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FY2013 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site: Quality Assurance Report

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ACRONYMS

C&WDA	Closure & Waste Disposal Authority
DLL	Dynamic Linked Library
EPA	U.S. Environmental Protection Agency
IHI	Inadvertent Human Intruder
K_d	Distribution Coefficient
MOP	Member of the Public
PA	Performance Assessment
QA	Quality Assurance
SA	Special Analysis
SDF	Saltstone Disposal Facility
SQAP	Software Quality Assurance Plan
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation
SRS	Savannah River Site

1.0 INTRODUCTION

The purpose of this report is to document input data verification and technical checking of model files and calculations developed in support of the FY2013 Special Analysis (SA) for the Saltstone Disposal Facility (SDF) at the Savannah River Site (SRS), hereafter referred to as the SDF SA. [SRR-CWDA-2013-00062] This report focuses on technical checking of work performed by Closure & Waste Disposal Authority (C&WDA) staff, as well as verification of inputs provided to C&WDA by organizations external to Savannah River Remediation (SRR), such as the Savannah River National Laboratory (SRNL).

Section 2 describes checking and verification activities related to input development. Sections 3 and 4 describe the checking of models developed in support of the SDF SA. Section 5 discusses checking and verification of post-processed data and model results. Section 6 provides a summary of software Quality Assurance (QA). Finally, Section 7 summarizes the results of these QA activities and describes modeling irregularities that were identified during these activities.

1.1 Scope and Method

The scope of this report focuses on input data verification and technical checking of inputs and modeling components that have changed relative to the SDF Performance Assessment (PA). [SRR-CWDA-2009-00017]

The activities documented within this report were performed according to the following documents:

- E7 Manual, *Conduct of Engineering*, Procedure 2.60, Technical Reviews [E7-2.60]
- S4 Manual, *Liquid Waste Organization Administrative Procedures*, Procedure ENG.51, *Verification and Checking of Technical Documents* (for SRR) [S4-ENG.51]
- *Technical Report Design Check Guidelines* (for SRNL) [WSRC-IM-2002-00011]
- 1Q *Quality Assurance Manual*, Procedure 20-1, *Software Quality Assurance* [1Q-20-1]

S4-ENG.51 and WSRC-IM-2002-00011 supplement E7-2.60. The objective of these documents is to ensure that inputs, calculations, and results are technically correct, accurate and complete. Sections 2 through 7 of this report describe how this objective was met for various aspects of the SDF SA development.

Completed QA documentation associated with the SDF SA accompanies this report as supporting files.

1.2 QA Summary

This report indicates that the SDF SA has no outstanding issues that require resolution. Therefore, the results of the SDF SA are technically defensible and complete. The SDF SA modeling results are appropriate for its intended use.

2.0 SDF SA INPUT DATA VERIFICATION

The following sections provide detailed information about data verification for various datasets used as inputs to the SDF SA.

2.1 Updated K_d Values

Due to the large number of contaminants considered in the SDF SA, many recent SRS reports related to K_d values do not include a complete set of the applicable K_d values; therefore, multiple reports were used to capture these inputs. For the SDF SA, new data was used from the following reports:

- SRNL-STI-2009-00473
- SRNL-STI-2010-00493
- SRNL-STI-2010-00667
- SRNL-STI-2011-00011
- SRNL-STI-2011-00672
- ML073510127

In every case, the SDF SA applied the most recent applicable values. Inputs obtained from these reports were independently reviewed.

2.2 Updated Technetium Solubility Data

Technetium solubility data for the SDF SA was drawn from *Solubility of Technetium Dioxides (TcO_2-c, $TcO_2 \cdot 1.6H_2O$ and $TcO_2 \cdot 2H_2O$) in Reducing Cementitious Material Leachates: A Thermodynamic Calculation*. [SRNL-STI-2012-00769] Technical data in this report has been checked during SRNL's technical review process, according to E7-2.60 and following the guidelines from WSRC-IM-2002-00011. The report was prepared by Dien Li and Daniel Kaplan and the independent, technical review was conducted by Miles Denham. In additional, the information in this report was externally reviewed by leading scientists actively conducting research in this subject matter: Dr. Wayne Lukens (Lawrence Berkeley National Laboratory) and Jeff Serne (Pacific Northwest National Laboratory).

2.3 Updated Cementitious Material and Degradation Properties

A number of recent studies have been performed by SRNL to advance the understanding of cementitious materials (i.e., saltstone, clean cap grout, concrete, etc.). All technical data in these reports has been checked during SRNL's technical review process, according to E7-2.60 and following the guidelines from WSRC-IM-2002-00011.

- Data on the effects of reducing capacity in cementitious materials comes from *Technetium Sorption by Cementitious Materials Under Reducing Conditions*. [SRNL-STI-2012-00596] The report was prepared by Shanna Estes, Daniel Kaplan, and Brian Powell and the independent, technical review was conducted by Morgana Whiteside.

- Revised recommendations for the initial saturated hydraulic conductivity of cementitious material comes from *Process Formulations and Curing Conditions that Affect Saltstone Properties*. [SRNL-STI-2012-00558] The report was prepared by Marissa Reigel, Bradley Pickenheim, and William Daniel and the independent, technical review was conducted by Christine Langton and Russell Eibling.

