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Use of Infiltration Model Results in the Total System Performance Assessment

Presented to:
NRC/DOE Technical Exchange on Infiltration at Yucca Mountain

Presented by:
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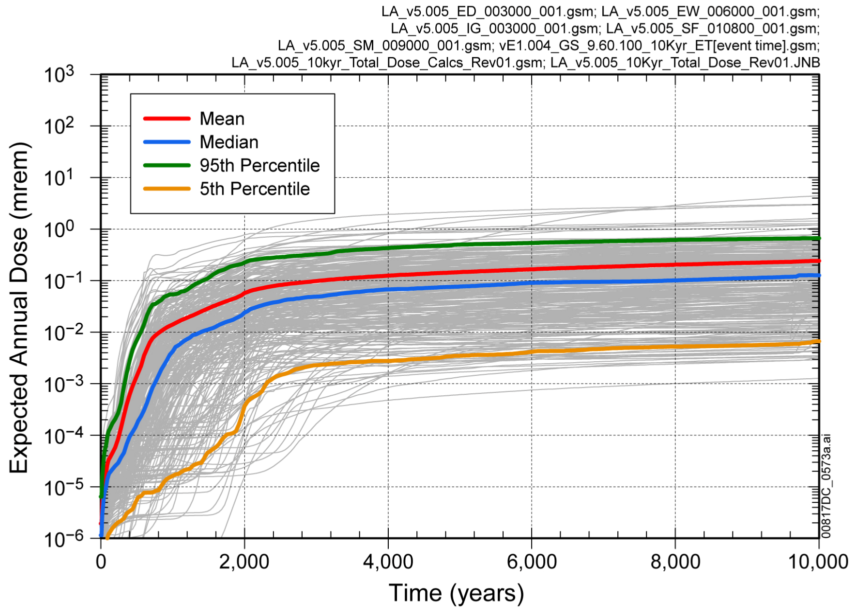
Sandia National Laboratories

