UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 26, 2015

Mr. William Levitan
Associate Deputy Assistant Secretary
of Site Restoration
Office of Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION STAFF REQUEST FOR ADDITIONAL INFORMATION ON THE "FISCAL YEAR 2014 SPECIAL ANALYSIS FOR THE SALTSTONE DISPOSAL FACILITY AT THE SAVANNAH RIVER SITE," SRR-CWDA-2014-00006, REVISION 2

Dear Mr. Levitan:

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed both the U.S. Department of Energy (DOE) "Fiscal Year (FY) 2014 Special Analysis for the Saltstone Disposal Facility (SDF) at the Savannah River Site," SRR-CWDA-2014-00006, Rev. 2 (FY14 SDF Special Analysis document) and the DOE "Comment Response Matrix for NRC Staff Request for Additional Information on the FY13 Special Analysis for the SDF at the Savannah River Site," SRR-CWDA-2014-00099, Rev. 1.

Enclosed is the NRC staff's Request for Additional Information (RAI) Questions related to both those DOE documents. Both the DOE FY14 SDF Special Analysis document and the DOE "FY13 Special Analysis for the SDF at the Savannah River Site," SRR-CWDA-2013-0062, Rev. 2 (FY13 SDF Special Analysis document) supplement the DOE "Performance Assessment for the SDF at the Savannah River Site," SRR-CWDA-2009-00017, Rev. 0.

The NRC staff expects that the DOE will respond to the enclosed RAI Questions, which are expected to enhance our overall understanding of and our confidence in the ability of the DOE to meet Title 10, *Code of Federal Regulations* Part 61, Subpart C Performance Objectives, as required by Section 3116(b) of the *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*.

The NRC staff expects to issue a new Technical Evaluation Report based on the FY13 SDF Special Analysis document, the FY14 SDF Special Analysis document, and the DOE responses to these enclosed RAI Questions.

If you have any questions about this, then please contact Mr. Harry Felsher of my staff at Harry.Felsher@nrc.gov or at (301) 415-6559.

Sincerely,

/RA/

Andrew Persinko, Deputy Director
Division of Decommissioning, Uranium Recovery,
and Waste Programs
Office of Nuclear Material Safety
and Safeguards

Docket No.: PROJ0734

Enclosure:
NRC RAI Questions on the DOE “FY 2014
Special Analysis for the Saltstone Disposal
Facility at the Savannah River Site”

cc:
WIR Service List
WIR e-mail Contacts List

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U.S. Nuclear Regulatory Commission Staff Request for Additional Information on the U.S. Department of Energy "Fiscal Year 2014 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site"

Review Scope:

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed both the U.S. Department of Energy (DOE) "Fiscal Year 2014 [(FY14)] Special Analysis for the Saltstone Disposal Facility [(SDF)] at the Savannah River Site," SRR-CWDA-2014-00006, Rev. 2 (FY14 SDF Special Analysis document) and the DOE "Comment Response Matrix for U.S. Nuclear Regulatory Commission Staff Request for Additional Information on the Fiscal Year 2013 [(FY13)] Special Analysis for the Saltstone Disposal Facility [(SDF)] at the Savannah River Site," SRR-CWDA-2014-00099, Rev. 1 (2015 Response to the NRC 2014 RAI Comments).

Based on the DOE "Fiscal Year 2013 [(FY13)] Special Analysis for the Saltstone Disposal Facility [(SDF)] at the Savannah River Site," SRR-CWDA-2013-0062, Rev. 2 (FY13 SDF Special Analysis document), the NRC staff provided the DOE with the Request for Additional Information (RAI) Comments on the FY13 SDF Special Analysis document (available via the NRC Agencywide Documents Access and Management System (ADAMS) at Accession No. ML14148A153). Both the DOE FY14 SDF Special Analysis document and the DOE FY13 SDF Special Analysis document supplement the DOE "Performance Assessment [(PA)] for the Saltstone Disposal Facility [(SDF)] at the Savannah River Site," SRR-CWDA-2009-00017, Rev. 0 (2009 SDF PA).

As with the DOE FY13 SDF Special Analysis document, many Monitoring Areas (MAs) that are in the NRC 2013 SDF Monitoring Plan (available via ADAMS at Accession No. ML13100A076) were not addressed in the DOE FY14 Special Analysis document. Each MA in the NRC 2013 SDF Monitoring Plan consists of one or more Monitoring Factors (MFs). Each MF and MA in the NRC 2013 SDF Monitoring Plan is open until the NRC closes it in writing to the DOE.

In the DOE FY13 SDF Special Analysis document, the DOE addressed Saltstone Disposal Structure (SDS) 1, SDS 4, and disposal structures similar to SDS 2A, which the DOE referred to as "Future Disposal Cells" (FDCs). Although all six of the disposal structures similar to SDS 2A have been built (i.e., SDS 2A, SDS 2B, SDS 3A, SDS 3B, SDS 5A, SDS 5B) and are therefore not "future" disposal cells, the NRC staff uses the term "FDC" for consistency with the FY13 SDF Special Analysis document (see description of the FDCs in Section 3.3.3 of the FY13 SDF Special Analysis document).

In the DOE FY14 SDF Special Analysis document, the DOE used the term "150-foot diameter disposal units" to refer to the FDCs. For consistency with the NRC terminology for disposal structures, the NRC uses the term "150-foot diameter cylindrical disposal structures" to refer to the FDCs. In the DOE FY14 SDF Special Analysis document, the DOE used the term "375-foot diameter disposal units" to refer to SDS 6, SDS 7, SDS 8, SDS 9, SDS 10, SDS 11, and SDS 12. For consistency with the NRC terminology for disposal structures, the NRC uses the term "375-foot diameter disposal structures" to refer the larger disposal structures (i.e., SDS 6, SDS 7, SDS 8, SDS 9, SDS 10, SDS 11, SDS 12) that the DOE intends to construct. Note that only SDS 6 is currently under construction.

Enclosure

Request for Additional Information (RAI) Questions:

The NRC RAI Questions are grouped by the following topics: (1) Performance Assessment Methods, (2) Saltstone Performance, (3) Infiltration and Erosion Control, (4) Disposal Structure Performance, and (5) Far-Field Transport. There are also Clarifying Comments. There are no NRC RAI Questions on following topics: (1) Inadvertent Intrusion and (2) Biosphere.

Performance Assessment Methods (PAM):

PAM-1 Question: A new up-to-date analysis is needed for how the DOE demonstrates that doses to the off-site members of the public be maintained As Low As Reasonably Achievable (ALARA), as required by §61.41 (Protection of the General Population from Releases of Radioactivity).

Basis: In Section 2.12.2 (NRC Evaluation – ALARA analysis) of the NRC 2012 SDF Technical Evaluation Report (TER), the NRC staff evaluated the DOE ALARA analysis using information from Section 5.7 (ALARA Analysis) of the DOE 2009 SDF Performance Assessment (2009 SDF PA) and the DOE responses to the NRC RAIs on the DOE 2009 SDF PA. That combined DOE ALARA analysis was based on information about the FDCs, PA models based on the FDCs, and dose calculations with an Evaluation Case using those PA models based on the FDCs.

In Section 5.7 (ALARA Analysis) of the DOE FY13 SDF Special Analysis document, the DOE included that: "The ALARA information presented in the [2009] SDF PA is not affected by the new information presented in this [document]."

It is not clear to the NRC staff how that could be true because the DOE FY13 SDF Special Analysis document supplements the DOE 2009 SDF PA, including new information about the FDCs, new radionuclide inventories in the FDCs, and new dose calculations with a new Evaluation Case based on the new information about the FDCs.

In Section 5.7 (ALARA Analysis) of the DOE FY14 SDF Special Analysis document, the DOE included that: "The ALARA information presented in the [2009] SDF PA is not affected by the new information presented in this [document]."

It is not clear to the NRC staff how that could be true because the DOE FY14 SDF Special Analysis document supplements both the DOE 2009 SDF PA and the DOE FY13 SDF Special Analysis document, including information about the 375-foot disposal structures, new radionuclide inventories in the FDCs, and new dose calculations with a new Evaluation Case based on both the FDCs and the 375-foot disposal structures.

Path Forward: Provide the current DOE information that replaces the collection of information in the DOE ALARA analyses in: (1) Section 5.7 of the DOE 2009 SDF PA, (2) the DOE responses to the NRC RAIs on the DOE 2009 SDF PA, (3) Section 5.7 of the DOE FY13 SDF Special Analysis document, (4) the DOE 2015 Response to the NRC 2014 RAI Comments, and (5) Section 5.7 of the DOE FY14 SDF Special Analysis document. Without that current DOE ALARA analysis information, the NRC staff cannot make a determination in a TER about the DOE ALARA analysis.

PAM-2 Question: Additional information is needed about parameter values sampled in higher-dose realizations of the uncertainty analysis.

Basis: Figures 5.6.5-19 and 5.6.5-20 of the DOE FY14 SDF Special Analysis document showed peak doses to an offsite member of the public within 10,000 and 50,000 years of site closure, respectively. The description for Figure 5.6.5-19 included that all of the higher-dose realizations between 1,200 and 2,000 years had sampled the highest parameter value for the initial hydraulic conductivity of saltstone. Many other dose peaks after 2,000 years approached 100 mrem/yr. The NRC staff needs to understand the parameters driving risk in those realizations to evaluate the system performance.

Figure 5.6.5-20 showed several peak doses of approximately 3 rem/yr and the description included that those doses corresponded to cases in which most of the Technecium-99 (Tc-99) was retained well in saltstone until it was released suddenly. In addition, those cases generally corresponded to low Tc-99 solubility, average infiltration rates, best estimate degradation rates, and high water consumption. However, some of the vertical clusters grouped by degradation rate and infiltration rate spanned approximately two orders of magnitude. The NRC staff needs to understand if variations in the remaining two parameters (i.e., Tc-99 solubility and water consumption) accounted for the majority of that variability or if there were other significant variables that accounted for the higher dose peaks.

