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Revision 0

Hanford Site Composite Analysis: Dose Sensitivity Analyses

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract 89303320DEM000030

P.O. Box 1464
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Terms

CA	composite analysis
CPCCo	Central Plateau Cleanup Company
CY	calendar year
DCF	dose conversion factor
DOE	U.S. Department of Energy
ECF	environmental calculation file
ERDF	Environmental Restoration Disposal Facility
F&T	fate and transport
FGR	federal guidance report
ICF	Integrated Computational Framework
IDF	integrated disposal facility
LFRG	low-level waste disposal facility federal review group
MT3DMS	modular three-dimensional multiple species
MODFLOW	modular groundwater flow
P2R	plateau to river
PFP	plutonium finishing plant
PUREX	plutonium uranium extraction
SIM	soil inventory model
UDF	unit dose factor
WMA	waste management area

1 Purpose

This environmental calculation file (ECF) documents the methodologies, assumptions, and results of five analyses that evaluate parameter changes to the revised Hanford Site Composite Analysis (CA) (DOE-RL-2019-52, *Composite Analysis for Low-Level Waste Disposal in the Hanford Site Central Plateau*). Specifically, this ECF describes the impact on total dose and analyte-specific doses for five sensitivity cases where changes to the following exposure-related parameters were implemented – (1) inventory, (2) recharge rate, (3) external dose conversion factors (DCFs) based on Federal Guidance Report (FGR) No. 15 in (EPA-402-R-19-002, *Federal Guidance Report No. 15*, *External Exposure to Radionuclides in Air, Water, and Soil*) instead of FGR No. 12 (EPA 402-R-93-081, *Federal Guidance Report No. 12*, *External Exposure to Radionuclides in Air, Water, and Soil*) for groundwater pathway scenario; (4) use of mean instead of 95th percentile intake assumptions for groundwater pathway scenario; and (5) consideration of limited sources based on U.S. Department of Energy (DOE) owned waste sites regulated under DOE O 435.1, *Radioactive Waste Management*. It should be noted that dose assessments for both base and sensitivity cases are based on the all-pathways representative person groundwater exposure scenario presented in DOE/RL-2022-52, *Composite Analysis for Low-Level Waste Disposal in the Hanford Site Central Plateau*.

The five analyses described in this ECF are as follows:

- **Inventory Sensitivity Case** – Determine the impact of using an updated inventory in groundwater pathway exposure scenario. The difference between the base case and the inventory sensitivity case is the activity contributions from the vadose zone to the saturated zone for selected waste management areas (WMAs).
- **Recharge Sensitivity Case** – Determine the impact of using updated recharge rates in groundwater pathway exposure scenario. The difference between the base case and the recharge sensitivity case is the amount of recharge assigned as a boundary condition to the vadose zone models for selected WMAs.
- **FGR No. 15 Sensitivity Case** – Determine the impact of using Adult external gamma DCFs published in FGR No. 15, instead of those published in FGR No. 12, in the groundwater pathway exposure scenario.
- **Central Tendency Sensitivity Case** – Determine the impact of using exposure assumptions based on central tendency instead of 95th percentile for groundwater pathway exposure scenario.
- **DOE O 435.1 Limited Sources Sensitivity Case** – the limited sources sensitivity case is based on contributions from DOE owned sites that are regulated under DOE O 435.1. The difference between the base case and the DOE 435.1 limited sources sensitivity case is the reduction in the number of continuing sources released from the vadose zone.

2 Background

ECF-HANFORD-20-0079, *Calculation of Groundwater Pathway Radiological Dose for the Hanford Site Composite Analysis Base Case* presents the methodology and the results of dose assessment for the base case. The background information for the five abovementioned sensitivity cases is presented in the following sections.

2.1 Inventory Sensitivity Case

The development of the Plateau to River (P2R) Model is documented in CP-57037, *Model Package Report for the Plateau to River Model Version 8.3*. Application of version 8.3 of the P2R Model for the CA is documented in two separate ECFs (ECF-HANFORD-19-0119, *Predictive Flow Simulation with the P2R Model for the Composite Analysis Base Case*, and ECF-HANFORD-19-0120, *Contaminant Transport Simulation with the P2R Model for the Composite Analysis Base Case*). The referenced report and ECFs provide the basis for model development and specific application to the CA base case simulations. The simulations rely heavily on the input parameters, assumptions, limitations, and data discussed in the abovementioned documents. It is assumed that the reader is familiar with those documents as much of the information is not repeated in this calculation. Rather, this calculation will focus on those parameters and simulation outputs that differ from those utilized in the preceding reports and ECFs.