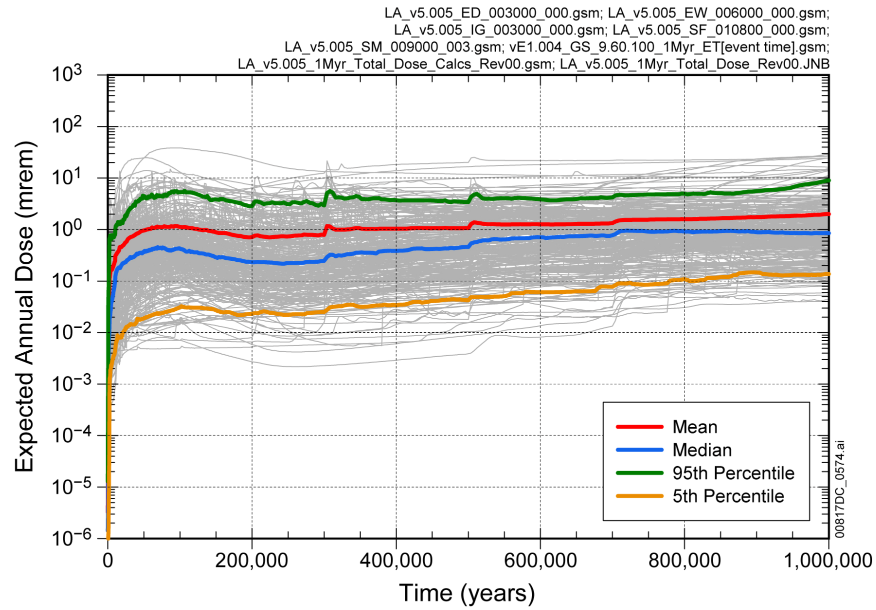
April 2, 2008
Las Vegas, Nevada

Total System Performance Assessment Results

Total Mean and Median Annual Dose



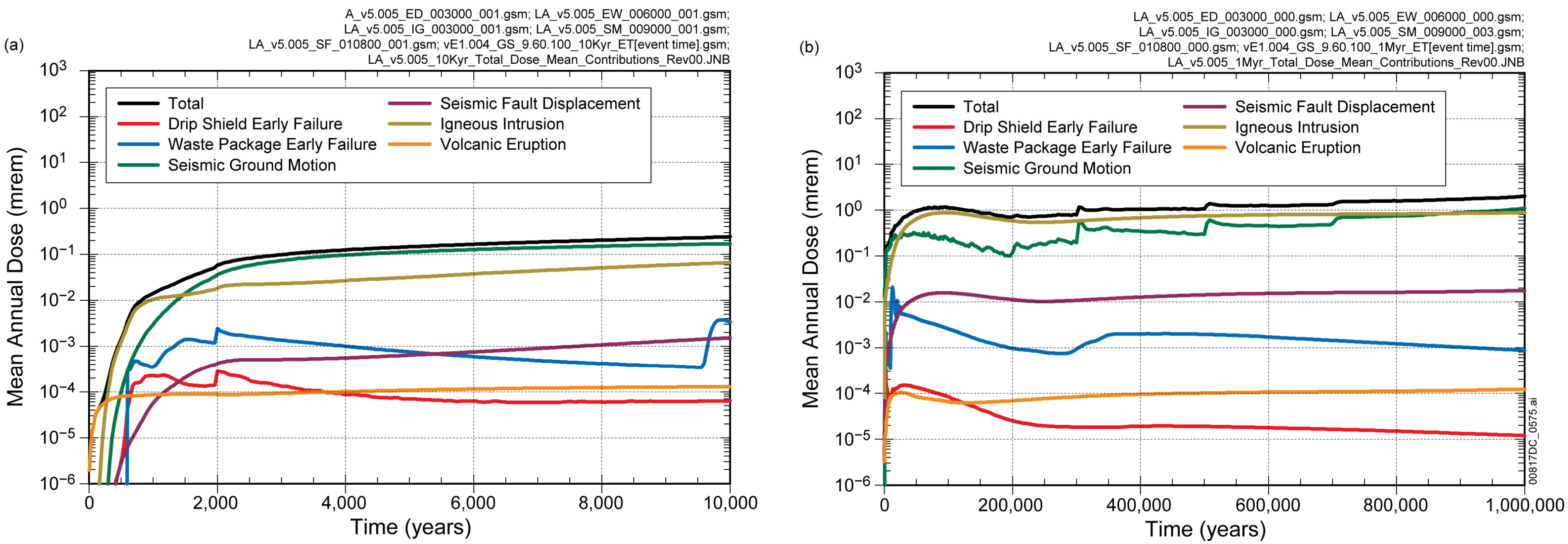
10,000 years



1,000,000 years