Path Forward: Provide parameter values sampled for several of the greatest dose peaks shown in Figures 5.6.5-19 and 5.6.5-20 of the DOE FY14 SDF Special Analysis document with an explanation why the combinations of the parameter values sampled were unlikely (e.g., similar to the explanation in Section 5.6.4.3 of the DOE FY13 SDF Special Analysis document). For the peaks shown in Figure 5.6.5-19 of the DOE FY14 SDF Special Analysis document, indicate the greatest five (or more) realizations that did not sample the highest initial saturated hydraulic conductivity of saltstone and provide parameter values and an explanation describing those peaks.

PAM-3 Question: Additional information is needed about the process of benchmarking the deterministic GoldSim model results to the PORFLOW model results.

Basis: The first three steps of the benchmarking procedure in Section 5.6.2 of the DOE FY14 SDF Special Analysis document compared results from the PORFLOW model and results of deterministic runs of the GoldSim model for: (1) radionuclide fluxes from the unsaturated zone (UZ) to the saturated zone (SZ) for each type of disposal structure; (2) radionuclide concentrations in the SZ at the 100-meter boundary for Sectors B, I, J, and K; and (3) projected dose to a member of the public for Sectors B, I, J, and K.

The DOE used GoldSim as a stand-alone model for uncertainty and sensitivity analyses. In addition, the DOE used GoldSim as a dose calculator to compute doses from PORFLOW-generated radionuclide concentrations. Section 5.6.2.1 of the DOE FY14 SDF Special Analysis document states that: "Dose calculations [in the GoldSim model] are performed using the same dose calculations that were used to determine the PORFLOW dose results."

If concentrations from both GoldSim and PORFLOW models were transformed into dose with the same dose calculations, then it is not clear to the NRC staff what the difference was between Benchmarking Step 2, where SZ concentrations were compared, and Benchmarking Step 3, where doses were compared. The NRC staff needs to understand the reason for performing Benchmarking Step 3 to ensure our understanding of the overall PA approach and the DOE benchmarking process for GoldSim and PORFLOW.

Path Forward: Provide an explanation how Benchmarking Step 3 (comparison of projected doses to a member of the public) provided different information than Benchmarking Step 2 (comparison of SZ concentrations at the 100-meter well).

PAM-4 Question: The future climatic or geologic conditions that will prevail at a site are not known, but the PA process requires consideration of possible future conditions. The DOE did not provide in the DOE FY14 SDF Special Analysis document an analysis or evaluation that examined possible future conditions at the site.

Basis: Sources of uncertainty inherent to waste disposal in the near surface include, but are not limited to incomplete knowledge of the natural system, the natural system's evolution, and the natural system's interactions. The NRC staff previously identified the uncertainties in a PA as: (1) scenario uncertainty; (2) model uncertainty, which spans conceptual model uncertainty and mathematical model uncertainty; and (3) parameter uncertainty (see NUREG/CR-5211 and NUREG/CR-5927). Scenario uncertainty, defined as the consideration of uncertainty in the future evolution of the site, may result in several different conceptual models for the system as distinguished by the effects of phenomena on the system. Uncertainty about the future of the site is the result of an inherent lack of knowledge about how the site will evolve over time. Climatic variation may significantly change groundwater flow pathways over time, which would necessitate changes to the groundwater flow model or the introduction of new parameters.

Path Forward: Provide an uncertainty analysis that examines possible future conditions at the site (e.g., net depositional or erosional changes at the site or changing climatic conditions within a 10,000-year period).

Saltstone Performance (SP):

SP-1 Question: Additional justification is needed for the DOE assumed change in hydraulic conductivity of saltstone with time, which does not account for the feedback of increasing hydraulic conductivity as decalcification progresses.

Basis: In Section 4.2.2.3 of the DOE FY14 SDF Special Analysis document, decalcification via advection was assumed to control the degradation of saltstone. The rate of decalcification was assumed to be constant and was based on the initial hydraulic conductivity of saltstone. However, decalcification would result in an increase in the hydraulic conductivity of saltstone and therefore, the rate of decalcification would increase as the hydraulic conductivity in saltstone increases in time. That dependency would create a feedback loop that was not accounted for by the DOE. Including that feedback loop of increasing hydraulic conductivity with decalcification would significantly decrease the amount of time required for complete degradation of saltstone to occur.

The DOE evaluated three cases: (1) best estimate, (2) nominal value, and (3) conservative estimate scenarios. Those three cases multiply the initial hydraulic conductivity by factors of 1, 10, and 100, respectively. The purpose of those cases was to account for the potential head gradient in the vadose zone for the saltstone. It is not clear to the NRC staff how much head may accumulate on top of a disposal structures and to what extent that could account for increasing hydraulic conductivity of saltstone with respect to time.

The DOE previously indicated that the assumed linear rate of degradation was overly conservative and accounts for other degradation mechanisms. As described in more detail in RAI Question SP-3 – later in these RAI Questions, the DOE basis for the selection of potential degradation mechanisms and justification that the rate of saltstone degradation was conservative is not clear to the NRC staff.

Path Forward: Provide justification for why the feedback mechanism of increased hydraulic conductivity with time does not need to be accounted for in the degradation analysis. (If that justification includes the conservatism associated with the linear rate of degradation, then it should also account for the NRC staff concern in RAI Question SP-3 – later in these RAI Questions).

SP-2 **Question:** Additional information is needed regarding the risk associated with gas-phase transport of oxygen into unsaturated fractures.

Basis: In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-4 in that document), the DOE indicated that the assumption of linear degradation provided some compensation for the potential effects of mechanical degradation. The DOE expected that degradation rates would initially be much slower and increase more gradually over time. Although the assumed linear degradation rate was more conservative than what the DOE assumed in the DOE 2009 SDF PA, it is not clear to the NRC staff that it is conservative or compensated for the potential effects of mechanical degradation (for more detailed information, see RAI Question SP-3 below).

In the DOE FY14 SDF Special Analysis document, the DOE described that the modeled column degradation in the DOE FY13 SDF Special Analysis document and in the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment CC-3 in that document) could be used as an analog for the effect of fractures. However, the DOE did not consider a completely interconnected pathway of oxidation from the top of the roof of a disposal structure, through the saltstone, and down to the floor of the disposal structure to be a credible scenario within the 10,000-year performance period. Degradation of the column forms a complete pathway by 7,200 years in the DOE evaluation case and by 2,000 years in a sensitivity case from the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment CC-3 in that document). In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-1 in that document), the DOE indicated that the interconnected flow path acted to channel oxygenated water away from the saltstone inventory. Based on the results of those analyses, the DOE assumed that the risks from any potential fractures were not likely to be significant.

Although the DOE column degradation analyses provided some insight into the effects of fractures with the through-going fast pathway, it is not clear to the NRC staff that those analyses adequately accounted for the potential effects of fractures. The rate and extent of fracturing of saltstone are not well understood. As such, it is difficult to compare the results from a through-going column analysis to saltstone grout with the potential for interconnected and unsaturated fractures. Although fast pathways can divert water away from the inventory, they can also potentially introduce much more oxygen into the wasteform than oxygen dissolved in water. Unsaturated fractures may have a significantly greater fracture-matrix interfacial area than what the DOE assumed in the column degradation analysis. Accordingly, that gas-phase oxidation may exceed the rate of oxidation assumed in the DOE evaluation case or column degradation sensitivity case. In addition, the potential exists for fractures to result in a pulse-like release of redox-sensitive radionuclides. A fractured region of saltstone may not be hydraulically active; but, it could still be susceptible to gas-phase oxidation. After water is introduced to the oxidized saltstone, redox-sensitive radionuclides could be released within several pore flushes.

In addition, the DOE column degradation analysis did not include any inventory for the column, whereas a damaged area of saltstone would contain inventory. Also, a completely interconnected pathway of oxidation from the top of the roof of a disposal structure, through the saltstone, and down to the floor of the disposal structure is not a prerequisite for gas-phase oxidation to occur. A disposal structure is not expected to be airtight. As such, any fracturing that was connected to the exterior of the saltstone grout would be susceptible to gas-phase oxidation.

Path Forward: Provide additional support for the DOE assumption that saltstone is not susceptible to fracturing and gas-phase oxidation. Model support activities could include degradation analyses that couple chemical and mechanical degradation models to provide a more complete degradation analysis. The NRC staff understands the challenges associated with developing and validating that type of degradation analysis. As such, as part of the model support activities, the DOE could provide a more realistic analysis evaluating the risk associated with fractures and gas-phase oxidation. In the DOE 2015 Response to the NRC 2014 RAI Comments, the DOE proposed a future activity of studying the rates of oxidation in potential unsaturated fractures. That type of information could help support the DOE assumptions regarding the risk-significance of fractures.

SP-3 **Question:** It is not clear to the NRC staff that the DOE assumption of a linear rate of degradation of saltstone is conservative and bounds all potential additional degradation mechanisms.

Basis: In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-4 in that document), the DOE indicated that the hydraulic conductivity of the roof of a disposal structure will increase by three orders of magnitude by the end of the 100-year institutional control period. Also, the DOE stated that: “No known degradation mechanisms would have such a substantial impact on the degradation of the cementitious materials.”

It is not clear to the NRC staff: (1) which degradation mechanism or coupled mechanisms may control the degradation of saltstone, (2) the extent to which saltstone may degrade prior to significant increases in hydraulic properties, and (3) the rate at which saltstone hydraulic properties evolve.

Saltstone is a unique cementitious material that is chemically and hydraulically very far from equilibrium with respect to the surrounding natural environment and has a porosity of approximately 60 percent (%). Generally, the further a material is from equilibrium the more quickly its properties evolve to that of the surrounding environment. The hydraulic conductivity of compacted clay barriers have been observed to increase by several orders of magnitude within several years due to the formation of preferential flow paths that controlled the hydraulic conductivity (see NUREG CR-7028, Vol. 1). The NRC staff understands that degradation of cementitious materials will differ from that of clay barriers; however, cementitious materials, in particular saltstone with a porosity of approximately 60%, would appear to be susceptible to the formation of preferential flow paths due to the low, contrasting matrix permeability.