- Revised recommendations for the cementitious diffusion coefficients come from *Saltstone Characterization and Parameters for Performance Assessment Modeling*. [SRNL-STI-2010-00515] The report was prepared by Christine Langton and the independent, technical review was conducted by Gregory Flach.
- The moisture characteristic curves used in the SDF SA come from *Moisture Retention Properties of High Temperature Cure ARP/MCU Saltstone Grout*. [SRNL-STI-2011-00661] The report was prepared by Kenneth Dixon and the independent, technical review was conducted by Ralph Nichols.
- Revised recommendations for the mechanisms and the rates of cementitious degradation come from *Degradation of Cementitious Materials Associated with Saltstone Disposal Units*. [SRNL-STI-2013-00118] The report was prepared by Gregory Flach and Frank Smith III and a design check was performed by Glen Taylor and James Laurinat.

2.4 Updated Dose Calculation Methodology

C&WDA updated the methodology for calculating dose to human receptors. The updates incorporated the most recent applicable input data. Details of the new approach are documented in the report *Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site*. [SRR-CWDA-2013-00058] This dose calculation methodology was developed by Steve Hommel and technically checked and reviewed by Michael Schubert according to the guidelines provided in S4-ENG.51.

3.0 PORFLOW MODELING

PORFLOW modeling performed in support of the SDF SA is pivotal to demonstrating the performance of the SDF system with respect to waste release and transport. Accordingly, the PORFLOW modeling underwent additional levels of scrutiny. The following checking and verification activities were performed to provide high confidence in the quality of the SDF SA PORFLOW models.

3.1 Technical Review of PORFLOW

The report that documents PORFLOW modeling, *PORFLOW Modeling Supporting the FY13 Saltstone Special Analysis*, underwent technical review per E7-2.60. The report was prepared by Jeffrey Jordan and Gregory Flach and the independent, technical review was conducted by Tom Butcher and Frank Smith III. [SRNL-STI-2013-00280]

The design check of the SDF SA PORFLOW modeling work is independently documented within SRNL-L3200-2013-00022 and not repeated herein.

4.0 GOLDSIM© MODELING

This section describes the checking and verification activities for the development of model files and calculations performed in support of the SDF SA.

4.1 GoldSim© Model File Development

GoldSim© modeling within the SDF SA serves three functions. First, GoldSim© facilitates uncertainty analyses by allowing uncertainty distributions as input parameters that can be sampled over multiple realizations (i.e., probabilistic modeling). Second, a fate and transport model is used for benchmarking the results from the PORFLOW model, providing greater confidence in the modeling approaches. Finally, a GoldSim© dose calculator converts concentration data into doses (either to hypothetical members of the public or hypothetical human intruders).

The GoldSim© models for the SDF SA were developed using the GoldSim© software and are documented in two reports: *Saltstone Disposal Facility Stochastic Fate and Transport Model* and *Updates to the Saltstone Disposal Facility Fate and Transport Model*. [SRR-CWDA-2011-00178; SRR-CWDA-2013-00073] In addition, the revision to the dose calculations was implemented according to the recommendations described in *Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site*. [SRR-CWDA-2013-00058]

4.2 GoldSim© Dose Calculations Using PORFLOW Concentrations

Doses were determined from the concentrations of six discrete PORFLOW runs in the FY2013 SDF SA. All six dose calculations used the exact same GoldSim© file, except that the concentrations were replaced using the desired concentrations as determined in PORFLOW. The initial GoldSim© file that was used was the same as was used (*SDF_PORFLOW_Concentration-SA1-1SL_20130411.gsm*) to calculate doses for the Evaluation Case as described in the SDF SA. [SRR-CWDA-2013-00062] This initial GoldSim© file was developed to implement the recommended dose calculations of the revised dose calculation methodology and accepted PORFLOW data as input concentrations.

Steven Hommel prepared the dose calculations. Richard Sheppard input the concentration data. Ben Dean independently checked each of these files according to the requirements of ENG.51 and documented his checking in *OSR_46-574_EngineeringTechReportCheck SA Sec 5.5.pdf* and *OSR_46-574_EngineeringTechReportCheck SA Sec 5.6.6.pdf*. Table 4.2-1 summarizes these files.

