set at 100 times the matrix diffusion coefficients in the base case. It should be noted that these parameter values are outside the range of base-case probability distributions, in contradiction to most of the other analyses in Section 5.2."

Going outside the range appears to be inconsistent with the general philosophy of the 5th and 95th percentile values used in the sensitivity analysis.

NRC would prefer that TSPA was more self-contained, i.e., more reference material contained within the document. Comments applies to all NRC transparency and traceability comments.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Section 5, Page 5-19.

DOE Response For parameters/models whose base case model was either deterministic (because a conservative/bounding model was used or because the model was well-characterized with little or no uncertainty) or had a very narrow parameter range, a one-off sensitivity on the key stochastic parameters was performed. If an alternative model was available for such cases, it was insightful to substitute an alternative model sensitivity analysis for the one-off 5th/95th analysis. DOE plans to continue to use this approach going forward to License Application. DOE will consider adding clarifying words in the introduction to Section 5.0 (CRWMS M&O 2000ar).

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.2

Tracking # J-TT1.2

Comment Input parameters for the DOE TSPA model are not easily traceable. Although Table E-1 of the TSPA-SR Technical Document (TDR-WIS-PA-000001 REV 00 ICN 01) provides a general listing of inputs to the TSPA-SR model, for the parameter values (i.e, parameter range and distribution functions), the reader is pointed to AMRs, PMRs or similar other documents, or to a data tracking number. To obtain a complete picture of the parameters used in the TSPA, the reader has to refer to all AMRs, which makes the task of reviewing all parameters used in the TSPA difficult.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000. Table E-1.

DOE Response DOE will work to improve traceability and transparency for the potential License Application.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.3

Tracking # J-TT1.3

Comment It is not readily apparent why one would expect the "periodic structure" of WP failures to be preserved in an average WF release curve, unless WP failures occur at the same time(s) for all realizations (CWRMS M&O, 2000; Table E-1, Figure 4.1-11, p. 4-8).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The "structure" is a result of the numerical discretization of the temperature and relatively humidity curves at late times.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.4

Tracking # J-TT1.4

Comment The logic in the following sentence is difficult to follow (CRWMS M&O, 2000; p. 4-24).

"Because it is assumed that the nominal models can be used in simulating the igneous disruption scenario, the annual dose for an igneous disruption, including all nominal processes, is approximated by Dn+Di."

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Dn and Di in this section are used to denote the conditional dose, rather than the probability-weighted dose. This equation simply acknowledges that, if an igneous event occurs, a person may receive doses from both the igneous-related processes and also the nominal processes that have occurred prior to the event and will continue to occur after the event. As stated in the following the probability-weighted dose for the igneous scenario is therefore p (Dn+Di). The probability weighted dose for the nominal scenario is (1-p)(Dn), and the total probability-weighted dose, which is the expected annual dose the NRC requires, is the sum of these two terms, which can be rearranged to yield Dt = Dn + pDi.

The approximation is based on the assumption that nominal release and transport processes are unaffected by the igneous event. If the nominal models are altered by the igneous event, then the conditional igneous dose should more rigorously be given by Dn (modified) + Di. Because Di is >>> Dn (without probability weighting) and is assumed to also be much greater than the unquantified Dn(modified), changes in Dn due to igneous activity can be neglected without significant change to Dt.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.5

Tracking # J-TT1.5

Comment Part of the explanation for the one-off analyses producing a greater difference between base case infiltration and low infiltration than between base case infiltration and high infiltration is that low infiltration has a lower probability. Generally speaking, one would not expect probabilities to be included in a one-off analysis; however, further reading (CRWMS M&O, 2000; Table 3.2-2, p. 3-29 and 5-10) indicates that the so-called probabilities that are assigned to each entry in the infiltration vs. climate table are integral to the model. In the last sentence of this paragraph the statement that the low probability effect in the low infiltration one-off analysis results from the "...low case [being] sampled less often than the others..." implies that the base and high cases are also sampled in the low infiltration one-off analyses. The overall presentation is confusing.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The base-case curve includes contributions from the low, medium, and high cases, according to their probabilities. Because the low case has a low probability, the base-case curve includes only a small contribution from that case. Thus, the base-case curve can be very different from the low-infiltration curve.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.6