Dissolution, cracking, or the combination of those two processes may initially have minimal impact on the hydraulic properties of saltstone until a threshold interconnectivity of pores exists. After that extent of degradation is reached and significant interconnectivity of pores exists, the hydraulic properties could increase at a rate greater than the DOE assumed linear increase in hydraulic conductivity.

Path Forward: Provide a technical basis to support the DOE assumption that saltstone will either not hydraulically degrade in a non-linear fashion or that the threshold for that degradation would not result in the DOE not meeting the performance objectives of 10 CFR Part 61.

SP-4 **Question:** The DOE assumption that degradation of saltstone was based on the amount of time for complete decalcification to occur, rather than a progression of increased hydraulic conductivity in the uppermost layer followed by the successive underlying layers, was not justified in either the DOE FY13 or the DOE FY14 SDF Special Analysis documents.

Basis: In both the DOE FY13 and the DOE FY14 SDF Special Analysis documents, the DOE assumed that saltstone degraded uniformly as an intact monolith with the hydraulic conductivity increasing linearly with respect to time due to decalcification. However, the process of decalcification would tend to result in the preferential removal of calcium from the uppermost layers, followed by removal of calcium in the successive underlying layers. Consequently, the hydraulic conductivity of the uppermost layers would increase more quickly than the underlying layers.

It is not clear to the NRC staff how that top-down progression of decalcification and the corresponding hydraulic properties of saltstone impacts the release of radionuclides; in particular as it is coupled with the Tc shrinking core model.

Path Forward: Provide a basis for why the DOE did not consider the top-down progression of decalcification for the hydraulic degradation of saltstone to be plausible or

risk-significant. Alternatively, provide dose results incorporating an analysis with a conceptual model of a top-down progression of decalcification for the hydraulic degradation of saltstone.

SP-5 **Question:** Additional analysis is needed to demonstrate the effect on dose of removing the modeled delay before saltstone degradation begins.

Basis: In the DOE FY14 SDF Special Analysis document, the DOE modeled saltstone in the 375-foot disposal structures as beginning to degrade 1,413 years after site closure and the DOE modeled saltstone in the 150-foot disposal structures as beginning to degrade 961 years after site closure. Previously, the DOE modeled saltstone in Saltstone Disposal Structure (SDS) 4 as beginning to degrade 2,112 years after site closure. In each model, the DOE assumed that saltstone degradation would not begin until after the roof was completely degraded by chemical mechanisms. However, saltstone fracturing caused by physical mechanisms could occur prior to complete chemical degradation of a roof. Certain mechanisms, such as shrinkage, cracking, or fracturing due to thermal gradients, could occur within the first year after emplacement. Also, saltstone fractures have occurred in SDS 4 already (see SRNL-ESB-2008-00017). In addition fracturing due to differential settlement could occur within several years after site closure.

Degradation of saltstone beginning earlier than DOE assumed could lead to higher hydraulic conductivity during the performance period. In addition, eliminating the DOE assumed degradation period could shift doses due to risk-significant radionuclides, such as Iodine-129, earlier in the performance period.

Path Forward: Provide an analysis that demonstrates the effects on all three types of disposal structures on dose of removing the delay before saltstone degradation begins.

SP-6 **Question:** Additional support is needed to justify the use of residual reducing capacity as a basis for Tc-99 release.

Basis: As described in the NRC RAI Comment SP-9 on the DOE FY13 SDF Special Analysis document, recent research from Savannah River National Laboratory (SRNL) (SRNL-STI-2013-00541) and the Cementitious Barriers Partnership (CBP) (CBP-TR-2013-002) has called into question the use of reducing capacity as the basis for the DOE Tc-99 release model. The SRNL research indicated that residual reducing capacity does not appear to be well-correlated to Tc-99 mobility in chemically reducing cementitious materials. The reason for the poor correlation between residual reducing capacity and Tc-99 release in the research is not clear to the NRC staff. However, that type of behavior could result if some of the reactions that the DOE modeled as going to equilibrium were kinetically limited.

In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-9 in that document), the DOE referenced the revised Tc-99 release model, which released Tc-99 from each PORFLOW finite element more gradually than the release model used to support the DOE FY13 SDF Special Analysis document. The revised Tc-99 release model was responsive to several different NRC RAI Comments; but did not address the

possible poor correlation of Tc oxidation with saltstone residual reducing capacity because the release was still computed as a function of the residual reducing capacity.

One implication of a potential poor correlation between Tc chemical reduction and residual reducing capacity in saltstone was to undermine the DOE assumption that Tc would be re-reduced if it was transported into an area of saltstone with residual reducing capacity. In the DOE FY14 SDF Special Analysis document, the DOE performed a sensitivity analysis to demonstrate the effects of modeled re-reduction of Tc-99 when it entered a PORFLOW model finite element with residual reducing capacity. That sensitivity analysis used a simple mass transfer to model the transfer of various fractions of Tc directly into the aquifer when it was oxidized (i.e., eliminating re-reduction for different fractions of Tc). That sensitivity analysis demonstrated increased Tc-99 release before 10,000 years when Tc-99 was assumed not to be re-reduced (i.e., peak release rate increased by a factor of 10 within 10,000 years) and decreased projected peak doses at longer times (i.e., peak release rate decreased by a factor of 15 within 50,000 years). However, that sensitivity analysis did not provide all of the needed information about the potential effects on dose if Tc-99 were oxidized and became mobile before the surrounding residual reducing capacity was consumed because the rate of Tc oxidation was still limited by the modeled progress of the oxidation front in saltstone.

In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-9 in that document), the DOE also referenced planned future research using a dynamic leaching procedure with cores of field-emplaced saltstone. Those experiments may provide important information on the release of Tc from field-emplaced samples.

In addition, a sensitivity analysis related to non-depleting oxygen sources in saltstone may provide insight into the potential effects of Tc oxidation in areas of saltstone that still have residual reducing capacity. The DOE originally provided that analysis in the DOE FY13 SDF Special Analysis document and described it further in Section 5.6.7.4 of the DOE FY14 SDF Special Analysis document. Although that sensitivity analysis bases Tc oxidation on the residual reducing capacity in saltstone, it is relevant to concerns about the potentially poor correlation of Tc mobility to saltstone reducing capacity because the non-depleting oxygen sources could be interpreted , non-mechanistically as areas where Tc is oxidized prior to being reached by an oxidation front moving through saltstone.

In the NRC RAI Comments on the DOE FY13 SDF Special Analysis document, the NRC staff identified that the results of the sensitivity analysis with non-depleting oxygen sources were difficult to interpret because Tc-99 released from areas near the non-depleting oxygen sources was immediately re-reduced by surrounding material. In the DOE FY14 SDF Special Analysis document, the DOE indicated that between 10,000 and 16,000 years after site closure, the oxidized areas began to interconnect, which provided connected pathways for Tc-99 migration. The DOE did not provide results in terms of dose for that sensitivity analysis. However, Figure 5.6.7-13 in the DOE FY14 SDF Special Analysis document showed release rates comparable to the release rate in the DOE evaluation case that resulted in a projected dose of 477 mrem/yr approximately 31,000 years after site closure. Figure 5.6.7-13 also showed that increasing the fraction of saltstone represented by non-depleting oxygen sources moved the Tc-99 release

significantly forward in time and where 20% of the saltstone was represented with a non-depleting oxygen source, the releases began within 10,000 years of site closure.

Path Forward: Provide a description of the potential effects on projected performance of an alternative conceptual model where residual reducing capacity of cementitious materials does not govern Tc-99 release. A potential analysis could combine the sensitivity analyses that the DOE conducted with non-mechanistic non-depleting oxygen sources and limited re-reduction. Alternately, the DOE could provide laboratory or field evidence that supports the use of residual reducing capacity as a basis for Tc-99 release. Any evidence supporting the use of residual reducing capacity as a basis for Tc-99 release should address the results of recent research from SRNL (SRNL-STI-2013-00541) and the CBP (CBP-TR-2013-002).

SP-7 **Question:** If the DOE demonstrates that residual reducing capacity is an appropriate basis for modeling the release of Tc-99 (see RAI Question SP-6 above), then additional justification is needed for the assumed reducing capacity of saltstone.

Basis: In both the DOE FY13 and the DOE FY14 SDF Special Analysis documents, the DOE assumed that the saltstone has a reducing capacity of 0.607 milliequivalents of electrons per gram. The NRC RAI Comment SP-10 on the DOE FY13 SDF Special analysis document requested that the DOE provide justification of the modeled reducing capacity of saltstone and provided several specific NRC staff concerns with the value used by the DOE. In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-10 in that document), the DOE addressed the specific NRC staff concern about sulfur solubility by indicating that ferrous iron may be more responsible for the measured reducing capacity of saltstone than sulfide species. The other specific NRC staff concerns in RAI Comment SP-10 on the DOE FY13 SDF Special Analysis document still remain current NRC staff concerns relevant to the DOE FY14 SDF Special Analysis document.

In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment SP-10 in that document), the DOE indicated that future research may be done to address the NRC staff concern that the components of saltstone that supply the measured reducing capacity may not be able to reduce Tc in a cementitious matrix. The NRC staff concern is based on both a CBP report (CBP-RP-2010-013-01) and a Pacific Northwest National Laboratory (PNNL) study (PNNL-22957), which indicated that nitrite was a major contributor to the measured reduction capacity. However, as described in the PNNL report, the reduction potential of nitrite was not sufficient to reduce Tc(VII) to Tc(IV). Accordingly, it may not be appropriate to include the measured reduction capacity of the saltstone simulant, which includes nitrite, in the assumed reducing capacity of saltstone.