The difference between the CA base case and the inventory sensitivity case is the change in activity contributions from the vadose zone to the saturated zone for A Trenches Area, BC Cribs and Trenches, and Plutonium Uranium Extraction (PUREX) Area. Based on results presented in ECF-HANFORD-21-0140, *Composite Analysis: Recharge and Inventory Sensitivity Analyses for the A Trenches, BC Cribs and Trenches, and PUREX Area Vadose Zone Models*, the peak doses at the CA compliance boundary could be coming from the A Trenches Area Model (tritium [H-3] and iodine-129 [I-129]), BC Cribs and Trenches Model (I-129 and technetium-99 [Tc-99]), or the PUREX Area Model (H-3 and I-129). The activity contributions were developed by increasing the inventory in the named model to the 90th percentile inventory from Soil Inventory Model (SIM) version 2 sources after 2018, compared to mean activity values used in the base case. Due to this change, more activity was transported to groundwater in the inventory sensitivity case. All other continuing sources of contaminants simulated as part of the base case remained the same for the dose calculation. Contamination sources from these three areas affect only Tc-99, I-129, and H-3 concentrations. Thus, only Tc-99, I-129, and H-3 are simulated for this specific sensitivity case.

2.2 Recharge Sensitivity Case

The development of the P2R Model and the associated reference reports and ECFs are previously described in Section 2.1 of this ECF.

The primary difference between the base case and the recharge sensitivity case is the change in the amount of recharge assigned as a boundary condition to the vadose zone models for A Trenches Area, BC Cribs and Trenches, and PUREX Area. Based on results presented in ECF-HANFORD-21-0140, the peak doses at the CA compliance boundary could be coming from the A Trenches Area Model (H-3 and I-129), BC Cribs and Trenches Model (I-129 and Tc-99), or the PUREX Area Model (H-3 and I-129). The recharge rates in these models were doubled after 2018, except for the barrier/cover rates, causing a change to the amount of activity entering the saturated zone from the vadose zone. All other continuing sources of contaminants simulated as part of the base case will remain the same for the dose calculations. Contamination sources from these three areas impact Tc-99, I-129, and H-3 concentrations and are the only radionuclides simulated for the sensitivity case.

2.3 FGR No. 15 Sensitivity Case

As part of CA base case, the Adult External DCFs, included in EPA 402-R-93-081 were used during the calculation of external doses for all-pathways representative person exposure scenario for groundwater pathway and the inadvertent intruder scenarios. However, in this ECF, external DCFs for adults were updated using values published in EPA-402-R-19-002.

Major differences between FGR No. 15 and FGR No. 12 DCFs are as follows.

1. Age-Weighted DCFs – FGR No. 15 incorporates six age-specific phantoms from newborn through adult while FGR No. 12 only considers a single age, Adult. Thus, FGR No. 15 contains six times more tissue and effective dose rate coefficient tables and the associated datasets are correspondingly larger.

2. Weighting Factors – FGR No. 15 incorporates updated tissue weighting factors, as recommended in ICRP, 2007, *The 2007 Recommendations of the International Commission on Radiological Protection, ICRP Publication 103*, while the FGR No. 12 effective dose numbers are based on ICRP, 1977, *Recommendations of the ICRP, ICRP Publication 26*. The most substantial effect of the updated tissue weighting coefficients is the inclusion of skin in the definition of effective dose. Many radionuclides, especially those that exclusively emit energy below 50 keV, have a skin dose which is higher than other organ doses. For these radionuclides, the ICRP Publication 103 definition of effective dose would, in general, be larger than the effective dose computed under ICRP Publication 26 guidance.