MDL-WIS-PA-000005 REV 00 AD 01, Figure 8.1-1[a] and Figure 8.1-2[a]

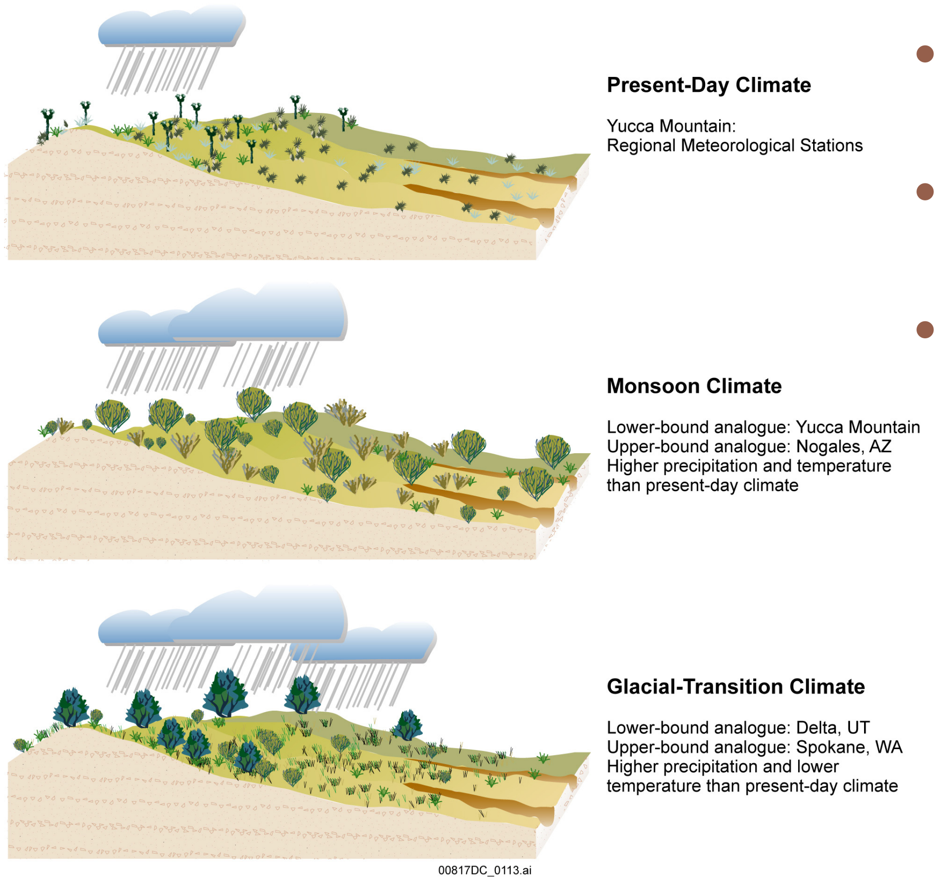
TSPA Results: Modeling Cases Contributing to Total Mean Annual Dose



10,000 years **1,000,000 years**

MDL-WIS-PA-000005 REV 00 AD 01, Figure 8.1-3[a].