Table 4.2-1. QA Summary of Dose Calculator Files Used in the SDF SA

Dose Files for PORFLOW Concentrations		**Description**
SDF_PORFLOW_Concentration-SA1-1SL_20130411.gsm		
Concentrations:	\\saltstone\AquiferZ_mpad\Transport\Case_sa\All	Evaluation Case
QA Result:	File developed by R. Sheppard and S. Hommel. Checked by B. Dean as part of Section 5.5 technical review. No errors identified.	
SDF_PORFLOW_Concentration-SA_100K.gsm		
Concentrations:	\\saltstone\AquiferZ_mpad\Transport\Case_sa_100k\All	Evaluation Case to 100,000 years after closure
QA Result:	File developed by R. Sheppard and S. Hommel. Checked by B. Dean as part of Section 5.5 technical review. No errors identified.	
SDF_PORFLOW_Concentration-FC10.gsm		
Concentrations	\\saltstone\AquiferZ_mpad\Transport\Case_param.10\All	Sensitivity using Flow Case 10
QA Result:	File developed by R. Sheppard and S. Hommel. Checked by B. Dean as part of Section 5.6.6 technical review. No errors identified.	
SDF_PORFLOW_Concentration-FC20.gsm		
Concentrations:	\\saltstone\AquiferZ_mpad\Transport\Case_param.20\All	Sensitivity using Flow Case 20
QA Result:	File developed by R. Sheppard and S. Hommel. Checked by B. Dean as part of Section 5.6.6 technical review. No errors identified.	
SDF_PORFLOW_Concentration-ox5.gsm		
Concentrations:	\\saltstone\AquiferZ_mpad\Transport\Case_sa_ox5	Sensitivity using a density of 20% for internal oxygen sources
QA Result:	File developed by R. Sheppard and S. Hommel. Checked by B. Dean as part of Section 5.6.6 technical review. No errors identified.	
SDF_PORFLOW_Concentration-sol2.gsm		
Concentrations:	\\saltstone\AquiferZ_mpad\Transport\Case_sa_sol2\All	Sensitivity using technetium solubility of 1.0E-7 mol/L
QA Result:	File developed by R. Sheppard and S. Hommel. Checked by B. Dean as part of Section 5.6.6 technical review. No errors identified.	

4.3 GoldSim© Benchmark Modeling

Two GoldSim© files were developed to support the benchmark modeling described in the SDF SA: *SRS Saltstone v4.1_20yr_Det_050613All.gsm* and *SRS Saltstone v4.1_20yr_Det_050613Up_FDC1.gsm*. These two benchmarking models were designed to run deterministically, rather than probabilistically, and to preserve many time histories for result comparisons. These models were prepared by Barry Lester and checked by Steve Hommel as documented in *FY2013_SDF-Benchmarking-Check.PDF*. There were no errors identified.

4.4 GoldSim© Probabilistic Modeling

Two GoldSim© files were developed to probabilistically model fate and transport of contaminants in support of the SDF SA. Barry Lester prepared the fate and transport calculations as described in *Updates to the Saltstone Disposal Facility Fate and Transport Model*. [SRR-CWDA-2013-00073]

Checking of the fate and transport calculations and the links to the dose calculations in these model files was performed by Steve Hommel and documented in: *FY2013_SDF-SRS Saltstone v4.101-Check.PDF*. All checking was performed according to the requirements of ENG.51.

Table 4.4-1 summarizes the files.

Table 4.4-1. QA Summary of Probabilistic Model Files Used in the SDF SA

GoldSim© Model Files	Model ID	Sampling Seed	Number of Reali-zations	Description
SRS Saltstone v4.101				
SRS Saltstone v4.101_20yr_RS01.gsm	TcRS1	1	1,000	Used external files for 12 flow cases and three Technetium solubility values.
SRS Saltstone v4.101_20yr_RS02.gsm	TcRS2	2	1,000	
QA Result: Fate and transport prepared by B. Lester and checked by S. Hommel. No errors identified. Irregularities were identified and dispositioned as negligible, as described in Section 7 of this report.				

5.0 OTHER CALCULATIONS AND TECHNICAL WORK

The following discusses the checking of calculations that were not discussed in the previous sections.

5.1 Peak Concentration Values

Concentration data, generated by the PORFLOW model, was evaluated for peak concentrations and provided in the Appendices of the SDF SA. This evaluation was performed in the Excel file: *FY2013 SDF PA beta-gamma.xlsx*. This file also included maximum concentration limit evaluations; however these were not included in the SDF SA. This evaluation was performed by David Watkins and checked by Steve Hommel, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-SA_PeakConcentrations-Check.pdf*.

5.2 Sensitivity Run Radionuclide Selections

PORFLOW dose results from the evaluation case model were used to determine sensitivity run radionuclides. This determination reduced the list of radionuclides used in sensitivity analyses, focusing on only those radionuclides that offer the most risk with respect to doses. This determination was performed in the Excel file: *Sect5.2.2-KeyRads.xlsx*. This determination of sensitivity run radionuclides was performed by Steve Hommel and checked by David Watkins, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-SensRunRads-Check.PDF*.

5.3 Flow Sensitivity Data and Figures

PORFLOW and GoldSim© model results were used to generate tables and figures in support of the flow sensitivity discussions in the SDF SA. This data was imported into Excel where it was manipulated and formatted to support the associated discussions. The Excel files used were: *SDU1 Flow Cases.xlsx*, *SDU2_FlowCases.xlsx*, and *SDU4_FlowCases.xlsx*. The data importing and manipulation was performed by Richard Sheppard and checked by Steve Hommel, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-FlowCases-Check.PDF*.

5.4 Roof Slope Sensitivity Data and Figures

PORFLOW and GoldSim© model results were used to generate tables and figures in support of the roof slope sensitivity discussions in the SDF SA. This data was imported into Excel where it was manipulated and formatted to support the associated discussions. The Excel file used was: *SDU2_Roof.xlsx*. The data importing and manipulation was performed by Richard Sheppard and checked by Steve Hommel, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-RoofSlope-Check.PDF*.

5.5 PORFLOW Dose Result Plots and Analyses

The dose calculator results from the six GoldSim© files identified in Table 4.2-1 (see Section 4.2) were copied and pasted into Excel for plotting and result analysis. The data importing and manipulation was performed by Richard Sheppard and checked by Steve Hommel, per E7-2.60

according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-PORFLOWRunDoses-Check.PDF*.