The PNNL report also demonstrated that the use of the Ce(IV) titration method, which included sulfuric acid, may overestimate the reducing capacity available in saltstone. The PNNL report indicated that the method measured nearly all of the reducing capacity of the solid sample because most of the solids dissolved in the strong acid. The PNNL report indicated that with the Cr(VI) method, which used neutral or alkaline conditions, only the reducing capacity of the solid surface and any internal surface that oxygen can reach in the available contact time was likely to be measured. The formation of a

passivation layer on the blast furnace slag was indicated as potentially contributing to the decreased reactivity under the Cr(VI) method. It is not clear to the NRC staff that the DOE use of the Ce(IV) method was appropriate for determining the reducing capacity of saltstone because the conditions for the Cr(VI) method were more consistent with the expected alkaline conditions of saltstone.

In addition to the previous NRC staff concerns in RAI Comment SP-10 on the DOE FY13 SDF Special Analysis document, the NRC staff has concerns about the effects of oxygen entrainment during full-scale mixing, pumping, and pouring on the reducing capacity of field-emplaced saltstone.

Path Forward: Provide justification for the modeled reducing capacity of saltstone available for reaction with infiltrating water, including the following issues: (1) applicability of the measurement method; (2) identity of species supplying the measured reducing capacity and the ability of those species to reduce Tc(VII) to Tc(IV) in a cementitious environment; (3) any kinetic limitations caused by the potential formation of a passivation layer on blast furnace slag particles; and (4) the effects of interactions with oxygen and oxygen entrainment during field-scale mixing, pumping, and pouring. Measurements of the reducing capacity of cores of field-emplaced saltstone could address concerns about field-emplaced saltstone but would not necessarily address all of the NRC staff concerns in this RAI Question (e.g., concerns about the applicability of the measurement method).

SP-8 **Question:** Additional information is needed to demonstrate the effects of uncertainty in modeled chemical reducing capacity in saltstone.

Basis: Section 5.6.3 of the DOE FY14 SDF Special Analysis document referenced both Section 5.6.3 of the DOE 2009 SDF PA and the DOE FY13 SDF Special Analysis document for the description of variables included in the probabilistic uncertainty analysis. Based on those references, Appendix D of the DOE FY14 SDF Special Analysis document, and the DOE document “Updates to the Saltstone Disposal Facility Stochastic Fate and Transport Model” (SRR-CWDA-2013-00073), it does not appear to the NRC staff that reducing capacity of saltstone was directly included in the DOE probabilistic uncertainty analyses. An alternate value for the residual reducing capacity of saltstone was modeled in the DOE Case K evaluation; however, as described in the NRC 2012 SDF TER, the results of that analysis were difficult to interpret because of modeled hold-up of Tc-99 in the disposal structure floors.

The DOE expected the reducing capacity of saltstone to serve as a key chemical barrier to Tc-99 release. Therefore, to evaluate the projected system performance, the NRC staff needs to understand the effects of modeled reducing capacity on the system performance. As described above in RAI Question SP-7, the NRC staff identified sources of uncertainty in the reducing capacity that will be available to reduce Tc(VII) to Tc(IV) in saltstone. Furthermore, as described in NRC RAI Comment SP-10 on the DOE FY13 SDF Special Analysis document, additional uncertainty may be imparted by variability in slag reactivity caused by inherent variability in the slag and variable storage times and storage conditions.

Path Forward: Provide a sensitivity or uncertainty analysis that demonstrates the effects of uncertainty in saltstone reducing capacity on projected dose from Tc-99. Because many of the factors that affect the available reducing capacity in saltstone are expected to apply to disposal structure concrete, the modeled reducing capacity in saltstone and disposal structure concrete should be correlated (see RAI Question DSP-10 – later in this document). A justification of the sensitivity analysis values used or the probabilistic uncertainty range used should address the issues discussed in RAI Question SP-7 above and additional variability caused by inherent variability in slag reactivity and variable slag storage times and storage conditions.

SP-9 **Question:** Additional information is needed about the sensitivity analysis results regarding increased dispersivity in saltstone.

Basis: The PORFLOW sensitivity analysis in Section 5.6.7.5 of the DOE FY14 SDF Special Analysis document provided useful information on the effects of increased vertical and lateral dispersivity in saltstone. In particular, that sensitivity analysis addressed some of the NRC staff concerns about the effects of cold joints resulting from multiple saltstone lifts. However, the DOE did not provide a basis for the horizontal and vertical dispersivity values used in that sensitivity analysis.

Figure 5.6.7-26 of the DOE FY14 SDF Special Analysis document showed a peak flux of over 200 g/yr for Tc-99 from a 375-foot disposal structure. The DOE did not provide that result in terms of dose. Although that dose peak was projected to occur between 40,000 and 45,000 years after disposal, the NRC staff needs to understand the likelihood of the conditions leading to that projected peak because of the NRC staff concerns about the timing of those projected Tc peaks.

Path Forward: Provide a basis for the horizontal and dispersivity values used in the sensitivity analysis. The basis should address the potential effects of cold joints between lifts. Provide results in terms of dose of the sensitivity analysis described in Section 5.6.7.5 of the DOE FY14 SDF Special Analysis document.

SP-10 **Question:** Additional information is needed on the results of the sensitivity analysis with non-depleting oxygen sources within saltstone.

Basis: The PORFLOW sensitivity analysis provided in Section 5.6 7.4 of the DOE FY14 SDF Special Analysis document provided useful information on the hypothetical effects of non-depleting oxygen sources within saltstone. That analysis could be used to non-mechanistically represent several phenomena of concern to the NRC staff, including: the effects of unsaturated fractures (see RAI Question SP-2 above); and the potentially poor correlation between Tc release and consumption of reducing capacity (see RAI Question SP-6 above). Although the cumulative fractional amount of Tc released was provided for 50,000 years, the dose results were provided for only 20,000 years and those results did not capture the Tc-99 peak doses. In addition, those results are difficult to interpret without information on storage in the floor and mud mats. In the DOE FY14 SDF Special Analysis document, the DOE indicated that assumed floor oxidation did not have a significant effect on the results. However, in the DOE 2009 SDF PA, there was a significant effect of retention of Tc-99 in the disposal structure floor in Case K. It is not

clear to the NRC staff how retention in the floor and basemat would affect Tc-99 release in the sensitivity analysis provided in the Section 5.6.7.4 of the DOE FY14 SDF Special Analysis document.

Path Forward: Provide results of the sensitivity analysis described in Section 5.6.7.4 of the DOE FY14 SDF Special Analysis document in terms of dose for 50,000 years. Either show the storage of Tc-99 in the floor and basemats or perform the analysis with oxidized floor and basemats.

SP-11 Question: Additional justification is needed for the sorption coefficient (K_d) values assumed for risk-significant and potentially risk significant radionuclides in saltstone in the DOE Evaluation Case and the ranges of values used in the sensitivity cases.

Basis: In the 2012 NRC SDF TER and in the NRC RAI Comments on the DOE FY13 SDF Special Analysis document, the NRC staff indicated that the K_d values assumed for iodine (I), selenium (Se), radium (Ra), and strontium (Sr) in cementitious materials were not adequately supported. Section 5.6.6.4 of the DOE FY14 SDF Special Analysis document showed results from sensitivity analyses that were performed to evaluate the potential effect on the projected dose from the K_d values assumed for cementitious materials.

In the sensitivity analyses performed for I, the K_d values were decreased by a factor of two. However, that reduction does not appear to the NRC staff to fully capture the range of potential K_d values for that element. For example, as described in the NRCs 2012 SDF TER, values that are lower than those assumed in that sensitivity analysis have been measured for the sorption of I onto cementitious materials. The basis for the assumed K_d value for I for cementitious materials was also discussed with the DOE during the NRC February 2015 Onsite Observation Visit (see SDF-CY15-01 Report in ADAMS as ML15041A562). In response to Follow Up-Action Item SDF-CY15-01-007, the DOE provided the NRC staff with additional documents related to the sorption of I (see ML15075A111). One of those documents (i.e., Wang et al. (2012)) included a recommendation for the use of a K_d value of 10 mL/g for I in Region II concrete based on expert opinion. However, that document did not provide the experimental data used to derive that value, so the applicability of that value to saltstone is not clear to the NRC staff.

In the sensitivity analyses performed for Ra, the K_d values were also decreased by a factor of two. There is limited availability of directly applicable measurements for the sorption of Ra onto cementitious materials. New measurements were reported in the DOE document, “Crosswalk of Select Documents Related to the Monitoring Programs for the Saltstone Disposal Facility,”(SRR-CWDA-2014-00002, Rev. 1) for the K_d of Ra in saltstone materials that were much higher than the values used in the modeling. However, the high values measured could be due to precipitation of the Ra, instead of sorption. Due to the uncertainty in the sorption of Ra onto cementitious materials, the use of a wider range of K*d* values in the sensitivity analysis may be more defensible.

The sensitivity analysis performed for the K_d values for the sorption of Se onto cementitious materials included a significant decrease in the assumed K_d values. The

values assumed in the sensitivity analysis appear to appropriately bound the potential K_d values for the reduced cementitious materials. However, the values assumed for the oxidized cementitious materials do not include the full range of measured values (i.e., measured K_d values ranging from 29.7 to 78.5 mL/g reported in SRNS-STI-2008-00045). The use of a lower K_d value for the oxidized concrete would be more defensible.

Because lower K_d values increase the rate of release of radionuclides from a source, the NRC staff is concerned that use of those K_d values to represent sorption in saltstone could lead to an underestimate of the dose.

Path Forward: Provide a justification for the K_d values assumed for I, Se, and Ra in saltstone and the ranges used in the sensitivity analyses in the DOE FY14 SDF Special Analysis document. Alternately, perform sensitivity analyses that include the range of observed K_d values for those elements to determine the potential effect of those parameters on the projected dose, or else provide a revised analysis that uses more defensible values.

SP-12 Question: Additional information is needed about the representation of Tc release from young cementitious materials.