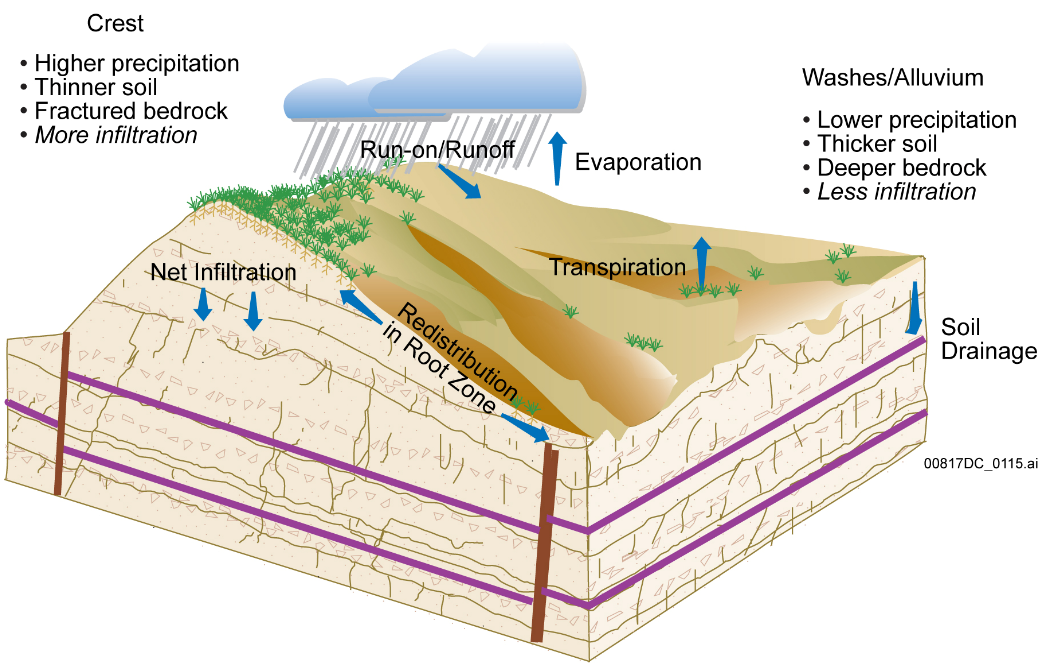
Future Climate Analysis for TSPA-LA



MDL-WIS-PA-000005 REV 00 Figure 6.3.1-3

- **Analysis outputs used in downstream models**
- **Infiltration model: precipitation and temperature**
- **TSPA: climate state durations**
  - **0-600 years: present day climate**
  - **600-2,000 years: monsoon climate**
  - **2,000-10,000 years: glacial transition climate**
  - **After 10,000 years: proposed regulatory specification of constant climate characterized by uncertain percolation flux**

Infiltration Model



MDL-WIS-PA-000005 REV 00 Figure 6.3.1-5

- **Model Inputs**
  - **Described in MDL-NBS-HS-000023 REV 01 AD 01 and later presentation**
- **Model outputs**
  - **Uncertainty characterized by 40 infiltration maps for each climate state**
  - **10th, 30th, 50th, and 90th percentile maps provided to Unsaturated Zone (UZ) flow model for each climate state (12 maps)**
  - **Weighting for TSPA established consistent with data from UZ (MDL-NBS-HS-000006 REV 03 and later presentation)**
- **Uncertainty propagated into TSPA**
  - **Sampled pointer variable used to select infiltration map**

Weighting Infiltration Maps in TSPA

- **Infiltration maps were generated independent of field data from deep unsaturated zone**
- **Chloride content and temperature at depth provide information about past infiltration and percolation flux**
- **Generalized Likelihood Uncertainty Estimation (GLUE) method used to establish infiltration map weights consistent with data from depth**
  - **See MDL-NBS-HS-000006 REV 003 Section 6.8 and later presentation**

Infiltration Case	Present-Day Climate (mm/yr)	Monsoon Climate (mm/yr)	Glacial-Transition Climate (mm/yr)	Post-10k Years (mm/yr) [a]	Probability-Weighting Factors (All Climate States)
10th Percentile	3.03	6.74	11.03	16.89	0.6191
30th Percentile	7.96	12.89	20.45	28.99	0.1568
50th Percentile	12.28	15.37	25.99	34.67	0.1645
90th Percentile	26.78	73.26	46.68	48.84	0.0596

Sources: SNL 2007 [DIRS 184614], Tables 6.1-2, 6.1-3, and LB0701PAWFINFM.001_R0 [DIRS 179283].

[a] Note that for the Post 10,000 Years data the Infiltration cases differ and represent scaled versions of the present-day 90th percentile, the 50th percentile Glacial Transition, the 90th percentile glacial transition, and the 90th percentile monsoon maps, respectively.