5.6 Cementitious Degradation Analyses

Section 4.2.2 of the SDF SA provides a detailed discussion of cementitious degradation mechanisms. A number of Excel files were used to support this discussion and to provide figures. These Excel files are: *For Section 4.2.3 Support.xlsx*, *FY13SA_degradation_PostReport.xlsm*, and *LLDL Degradation.xlsx*. This data was generated by Richard Sheppard and checked by David Watkins, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-CementDeg-Check.PDF*.

5.7 Hydraulic Properties Analyses

Section 4.2.3 of the SDF SA provides a detailed discussion of the hydraulic properties of cementitious materials. The Excel file: *SA Degradation_Sec 5.6.xlsx* was used to support this discussion and to provide figures. This data was generated by Richard Sheppard and checked by Steve Hommel, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-HydrProp-Check.PDF*.

5.8 Probabilistic Sensitivity Analyses (MVIEW)

Section 5.6.5 and Section 6.5 of the SDF SA provide data and figures supporting the probabilistic sensitivity analyses that were performed on multi-realization data sets. Multiple files within two subdirectories were generated and checked. The subdirectories were: *Section5.6.5-MVIEW* and *Section6.5-MVIEW*. This data was generated by Steve Hommel and checked by David Watkins, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented the PDF: *FY2013_SDF-MVIEW-Check.PDF*.

5.9 Uncertainty Analysis Results Tables and Figures

Section 5.6.4 and Section 6.5 of the SDF SA provide data and figures supporting the probabilistic uncertainty analyses that were performed on multi-realization data sets. Data from the two GoldSim model files (*SRS Saltstone v4.101_20yr_RS01.gsm* and *SRS Saltstone v4.101_20yr_RS01.gsm*) were copied and pasted into Excel files where they were plotted (and sometimes combined) to generate figures and data in support of the uncertainty analyses described in the SDF SA. This data was generated by Steve Hommel and checked by Janessa Roy, per E7-2.60 according to guidelines provided in S4-ENG.51, and documented in *FY2013_SDF-UncertaintyAnalysis-Check.PDF*.

6.0 SDF SA SOFTWARE QUALITY ASSURANCE

Table 6.0-1 maps the software used in the development of the SDF SA to the related Software Quality Assurance Plans (SQAPs) and related QA documentation.

Table 6.0-1: Summary of Software Used for the SDF SA

Software Name	**Version**	**Software Quality Assurance Documentation**	**Purpose/Use**
GoldSim©	10.50 (SP3)	*Software Quality Assurance Plan for GoldSim© for the Savannah River Site's Liquid Waste Program* [B-SQP-C-00002]	Used for probabilistic modeling, benchmark testing, and dose calculations.
GoldSimFlows	N/A	*Software Quality Assurance Plan for PORFLOW Flow-Field Extraction Tool (GoldSimFlows)* [Q-SQP-A-00008]	Used to extract PORFLOW data and format it to be read by ReadPORFLOWData.dll.
MVIEW	4.00	*Software Quality Assurance Plan for mView* [B-SQP-C-00005]	Used for sensitivity analysis of probabilistic modeling results.
PORFLOW	6.30.2	*Software Testing and Verification of PORFLOW Versions 6.30.1 and 6.30.*2 [SRNL-TR-2010-00213]	Used for deterministic modeling of flow and contaminant transport.
ReadPORFLOWData.dll	2.0	*Software Quality Assurance Plan for ReadPORFLOWData.dll for the Savannah River Site's Liquid Waste Program* [B-SQP-C-00003]	Dynamic linked library called by GoldSim© software to read data from external files (i.e., PORFLOW result data).

All of the software listed above has undergone software qualification per SRS software qualification procedures (i.e., 1Q-20-1).

7.0 CONCLUSIONS

The SDF SA is a collection of model files and analyses that are technically correct, accurate, and complete. The results of the SDF SA provide an appropriate technical basis for informing decisions related to compliance requirements for final closure of the SDF.

During the course of the extensive checking and verification process, some minor irregularities were identified within the GoldSim© modeling and are described below. These shall be included in the SDF PA Maintenance Plan for correction in future modeling activities. These irregularities have no significant impact on the results of the SDF SA, as described below.

7.1 Technetium K_d Sampling in Cementitious Materials in the Probabilistic Model

The probabilistic model includes stochastic parameters to sample the K_d values for each element within each material type. During checking it was determined that the technetium K_d values sampled within Oxidized Region II cements, within GoldSim©, applied a base value (i.e., sampled median) of 0.8 mL/g. This was based on values from site-specific studies (SRNL-STI-2010-00667 and SRNL-STI-2012-00769); however, the SDF SA conservatively assumed a slightly lower K_d of 0.5 mL/g in order to address concerns specific to Tc-99 (see the note below Table 4.1-3 of the SDF SA).

