Saltstone Disposal Facility Performance Assessment

DOE Responses and Approaches to Second Round of NRC Requests for Additional Information

April 27, 2010

Closure and Waste Disposal Authority
Savannah River Remediation

SRR-CWDA-2011-00081

Second Round of NRC RAIs Summary

- 50 RAIs in First Round
  - NRC categorization
    - 14 responses closed
    - 3 transferred to monitoring activities
    - 33 require further information
- 21 Clarifying Questions
  - 20 responses closed
  - 1 requires further information
- 20 New RAIs in Second Round

Second Round of NRC RAIs Summary

- 34 RAIs from First Round
  - 2 considered monitoring issues
  - 1 response (PA-3) provided in PA-4
- 1 Clarifying question from First Round
- 20 New RAIs
- 55 Responses total

Second Round of NRC RAI Responses

- First Package
  - 19 Responses
  - Response summaries provided
- Second Package
  - 36 Responses
  - Proposed approach summaries provided

Second Round of RAIs – 1st Package

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First Package RAIs (19 responses)

- Includes RAIs that could be prepared in a timely manner
- Developed dose methodology for use in second package RAIs
- First package includes the following
  - PA-6, PA-12, PA-13
  - IN-5, IN-6
  - SP-14, SP-15, SP-18
  - VP-5
  - FFT-1, FFT-2
  - B-1, B-2, B-3, B-4, B-5
  - C-8, C-22, C-23

Second Round of RAIs – 2nd Package

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Second Package RAIs (36 responses)

- Requires additional PORFLOW runs
  - New sensitivity case (Case K)
    Supports responses to 16 RAIs
  - Additional sensitivity case for RAI SP-4
  - Current model with additional radionuclides supports response to RAIs PA-4 and PA-9
- Requires additional GoldSim transport runs
  Supports response to PA-5
- Remaining 17 RAIs

Second Round of RAIs – 1st Package

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- RAI PA-6
- NRC Comment Summary
  - Provide a list of the radionuclides that were included in the 40,000-year PORFLOW dose calculation (see Section 5.5.1.5)
- DOE Response Summary
  - The requested list of radionuclides was provided as follows

Inventory Inputs		Concentration Outputs
I-129	⇨	Ac-227 Tc-99
Np-237		I-129 Th-229
Pu-238		Np-237 Th-230
Tc-99		Pa-231 U-233
Th-230	⇨	Pb-210 U-234
U-234		Pu-238 U-235
U-235		Ra-226

Second Round of RAIs – 1st Package

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- RAI PA-12
- NRC Comment Summary
  - Provide additional information about the disposal of containerized waste from Vault 4 operations and soil remediation
- DOE Response Summary
  - NRC referenced a letter from SCDHEC to DOE as part of an ongoing discussion
    - Studies are ongoing—no final decision has been made
  - Operational conditions are not representative of the closure conditions
  - The facility is still in operation so current inventory is not representative of final closure

Second Round of RAIs – 1st Package

- RAI PA-13
- NRC Comment Summary
  - Assess doses from increased water through vaults prior to cap completion
- DOE Response Summary
  - Drain systems will remove water from vaults and future disposal cells
  - Operational control of disposal units includes timely removal of water
  - The time between the end of the operational life for a disposal unit and closure activities is expected to be short
  - Impacts of potential increased oxygen is not risk-significant to the PA results

Second Round of RAIs – 1st Package

- RAI IN-5
- NRC Comment Summary
  - Provide information about the Vault 4 Th-230 inventory and the process used to confirm all risk-significant radionuclides have been identified
- DOE Response Summary
  - To ensure all risk significant radionuclides were identified for this PA, a conservative approach was used with Th-230 and Ra-226 in equilibrium with their parent U-234
  - DOE is confident that the sufficient constituents have been evaluated
  - Future SDF inventory estimates will be based on samples from Tank 50

Second Round of RAIs – 1st Package

- RAI IN-6
- NRC Comment Summary
  - Provide additional information about changes to the salt solution feed batch preparation tanks and the sampling methodology that will be used for these tanks
- DOE Response Summary
  - Current plans are to continue to use Tank 50 for the low-level waste streams destined for disposal in SDF
  - No change to the salt solution feed batch preparation tanks

Second Round of RAIs – 1st Package

- RAI SP-14
- NRC Comment Summary
  - Iodine K_d values consistent with simulated saltstone measurements should be used in the PA
  - Future research should include the sorption of radium onto simulated saltstone, particularly under oxidizing conditions
- DOE Response Summary
  - After finishing the SDF PA, a new report was issued with K_d values for iodine sorbed to saltstone (SRNL-STI-2009-00636)
    - K_d values in the SDF PA are consistent with measured values
  - Future work regarding radium sorption studies will be considered