Basis: In NRC RAI Comment SP-8 on the DOE FY13 SDF Special Analysis document, the NRC staff was concerned about the value of $1x10^{-8}$ moles/liter used by the DOE to represent Tc solubility in saltstone. The NRC staff specifically cited higher solubility values (i.e., approximately $1x10^{-6}$ moles/liter) observed by Cantrell and Williams in the PNNL-21723 report from 2012 and questioned how those results were incorporated into the DOE analysis. During the NRC May 2014 Onsite Observation Visit (see SDF-CY14-01 Report in ADAMS as ML14199A219), the DOE explained that those values were measured at a higher pH than anticipated in moderately-aged saltstone (i.e., approximately 10.5). Section 4.1.2 of the DOE FY14 SDF Special Analysis document included the following:

> "Under reducing conditions (Eh < -0.38 V), the calculated technetium solubility decreased as the pH decreased. For example, when pH changed from 12.7 to 10.5 (the approximate pH decrease between the young and moderately-aged saltstone stages used in [this document]) at a fixed Eh of -0.38 V, the calculated solubility of TcO2·1.6H2O is predicted to significantly decrease from 6.3E-07 M to 5.2E-09 M."

However, the DOE FY14 SDF Special Analysis document did not address how the higher solubility representative of young concrete was represented in the model, which used a value of 1×10^{-8} moles/liter for the entire 10,000 year performance period.

Path Forward: Perform an analysis and provide results that project Tc-99 release during the time period when saltstone has a pH higher than moderately-aged cementitious material (i.e., higher than a pH of 10.5), including considering the higher Tc solubility expected at those pH values.

Infiltration and Erosion Control (IEC):

IEC-1 Question: Technical justification is needed for the expectation that future infiltration rates will be between the minimum and average values. In addition, information is needed about the status of the Hydrologic Evaluation of Landfill Performance (HELP) code replacement evaluation.

Basis: Section 5.6.3.1 in the DOE FY14 SDF Special Analysis document included the following:

> "This referenced report [WSRC-STI-2008-00244] indicates that a number of conservatisms were assumed in the development of the HELP model used to generate these infiltration rates. Giving credit for these conservatisms, it is reasonable to expect that future infiltration rates would be between the minimum and average values. Therefore, a discrete distribution was applied in which the minimum infiltration rate was assigned a 40% probability, the average infiltration rate was assigned a 40% probability, and the maximum infiltration rate was assigned a 20% probability."

However, expected conservatisms in the HELP code are not adequate justification given the concerns about the reliability of HELP for predicting performance without site-specific calibration. The NRC 2012 SDF TER includes the following:

> "Although the HELP code may be suitable for estimating long-term water balances, short-term events and trends may not be adequately represented [(U.S. Environmental Protection Agency (EPA) Report EPA-600-R-02-099, Bonaparte et al. (2002). That EPA report included:] '… the model will generally not be adequate for use in a predictive or simulation mode, unless calibration is performed using site-specific measured (not default) material properties and actual leachate generation data'. Since calibration data over the lifetime of the planned closure cap is unavailable, the use of an alternative code may provide more defensible infiltration estimates."

The DOE document WSRC-STI-2007-00184, Rev.2 included that the HELP results were generally conservative, but page 59 of that DOE document included the following:

> "However as indicated in Section 8.7.1, the HELP model is not capable of appropriately considering the results of the probability based root penetration model which has been developed to evaluate root penetration of the [Geosynthetic Clay Liner (GCL)] through tensile stress cracks within the overlaying HDPE geomembrane. For this reason in the future other models will be evaluated as a replacement to the HELP model. The models to be considered may include but are not limited to FEHM, HYDRUS-2D, LEACHM, TOUGH-2, UNSAT-H, and VADOSE/W."

Because of the importance of infiltration to the dose results, the NRC staff continues to monitor the hydraulic performance of the closure cap and needs information about the status of that DOE evaluation. The importance of infiltration rates to peak dose was seen in Figure 5.6.5-20 in the DOE FY14 SDF Special Analysis document, which presented a comparison of minimum, average, and maximum infiltration rates.

Path Forward: Provide technical justification for the expectation that future infiltration rates will be between the minimum and average values**.** Provide the results or the status of the HELP code replacement evaluation.

Disposal Structure Performance (DSP):

DSP-1 Question: The evaluation of a potential breach of High Density Polyethylene (HDPE) did not consider the potential impacts of a breach in the HDPE or HDPE seam welds in the closure cap or below the drainage layer above a disposal structure.

Basis: During the February 2015 Onsite Observation Visit (see SDF-CY15-01 Report in ADAMS as ML15041A562), the DOE discussed that the observance of water in the leak detection system of SDS 3A was most likely caused by the failure of an extrusion weld. Although the observations of water in the leak detection system are consistent with the failure of an extrusion weld, the DOE evaluation did not rule out the possibility of an HDPE tear or a failure of a seam weld. The NRC staff is concerned that the evaluation only included the potential impacts of a breach in the HDPE around the disposal structure and did not evaluate the potential impact of a breach in the HDPE layer in either the closure cap or below the drainage layer above each disposal structure.

The NRC staff understands that the HDPE seam welds are tested in the field during the construction phase. However, the NRC staff is not aware of longer-term tests of these seam welds after the initial testing period.

Path Forward: Provide information to support the DOE assumption of longer-term performance of the HDPE and HDPE seam welds, in particular field welds on 100 mil HDPE. Examples of that type of information include: field studies of similar materials, accelerated laboratory studies on HDPE and HDPE seam welds, and confirmatory testing of welds that have been conducted after the initial construction testing. Alternatively, provide a revised dose estimate that includes an early failure of these materials.

DSP-2 Question: Additional information is needed to support the delays before carbonation of the roof and floors of the disposal structures were modeled to begin.

Basis: The DOE Evaluation Case delayed modeled carbonation of the floor and roof of the 150-foot and 375-foot disposal structures until 1,400 years after site closure. The DOE FY14 SDF Special Analysis document attributed those delays to the performance of the HDPE-GCL layer. However, it is not clear to the NRC staff why carbonation would not occur due to diffusion of carbon dioxide gas from the unsaturated soil into the roofs and floors of the disposal structures. The DOE FY14 SDF Special Analysis document provided a projection of the hydraulic performance of the HDPE-GCL layers; but did not discuss their permeability to gas. Furthermore, the sides of the 375-foot disposal structures are in direct contact with soil that would serve as a source of carbon dioxide.

Section 4.2.2.2 of the DOE FY14 SDF Special Analysis document showed the results of a mechanistic model of carbonation of disposal structure concrete performed with the CBP toolbox model LeachXS/Orchestra. The DOE determined that the analytical solution represented in the DOE Evaluation Case predicted a conservative carbonation

rate compared to the numerical solution determined with LeachXS/Orchestra. However, the LeachXS/Orchestra solution did not support the assumption that carbonation would not begin until the complete degradation of the HDPE-GCL.

Although degradation through sulfate attack of the roofs and floors of the 150-foot and 375-foot disposal structures was modeled as beginning at the time of closure, delaying the modeled onset of carbonation increased the total time needed for degradation. The time until complete degradation of the disposal structure roofs and floors, in turn, delayed the modeled onset of saltstone degradation. Earlier degradation of saltstone and disposal structure components could shift doses due to risk-significant radionuclides, such as I-129, earlier in the performance period and could contribute to moving doses from other radionuclides into the performance period.

Path Forward: Provide support to the assumption that the HDPE and HDPE-GCL layers delay carbonation of disposal structure cementitious components or provide a revised analysis that demonstrates the effects of assuming disposal structure carbonation begins immediately after emplacement.

DSP-3 Question: Additional information is needed about I-129 sorption in and release from the walls, floors, and mud mats of the 375-foot and 150-foot disposal structures to support the conceptual model of the peak dose within 10,000 years.

Basis: The DOE FY14 SDF Special Analysis document included the following:

> "Figure 5.5-4 shows I-129 climbing from about 2,000 years until it reaches the two peaks, at around 5,000 years and 5,300 years after closure. These peaks correspond to releases from [SDS 9 and SDS 7], respectively, as the modeled wall segments become oxidized (starting around 1,600 and completing 4,100 years after closure). As oxidation occurs, and as flow through the [disposal structure] saltstone increased due to degradation, I-129 is more readily transported."

However, Table 4.1-4 in the DOE FY14 SDF Special Analysis document showed that I-129 is modeled with a higher K_d value under oxidized conditions as compared to reduced conditions (i.e., 15 mL/g under oxidized Region II conditions and 9 mL/g under reduced Region II conditions), which does not support the explanation of I-129 release due to a transition to oxidizing conditions.

Figure 4.8-3 of the DOE FY14 SDF Special Analysis document showed the K_d values for I-129 in the lower and upper mud mats of the 375-foot disposal structures were greater than the K_d values in saltstone during a 20,000 year analysis period. That difference in K_d values may lead to modeled reconcentration of I-129 in the mud mats. Similarly, Figures 4.8.2 and 4.8.3 showed that, at different times during a 20,000 year analysis period, the walls and lower mud mat of the 150-foot disposal structures and wall segments of the 375-foot disposal structures have greater K_d values for I-129 than saltstone does.

Iodine-129 is a key risk driver in the DOE FY14 SDF Special Analysis document. Information about iodine storage in and release from saltstone and the disposal structures is needed to support an accurate understanding of the conceptual and mathematical models of I-129 release.

Path Forward: Provide intermediate model results that show the total concentration of I-129 in saltstone in the disposal structure walls, floor, and mud mats of both the 150-foot and 375-foot disposal structures as a function of time. If I-129 is shown to reconcentrate in the disposal structure walls, floors, or mud mats, justify whether that reconcentration is an intended part of the conceptual model. If necessary, clarify the description in Section 5.5.1.2 of the DOE FY14 SDF Special Analysis document related to the I-129 peaks in Figure 5.5-4.

DSP-4 Question: Information is needed on the dose results of the PORFLOW sensitivity analysis for the roof slope of the 375-foot disposal structures.