Tracking # J-TT1.6

Comment It is not readily apparent why the use of a deterministic as opposed to a stochastic approach for the EBS environment explains the one-off analyses for the EBS parameters not being "very enlightening" (CRWM M&O, p. 5-12). Is it the structure of the model that precludes one-off analyses or is it that the computer code prevents the parameters from being modified?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response There are very few parameters in the engineered barrier system environments that are stochastic and those that are stochastic have little effect on dose. Therefore, there were no "enlightening" or meaningful one-off 5th/95th analyses that could be done for the engineered barrier system environments submodel. Since most of the models are deterministic, it was not possible to carry out 5th/95th percentile analyses as was done with other submodels. However, the text does point the reader to some alternative engineered barrier system environment model studies carried out for the robustness analyses of Section 5.3 (CRWMS M&O 2000ar).

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.7

Tracking # J-TT1.7

Comment The finding that dose is relatively insensitive to the range of water usage volume seems to contradict the plot shown in Figure 5.1-11 (CRWMS M&O, 2000; p. 5-21) for uncertainty-importance analysis.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response As shown in Figure 5.1-11 (CRWMS M&O 2000ar), water usage has an uncertainty importance factor of approximately 0.01 at 100,000 years. This is consistent with the conclusion stated on page 5-21, based on the interpretation of Figure 5.2-16, that dose is relatively insensitive to uncertainty in water usage volume. Although not stated in the text on page 5-21 or in the caption to Figure 5.2-16, the conclusion of relative insensitivity was intended to apply to the first 100,000 years, consistent with the analyses shown in Figure 5.2-16. Figure 5.1-11 shows that the relative importance of water usage rises somewhat after 100,000 years, but it remains a minor contributor, compared to the Alloy 22 general corrosion rate, until quite late in the simulation (900,000 years and beyond). As shown in Figure 5.1-11, relative importance of different components of the system change through time. In particular, importance of parameters affecting radionuclide concentrations in the natural barrier system (groundwater flux) and the biosphere (water usage) tends to increase as engineered barriers degrade.

The relevant figures and text are correct in TSPA-Site Recommendation (CRWMS M&O 2000ar) (except for an editorial error in the last paragraph in Section 5.2.8.2, page 5-21, where "BDCFs" should be "water usage volume"). The conclusions in Section 5.2 are based on interpretation of analyses for 100,000 years only (or 20,000 years for igneous groundwater release cases). The million-year analyses are discussed in Section 5.1.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective J-TT1.8

Tracking # J-TT1.8

Comment The area covered by the infiltration bins do not appear to cover the entire repository waste emplacement area. It is not clear what infiltration rate is used for the areas not covered by the infiltration bins (CRWMS M&O, 2000; Figures 3.3-3 and 4.1-16).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The waste-emplacement area does not cover the whole area inside the perimeter drift. The infiltration bins include the entire loaded area, as modeled.

Agreement Number

Agreement DOE response during Technical Exchange was considered adequate by the NRC. Total System Performance Assessment and Integration Technical Exchange, August 6-10, 2001.

Subissue #4 - Overall Performance Objective OPO-1

Tracking # OPO-1

Comment Stability of analyses and calculations has not been demonstrated.

There are many areas in the performance assessment where stochastic (Monte Carlo) calculations are performed. When performing Monte Carlo calculations it is important to verify that stability of the output has been attained. Stability verification applies to the final output (peak mean dose), sensitivity calculations, and process-level analyses where stochastic simulations are performed. Figure F4-23 was provided to address this issue. However, upon examining the data used to construct the figure, the dose at 100,000 years is increasing almost linearly with increasing realizations. Other areas are identified as example with possible stability problems.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000a.
CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000b.