Second Round of RAIs – 1st Package

- RAI SP-15
- NRC Comment Summary
  - DOE should use a technetium K*d* value consistent with values measured by SRS staff for the saltstone wasteform in the PA
    - The basis for the adopted pseudo-Kd of 1,000 mL/g for reducing conditions is unclear
    - NRC does not believe that the "recommended values" are applicable to the saltstone wasteform

Second Round of RAIs – 1st Package

- RAI SP-15 (cont'd)
- DOE Response Summary
  - Modeling parameters used in the PA are supported by existing literature and experimental results
    - Experiments conducted under reducing conditions obtained Tc K*d* values of approximately 1,000 mL/g in nominal saltstone
    - The site-specific reduction capacity is consistent with literature values of cementitious materials with blast furnace slag
    - Only trace concentrations of atmospheric oxygen at high pH levels of cementitious systems is required to maintain technetium as Tc(VII)
    - The wide variability of measured K*d* values, such that they are either very low (~ 1 mL/g), or they are very high (~ 1,000 mL/g), appears to be the result of experimental conditions, especially direct controls of oxygen contact with the sample

Second Round of RAIs – 1st Package

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- RAI SP-18
- NRC Comment Summary
  - Justify the sandy-soil-based uncertainty distribution for cementitious Kd values and the conclusion that this does not underestimate uncertainty
- DOE Response Summary
  - 9 radionuclides from 27 samples were measured to assign variability, range, and distribution types
  - Uncertainty ranges used mean K*d* values bounded by ±25% for sandy soil and ±50% for clayey soil
  - Uncertainty approach is the best available approach given the lack of measured cement K*d* information

Second Round of RAIs – 1st Package

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- RAI VP-5
- NRC Comment Summary
  - Show that recent events and discrete features will have a negligible impact on the dose results
  - Alternatively, reevaluate the expected performance of Vaults 1, 2, and 4
- DOE Response Summary
  - New disposal units will not be used until performance of the engineered barriers are consistent with the PA
    - Design changes will mitigate the deficiencies referenced in the NRC's comment
  - Note that Vaults 1 and 4 were modeled in the PA with cementitious material properties that reflect the known conditions (i.e., fractured concrete)

Second Round of RAIs – 1st Package

- RAI FFT-1
- NRC Comment Summary
  - Justify the uncertainty ranges used for K_d values in site soils
- DOE Response Summary
  - Geology of the GSA has relatively uniform stratigraphy
    - The complex Upland unit represents only a thin layer at the top of the model
    - Geologic formations below the Upland unit comprise the majority of the SDF footprint and has consistent and predictable characteristics
    - The radionuclides evaluated for K_d variability represent a broad range of elemental K_d values

Second Round of RAIs – 1st Package

- RAI FFT-2
- NRC Comment Summary
  - Provide the document: SRR-CWDA-2010-00057
  - If the measured Ra K_d value is significantly different than as assumed in the PA, the new value should be used in a revised base case
- DOE Response Summary
  - The requested document was provided
  - For radium, recommended K_d values increased from 5 to 25 mL/g for sandy soils and from 17 to 185 mL/g for clayey soils
    - Because the K_d values for radium have increased, the modeling results for radium in the SDF PA are considered conservative

Second Round of RAIs – 1st Package

- RAI B-1
- NRC Comment Summary
  - Provide technical basis for the expected value and distributions of transfer factors used in the analysis
    - The basis for excluding biotic transfer factors from the uncertainty analysis is unclear
  - The impact of biotic transfer factor uncertainty should be part of the base case assessment

Second Round of RAIs – 1st Package

- RAI B-1 (cont'd)
- DOE Response Summary
  - DOE did not develop uncertainty ranges for the transfer factors during initial PA development for several reasons
  - PNNL-13421, ORNL-5786, and IAEA-364 set precedence applying geometric means to determine distributions
  - Applying the geometric mean did not result in significant underestimation of doses
  - Sensitivity analysis provided in the response to B-2 includes uses bioaccumulation factors from more current data, developed without use of geometric means

Second Round of RAIs – 1st Package

- RAI B-2
- NRC Comment Summary
  - Evaluate dose from poultry and egg pathways
  - Sufficient basis for excluding these pathways was not provided
- DOE Response Summary
  - An evaluation of the dose to the MOP from the poultry and egg ingestion was provided
    - Updated information on radionuclide transfer factors was used (per B-1)
    - Modified soil irrigation buildup factor was used (per B-3)
    - Revised soil-to-plant transfer factors and a garden productivity yields were used (per B-4)
    - The poultry and egg ingestion pathways are not significant contributors to the total dose
  - A similar evaluation will be provided for the intruder in the response to RAI II-1