Regardless, the current modeling approach (i.e., the shrinking core model) required Tc-99 releases to be modeled externally, meaning that these specific K_d values were not actually used in GoldSim©. Instead, the release of technetium was calculated independently, using PORFLOW, then read back into the GoldSim© model via the Dynamic Linked Library (DLL) software: *ReadPORFLOWData.dll*. In other words, the technetium K_d values in GoldSim© do not currently link to any transport calculations, but are only in the model as place holders in case the current modeling strategy is changed. As such, this irregularity has no quantitative impact on any of the reported results.

7.2 Irregularities in Dose Calculation Inputs

The dose calculations for the SDF SA were performed at-risk, while the latest dose calculation methodology was under development. As such, a few irregularities have been identified in which input data from earlier iterations (i.e., draft versions of the dose calculation methodology) were applied rather than those recommended in the final, developed reference report: *Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site*. [SRR-CWDA-2013-00058] In summary, the dose calculations in the SDF SA did not use the recommended values for: (1) the soil-to-plant ratios, (2) the fraction of time spent in a contaminated garden, and (3) the soil density parameters.

These irregularities were left uncorrected in the SDF SA because they were identified after completion of major modeling activities and it was determined that these have a negligible impact on the modeled dose results. The following describes each of these irregularities and provides justification for dispositioning these as either "no impact" or a "negligible impact."

Soil-to-Plant Ratio

It was determined during checking that all the dose calculations performed in support of the SDF SA used a set of soil-to-plant ratios that was inconsistent from the values recommended in the referenced report *Dose Calculation Methodology for Liquid Waste Performance Assessments at the Savannah River Site*. [SRR-CWDA-2013-00058] The values that were used in the SDF SA came from a superseded, draft iteration of the data set that had been developed for the reference dose calculation report. Table 7.2-1 provides a comparison of the values that were used in the SDF SA versus the recommended values. As shown, the SDF SA applied slightly higher (i.e., conservative) soil-to-plant ratios.

Note that both sets of soil-to-plant ratio data are technically correct as both sets are derived from the same acceptable, intermediate technical references. The values only vary based on which of these intermediate technical references were assumed to have a higher priority, as based on applicability or which reference was most current.

Fraction of Time Spent in Contaminated Garden

The dose calculations in the SDF SA used 0.2 hrs/day (i.e., a fractional value of 0.0083). This value reflects an average value provided by the U.S. Environmental Protection Agency (EPA), i.e., the average person spends 0.2 hrs/day performing lawn and garden care. [EPA-600-R-090-052F] However, this average value includes the 69% of households that do not have any gardens. The referenced dose calculation report recommended modifying this value to conservatively assume that *all* Members of the Public (MOP) and Inadvertent Human Intruder (IHI) receptors have gardens (0.0083 ÷ 0.31 = 0.027). [SRR-CWDA-2013-00058] In summary, the SDF SA used the average value rather than the recommended value based on a conservative assumption.

This value only affects external exposure and inhalation pathways for crop and gardening activities. All of which have a minor impact on the total dose results.

Deterministic Evaluation

A detailed evaluation was performed to disposition these irregularities. For this investigation, a revised dose calculator model was developed (*SRS Saltstone v4.102_20yr_Det.gsm*) and was run using the same GoldSim© calculation described within the benchmarking discussion from Section 5.6.2 of the SDF SA. The MOP and IHI dose results from both the uncorrected and the corrected dose calculations were plotted (see Figures 7.2-1 and 7.2-2), showing that these irregularities had a minimal impact on the total dose results. These figures are comparable to Figures 5.6-23 and 5.6-36 of the SDF SA. Over the entire 20,000-year simulation period, the total MOP doses varied by only 2.0E-04 mrem/yr and the total IHI doses varied by only 1.0E-03 mrem/yr. This difference between the two models is four to five orders of magnitude smaller than the respective peak doses, thus these irregularities are considered negligible.

Table 7.2-1. Comparison of Corrected Versus Uncorrected Soil-to-Plant Ratio Values for the SDF SA

Element	Recommended Values (unitless)[a]	Values Used in the SDF SA (unitless)	Difference
Ac	6.00E-05	7.13E-05	16 %
Al	2.90E-05	2.90E-05	0 %
Am	7.74E-05	9.13E-05	15 %
C	1.35E-01	1.68E-01	20 %
Cf	6.00E-05	7.13E-05	16 %
Cl	3.32E+00	3.32E+00	0 %
Cm	1.37E-04	1.49E-04	8 %
Co	2.48E-02	3.02E-02	18 %
Cs	7.03E-03	7.84E-03	10 %
Eu	3.85E-03	4.80E-03	20 %
Gd	3.85E-03	4.80E-03	20 %
H	1.15E+00	1.15E+00	0 %
I	1.07E-02	1.45E-02	26 %
K	1.36E-01	1.62E-01	16 %
Mo	8.44E-02	8.44E-02	0 %
Nb	2.18E-03	2.56E-03	15 %
Ni	2.04E-02	2.32E-02	12 %
Np	4.05E-03	4.74E-03	15 %
Pa	6.00E-05	7.13E-05	16 %
Pb	5.26E-03	5.84E-03	10 %
Pd	1.21E-02	1.40E-02	14 %
Pt	8.80E-03	8.80E-03	0 %
Pu	2.19E-05	2.44E-05	10 %
Ra	7.60E-03	8.25E-03	8 %
Rn	1.00E-20	1.00E-20	0 %
Se	1.76E-02	2.00E-02	12 %
Sm	3.85E-03	4.80E-03	20 %
Sn	2.12E-03	2.40E-03	12 %
Sr	1.37E-01	1.50E-01	9 %
Tc	1.14E+01	1.14E+01	0 %
Th	1.65E-04	1.95E-04	15 %
U	2.58E-03	3.16E-03	18 %
Zr	7.70E-04	9.60E-04	20 %