DOE Response DOE will provide better justification of the stability of the expected annual dose and supporting analyses. Note that the figure referenced in the NRC comment is Figure 4.1-22 on page F4-23 of the TSPA-Site Recommendation (CRWMS M&O 2000ar).

See also previous response to NRC Comment J-O3.17.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.4.03, TSPAI.4.04

Agreement TSPAI.4.03
DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1

TSPAI.4.04
DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex1

Tracking # OPO-1.Ex1

Comment Has a stability check been done related to Item #3 on page 58 of CRWMS M&O (2000)?

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The stability check has been performed and will be documented in the TSPA-License Application Model Report.

Agreement Number TSPAI.4.04

Agreement DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex2

Tracking # OPO-1.Ex2

Comment Only 100 realizations worth of uncertain SZ results are produced and then replicated for simulations with more realizations (CRWMS M&O, p. 109).

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Multiple replicates of 100 realizations may not get carried forward because of lack of sensitivity of infiltration in the saturated zone.

For future TSPA runs, the use of 300 realizations of the Saturated Zone model results is planned, even though the sensitivity of the overall model results to Saturated Zone parameters is relatively minor.

Agreement Number TSPAI.4.03

Agreement DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex3

Tracking # OPO-1.Ex3

Comment Are human intrusion calculations stable with respect to realizations and time-stepping (CRWMS M&O, p. 516)?

References CRWMS M&O. "Total System Performance Assessment (TSPA) Model for Site Recommendation." MDL-WIS-PA-000002 Revision 00. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Human intrusion calculations for 300 realizations have been conducted. The calculations result in lower peak dose during the 10,000-year time frame. Both 300 and 100 realizations are well below the regulatory limit. The supporting basis the number of realizations will be documented in the TSPA-License Application Technical Report and the time-stepping in the TSPA-License Application Model Report.

Agreement Number TSPAI.4.03, TSPAI.4.04

Agreement TSPAI.4.03
DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

TSPAI.4.04
DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex4

Tracking # OPO-1.Ex4

Comment The insensitivity of results to the number of drip-shield patches does not necessarily mean that a larger number of waste package patches will be sufficient. If the waste package functions differently it may still have significant stability problems at 1000 patches (CRWMS M&O, p. 3-89).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Analyses shown in the Waste Package Degradation Model (CRWMS M&O 2000az, Section 6.4.3) serve as sufficient evidence of the appropriateness of the number of drip shield patches, waste package patches, and number of drip shield waste package pairs selected for the analyses. Analogous analyses have been completed in analogous Analysis/Model Reports for other stochastic simulation models used within the TSPA.

Reference: CRWMS M&O 2000az. WAPDEG Analysis of Waste Package and Drip Shield Degradation. ANL-EBS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001208.0063.

Agreement Number TSPAI.4.04

Agreement DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex5

Tracking # OPO-1.Ex5

Comment Where is the information provided regarding the stability of the results as a function of the size of the time-steps used in the PA (CRWMS M&O, p. 3-93)?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Stability results will be documented in the TSPA-License Application Model Report.

Agreement Number TSPAI.4.04

Agreement DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex6

Tracking # OPO-1.Ex6

Comment Was a test done for the stability of the regression analysis results to verify these important calculations are not numerical aberrations (CRWMS M&O, p. 5-2)?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The statistical significance of regression coefficients was determined using the F-test.

Agreement Number TSPAI.4.03

Agreement DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex7

Tracking # OPO-1.Ex7

Comment It is likely the sensitivity results are unstable with only 100 realizations completed (CRWMS M&O, p. 5-9).