Net Infiltration Rates Averaged over the Unsaturated Zone Model Domain and Probability-Weighting Factors for the Infiltration Scenarios

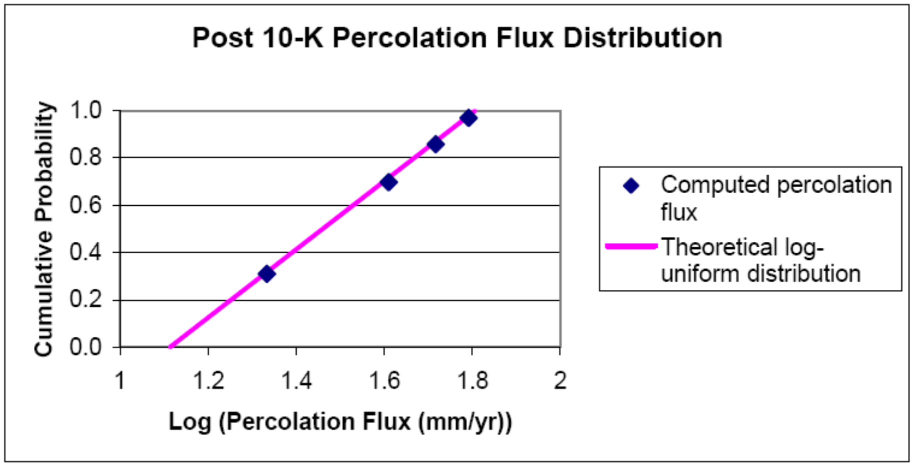
Source: MDL-WIS-PA-00005 REV 00 Table 6.3.1-2.

Uncertainty in Climate after 10,000 Years

- **Proposed 10 CFR Part 63.342(c)(2):**
  - "The constant value to be used to represent climate change is to be based on a log-uniform probability distribution for deep percolation rates from 13 to 64 mm/yr" (70 FR 53320)
  - I.e., constant, but uncertain, deep percolation flux with a specified spatial average over the repository footprint
    - Log-uniform, 13-64 mm/yr
- **Project approach (MDL-NBS-HS-000006 REV 03, Section 6.1.4)**
  - Spatially averaged flux at repository horizon ± 3% of spatially averaged infiltration
  - Repository footprint average infiltration for 12 maps (10^{th}, 30^{th}, 50^{th}, and 90^{th} percentiles for 3 climate states) provides basis for fitting specified log-uniform distribution

Uncertainty in Climate after 10,000 Years

- **Project approach to post-10 kyr uncertainty in climate**
  - Calculate repository-footprint average infiltration for 12 infiltration maps
  - Identify “target values” on proposed NRC distribution that correspond to midpoints of weighting factors used for pre-10 kyr infiltration
  - Scale maps with closest average infiltration values to match targets
  - Calculate corresponding UZ flow fields for each of four post-10 kyr maps
  - Use in TSPA with same weighting factors used in pre-10 kyr analyses



Percentile	Average Infil of Selected Map Over UZ Model Domain		Target Average Infil within Repository Footprint	
	Average (mm/yr)	Scenario	Rate (mm/yr)	Mid-point Cumulative Probability
10	16.89	present-day 90th percentile	21.29	0.3096
30	28.99	glacial transition 50th percentile	39.52	0.6975
50	34.67	glacial transition 90th percentile	51.05	0.8582
90	48.84	monsoon 90th percentiles	61.03	0.9702

Source: MDL-NBS-HS-000006 REV 03, Table 6.1-3 and Figure 6.1-6

TSPA Sensitivity Analysis Results 10,000-year Total Mean Annual Dose

(a)

	3,000 Years			5,000 Years			10,000 Years		
Step[a]	Variable[b]	R^{2c}	SRRC[d]	Variable	R^2	SRRC	Variable	R^2	SRRC
1	SCCTHRP	0.55	−0.72	SCCTHRP	0.66	−0.79	SCCTHRP	0.69	−0.83
2	IGRATE	0.62	0.28	IGRATE	0.71	0.24	IGRATE	0.73	0.22
3	SZGWSPDM	0.67	0.21	SZGWSPDM	0.74	0.15	SZGWSPDM	0.76	0.16
4	INFIL	0.71	0.19	MICTC99	0.76	0.14	MICTC99	0.77	0.14
5	MICTC99	0.73	0.15	MICC14	0.78	0.12	WFDEGEXF	0.78	0.10
6	SZFISPVO	0.75	0.14	INFIL	0.79	0.11	MICC14	0.79	0.11
7	MICC14	0.76	0.12	DSNFMASS	0.80	0.11	UZGAM	0.80	−0.09
8	DSNFMASS	0.77	0.10	SZFISPVO	0.81	0.09	INFIL	0.81	0.09
9	UZFAG8	0.78	−0.10	UZFAG8	0.82	−0.10	CSWFA0AC	0.81	−0.07
10	UZGAM	0.79	−0.09	UZGAM	0.82	−0.10	UZKDSRDT	0.82	0.07
11	SZDIFCVO	0.79	−0.08	WFDEGEXF	0.83	0.10			
12	WFDEGEXF	0.80	0.08	WDCRCDEN	0.83	0.08			
13	KDUSMEC	0.80	0.08	WDZOLID	0.84	−0.07			
14	MICPA231	0.81	−0.08	WDGCUA22	0.84	0.07			
15				BCKRA226	0.85	−0.06			