3. Radiological Decay Rates – FGR No. 15 incorporates radionuclide decay data (as provided in ICRP, 2008, *Nuclear Decay Data for Dosimetric Calculations*, *ICRP Publication 107,* while the FGR No. 12 includes decay information related to ICRP, 1983, *Radionuclide Transformations: Energy and Intensity of Emissions, ICRP Publication 38*. ICRP 107 includes a larger number of radionuclides (1,252 radionuclides) and refinements to the decay data relative to ICRP 38. Therefore, FGR No. 15 provides external dose rate coefficients for more radionuclides than FGR No. 12.

2.4 Central Tendency Sensitivity Case

In ECF-HANFORD-20-0079, the total dose for groundwater pathway was calculated based on the 95th percentile intake assumptions for all-pathways representative person. During a review of the CA, the Low-Level Waste Disposal Facility Federal Review Group (LFRG) team stated that "the use of 95th percentile assumptions, in general and especially for all parameters, is likely to be pessimistic when using site specific information. The potential use of central tendencies should be considered." Therefore, a sensitivity case was undertaken to consider the impacts of using exposure assumptions based on central tendency for the 16 radionuclides evaluated in the CA.

2.5 DOE O 435.1 Limited Sources Sensitivity Case

The development of the P2R Model and the associated reference reports and ECFs are previously described in Section 2.1 of this ECF.

The difference between the base case and the DOE O 435.1 limited sources sensitivity case is the reduction in the number of continuing sources released from the vadose zone. The limited source sensitivity case only evaluates the sources from the sites regulated under DOE O 435.1. The vadose zone simulations conducted to estimate mass contribution to the saturated zone from DOE O 435.1 sources are documented in ECF-HANFORD-22-0002, *Composite Analysis Vadose Zone Transport of Selected Radionuclides Released from DOE O 435.1 Sources*. A limited number of models used for the CA base case were involved in the DOE O 435.1 limited sources sensitivity case due to the reduction in the sites involved. The models used are the A Farms Area, B Complex, B-63 Area, B Plant Area, LLBG-200W A, LLBG-200W B, LLBG 218-E-10, Plutonium Finishing Plant (PFP) Area, S Farms Area, T Farms Area, T Plant Area, U Farm Area, Environmental Restoration Disposal Facility (ERDF), Integrated Disposal

Facility (IDF), and Waste Management Area (WMA) C simulation results. Radionuclides simulated as part of this sensitivity case are Tc-99, I-129, and U-238.

3 Methodology

The following sections present the dose assessment methodologies for the five sensitivity cases.

3.1 Inventory Sensitivity Case

The predictive fate and transport (F&T) are simulated using the P2R Model developed using the acquired computer software: the United States Geological Survey software MODular Groundwater FLOW code (MODFLOW) (USGS, 2000, MODFLOW-2000, The U.S. Geological Survey Modular Ground-water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process) and the Modular Three-Dimensional Multiple Species transport code (MT3DMS) (Zheng and Wang, 1999, *MT3DMS: A Modular Three-Dimensional Multispecies Transport Model for Simulation of Advection, Dispersion, and Chemical Reactions of Contaminants in Groundwater Systems; Documentation and User's Guide*) (see Section 5 of ECF-HANFORD-22-0005, *Predictive Contaminant Transport Simulation with the P2R Model for the Composite Analysis – Inventory Sensitivity Case*). The model simulates hydraulic head, groundwater fluxes, and contaminant F&T on a cell-by-cell basis within the model domain. The calculation of contaminant F&T in the saturated zone is completed by solving the governing equations of MT3DMS based on input parameters stored in the model input files that describe the nature of porous media in the subsurface. The results of vadose zone simulations are used to simulate the rates and locations of continuing sources of contaminants entering the saturated zone from the vadose zone. The steps for generating the F&T simulations to evaluate the inventory sensitivity case are as follows:

1. Simulate F&T using the CA base case simulation files except for the continuing source term from the vadose zone.
    a. Link the simulated groundwater flow field documented in ECF-HANFORD-19-0119, to the MT3DMS simulation.
    b. Keep all F&T input parameters consistent with the base case simulations documented in ECF-HANFORD-19-0120.
    c. Construct model inputs for continuing sources of contamination from the vadose zone (ECF-HANFORD-21-0140) for the inventory sensitivity case.
    d. Execute simulations to obtain estimated concentrations that can be used to calculate the dose.
    e. Compute the total and analyte-specific dose by multiplying estimated concentrations by the radionuclide-specific unit dose factor (UDF) used in the CA base case.