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response DOE recognizes that sensitivity analyses that are used to support regulatory compliance (e.g., those that are used for multiple barrier analyses) will need to be done with sufficient sample size to be stable. In TSPA-SR Section 5.1, the calculations were performed with 300 realizations which seems to produce stable results.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.4.04

Agreement DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex8

Tracking # OPO-1.Ex8

Comment What are the biggest blocks and the stability or confidence in the Monte Carlo simulations of the biggest block size (CRWMS M&O, p. 3-47)?

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response The verification that stability of the rockfall model output has been attained is provided in the Drift Degradation Analysis (CRWMS M&O 2000cd, Attachment IV). Additional sensitivity calculations for the rockfall model have been conducted as documented in the Supplemental Science and Performance Analysis Vol. 1 (BSC 2001e, Section 6.3.4), including a more detailed assessment of the stability of the output from the Monte Carlo simulations in the rockfall model. These supplemental analyses provided block size distributions for a range of Monte Carlo simulations up to 800, demonstrating that the rockfall model is stable at 400 simulations (i.e., the model produces a consistent maximum block and a consistent frequency of blocks). The largest blocks simulated in the rockfall model include 14.0 cubic meters in the Tptpmn unit, 1.3 cubic meters in the Tptpll unit, and 57.3 cubic meters in the Tptpln unit (Drift Degradation Analysis, Tables 23, 24, and 25).

References: CRWMS M&O 2000cd. Drift Degradation Analysis. ANL-EBS-MD-000027 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001206.0006.

BSC 2001e. FY01 Supplemental Science and Performance Analyses, Volume 1: Scientific Bases and Analyses. TDR-MGR-MD-000007 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010712.0062.

Agreement Number TSPAI.4.03, TSPAI.4.04

Agreement TSPAI.4.03
DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex8

TSPAI.4.04
DOE will conduct appropriate analyses and provide documentation that demonstrates the results of the performance assessment are stable with respect to discretization (e.g. spatial and temporal) of the TSPA model. This will be documented in the TSPA for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex9

Tracking # OPO-1.Ex9

Comment As shown in the figure on page F4-23, the mean base case results continue to increase with increasing number of realizations, exhibiting a 50% increase in the peak dose at 100,000 years when increasing the number of realizations from 100 to 500.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Page F4-23, Instability in mean base case results with increasing sample size: DOE acknowledge that the mean increases somewhat from 100 to 500 realizations. It increases from 62 to 72 or about 15%, not 50%. For any potential License Application DOE will conduct several replicate runs (with different random seeds) to show stability of the mean.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.4.03

Agreement DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.

Subissue #4 - Overall Performance Objective OPO-1.Ex10

Tracking # OPO-1.Ex10

Comment As shown on the figure on page F4-33, 10,000-year igneous results seem to increase significantly with increasing number of realizations per simulation year.

References CRWMS M&O. "Total System Performance Assessment for the Site Recommendation." TDR-WIS-PA-000001 Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000.

DOE Response Note that the appropriate test is not whether or not the mean shifts from one sample size to the next, but rather whether or not the mean is stable at the largest sample size shown. Thus, the change from 1000 to 5000 is not unexpected. DOE intends to show that the mean is stable at 5000. For any potential License Application, several replicates will be conducted to show that the mean is stable.

Reference: CRWMS M&O 2000ar. Total System Performance Assessment for the Site Recommendation. TDR-WIS-PA-000001 REV 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001220.0045.

Agreement Number TSPAI.4.03

Agreement DOE will document the method that will be used to demonstrate that the overall results of the TSPA are stable. DOE will provide documentation that submodels (including submodels used to develop input parameters and transfer functions) are also numerically stable. DOE will address in the method the stability of the results with respect to the number of realizations. DOE will describe in the method the statistical measures that will be used to support the argument of stability. The method will be documented in TSPA LA Methods and Assumptions Document in FY02. The results of the analyses will be provided in the TSPA (or other appropriate documentation) for any potential license application in FY 2003.