Basis: Section 5.7.1 of the DOE FY14 SDF Special Analysis document provided an analysis of the sensitivity of the projected volumetric flow through a 375-foot disposal structure to the slope of the roof. The analysis showed that changing the slope from 1.5% to 1.0% increased the projected flow through the disposal structure by 70% at approximately 4,000 years after site closure. However, neither the release of I-129 nor the effect on dose is projected. The section also indicated that the dose from I-129, with a peak dose at approximately 5,300 years, was expected to arrive slightly earlier; but, not expected to increase significantly in magnitude. That result is unexpected to the NRC staff because increased flow is expected to increase the annual fractional release rate (i.e., sharpen the dose peak).

Path Forward: Provide results for the sensitivity analysis of the slope of the roofs of the 375-foot disposal structures in terms of projected dose.

DSP-5 Question: Justifications are needed for the assumptions related to the lower lateral sand drainage layer as used in both the DOE FY13 and FY14 SDF Special Analysis documents.

Basis: In the RAI Comments on the FY13 Special Analysis document, the NRC staff was concerned about several specific aspects of the closure cap design. The DOE 2015 Response to the NRC 2014 RAI Comments included the following:

> “There are key questions related to closure cap design and performance that could affect the results of the modeling (e.g., plugging of the drainage layer). However, the … parameters [that are] most sensitive to SDF performance are related to the saltstone waste form and the disposal [structures] themselves… As such, in the near term, resources are prioritized to support testing and modeling research activities related to key parameters of the saltstone waste form and the disposal [structures] ...”

The NRC staff understands that the closure cap design has not been finalized by the DOE. However, the NRC staff is concerned about the practicality of the DOE achieving

the final reduced saltstone infiltration rates. Despite the SDF closure cap design and installation being at least 20 years in the future, the NRC staff needs to have confidence that infiltration rates in the future will not exceed a rate that would endanger public health and safety. The importance of infiltration rates to peak dose are seen in Figure 5.6.5-20 in the DOE FY14 SDF Special Analysis document, which presented a comparison of minimum, average, and maximum infiltration rates.

The lower lateral drainage layer, also known as the sand drain, diverts a significant percentage of the infiltrating water from the surface away from the disposal structures within 10,000 years. Although less water is drained in the DOE FY14 SDF Special Analysis document compared to that in the DOE 2009 SDF PA, the lower lateral drainage layer, together with the HDPE-GCL and the concrete roof, are a significant component of the system and requires strong bases. Regarding that NRC staff concern, the DOE assumptions in the DOE FY14 SDF Special Analysis document that need stronger supporting technical bases or information include the following:

(a) *Assumption: The backfill overlying the sand drain below will remain relatively separate for thousands of years.*
That assumption relies on relatively clean sand layers lying directly beneath clayey layers in natural geologic units tens of millions of years old. However, the backfill is not a natural geologic unit. Soil and material have been placed there by heavy equipment and therefore lack the natural depositional structures that link individual particles in natural clay units.

(b) *Assumption: Clay from the backfill will accumulate in the sand drain from the bottom up and form a depositional layer at the bottom of the drainage layer similar to the formation of the B soil horizon as documented in the soil literature.*
Although most literature described accumulation of clay that has either been deposited out of percolating waters or precipitated by chemical processes involving dissolved products of weathering, most did not discuss deposition from the bottom up.

(c) *Assumption: Hydraulic properties of the material being deposited in the lower lateral drainage layer are similar to that of backfill.*
Although the NRC staff expects that material deposited in the drainage layer would be clay, the parameter values used by the DOE were that of a backfill, which is considerably sandier than clay.

Path Forward: Provide the technical bases or additional information to address the DOE assumptions listed in RAI Question DSP-5 in (a), (b), and (c) above.

DSP-6 Question: Support is needed for the assumption that modeling features that extend beyond the footprint of the disposal structure walls as flush with outer edges of the disposal structure walls will not have a significant impact on projected flow fields.

Basis: Without any explanation or justification, Section 3.3.1.2 of the DOE FY14 SDF Special Analysis document includes the following:

> " … except for the sand drainage layer above the roof, those parts of features that extend beyond the footprint of the [disposal structure] walls are ignored (e.g., the roof and mud mats are modeled as being flush with outer edges of the [disposal structure] walls)."

In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment DSP-6 in that document), the DOE indicated that velocity flow fields exhibit water moving in and out of the disposal structure components (e.g., water moves out of the components near the top and near the bottom of the disposal structure and water moves into disposal structure components between the top and bottom). Modeling the portions of the features that extend beyond the footprint of the disposal structure could change the velocity flow fields which could have an effect on the overall speed and direction of radionuclide transport.

Path Forward: For a variety of conditions that could represent future environments (e.g., changes to infiltration rates, degradation rates, or soil properties), provide a technical basis that demonstrates whether modeling the roof and mud mats as being flush with outer edges of the disposal structure walls significantly changes projected flow fields.

DSP-7 Question: Additional information is needed about how the GoldSim model captures horizontal advective radionuclide transport from the floor and the mud mats.

Basis: Section 4.4.4.3 of the DOE FY14 SDF Special Analysis document includes the following:

> "Unlike the 150-foot diameter [disposal structures], the volumetric flows through the saltstone of the 375-foot diameter [disposal structures] are much more variable. This is because the walls of the larger [disposal structures] are not protected by a layer of HDPE liner and are, therefore, subject to more influence from horizontal flow."

However, the DOE document, "Updates to the Saltstone Disposal Facility Stochastic Fate and Transport Model" SRR-CWDA-2013-00073, Rev. 2, includes the following:

> "Several simplifying assumptions are made in conjunction with the abstraction model used in the SDF GoldSim Model. With exception of the wall-to-floor joint cells in the FDCs, only vertical advection through the engineered barrier (and UZ) is considered in the model abstraction upon which the three [disposal structure] models are based."

If horizontal advective transport of radionuclides into the backfill from the disposal structure floor and mud mats is not captured, then the dose and concentration results may be too low.

Path Forward: Provide a description that demonstrates how the GoldSim model is capturing horizontal advective radionuclide transport from disposal structure components into the backfill.

DSP-8 Question: Additional information is needed about how the parameters used to develop the flow cases were selected.

Basis: In Section 3.1.4 of the DOE FY14 SDF Special Analysis document, the DOE identified that the sampling set of 36 flow cases was developed for the DOE FY13 SDF Special Analysis document to evaluate the effects on flow from varying the input values for selected parameters. Those input values that were varied were infiltration rates, cement degradation, initial hydraulic conductivity of grout, and moisture characteristic curves. The DOE FY13 Special Analysis document also evaluated roof slope. The DOE FY14 SDF Special Analysis document used infiltration rates, cementitious material degradation, and initial hydraulic conductivity of grout to obtain the flow cases, and described why the moisture characteristic curves were not varied in the DOE FY14 SDF Special Analysis document. However, neither the DOE FY13 nor the DOE FY14 SDF Special Analysis documents described how the five parameters that were varied were initially selected. For example, it is not clear to the NRC staff how the DOE determined that the volumetric flow rates were not sensitive to HDPE/GCL degradation, the shape of saltstone degradation (e.g., shrinking core, entire block, or from top down), or the hydraulic property of the adjacent backfill.

Path Forward: Provide the criteria and basis for how the parameters that were varied to develop the sampling set of 36 flow cases were initially selected.

DSP-9 Question: Additional justification is needed for the K_d values assumed for risk-significant and potentially risk-significant radionuclides in disposal structure concrete in the DOE Evaluation Case and the ranges of values used in sensitivity cases.

Basis: The K_d values assumed for disposal structure concrete were identical to those assumed for saltstone. Therefore, the basis for this RAI Question is the same as the basis for RAI Question SP-11 above.

Path Forward: Provide a justification for the K_d values assumed for I, Se, and Ra in disposal structure concrete and the ranges used in the sensitivity analyses included with the DOE FY14 SDF Special Analysis document. Alternately, perform sensitivity analyses that include the range of observed K_d values for those elements to determine the potential effect of those parameters on the projected dose or provide a revised analysis that uses more defensible values.

DSP-10 Question: Additional information is needed to demonstrate the effects of uncertainty in modeled chemical reducing capacity in disposal structure concrete.

Basis: The NRC staff concerns about the quantification of reducing capacity in saltstone also apply to the quantification of reducing capacity in disposal structure concrete. Therefore, the basis for RAI Question SP-8 above also applies to this RAI question.

Path Forward: Provide a sensitivity or uncertainty analysis demonstrating the effects of uncertainty in the reducing capacity of disposal structure concrete on projected dose from Tc-99. Because many of the factors that affect the available reducing capacity in disposal structure concrete are expected to apply to saltstone, the modeled reducing capacity in saltstone and disposal structure concrete should be correlated (see RAI Question SP-8 above). A justification of the sensitivity analysis values used or the probabilistic uncertainty range used should address the issues discussed in RAI Question SP-7 above as well as additional variability caused by inherent variability in slag reactivity and variable slag storage times and conditions.

DSP-11 Question: Additional information is needed about the grid, saturation, and Darcy velocity fields for different time periods as well as for vertical and horizontal volumetric flow rates for the disposal structure components.

Basis: The Closure System Modeling section in the "Analysis of Performance" in the DOE 2009 SDF PA had detailed cross-sectional figures from the PORFLOW model, including detailed close-ups of the grid, saturation, and Darcy velocity fields for 100, 1000, 5000, and 10,000 years. Such detailed cross-sectional figures were not included in same section in the DOE FY14 SDF Special Analysis document. The DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment DSP-6 in that document) provided useful information, such as, cross-sectional views of flow rate transient and flow fields for different time periods and volumetric flow rates for the disposal structure components.

The DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment DSP-5 in that document) included the following: "A portion of the infiltrating water that initially bypasses saltstone via the sand drainage layer (and to a lesser extent the roof) is commonly observed to enter (or re-enter) the engineered structure through the side. As a result, the total flow through the engineered system tends to increase moving down the disposal [structure] starting a short distance below the roof."

Based on the information in the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comments DSP-5 and DSP-6 in that document), the NRC staff has the following additional specific questions and concerns:

- Considering that that the HDPE in the wall still has a relatively low hydraulic conductivity value (6.44×10^{-7} cm/sec after 10,000 years) in comparison to the other components, how is the reentry flow into SDS 2 possible?