Second Round of RAIs – 1st Package

- RAI B-3
- NRC Comment Summary
  - The base case PA model should include improved modeling of the build-up of radionuclides during multiple years of irrigation
- DOE Response Summary
  - Assessment takes credit for leaching and the build-up time is considered to be 25 years
  - Radionuclide-specific soil build-up factors were calculated and provided
  - The improved soil build-up model was included in the dose model described in response to B-2

Second Round of RAIs – 1st Package

- RAI B-4
- NRC Comment Summary
  - Include the leafy vegetable pathway explicitly in the plant pathway dose calculation and consider using EPA or NRC references for garden productivity data
- DOE Response Summary
  - Leafy vegetables were considered negligible to the total vegetable production
  - A sensitivity analysis incorporated several improvements and updates to the dose calculation based upon new references (see B-2)
    - The increases in total dose from the leafy vegetable pathway were negated by decreases in the updated water-to-fish transfer factor and an increase in the vegetation production yield

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Second Round of RAIs – 1st Package

- RAI B-5
- NRC Comment Summary
  - Modify the drinking water consumption rates to be consistent with the defined receptor and scenario
    - The drinking water consumption rate should be a minimum of 87% of the total water ingestion rate (392 L/yr)
- DOE Response Summary
  - The water ingestion rate in the PA (337 L/yr) is based on an EPA survey
    - For calculating dose, only the primary water source was assumed to be contaminated water (75% from a community well)
    - DOE performed a sensitivity analysis to determine the impact from increasing the consumption rate (results on next slide)

Second Round of RAIs – 1st Package

- RAI B-5 (cont'd)
  - Increasing the water ingestion rate 16% represents a 10% increase in the total dose for Sectors B and I

Peak Dose Comparison of Varied Water Ingestion from the 100-Meter Well for the MOP				
	10,000 yr Peak		20,000 yr Peak	
	337 L/yr	392 L/yr	337 L/yr	392 L/yr
Sector B Water Ingestion	6.9E-01 mrem/yr (77.1%)	8.1E-01 mrem/yr (79.6%)	1.3E+00 mrem/yr (65.1%)	1.5E+00 mrem/yr (68.4%)
Sector B Total Dose	9.0E-01 mrem/yr (100%)	1.0E-01 mrem/yr (100%)	2.0E+00 mrem/yr (100%)	2.2E+00 mrem/yr (100%)
Sector I Water Ingestion	5.8E-02 mrem/yr (53.9%)	6.7E-02 mrem/yr (57.6%)	1.4E+00 mrem/yr (66.4%)	1.6E+00 mrem/yr (69.6%)
Sector I Total Dose	1.1E-01 mrem/yr (100%)	1.2E-01 mrem/yr (100%)	2.0E+00 mrem/yr (100%)	2.3E+00 mrem/yr (100%)

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Second Round of RAIs – 1st Package

- RAI C-8
- NRC Comment Summary
  - Provide a list of the radionuclides that were included in Cases B thru E for the benchmarking calculations (see Section 5.6.2.3)
- DOE Response Summary
  - The requested list of radionuclides was provided as follows

Inventory Inputs	Concentration Outputs
I-129	Ac-227 Tc-99
Np-237	I-129 Th-229
Pu-238	Np-237 Th-230
Tc-99	Pa-231 U-233
Th-230	Pb-210 U-234
U-234	Pu-238 U-235
U-235	Ra-226

Second Round of RAIs – 1st Package

- RAI C-22
- NRC Comment Summary
  - Clarify why different hydraulic conductivity values were implemented in the PORFLOW model
- DOE Response Summary
  - The PORFLOW time period of 15,000 years to 20,000 years (a period spanning 5,000 years) utilizes the average value spanning that time period (4.9E-3 cm/s) rather than an endpoint value (4E-5 cm/s)

Second Round of RAIs – 1st Package

- RAI C-23
- NRC Comment Summary
  - Given specifications from the HELP model, provide the basis for selecting the placement quality for the geomembrane layer of the closure cap
- DOE Response Summary
  - Consistent with HELP model documentation
    - Geomembrane Installation Defects number was based upon having a good QA/QC program
    - Geomembrane Placement Quality value was based upon having the HDPE underlain by a GCL and specially prepared foundation layer