(a) From SRR-CWDA-2013-00058

Figure 7.2-1: Comparison of 100-Meter MOP Dose Results, Corrected versus Uncorrected

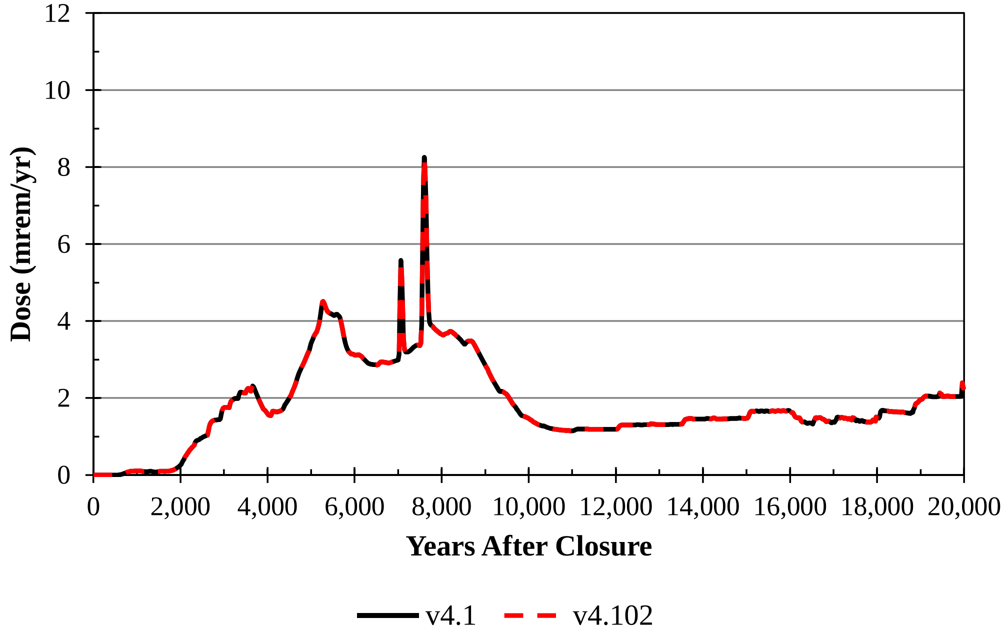
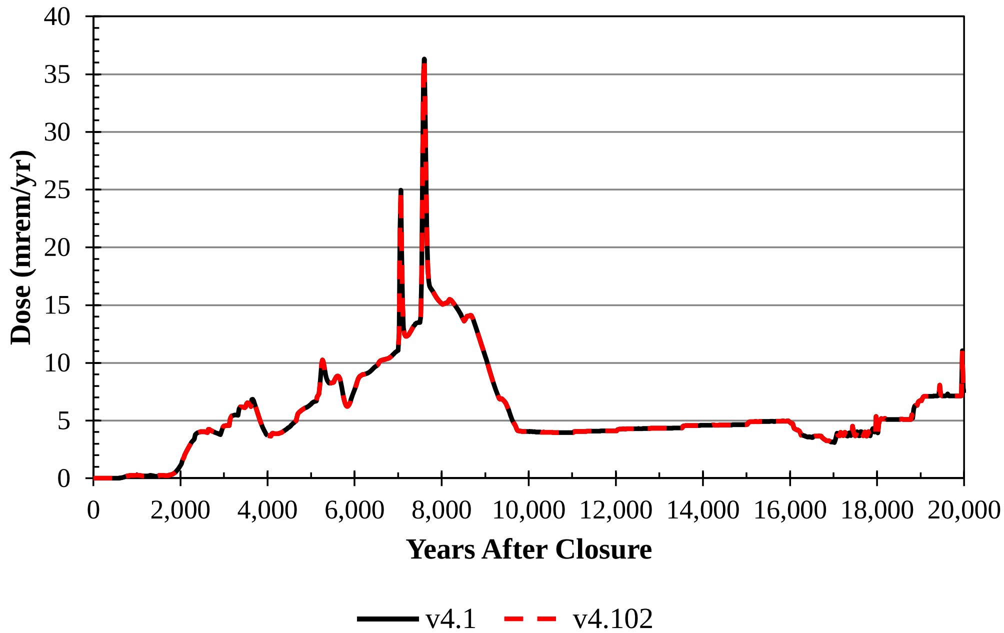


Figure 7.2-2: Comparison of Chronic IHI Dose Results, Corrected versus Uncorrected