a: Steps in stepwise rank regression analysis
b: Variables listed in order of selection in stepwise regression
c: Cumulative R^2 value with entry of each variable into regression model
d: Standardized rank regression coefficients (SRRCs) in final regression model

MDL-WIS-PA-000005 REV 00 AD 01, Figure K8.1-2[a](a). Stepwise Rank Regression Analyses for Total Mean Expected Annual Dose for 10,000 Years after Closure

- **TSPA Regression Analyses:**
  - **Uncertain parameters contributing significantly to epistemic uncertainty in mean annual dose**
- **For total dose at 10,000 years, significant uncertain parameters are**
  - **Stress corrosion crack threshold**
  - **Probability of igneous intrusion**
  - **Saturated zone groundwater specific discharge**
  - **Infiltration map uncertainty appears as a minor contributor at early time only, when transport time uncertainty is significant**

TSPA Sensitivity Analysis Results 1,000,000-year Total Mean Annual Dose

(a)

	EXPDOSE: 50,000 Years			EXPDOSE: 200,000 Years			EXPDOSE: 500,000 Years		
Step[a]	Variable[b]	R^{2c}	SRRC[d]	Variable	R^2	SRRC	Variable	R^2	SRRC
1	SCCTHRP	0.27	−0.48	IGRATE	0.38	0.61	IGRATE	0.29	0.54
2	IGRATE	0.43	0.41	SZGWSPDM	0.48	0.28	WDGCA22	0.46	−0.38
3	SZGWSPDM	0.55	0.33	EP1LOWPU	0.53	0.23	SZGWSPDM	0.53	0.24
4	EP1LOWPU	0.60	0.20	SCCTHRP	0.57	−0.21	EP1LOWNU	0.56	0.19
5	MICNP237	0.62	0.11	SZFISPVO	0.60	0.15	MICNP237	0.59	0.16
6	INFIL	0.63	0.13	INFIL	0.62	0.16	EP1L0WPU	0.61	0.17
7	EP1NPO2	0.65	0.13	EP1NPO2	0.64	0.14	SZCONCOL	0.64	0.15
8	MICTC99	0.66	0.11	GOESITED	0.66	−0.14	SZFISPVO	0.66	0.15
9	ALPHAL	0.67	0.10	MICSE79	0.68	0.09	INFIL	0.67	0.11
10				MICNP237	0.69	0.14	GOESITED	0.68	−0.10
11				EP1LOWNU	0.70	0.11	SZKDCSVO	0.69	−0.10
12				SZCONCOL	0.71	0.11	HFOSITED	0.69	−0.09
13				PHCSS	0.72	−0.11	SZDIFCVO	0.70	−0.09
14				HFOSA	0.73	−0.09			
15				SZDIFCVO	0.73	−0.09			
16				SEEPCOND	0.74	−0.09			

MDL-WIS-PA-000005 REV 00 AD 01, Figure K8.2-2[a](a). Stepwise Rank Regression Analyses for Total Mean Expected Annual Dose for 1,000,000 Years after Closure

- **TSPA Regression Analyses:**
  - **Uncertain parameters contributing significantly to epistemic uncertainty in mean annual dose**
- **For total dose at 500,000 years, significant uncertain parameters are**
  - **Probability of igneous intrusion**
  - **Alloy 22 general corrosion temperature dependency**
  - **Saturated zone groundwater specific discharge**
  - **Infiltration map uncertainty is not significant**

Conclusions

- Infiltration incorporated in TSPA through UZ flow model
- Uncertainty in infiltration incorporated in TSPA through sampling on infiltration maps
  - Pre-10,000 years, weighting calibrated to UZ chloride and temperature data using Generalized Likelihood Uncertainty Estimation
  - Post-10,000 years, uncertainty treatment is prescribed by proposed rule
- Uncertainty associated with infiltration is a minor contributor to uncertainty in total dose

References

- **Bechtel SAIC 2004. *Future Climate Analysis*, ANL-NBS-GS-000008 Rev 01**
- **SNL 2007. *Simulation of Net Infiltration for Present-Day and Potential Future Climates*, MDL-NBS-HS-000023 Rev 01 (SNL 2008. Rev 03 AD 01)**
- **SNL 2007. *UZ Flow Models and Submodels*, MDL-NBS-HS-000006 Rev 03 (SNL 2007. Rev 03 AD 01; SNL 2008. Rev 03 AD 02 ACN 01).**
- **SNL 2008. *Total System Performance Assessment Model/Analysis for the License Application*, MDL-WIS-PA-000005 Rev 00 and Rev 00 AD01**