Second Package RAIs

- The following are addressed with "Case K" results
  - PA-8, PA-9, PA-10
  - IEC-8
  - SP-1, SP-2, SP-3, SP-5, SP-6, SP-7, SP-12, SP-13, SP-17
  - VP-2, VP-3, VP-6
- Remaining Second Package RAI responses
  - PA-4, PA-5, PA-7, PA-11, PA-14
  - IN-2, IN-3, IN-4
  - IEC-7
  - SP-4, SP-8, SP-10, SP-11, SP-19
  - FFT-3, FFT-4
  - II-1, II-2
  - A-1
  - C-4

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Second Round of RAIs - 2nd Package

Case K (New PORFLOW Sensitivity Case)

- Developed proposed approach for responses to RAIs PA-8 and other RAIs (identified below)
- Proposed Case K <u>assumptions</u> from PA-8
  - Fracturing of saltstone occurs one year after closure and continues until fully fractured (SP-2)
  - Diffusivity of saltstone is increased as saltstone degrades (SP-6)
  - Material interfaces unchanged from Base Case [VP-5 (First Package)]
  - Hydraulic conductivity of saltstone is increased as saltstone degrades (SP-1)

Second Round of RAIs - 2nd Package

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- Proposed Case K assumptions from PA-8 (continued)
  - Initial hydraulic conductivity of saltstone based on highest reported value from testing at nominal curing temperature (SP-5)
  - Pore volumes for Eh and pH transitions assumed 75% of base case values (SP-12)
  - Vault and FDC concrete degrades within 10,000 years after closure (VP-2)
  - Clay migration into sand drainage layers is twice that assumed in the Base Case (IEC-8)
  - Time variant moisture characteristic curves utilized for cementitious materials (SP-3, SP-4)
  - Initial K_d for Technetium is 1,000 mL/g in reducing cementitious materials [SP-15 (first package)]

Second Round of RAIs - 2nd Package

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- Proposed Case K assumptions from PA-8 (continued)
  - Biotic transfer factors based on latest site-specific data [B-1 (first package)]
  - Chicken and egg ingestion pathways are included in the dose model [B-2 (first package)]
  - Radionuclide build-up in irrigated soil is included in the dose model [B-3 (first package)]
  - Leafy component of soil-to-plant transfer factors are included in the dose model [B-4 (first package)]

Second Round of RAIs - 2nd Package

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- Proposed Case K assumptions support approach to PA-9
  - In addition to items addressed from PA-8, proposed Case K is expected to have greater flow through saltstone than presented in PA (VP-6)
  - Water ingestion rate is unchanged from the PA model [B-5 (First Package)]
- Proposed Case K assumptions support approach to PA-10
  - Specific RAIs referred to in RAI PA-10 have been addressed above

Second Round of RAIs - 2nd Package

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Proposed Approach to RAIs associated with Case K

- RAI PA-8
- NRC Comment Summary
  - Base Case does not represent the current and expected future conditions
- DOE Proposed Approach
  - Case A in the PA is considered the Base Case from which additional model conservatisms are employed to evaluate pessimistic considerations of system behavior
  - Case K will evaluate the impact from additional considerations identified in the RAIs specified in PA-8

Second Round of RAIs - 2nd Package

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Proposed Approach to RAIs associated with Case K

- RAI PA-9
- NRC Comment Summary
  - Conclusions about the conservatism of the synergistic case are not clear as certain assumptions appear to be overly optimistic, while other assumptions are potentially conservative
- DOE Proposed Approach
  - The Sensitivity Case presented in the PA is re-evaluated with additional radionuclides
  - Case K has been developed to evaluate the impact from additional considerations identified in the RAIs specified in PA-9

Second Round of RAIs - 2nd Package

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Proposed Approach to RAIs associated with Case K

- RAI PA-10
- NRC Comment Summary
  - Assumptions in the PA model and parameters may result in unsupported flow through saltstone
- DOE Proposed Approach
  - Case K has been developed to evaluate the impact from additional considerations identified in the RAIs specified in PA-10

Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI IEC-8
- NRC Comment Summary
  - Provide technical basis for the long term performance of the geotextile filter fabric in the upper and lower drainage layers
  - Discuss the apparent discrepancy in the PORFLOW model
- DOE Proposed Approach
  - The conservative nature of the colloidal clay degradation also encompasses any degradation that might occur due to silt migration
  - PORFLOW uses average value over the time period rather than the endpoint value
  - Case K assumes that the rate of clay migration into the drainage layers is twice that assumed in the PA

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Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-1
- NRC Comment Summary
  - Additional justification is required for the assumption that saltstone does not degrade hydraulically for 20,000 years
- DOE Proposed Approach
  - Current and planned future research will be discussed
  - Case K has been developed to evaluate the impact of saltstone fully degrading hydraulically within 10,000 years