Soil Density Sampling

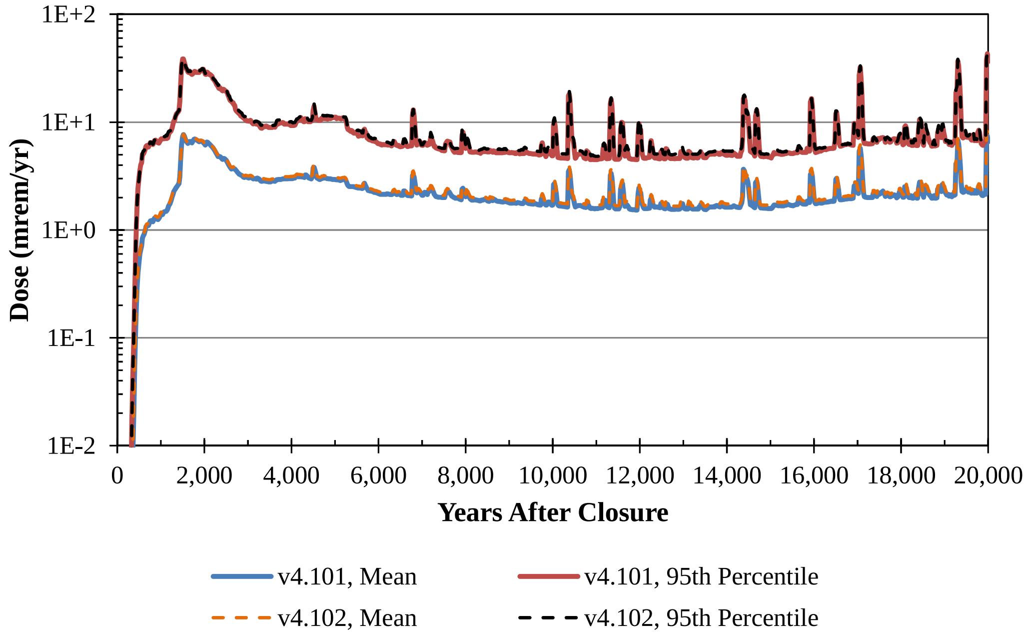
In addition to the soil-to-plant ratio and the garden time fraction discussed above, the referenced dose calculation report describes two soil density parameters used in the dose calculations: (1) the surface density of soil and (2) the bulk sandy soil density. The dose calculation report recommended that these two values be perfectly correlated to each other; however, as was done in earlier PA dose calculations, these values were not correlated. The dose calculation report also recommended truncating the sampled values of the surface density parameter, but this value was not truncated in the SDF SA. Finally, the bulk sandy soil density applied a standard deviation of 100 kg/m^3, whereas the dose calculation report recommended a standard deviation of 120 kg/m^3.

These irregularities only affected probabilistic modeling. Correcting these values would reduce variability in the sampling results for these parameters, but not significantly affect the statistical outcome of such sampling (e.g., the mean of the sampled value would not be significantly affected). Note that these parameters did not show up as being important during the sensitivity analyses in the SDF SA; therefore, reducing parameter variability is not expected to significantly affect the outcome. Thus, revising the uncertainty or sensitivity analyses is not necessary to evaluate this irregularity. Instead, a probabilistic model that incorporates corrections to all of the aforementioned irregularities was run for 1,000 realizations and the 95^{th} percentile and the mean was compared to the equivalent dose results from the SA model file: *SRS Saltstone v4.101_20yr_RS01.gsm*, as described below.

Probabilistic Evaluation

A detailed evaluation was performed to disposition these irregularities. For this investigation, a revised dose calculator model was developed (*SRS Saltstone v4.102_20yr_RS01.gsm*) and was run using the same GoldSim© calculation as used in the Uncertainty Analysis discussion from Section 5.6.4 of the SDF SA (using a random seed of 1, the equivalent SDF SA model file is: *SRS Saltstone v4.101_20yr_RS01.gsm*). The MOP dose results from both the uncorrected and the corrected dose calculations were plotted (see Figures 7.2-3), showing that these irregularities had a minimal impact on the total dose results. This figure is comparable to Figure 5.6-40 of the SDF SA. In general, the doses increased between 1 % and 5 %. For example, the peak of the mean in 10,000 years was 7.66 mrem/yr in *SRS Saltstone v4.101_20yr_RS01.gsm* compared to 7.73 mrem/yr in *SRS Saltstone v4.102_20yr_RS01.gsm*. Given that the probabilistic model results between individual realizations can vary by orders of magnitude, this percentage increase is considered negligible.

Figure 7.2-3: Comparison of Probabilistic 100-Meter MOP Dose Results, Corrected versus Uncorrected



7.3 Updated Iodine K_d in Soils

Upon completion of the initial draft of the SDF SA, a new technical report, *Radioiodine Geochemistry in the SRS Subsurface Environment*, was issued with revised site-specific iodine K_ds in SRS soils. [SRNL-STI-2012-00518] In sandy soils, the iodine K_d increased from 0.3 mL/g to 1.0 mL/g. Similarly, in clayey soils, the iodine K_d increased from 0.9 mL/g to 3.0 mL/g. By applying the cement leachate factors from Table 13 of SRNL-STI-2009-00473, the new leachate-impacted soils K_ds are 0.1 mL/g and 0.3 mL/g for sandy and clayey soils, respectively.

Although the change is likely to reduce the expected dose by retarding the transport of I-129, it is also possible that the new values could cause the I-129 dose peak to occur at the same time as one of the Tc-99 peaks, thus potentially resulting in a higher overall peak dose. Therefore, these new K_d values were evaluated using the model file *SRS Saltstone v4.102_I_Kd.gsm*.