Uncertain Epistemic Parameters Appearing in Slides 11 and 12 (from MDL-WIS-PA-000005 REV 00 Table K3-1)

ALPHAL van Genuchten capillary strength parameter in lithophysal rock units (Pa). *Distribution:* Triangular. *Range:* -105 to 105. *Mean/Median/Mode:* 0. *TSPA-LA Name:* Alpha_Uncert_Lith_a. *Location in TSPA-LA:* Sections 6.3.3.1.2 and 6.3.3.1.3; Tables 6.3.3-1, 6.3.3-3 and 6.3.5-4
BCKRA226. Natural background levels of combined ^{226}Ra and ^{228}Ra in groundwater (pCi/L). *Distribution:* Truncated normal. *Range:* 0 to 0.71. *Mean/Median/Mode:* 0.5. *TSPA-LA Name:* Background_Ra226_Ra228_a. *Location in TSPA-LA:* Sections 6.3.10.2, 6.3.11.2, and Table 6.3.10-6.
CSWFA0AC. Correlated regression coefficient a0 in the abstracted rate model under acidic conditions (dimensionless). *Distribution:* Normal. *Mean/Median/Mode:* 0. *Standard Deviation:* 1. *TSPA-LA Name:* CSNF_WF_Uncert_a0_Acid_a. *Location in TSPA-LA:* Section 6.3.7.4.1.2; Equation 6.3.7-6.
DSNFMASS. Scale factor used to characterize uncertainty in radionuclide content of DSNF (dimensionless). *Distribution:* Triangular. *Range:* 0.45 to 2.9. *Most Likely:* 0.62. *TSPA-LA Name:* DSNF_Mass_Uncert_a. *Location in TSPA-LA:* Sections 6.3.7.1.2 and 6.3.7.1.3; Table 6.3.7-7.
EP1LOWPU. Logarithm of the scale factor used to characterize uncertainty in plutonium solubility at an ionic strength below 1 molal (dimensionless). *Distribution:* Truncated normal. *Range:* -1.4 to 1.4. *Mean/Median/Mode:* 0. *Standard Deviation:* 0.7. *TSPA-LA Name:* Pu_Eps_1_low_a. *Location in TSPA-LA:* Sections 6.3.7.5.1, 6.3.7.5.2 and 6.3.7.5.3; Table 6.3.7-44; Equation 6.3.7-13a.
EP1LOWNU. Logarithm of the scale factor used to characterize uncertainty in uranium solubility under nominal or seismic conditions at an ionic strength below 1 molal (dimensionless). *Distribution:* Truncated normal. *Range:* -1 to 1. *Mean/Median/Mode:* 0. *Standard Deviation:* 0.5. *TSPA-LA Name:* U_Eps_1_low_Nominal_a. *Location in TSPA-LA:* Section 6.3.7.5.1, 6.3.7.5.2 and 6.3.7.5.3; Table 6.3.7-54; Equation 6.3.7-13a.
EP1NPO2. Logarithm of the scale factor used to characterize uncertainty in NpO_2 solubility at an ionic strength below 1 molal (dimensionless). *Distribution:* Truncated normal. *Range:* -1.2 to 1.2. *Mean:* 0. *Standard Deviation:* 0.6. *TSPA-LA Name:* NpO2_Eps_1_low_a. *Location in TSPA-LA:* Sections 6.3.7.5.1, 6.3.7.5.2 and 6.3.7.5.3; Table 6.3.7-43; Equation 6.3.7-13a.
GOESITED. Density of sorption sites on goethite (1/nm^2). *Distribution:* Discrete. *Range:* 1.02 to 8.59. *TSPA-LA Name:* Goethite_Site_Density_a. *Location in TSPA-LA:* Table 6.3.8-3.
HFOSA. Hydrous ferric oxide (HFO) surface area (m^2/g). *Distribution:* Truncated log normal. *Range:* 68 to 600. *Mean:* 275.6. *Standard Deviation:* 113.4. *TSPA-LA Name:* HFO_SA_a. *Location in TSPA-LA:* Table 6.3.8-4; S_{CP} in Equation 6.3.8-19.
HFOSA. Hydrous ferric oxide (HFO) surface area (m^2/g). *Distribution:* Truncated log normal. *Range:* 68 to 600. *Mean:* 275.6. *Standard Deviation:* 113.4. *TSPA-LA Name:* HFO_SA_a. *Location in TSPA-LA:* Table 6.3.8-4; S_{CP} in Equation 6.3.8-19.
HFOSITED. Sorption site density for hydrous ferric oxide (HFO) (1/nm^2). *Distribution:* Discrete. *Range:* 0.56 to 5.65. *TSPA-LA Name:* HFO_Site_Density_a. *Location in TSPA-LA:* Table 6.3.8-3.
IGRATE. Frequency of intersection of the repository footprint by a volcanic event (yr^{-1}). *Distribution:* Piecewise uniform. *Range:* 0 to 7.76E-07. *TSPA-LA Name:* Igneous_Event_Prob_a. *Location in TSPA-LA:* Table 6.5-2.
INFIL. Pointer variable for determining infiltration conditions: 10th, 30th, 50th or 90th percentile infiltration scenario (dimensionless). *Distribution:* Discrete. *Range:* 1 to 4. *TSPA-LA Name:* Infiltration_Scenario_a. *Location in TSPA-LA:* Section 6.3.1.2; Tables 6.3.1-2 and 6.3.5-4.
KDUSMEC. Distribution coefficient for reversible sorption of uranium to waste form (smectite) colloids (mL/g). *Distribution:* Log uniform. *Range:* 5.00E+02 to 5.00E+04. *TSPA-LA Name:* Kd_U_Rev_Smectite_a. *Location in TSPA-LA:* Sections 6.3.7.6.2 and 6.3.7.6.3; Equation 6.3.7-20; Tables 6.3.7-62 and 6.3.7-66.
MICC14. Groundwater Biosphere Dose Conversion Factor (BDCF) for ^{14}C in modern interglacial climate ((Sv/year)/(Bq/m^3)). *Distribution:* Discrete. *Range:* 7.18E-10 to 2.56E-08. *Mean:* 1.93E-09. *Standard Deviation:* 1.85E-09. *TSPA-LA Name:* GW_BDCF_MIC_C14. *Location in TSPA-LA:* Sections 6.3.11.2 and 6.3.11.3; Table 6.3.11-3.
MICNP237. Groundwater Biosphere Dose Conversion Factor (BDCF) for ^{237}Np in modern interglacial climate ((Sv/year)/(Bq/m^3)). *Distribution:* Discrete. *Range:* 1.06E-07 to 8.05E-07. *Mean:* 2.74E-07. *Standard Deviation:* 9.70E-08. *TSPA-LA Name:* GW_BDCF_MIC_Np237. *Location in TSPA-LA:* Sections 6.3.11.2 and 6.3.11.3; Table 6.3.11-3.
MICPA231. Groundwater Biosphere Dose Conversion Factor (BDCF) for ^{231}Pa in modern interglacial climate ((Sv/year)/(Bq/m^3)). *Distribution:* Discrete. *Range:* 6.58E-07 to 8.56E-06. *Mean:* 2.44E-06. *Standard Deviation:* 1.02E-06. *TSPA-LA Name:* GW_BDCF_MIC_Pa231. *Location in TSPA-LA:* Sections 6.3.11.2 and 6.3.11.3; Table 6.3.11-3.