Second Round of RAIs – 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-2
- NRC Comment Summary
  - A basis is required for the modeled extent of saltstone fracturing
- DOE Proposed Approach
  - The observation of "saltstone cracking" reported in SRNL-ESB-2008-00017 does not imply that fracturing is occurring within the saltstone monolith
  - Further observations of saltstone conditions will be presented as they become available
  - Case K includes a time variant progressive fracturing model within the saltstone monolith

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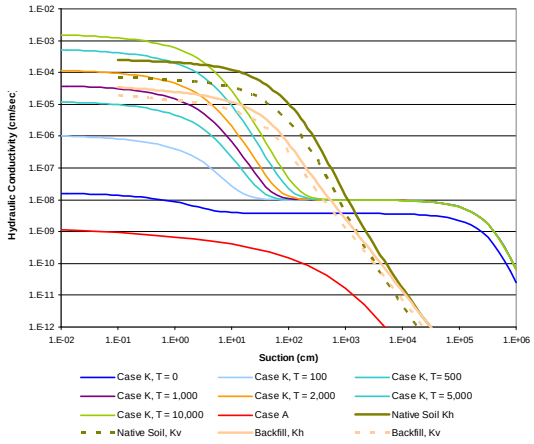
Second Round of RAIs – 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-3
- NRC Comment Summary
  - The moisture characteristic curves (MCCs) for intact saltstone used in the PORFLOW model does not account for experimental uncertainties and is inconsistent with literature values
- DOE Proposed Approach
  - Case K includes MCCs that are more representative of literature values and are incorporated within the progressive fracture model identified in the proposed approach for SP-2
  - Figure SP-3.1 illustrates an example of MCCs reflecting progressive fracturing at the start of various time steps with comparison to the Case A model and soils.

Second Round of RAIs - 2nd Package

Figure SP-3.1
Moisture Characteristic Curves for Saltstone
Reflecting Progressive Fracturing in Case K



Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-5
- NRC Comment Summary
  - Additional support is needed for the value of 2E-09 cm/sec used for the hydraulic conductivity of intact saltstone
- DOE Proposed Approach
  - The hydraulic conductivity of intact saltstone was based on information available at the time of PA development
  - Additional research is being planned to continue investigating parameters that impact saltstone hydraulic conductivity
  - Case K assumes the hydraulic conductivity of intact saltstone is 1E-08 cm/sec – the highest reported value based on laboratory testing at a curing temperature of 22 degrees C

Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-6
- NRC Comment Summary
  - Additional basis is required for the values of effective diffusivity of intact and degraded saltstone
- DOE Proposed Approach
  - Current value in the PA assumes that intact saltstone has an effective diffusion coefficient associated with ordinary concrete - 1E-07 cm^2/sec
  - Latest SIMCO testing indicates that intact saltstone has an effective diffusion coefficient of 1E-08 cm^2/sec
  - Case K assumes that the diffusion coefficient of intact saltstone has the same PA value but increases as the saltstone degrades

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Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-7
- NRC Comment Summary
  - Given constraints associated with proprietary information, evaluate whether the blended cement formulations that have been evaluated using STADIUM can be compared to the saltstone and concrete formulations used for saltstone disposal
- DOE Proposed Approach
  - Technical publications of the Cementitious Barriers Partnership (CBP) will be examined to identify those having bearing on sulfate attack in Saltstone and provide a comparison between related CBP and SIMCO analyses.
  - Case K will investigate system performance by increasing concrete degradation to reflect model uncertainties

Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-12
- NRC Comment Summary
  - Model support is needed to demonstrate the uncertainty associated with the pore fluid volumes necessary for Eh and pH transitions in cementitious materials
- DOE Proposed Approach
  - Model predictions will be compared to any existing experimental data to provide model support. Plans for further experiments examining Eh and pH changes will be developed. The experiments will likely be a combination of accelerated flow and sequential batch experiments.
  - Case K includes a 25% reduction in the pore fluid volumes necessary for Eh and pH transitions

Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-13
- NRC Comment Summary
  - The effect of limiting the shrinking core model to the effects of Eh evolution of saltstone on technetium should be analyzed
- DOE Proposed Approach
  - Utilizing PA Table 4.2-18, identify any other radionuclides that would be appropriate to include in a shrinking core model for Eh and pH evolution
  - Case K includes a modified shrinking core model for technetium that could be applied to other radionuclides

Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI SP-17
- NRC Comment Summary
  - Provide additional basis for neglecting gas-phase oxygen diffusion in cases representing fractured and degraded saltstone or provide updated dose estimates considering the potential effects of gas-phase oxygen diffusion
- DOE Proposed Approach
  - Case K will implicitly incorporate combined gas-phase and liquid-phase oxidation of fractured reducing cementitious materials. This oxidation sub-model will be based on the approach of Smith and Walton (1993, Mat. Res. Soc. Symp. Proc. Vol. 294).