Figures 7.3-1 and 7.3-2 show that the new K_d values have no adverse impact on the overall peak doses. The new K_d values do not significantly affect the timing of the peak doses, but does decrease the peak doses by about 10 %. The peak MOP dose decreased from about 8.3 mrem/yr to about 7.5 mrem/yr and the peak IHI dose decreased from about 36 mrem/yr to about 33 mrem/yr. Therefore, the results discussed in the SDF SA may be considered conservative.

Figure 7.3-1: Comparison of 100-Meter MOP Doses Using the Latest Soil K_ds for Iodine

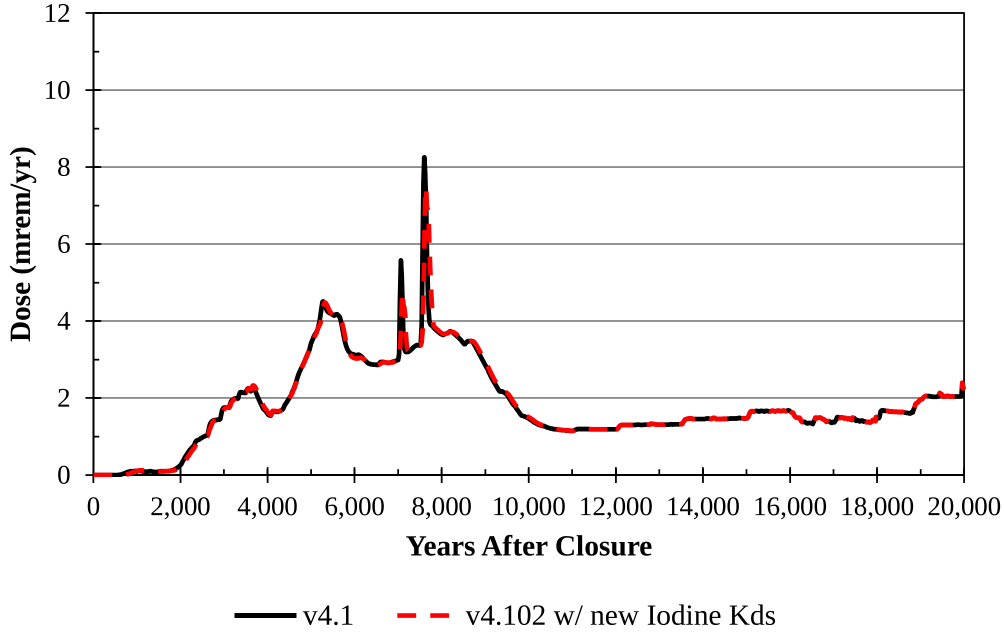
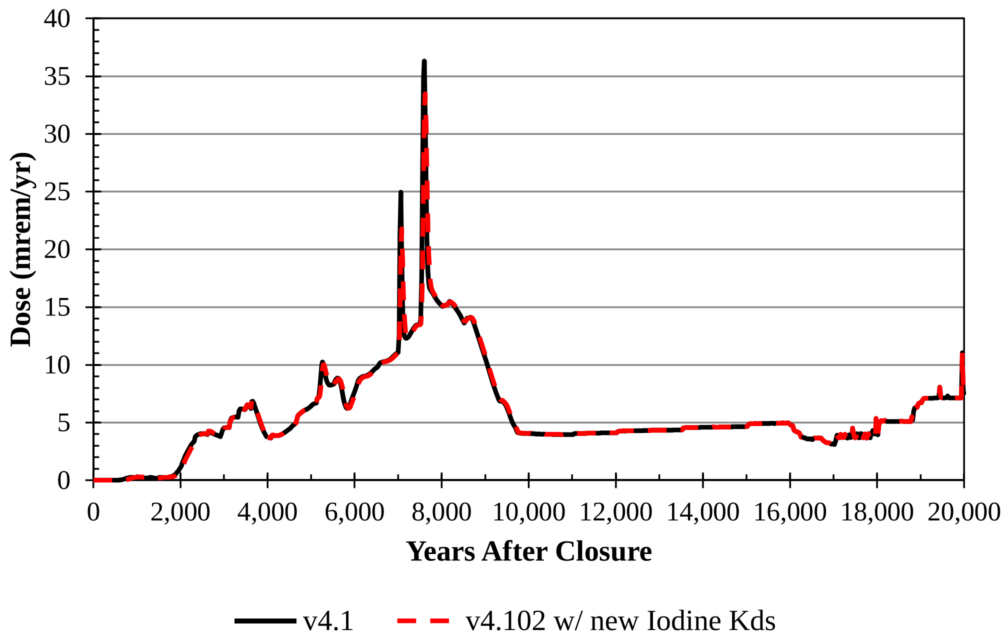


Figure 7.3-2: Comparison of Chronic IHI Doses Using the Latest Soil K_ds for Iodine



7.4 Summary of Irregularity Evaluations

The data reported within the SDF SA reflects the results using these aforementioned irregularities (i,e., the uncorrected data). However, the irregularities identified do not adversely impact to the reported results, with respect to the purpose of the SDF SA; therefore, these irregularities do not impact any compliance decisions that may result from the SDF SA. As such, the current SDF SA meets the intended purpose and is technically defensible.

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