- Most of the wall for SDS 6 has water flow into the disposal structure. However, most of the water appears to be exiting in a relatively small section at the bottom of the disposal structure. Considering that the HDPE extends up the side of the disposal structure, is embedded in the middle part of the floor, and still has a relatively low hydraulic conductivity value of 6.44×10^{-7} cm/sec after 10,000 years, why is there no bathtub effect above the floor HDPE/GCL of SDS 6?

- Considering the horizontal component of water flow exiting in a relatively small vertical section at the bottom of SDS 6, has a floor slope evaluation of flow similar to the roof slope evaluation been performed for SDS 6 type disposal structures?

- Why did the SDS 2 and SDS 6 roofs remain relatively unsaturated compared to the grout (See Figures DSP-6.6 and DSP-6.8 from the DOE 2015 Response to the NRC 2014 RAI Comments)?

- In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment DSP-1 in that document), the DOE response included: "DOE has modeled construction joints (with the hydraulic properties associated with gravel) that penetrate through the roof of the 375-foot diameter [disposal structures] (see Section 4.2.3 of the [DOE FY14 SDF Special Analysis document])." However, that information was not included in the DOE responses to RAI Comments DSP-5 and DSP-6 in that document.

- To provide a more accurate understanding of the flow regime within a disposal structure at any particular time, both vertical and horizontal volumetric flow rates for each disposal structure component at different time steps is needed. The inflow and outflow of the backfill in relation to the disposal structure components needs to be included with vertical and horizontal volumetric flow rates.

- Detailed cross-sectional views of the grid, saturation, and Darcy velocity fields for different time periods as well vertical and horizontal volumetric flow rates for the disposal structure components and the underlying vadose units are important and needed for understanding the how processes are being modeled and discovery risk significant features or processes.

Path Forward: Provide information relevant to the NRC staff questions and concerns in this RAI Question.

Far-Field Transport (FFT):

FFT-1 **Question:** In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment FFT-1 in that document), the DOE referenced the DOE document SRR-CWDA-2014-00095. The NRC staff has concerns about information in that document and additional information is needed.

Basis: Figure 2.1-8 in the DOE document SRR-CWDA-2014-00095 showed the dose within 50,000 years for various SZ and UZ thicknesses, including the importance of the

leachate impact on K_d values in the UZ. However, considering that the transport of certain radionuclides were delayed by the thicker UZ, it is not clear to the NRC staff why the timing of the peaks in the case with the thinner SZ and thicker UZ are the same as those of the other cases. Additional information is needed to explain the match in timing of peaks between those cases.

Table 2.1-1 in the DOE document SRR-CWDA-2014-00095 showed SZ thickness by taking the differences in elevation between the water table elevation and the elevation of the top of the Gordon Confining Unit or Green Clay. However, the Tan Clay Confining Zone (TCCZ) acts locally as an aquitard. For a better representation, the DOE should take the differences between the bottom elevation of the TCCZ (or the water table elevation if lower than the bottom of the TCCZ) and the top of the Gordon Confining Unit.

Figure 2.2-1 in the DOE document SRR-CWDA-2014-00095 showed the importance of the dispersivity values in the SZ. To reduce potential uncertainty with regard to the potential significance of the dispersivity values used in Z-Area, the DOE could compare modeled plume results for the SDF against other plumes at the Savannah River Site (SRS), especially nearby plumes. The presence of structure and contours in the subsurface appears to have resulted in the unexpected narrowing and updip migration of a contaminant plume at P Reactor (see Cameron, González, et al., (2010)). Although the specific features at P Reactor may not be relevant to Z-Area, the DOE has observed subsurface structure in the TCCZ that could result in channeling of contaminants in the subsurface and similar structure could exist in the underlying stratigraphic layers. It is not clear to the NRC staff whether and how much those potential features could impact the dose results.

Path Forward: Provide additional information on how the properties of radionuclides represented in Figure 2.1-8 in the DOE document SRR-CWDA-2014-00095 and the characteristics of the sediments beneath the disposal structures can explain the timing of the peak doses for the different cases. Provide the thickness between the bottom elevation of the TCCZ (or the water table elevation if lower than the bottom of the TCCZ) and the elevation of the top of the Gordon Confining Unit. Provide a description of what effect such saturated thicknesses would have on the dose results. Provide the results and the DOE interpretation of the significance of applied dispersivity values by comparing the DOE modeled plume results for the Z-Area against other plumes at SRS, especially nearby plumes.

FFT-2 **Question:** Additional information is needed to support the values for the parameters used in the equation in Section 3.0 of the DOE document SRNS-TR-2014-00283.

Basis: The value of the effective porosity was provided as 0.25% and that value was referenced to be from the DOE document WSRC-TR-2007-00283. However, the NRC staff could not find that value for that parameter in that document.

Well ZBG 7 is screened in the upper zone of the Upper Three Runs (UTR) aquifer and Well ZBG 4 is screened in the lower zone of the UTR aquifer. Consequently, the head difference that DOE described was between two different aquifer zones with different hydraulic properties, separated by the TCCZ. The head difference should be between

either two upper aquifer zone wells or two lower aquifer zone wells, unless the DOE shows that the influence of the TCCZ is minimal in that area (i.e., not a confining zone).

The DOE showed that flow existed in the upper zone of the UTR aquifer (e.g., in Well ZGB 2). However, only the hydraulic conductivity value for the lower zone of the UTR aquifer was used (i.e., 13 ft/day rather than 10 ft/day). In addition, prior to 2013 the assumed hydraulic conductivity was 1.7 ft/day (see the DOE document SRR-ESH-2012-00066). In the 2013 Groundwater Monitoring report (see the DOE document SRNS-TR-2013-00275), the hydraulic conductivity was revised to 13 ft/day. That report indicated that parameters were changed to be consistent with the PA modeling data in the SRS General Separations Area. However, it is not clear to the NRC staff why it was appropriate for the DOE to change parameter values from the field-derived values to the model results. If the higher hydraulic conductivity value is not supported, then the model could be adding unrealistic dilution.

Path Forward: Provide the original reference for the assumed effective porosity. Explain the use of the head difference between two different aquifer zones (i.e., Wells ZBG 7 and ZBG 4). Provide justification for why the as-modeled hydraulic conductivity of the aquifer was used in the DOE FY14 SDF Special Analysis document rather than the value that appears to be field-derived. If the field-derived value is more defensible, then provide a revised dose estimate using the field-derived hydraulic conductivity.

FFT-3 **Question:** Additional information is needed to support assumptions about potential saturated conditions in the upper zone of the UTR aquifer in Z-Area and potential contamination in the upper zone of the UTR aquifer in Z-area.

Basis: The DOE document SRNS-TR-2014-00283 in Section 7 included: "The two samples collected at ZBG002C in 2014 indicate no contamination is migrating through the TCCZ." That indicated to the NRC staff that contaminates may flow horizontally on top of the TCCZ rather than solely through the TCCZ. However, contamination remaining in water from the upper zone of the UTR aquifer and serving as the main source of water to a receptor well was not considered as an alternative conceptual model.

Only seven wells are screened in the upper zone of the UTR aquifer (i.e., ZBG 1, ZBG 2, ZBG 6, ZBG 7, ZBG 8, ZBG 15D, ZBG 16D). Except for Well ZBG 2, most of those wells are located in one area of Z-Area. However, other areas have been shown to have water present above the TCCZ, as seen in Figures 2, 3, and 4 in the DOE document K-ESR-Z-00001.

Most wells are located in either the TCCZ or the lower zone of the UTR aquifer. Therefore, water level measurements from those wells showed the potentiometric surface rather than the UTR upper zone water table level, as indicated in Figure 3 in the DOE document SRNS-TR-2014-00104.

Path Forward: Provide information on the extent and thickness of water in the upper zone of the UTR aquifer over an extended time period in the entire Z-Area. As an alternative conceptual model, the water in the upper zone of the UTR aquifer could be a

primary source of radionuclides for a receptor well. Either provide justification that the alternative conceptual model is invalid or provide the dose estimates using that alternative conceptual model.

FFT-4 **Question:** Additional information is needed about the extent and thickness of the TCCZ in the entire Z-Area and how it was modeled in PORFLOW.

Basis: Section 3.1.5.2 in the DOE 2009 SDF PA included the following:

> "Contained within the Dry Branch Formation, the hydrostratigraphic unit, known (at SRS) as the [TCCZ], is of particular interest because it acts locally as an aquitard, supporting a water table and retarding the downward flow of groundwater. The presence or absence, thickness, and extent of this unit are important inputs into groundwater flow and transport models that are in turn used to demonstrate expected compliance with applicable groundwater regulatory requirements."

The NRC staff agrees with the importance of the TCCZ. However, the extent, thickness, and properties of the TCCZ are not fully known. For example, the vertical gradient of the water in and around the TCCZ, which is significant for radionuclide transport through the TCCZ, is not well known.

The DOE document SED-GTE-2008-002 included the following:

> "… interpretation indicates that the TCCZ is present in every borehole and [Cone Penetrometer Test] evaluated at the Saltstone site, ranging from 4.7 to 14.8 feet thick, with an average thickness of 10 feet."

Figures 3 and 5 from the DOE document K-ESR-Z-0002 showed the TCCZ to be entirely missing in a section of the disposal structure area. The DOE document SED-GTE-2008-002 relied on borehole SDS21A in Table 2 to conclude that the TCCZ was present in every borehole. However, borehole SDS21A was previously examined in a U.S. Geological Survey (USGS) report (see WRI Report 88-4221) and Figure 10 in that USGS report showed that the TCCZ was missing in that part of Z-Area. The TCCZ in Z-Area is not well defined and the dose implications are not clear to the NRC staff because of uncertainty regarding lateral transport and sorption due to that layer.

Due to the importance of the TCCZ, the DOE should provide additional documentation on how the TCCZ is modeled in PORFLOW, including either input values with output results or effects of the unit.