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Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI VP-2
- NRC Comment Summary
  - Provide justification for neglecting other forms of concrete degradation (other than sulfate attack) on the walls, roof, and floor of the disposal units
  - Provide summary of observed corrosion of reinforced concrete at SRS
- DOE Proposed Approach
  - Case K assumes that the disposal unit concrete fully degrades within 10,000 years (3,500 years for Vault 4 roof; and initially degraded for the walls of Vaults 1 and 4)
  - Will investigate if any studies have been conducted on corrosion of reinforced concrete at SRS

Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI VP-3
- NRC Comment Summary
  - Include vault floor fractures in the base case or provide technical basis for not including them
  - Reducing conditions in the vault floor during the performance period may not be supported when fracturing is included
- DOE Proposed Approach
  - Preliminary review of inspections of the Vault 4 floor does not indicate the existence of potential leak paths at bolt locations
  - Case K includes a progressive fracture growth model in the floor of all of the disposal units

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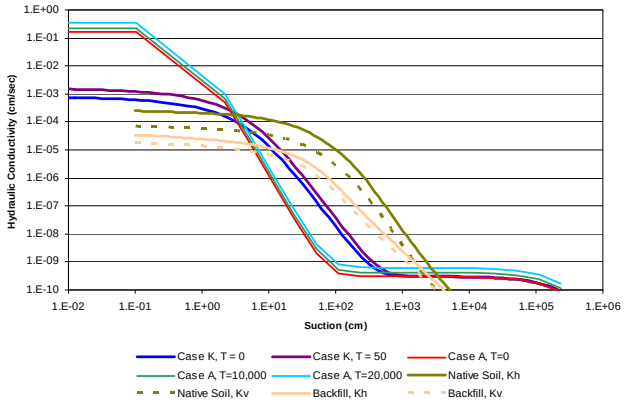
Second Round of RAIs - 2nd Package

Proposed Approach to RAIs associated with Case K

- RAI VP-6
- NRC Comment Summary
  - Provide support for the assumed hydraulic conductivity of the degraded Vaults 1 and 4 walls that result in the modeled bypassing of flow around the saltstone wasteform
- DOE Proposed Approach
  - The initial hydraulic conductivity of the walls for Vaults 1 and 4 is based on a macroscopic crack model to acknowledge current wall seepage
  - Case K utilizes a different initial cracking spacing that results in a hydraulic conductivity 100 times less than used in the PA. Figure VP-6.1 illustrates the moisture characteristic curves used for the Vault 1 and Vault 4 walls for Case K, the PA Base Case, and soils.

Second Round of RAIs - 2nd Package

Figure VP-6.1
Moisture Characteristic Curves for Walls
of Vaults 1 and 4 for Case K, Case A, and Soils



Second Round of RAIs - 2nd Package

- RAI PA-4
- NRC Comment Summary
  - Benchmarking based only on key radionuclides identified in the base case analysis does not provide adequate support for the interpretation of alternate-case GoldSim model results
- DOE Proposed Approach
  - PORFLOW runs will be conducted with the key radionuclides and additional radionuclides for PA Case C (a fast flow path case) and for the synergistic case presented in PA Section 5.6.6.5 (included in response to PA-9)
    - Additional radionuclides are: Am-241, Am-243, Cm-244, Cm-245, Cs-135, Nb-93m, Pu-239, Pu-230, Pu-241, Pu-244, Th-229, U-233, U-235, and U-238
  - MOP dose will be estimated using the dose methodology described in the responses to RAIs B-1 through B-4

Second Round of RAIs - 2nd Package

- RAI PA-5
- NRC Comment Summary
  - Provide greater transparency in the benchmarking adjustments made to the GoldSim transport model
- DOE Proposed Approach
  - The differences between the pre- and-post benchmarking results will be presented
    - Results will be presented in a stepwise manner to show the degree of change associated with individual benchmarking factors
    - Updated graphs will be presented based on the new outputs to show the degree of change associated with each benchmarking factor

Second Round of RAIs - 2nd Package

- RAI PA-7
- NRC Comment Summary
  - Model support for the PA is limited and plans for development of additional support are not provided
- DOE Proposed Approach
  - Additional model support is discussed in PA Section 8.2
  - Studies for model support are discussed in SRR-CWDA-2011-00055, *FY2010 Annual Review Saltstone Disposal Facility (Z Area) Performance Assessment*
  - Other planned model support activities will be discussed in SRR-CWDA-2011-00052, *SRS Liquid Waste Facilities Performance Assessment Maintenance Program – FY2011 Implementation Plan*