Uncertain Epistemic Parameters Appearing in Slides 11 and 12 (from MDL-WIS-PA-000005 REV 00 Table K3-1) (continued)

MICSE79. Groundwater Biosphere Dose Conversion Factor (BDCF) for ^{79}Se in modern interglacial climate. ((Sv/year)/(Bq/m^3)). *Distribution:* Discrete. *Range:* 3.62E-09 to 1.51E-06. *Mean:* 2.42E-08. *Standard Deviation:* 7.48E-08. *TSPA-LA Name:* GW_BDCF_MIC_Se79. *Location in TSPA-LA:* Sections 6.3.11.2 and 6.3.11.3; Table-6.3.11-3.
MICTC99. Groundwater Biosphere Dose Conversion Factor (BDCF) for ^{99}Tc in modern interglacial climate ((Sv/year)/(Bq/m^3)). *Distribution:* Discrete. *Range:* 5.28E-10 to 2.85E-08. *Mean:* 1.12E-09. *Standard Deviation:* 1.26E-09. *TSPA-LA Name:* GW_BDCF_MIC_Tc99. *Location in TSPA-LA:* Sections 6.3.11.2 and 6.3.11.3; Table-6.3.11-3.
PHCSS. Pointer variable used to determine pH in CSNF Cell1 under liquid influx conditions (dimensionless). *Distribution:* Uniform. *Range:* 0 to 1. *TSPA-LA Name:* Inpkg_pH_CSNF_S_Rand_a. *Location in TSPA-LA:* Section 6.3.7.2.2 Part IV.
SEEPCON. Pointer variable to determine the seepage/condensation regime for the first failed waste package in a percolation subregion (dimensionless). *Distribution:* Uniform. *Range:* 0 to 1. *TSPA-LA Name:* Seepage_Condensation_Prob_a*.
SCCTHRP. Residual stress threshold for SCC nucleation of Alloy 22 (as a percentage of yield strength in MPa) (dimensionless). *Distribution:* Uniform. *Range:* 90 to 105. *TSPA-LA Name:* Stress_Thresh_A22_a. *Location in TSPA-LA:* Section 6.6.1.3.7; Table 6.6-2.
SZCONCOL. Logarithm of ambient concentration of colloids in groundwater (g/mL). *Distribution:* Piecewise uniform. *Range:* -9 to -3.6. *TSPA-LA Name:* Conc_Col. *Location in TSPA-LA:* Table 6.3.10-2.
SZDIFCVO. Logarithm of effective diffusion coefficient in fractured volcanic units (m^2/s). *Distribution:* Piecewise uniform. *Range:* -11.3 to -9.3. *TSPA-LA Name:* DCVO. *Location in TSPA-LA:* Sections 6.3.10.2 and 6.3.10.5; Table 6.3.10-2.
SZFISPVO. Flowing interval spacing in fractured volcanic units (m). *Distribution:* Piecewise uniform. *Range:* 1.86 to 80. *TSPA-LA Name:* FISVO. *Location in TSPA-LA:* Section 6.3.10.5; Table 6.3.10-2.
SZGWSPDM. Logarithm of the scale factor used to characterize uncertainty in groundwater specific discharge (dimensionless). *Distribution:* Piecewise uniform. *Range:* -0.951 to 0.951. *TSPA-LA Name:* GWSPD. *Location in TSPA-LA:* Section 6.3.10.2; Table 6.3.10-2.
SZKDCSVO. Cesium sorption coefficient in volcanic units (mL/g). *Distribution:* Piecewise uniform. *Range:* 100 to 6783. *TSPA-LA Name:* Kd_Cs_Vo. *Location in TSPA-LA:* Section 6.3.10.2; Table 6.3.10-2.
UZFAG8. Fracture aperture for group 8 rock units (tswf[4,5], tswf[6,7], tswf8, pcf38) (m). *Calculated by:* Por_group8_a/ff_group8_a. *TSPA-LA Name:* fa_group8_a. *Location in TSPA-LA:* Section 6.3.9.2; Equation 6.3.9-2; Fracture porosity values and frequency values are shown in Tables 6.3.9-6 and 6.3.9-7.
UZGAM. Active fracture model (AFM) Gamma parameter (dimensionless). *Distribution:* Uniform. *Range:* 0.2 to 0.6. *TSPA-LA Name:* Gamma_AFM_a. *Location in TSPA-LA:* Sections 6.3.9.2, 6.3.9.3 and 6.3.9.4.1; Table 6.3.9-5.
UZKDSRDT. Sorption coefficient for strontium in devitrified tuff units of UZ (mL/g). *Distribution:* Uniform. *Range:* 10 to 70. *TSPA-LA Name:* KdSr_Devit_a. *Location in TSPA-LA:* Sections 6.3.9.2 and 6.3.9.3; Equation 6.3.9-3; Table 6.3.9-2.
WDCRCDEN. Ratio of SCC area to unit of seismic damaged area for a waste package (dimensionless). *Distribution:* Uniform. *Range:* 0.00327 to 0.0131. *TSPA-LA Name:* WP_Crack_Area_Density_a. *Location in TSPA-LA:* Table 6.6-2.
WDGCA22. Temperature dependent slope term of Alloy 22 general corrosion rate (K). *Distribution:* Truncated normal. *Range:* 666 to 7731. *Mean:* 4905. *Standard Deviation:* 1413. *TSPA-LA Name:* C1_GenCorr_A22_a. *Location in TSPA-LA:* Sections 6.3.5.1.2 and 6.3.5.1.3; Tables 6.3.5-3 and 6.3.5-4; Equation 6.3.5-4.
WDGCUA22. Variable for selecting distribution for general corrosion rate (low, medium, or high) (dimensionless). *Distribution:* Discrete. *Range:* 1 to 3. *TSPA-LA Name:* GC_ULevel_A22_a. *Location in TSPA-LA:* Table 6.3.5-4.
WDZOLID. Deviation from median yield strength range for outer lid (dimensionless). *Distribution:* Truncated normal. *Range:* -3 to 3. *Mean/Median/Mode:* 0. *Standard Deviation:* 1. *TSPA-LA Name:* z_OL_a. *Location in TSPA-LA:* Sections 6.3.5.1.2 and 6.3.5.1.3; Table 6.3.5-3.
WFDEGEXF. The surface area exposure factor for the amount of HLW glass contacted by water (dimensionless). *Distribution:* Triangular. *Range:* 4 to 17. *Mode:* 4. *TSPA-LA Name:* Exposure_Factor_a. *Location in TSPA-LA:* Sections 6.3.7.4.3.2 and 6.3.7.4.3.3; Equation 6.3.7-9; Table 6.3.7-32.