Path Forward: Provide information on the extent and thickness of TCCZ in the entire Z-Area, and, if saturated, information on the vertical gradient within the TCCZ. Provide additional documentation on how the TCCZ is modeled in PORFLOW.

FFT-5 **Question:** Additional justification is needed for the soil K_d values for Se assumed in the DOE FY14 SDF Special Analysis document.

Basis: This is the same NRC staff concern as in NRC RAI Comment FFT-2 on the DOE FY13 SDF Special Analysis document and the basis is the same as before.

In the DOE document SREL Doc. R-13-0005, the measured K_d values for Se on SDF soil that has been impacted by leachate from cementitious materials were reported. Those measured values ranged from 1 to 41 milliliters per gram (mL/g). Those values are much less than the values assumed in the DOE FY14 SDF Special Analysis document (i.e., 1,400 mL/g for both clayey and sandy soils). In addition, as described in the 2012 SDF NRC TER, the measurements that the assumed Se soil K_d values are based on may have been affected by experimental errors, which could have resulted in an overestimation of the K_d values.

In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment FFT-2 in that document), the DOE referenced a sensitivity analysis included in the DOE FY14 SDF Special Analysis document. In that sensitivity analysis, the K_d value for sandy soil was reduced from 1,000 to 500 mL/g and the K_d value for leachate impacted sandy soil was reduced from 1,400 to 20 mL/g. It is not clear to the NRC staff that the value of 500 mL/g appropriately considered the uncertainty in the K_d value for Se for sandy soil. The high values measured for the soil K_d for Se under low pH conditions appear to be due to solubility limitation instead of sorption. Those values may not reflect the behavior of Se in the subsurface if the conditions in the experiments were not consistent with the conditions in the subsurface. For example, if the concentration of Se in the experiments was higher than the concentration in the subsurface, then the real system may not reach a solubility limit as quickly. Also, if the pH in the experiments differed from the pH in the saturate zone, then the experimental values may not be applicable to the real system. Previously, the DOE indicated that the estimated Se K_d values will decrease sharply as the pH increases above a pH of 6 and will decrease an order of magnitude as the pH value approaches 7 (see DOE document SRR-CWDA-2011-00044). If the pH of the groundwater in the saturated zone is higher than the pH in the experiments, then the experimental results may over-represent the amount of sorption. Additionally, the value of 20 mL/g for the K_d value for leachate impacted sandy soil did not capture the range of values measured for leachate impacted soils (i.e., 1 to 41 mL/g).

Path Forward: Provide additional justification for the values assumed for the soil K_d values for Se or provide an evaluation of the potential impact on the projected dose due to the assumption of high values for the K_d for Se for soil that incorporates the full range of experimental values measured. That evaluation should include a consideration of the combined effect of the soil and cementitious material K_d values.

FFT-6 **Question:** Additional information is needed for the leachate impacted K_d values for clayey and sandy soil listed in Table 4.1-3 of the DOE FY14 SDF Special Analysis document.

Basis: In the NRC RAI Comments on the DOE FY13 SDF Special Analysis document (see RAI Comment FFT-3 in that document), the NRC requested additional information

for the assumed K_d values for leachate impacted clayey and sandy soil. The DOE response to RAI Comment FFT-3 in that document was minimal and the basis for those values in the DOE response is not clear to the NRC staff. In many cases, the DOE assumed values differed significantly from the values assumed for soil that was not leachate-impacted and those values are potentially significant to the projected dose. For example, the K_d for leachate-impacted sandy soils for Ra was identified as a sensitive parameter in the DOE probabilistic sensitivity analysis performed as part of the FY14 SDF Special Analysis document.

In the DOE 2015 Response to the NRC 2014 RAI Comments (see RAI Comment FFT-3 in that document), the DOE referenced future research, but did not respond to the entire specific concern raised by the NRC staff. That information is needed to support DOE assumptions about radionuclide transport in the UZ at the SDF.

Path Forward: Provide an explanation of the origin of the leachate impacted K_d values listed in Table 4.1-3 of the DOE FY14 SDF Special Analysis document, including the original reference(s).

Clarifying Comments (CC):

CC-1 **Comment:** Please clarify which direction (i.e., into or out of the disposal structures) the water is flowing through the construction joints. In the first 2,000 years after site closure, the volumetric flowrate through the joints and floor is essentially equivalent for those two different materials. It is not clear to the NRC staff if that is a coincidence or if there is another explanation (e.g., water flowing up through the construction joints and then down through the floor).

CC-2 **Comment:** Section 5.6.3 of the DOE FY14 SDF Special Analysis document referenced the DOE 2009 SDF PA for the description for how the parameters were selected for inclusion in the probabilistic uncertainty analysis. That selection process was described as being based on “modeling experience informed by the basis for the selected values and available generic and site-specific data.” Please clarify the role that the availability of generic and site-specific data played in the selection of parameters selected for inclusion in the probabilistic uncertainty analysis. Were parameters more likely to be included if data was scarce? Were parameters excluded from the uncertainty analysis on the basis that there was insufficient data available to generate a probabilistic distribution for the parameter value?

CC-3 **Comment:** The DOE document SRR-CWDA-2013-00073 Rev. 2, described the column-by-column calculation of radionuclide transport through saltstone and the disposal structure in the GoldSim model. That document described that the analysis implicitly assumed that transport was due only to vertical advection. To simulate horizontal diffusion, Equation 3.2-1 in that document allowed the user to specify a percentage of a mixing cell’s mass to be released to the UZ at cell-specific transition times. However, that document did not indicate the basis for Equation 3.2-1. In addition, it is not clear to the NRC staff whether that provision was used in the model runs in the DOE FY14 SDF Special Analysis document. If that provision was used by the DOE, then it is not clear to the NRC staff what range of values were used and the justification for those values. Provide the basis for Equation 3.2-1 in the DOE document

SRR-CWDA-2013-00073. Clarify whether that provision in the DOE document SRR-CWDA-2013-00073 was used in the model runs in the DOE FY14 SDF Special Analysis document. If that provision was used in those model runs, then provide the DOE assumed percentage of mass transferred through diffusion and provide justification for that value.

CC-4 **Comment:** The DOE document SRR-CWDA-2013-00073 Rev. 2, described that the transition time for Tc oxidation was calculated by the FORTRAN dynamic link library (DLL). That document indicated that the DLL: (1) calculated the time required for oxidation due to vertical flow, (2) calculated the time required for oxidation due to horizontal flow, and (3) used the minimum of those two values as the transition time. It appears to the NRC staff that both horizontal and vertical flow would occur and the transition time would be calculated from the combination of those two factors, not the minimum of each separately considered factor. Please clarify how the process the DLL used to calculate the Tc transition times accounted for the combined effects of horizontal and vertical flow.

CC-5 **Comment:** Additional information is needed about the configuration of the waterstop in the floor shown in Figure 3.3-6 of the DOE FY14 Special Analysis document. That figure showed that the floor segment above the waterstop has two joints (i.e., the concrete segment above the waterstop is separated from the main floor by the joints). It is not clear to the NRC staff how that piece of the floor is connected to the rest of the disposal structure. Please clarify as to whether all joints around waterstops in the disposal structure have two joints on one side and one joint on the other side of the waterstop, or if the joints around the waterstops in the floor are an exception.

CC-6 **Comment:** Table 23 in the DOE document SRNL-STI-2009-00473 indicated that the leachate impacted values for iodine should be 0.1 for clay and 0.0 for sand. However, Table 4.1-3 in the DOE FY14 SDF Special Analysis document has K_d values of 0.3 for clay and 0.1 for sand. Please clarify how and why those values have changed.

CC-7 **Comment:** Table 4.1-3 in the DOE FY14 Special Analysis document showed distribution coefficients for sandy and clayey soils. Please clarify whether the information below, which the NRC staff understands to be true, is correct for the DOE modeling effort:

- Values for no leachate impacted clayey soils were applied to the saturated portion of the TCCZ and the Green Clay (Gordon Confining Unit).
- Values for leachate impacted clayey soils were applied to the unsaturated portion of the TCCZ and the surrounding backfill.
- Values for no leachate impacted sandy soils were applied to the saturated portion of the UTR Aquifer.
- Values for leachate impacted sandy soils were applied to the unsaturated portion of the UTR Aquifer.

CC-8 **Comment:** The NRC staff understands that volumetric flow is a key factor in determining if distribution coefficients are considered leachate impacted. The SZ is not considered impacted due the quantity of water that dilutes the leachate. Please clarify the criterion or cutoff value for a medium to be considered impacted by leachate (e.g., any unit containing leachate that is less than saturated is considered leachate impacted). Please clarify the criterion for making that determination and the basis for that criterion.

CC-9 **Comment:** Section 5.6.2.3.1 of the DOE FY14 SDF Special Analysis document included that: "Because of the influences of the column zone on the saltstone flow domain, the saltstone is divided into two rectangles (central and outer) for [SDS 1 and SDS 4] and two cylinders (inner and outer cylinder) for the other [disposal structures]." Please clarify the DOE basis for modeling SDS1 with two rectangles (central and outer), even though there are no columns in SDS 1.

CC-10 **Comment:** Section 03740 in document C-SPP-Z-00008, Rev. 3 contained information about "Crack Repair Epoxy Injection Grouting." Please provide further details under what circumstances that epoxy injection grouting might occur.

CC-11 **Comment:** Section 3.3.1.2 of the DOE FY14 SDF Special Analysis document indicated that the 375-foot disposal structures will have 2-inch thick bearing pads made out of neoprene and sponge rubber positioned between the floor and the wall. The NRC staff expects that the weight of the wall and roof will compress the bearing pads to a smaller thickness. It is not clear to the NRC staff how the potential effects on the structural integrity of the wall due to settlement caused by decreasing thickness of the bearing pads was evaluated and incorporated into the DOE projections of SDF performance. Please clarify what the DOE has done in the past and what the DOE intends to do in the future regarding this.

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