Second Round of RAIs - 2nd Package

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- RAI PA-11
- NRC Comment Summary
  - Provide justification to support the GoldSim probabilistic model used for sensitivity and uncertainty analyses
- DOE Proposed Approach
  - Clarify the difference between the roles of the deterministic (Base Case) modeling and the probabilistic modeling.
  - Describe the approach for assigning probability values to each of the alternative configurations for the probabilistic models
  - Provide the basis for the uncertainty values assigned to the remaining stochastic elements within the GoldSim model
  - Point to related RAI responses as appropriate

Second Round of RAIs - 2nd Package

Savannah River Remediation
We do the right thing.

- RAI PA-14
- NRC Comment Summary
  - Provide any additional documentation of calcareous features at Z-Area
- DOE Proposed Approach
  - The RAI is similar to FTF RAI-FF-1
  - A summary of the information from WSRC-TR-99-4083 will be presented
  - Site-specific documents mentioned by the NRC will be reviewed to see if there are any adjustments needed to the interpretation of the formations

Second Round of RAIs - 2nd Package

- RAI IN-2
- NRC Comment Summary
  - Justify the distributions for the radionuclide inventories used in the GoldSim calculations, or change the distributions
- DOE Proposed Approach
  - Describe the conservatism in the uncertainty distributions
  - Describe the salt dissolution process – dissolved salt creates supernate
  - Describe how the removal efficiencies used were conservative estimates and, if uncertainties were used, only increase efficiencies would be used

Second Round of RAIs - 2nd Package

- RAI IN-3
- NRC Comment Summary
  - Provide a description of the strategy that will be used to assess the dose from the actual inventory disposed of in the FDCs
- DOE Proposed Approach
  - Describe the sample and analysis process for Tank 50 and projecting the grout material into each FDC prior to disposal as part of the WAC
  - Describe the final disposal unit inventory report

Second Round of RAIs - 2nd Package

- RAI IN-4
- NRC Comment Summary
  - Provide information on the volume of liquid (and estimated inventory) that is expected to remain in the drain water collection system for Vault 1, Vault 4, and the FDCs
- DOE Proposed Approach
  - Describe that with the limited mixing that is expected to occur in the sheet drains, the system would be expected to respond in a plug flow manner instead of a stirred tank
  - Expect residual inventory at closure to be negligible

Second Round of RAIs - 2nd Package

- RAI IEC-7
- NRC Comment Summary
  - Provide the saturation and average head for each cover for all time periods
  - Discuss effects of saturation on stability, vegetation, erosion, and the performance of cover materials under hydrostatic pressure
- DOE Proposed Approach
  - Provide the requested information
  - Much of this discussion can be extracted and modified from the FTF RAI response for closure cap performance, except that
    - The drainage layer and composite barrier layers are on a 4% slope rather than a 2% slope
    - The middle backfill varies in thickness from 1-foot to 20 feet

Second Round of RAIs - 2nd Package

- RAI SP-4
- NRC Comment Summary
  - Moisture characteristic curves (MCCs) used in the PA model are based on a continuum approach that does not reflect non-equilibrium flow
- DOE Proposed Approach
  - The impact on overall system performance will be investigated via an additional sensitivity case using PORFLOW. This case will use an alternative functional form for MCCs termed "Active Fracture Model" (AFM) on the PA Base Case. The AFM presumes gravity-dominated non-equilibrium preferential water flow in fractures.

Second Round of RAIs - 2nd Package

- RAI SP-8
- NRC Comment Summary
  - Provide a basis for using different initial grout mineralogies to determine pH and Eh transitions or demonstrate that results are not significantly affected by these differences
  - Provide a basis for the uncertainty range assigned to the Eh and pH transitions
- DOE Proposed Approach
  - Calculations will be provided that demonstrate the sensitivity of Eh and pH transitions to initial mineralogy. This will include mineral compositions associated with different initial Saltstone formulas and different normative mineral compositions calculated for a particular formula.

Second Round of RAIs - 2nd Package

- RAI SP-10
- NRC Comment Summary
  - Pu and Np sorption in cementitious materials may be overestimated
    - Dissolved concentrations may be solubility limited rather than sorption controlled
    - With the Kds set to zero total dose more than doubled
    - Provide an updated base case that includes technically defensible Kd values for Pu and Np
- DOE Proposed Approach
  - WSRC-STI-2007-00640 concluded that there was precipitation in the Np and Pu samples because the no-solids controls had Np and Pu losses from the aqueous phase.
  - Because solubility is so low at high pH levels there are no available Kd values in the literature where no-solid controls have not precipitated from solution.
  - Reflect this strong solid phase uptake with large Kd value.

Second Round of RAIs - 2nd Package

- RAI SP-11
- NRC Comment Summary
  - When defining the K_d values for the cementitious materials, justify neglecting the differences between solid phases and those of water chemistry for "middle" and "old" age conditions
- DOE Proposed Approach
  - This is presently under review and to-date no other surrogate aged cementitious solid phases have been identified in the literature

Second Round of RAIs - 2nd Package

- RAI SP-19
- NRC Comment Summary
  - Research related to the release of Tc-99 from saltstone appears to be inconsistent with the Tc-99 releases modeled in the PA
  - PA should be consistent with relevant research or justification should be provided discussing why it was excluded
  - Provide any additional references on Tc-99 leaching from saltstone that have not already been provided to the NRC
- DOE Proposed Approach
  - New report on testing and literature review, SRNL-STI-2010-00668, will provide latest data.

Second Round of RAIs - 2nd Package

- RAI FFT-3
- NRC Comment Summary
  - Justify the K_d used for selenium in vadose and backfill soils
- DOE Proposed Approach
  - Discuss pH data for Z-Area monitoring wells
    - Include data from 2006-2010
    - Explain screening of pH data
    - Discuss the statistical ranges of the data, including outliers
  - Discuss variability of selenium K_ds by pH
    - Show that the pH values used are bounding and represent best estimate values for current/future conditions

Second Round of RAIs - 2nd Package

Savannah River Remediation
We do the right thing.

- RAI FFT-4
- NRC Comment Summary
  - PA should discuss the implications of calcareous zones within the far field transport model
- DOE Proposed Approach
  - Similar to Item 1 from FTF RAI-FF-1 and RAI-FF-4
    - Reference reports to show that calcareous zones are not filled with cavernous voids
    - Soft zones and carbonates are generally represented by very small and infrequent pockets in the UTR-Lower Zone (LZ) that do not continuously run the length of the flow path of the plume and are located near the base of the UTR-LZ
    - It is not reasonable to assume that the effects of the presence of grout in soft zones on mobility should be spread across the entire aquifer
  - Provide the requested document

Second Round of RAIs - 2nd Package

Savannah River Remediation
We do the right thing.

- RAI II-1
- NRC Comment Summary
  - Key assumptions on the dose pathways of exposure to the inadvertent intruder may underestimate the dose
- DOE Proposed Approach
  - Dose to the inadvertent intruder based on water concentrations below Vault 4 and below an FDC will be computed using the dose methodology described in the responses to RAIs B-1 through B-5 (first package)

Second Round of RAIs - 2nd Package

Savannah River Remediation
We do the right thing.

- RAI II-2
- NRC Comment Summary
  - Provide and assessment of the intruder dose based on a realistic and reasonable compliance case
- DOE Proposed Approach
  - The Base Case is considered a realistic and reasonable compliance case and the dose to the intruder is provided for this case in the response to RAI II-1
  - Case K has been developed as an additional sensitivity case to address areas of concern described in the response to RAI PA-8
  - Dose to the intruder from water concentrations below the disposal units will be provided based on Case K and the dose methodology presented in the responses to RAIs B-1 through B-5 (first package)

Second Round of RAIs - 2nd Package

Savannah River Remediation
We do the right thing.

- RAI A-1
- NRC Comment Summary
  - Social, economic, and public policy considerations do not appear to have been considered for the ALARA analysis
    - Describe methodology used to minimize the inventory sent to SDF
    - Describe controls that exist to minimize dose to the workers
- DOE Proposed Approach
  - Discuss social, economic, and public policy considerations in the SEIS analysis and the options evaluated in it
  - Discuss separation technologies evaluated for separating the "high activity fraction" from the "low activity fraction"
  - Describe the elements/procedures of the ALARA program

Second Round of RAIs - 2nd Package

- RAI C-4
- NRC Comment Summary
  - Support the selenium K_d value (150 mL/g) for old oxidizing conditions or revise the base case Kd value
    - Clarify whether selenium as selenate was considered
    - Site-specific batch experiments showed lower selenium Kd values
    - The K_d values of 180 and 380 mL/g from Baur and Johnson (2003) were for selenite, not selenate
    - Clarify why the sorption coefficient for selenium would approach that of sediment as cementitious materials degrade
- DOE Proposed Approach
  - The sensitivity of Se-79 to the MOP dose will be investigated to ascertain the risk significance of its K_d value.
  - If the Kd value for Selenium in old age oxidized cementitious material is found to be risk significant then future laboratory testing will be planned.