3.2 Recharge Sensitivity Case

The predictive F&T are simulated using the P2R Model developed using the acquired computer software MODFLOW and MT3DMS (Zheng and Wang, 1999) (see Section 5 of ECF-HANFORD-22-0004, *Predictive Contaminant Transport Simulation with the P2R Model for the Composite Analysis – Recharge Sensitivity Case*). The model simulates hydraulic head, groundwater fluxes, and contaminant F&T on a cell-by-cell basis within the model domain. The calculation of contaminant F&T in the saturated zone is completed by solving the governing equations of MT3DMS based on input parameters stored in the model input files that describe the nature of porous media in the subsurface. The results of vadose zone simulations are used to simulate the rates and locations of continuing sources of contaminants

entering the saturated zone from the vadose zone. The steps for generating the F&T simulations to evaluate the recharge sensitivity case of the CA base case are as follows:

1. Simulate F&T using the CA base case simulation files except for the continuing source term from the vadose zone.
    a. Link the simulated groundwater flow field documented in ECF-HANFORD-19-0119 to the MT3DMS simulation.
    b. Keep all F&T input parameters consistent with the base case simulations documented in ECF--HANFORD-19-0120.
    c. Construct model inputs for continuing sources of contamination from the vadose zone (ECF--HANFORD-21-0140) derived from the simulations where recharge rates were doubled.
    d. Execute simulations to obtain estimated concentrations that can be used to calculate the dose.
    e. Compute the total and analyte-specific dose by multiplying estimated concentrations by the radionuclide-specific UDF used in the CA base case.

3.3 FGR No. 15 Sensitivity Case

The external gamma DCFs were updated and the dose assessments methodologies for the FGR No. 15 sensitivity case are summarized as follows.

1. Calculate the radionuclide specific FGR No. 15 Adult DCF for each radionuclide of concern.
2. The base case maximum dose assessment for three compliance boundaries presented in ECF-HANFORD-20-0079, reports the maximum doses occurred for two types of soil - loamy sand soil (Burbank) and sandy loam soil (Ephrata). Therefore, the radionuclide-specific UDFs (mrem/yr per pCi/L) were calculated for the two soil types by using FGR No. 15 Adult DCF for the radionuclides of concern instead of FGR No. 12 Adult DCFs.
3. Compute the ratio of the FGR No. 15 Adult DCFs to the CA base case.
4. Compute the total and analyte-specific dose at location of maximum dose for FGR No. 15 sensitivity case by multiplying the radionuclide-specific ratio to the results of their corresponding base case dose results to determine the impact of utilizing FGR No. 15 Adult DCFs instead of FGR No. 12 Adult DCFs.

3.4 Central Tendency Sensitivity Case

The intake assumptions based on the 95th percentile were updated using the central tendency within the base case model to perform the dose assessment for this sensitivity case. The methodologies for performing dose assessments are summarized as follows.

1. Calculate the mean intake rates for representative person
2. Replace the 95th percentile intake assumptions with the mean intake assumptions to calculate the radionuclide-specific UDFs for two types of soil- loamy sand soil (Burbank) and sandy loam soil (Ephrata).
3. Compute the ratio of radionuclide-specific UDFs using the mean intake rate to the same for the base case.

4. Compute the total and analyte-specific dose at location of maximum dose for the sensitivity case by multiplying the radionuclide-specific ratio to the result of their corresponding base case dose to determine the impact of utilizing mean intake assumptions instead of 95th percentile intake assumptions.

3.5 DOE O 435.1 Limited Sources Sensitivity Case

The predictive F&T are simulated using the P2R Model developed using the acquired computer software MODFLOW and MT3DMS (Zheng and Wang, 1999) (see Section 5 of ECF-HANFORD-22-0006, *Predictive Contaminant Transport Simulation with the P2R Model for the Composite Analysis – Limited Source Sensitivity Case*). The model simulates hydraulic head, groundwater fluxes, and contaminant F&T on a cell-by-cell basis within the model domain. The calculation of contaminant F&T in the saturated zone is completed by solving the governing equations of MT3DMS based on input parameters stored in the model input files that describe the nature of porous media in the subsurface. The results of vadose zone simulations are used to simulate the rates and locations of continuing sources of contaminants entering the saturated zone from the vadose zone. The steps for generating the F&T simulations to evaluate the limited source sensitivity case are as follows:

1. Simulate F&T using the CA base case simulation files except for the continuing source term from the vadose zone.

    a. Link the simulated groundwater flow field documented in ECF-HANFORD-19-0119, to the MT3DMS simulation.

    b. Keep all F&T input parameters consistent with the base case simulations documented in ECF-HANFORD-19-0120.

    c. Construct model inputs for continuing sources of contamination from the sites regulated under DOE O 435.1. The comprehensive list of sites included in this effort is shown in Table 1 and Table 2 of ECF-HANFORD-22-0006.

    d. Execute simulations to obtain estimated concentrations.

    e. Compute the total and analyte-specific dose by multiplying estimated concentrations by the radionuclide-specific UDF used in the CA base case.

4 Assumptions and Inputs

This section provides key assumptions and inputs used to calculate doses for the base and sensitivity cases based on all-pathways representative person groundwater pathway exposure scenario.

4.1 Radionuclides of Concerns

Table 4-1 of ECF-HANFORD-20-0079 lists 16 radionuclides of concern for revised Hanford Site CA that were used in the FGR No. 15 and the central tendency sensitivity cases. The inventory and recharge sensitivity cases focus on Tc-99, I-129, and H-3 whereas DOE O 435.1 limited sources sensitivity case include only Tc-99, I-129, and U-238.

4.2 Conceptual Exposure Model for the Receptor Scenarios

Figure 2-1 of CP-64491, *Hanford Site Composite Analysis Data Package: Exposure Scenarios and Radionuclide Specific Dose Conversion Factors*, presents exposure pathways and exposure routes for

all-pathways representative person exposure scenario. According to Figure 2-1 of CP-64491, an all-pathways representative person will be exposed through the following exposure routes:

- Ingestion of water
- Ingestion of homegrown crops (fruits and vegetables)
- Ingestion of beef
- Ingestion of milk
- Ingestion of eggs
- Ingestion of poultry
- Incidental ingestion of soil
- Inhalation of soil particulates
- Inhalation of water vapor
- External exposure

4.3 Assumptions and Inputs for Sensitivity Cases

This section provides key assumptions and inputs used to calculate doses for the sensitivity cases based on all-pathways representative person groundwater pathway exposure scenario.

4.3.1 Inventory Sensitivity Case

The input parameter selection for the base case flow and F&T simulations is provided in ECF-HANFORD-19-0119 and ECF-HANFORD-19-0120, respectively. Alterations to input data files for the inventory sensitivity case include the continuing source of contaminants from the vadose zone to the saturated zone. These changes were the only required alterations for the sensitivity case and more detailed description of assumptions and inputs can be found in ECF- HANFORD-22-0005.

4.3.2 Recharge Sensitivity Case

The input parameter selection for the base case flow and F&T simulations is provided in ECF-HANFORD-19-0119 and ECF-HANFORD-19-0120, respectively. Alterations to input data files for the recharge sensitivity case include the continuing source of contaminants from the vadose zone to the saturated zone. These changes were the only required alterations for the recharge sensitivity case and more detailed description of assumptions and inputs can be found in ECF-HANFORD-22-0004.

4.3.3 FGR No. 15 Sensitivity Case

As mentioned in Section 2.0 of this ECF, the Adult external DCFs published in FGR No. 15 were used to calculate external doses for groundwater pathway scenario. The calculation of external exposure DCFs (based on FGR No. 15 Adult) for the long-lived radionuclides account for radionuclide progenies and can be found in Appendix A of this ECF.

4.3.4 Central Tendency Sensitivity Case

The 95th percentile intake assumptions were used during the base case dose assessment for the representative person. The representative person is described as an age- and gender-weighted average person receiving a dose that is representative of a more highly exposed individual in the population. DOE O 458.1, *Radiation Protection of the Public and the Environment*; ICRP, 2006, *Assessing Dose of the Representative Person for the Purpose of the Radiation Protection of the Public*, *ICRP Publication 101a*; and ICRP (2007) further define a “Representative Person” by six age subgroups including newborn, 1-year, 5-year, 10-year, 15-year, and adult. EPA/600/R-09/052F, *Exposure Factors Handbook: 2011 Edition* publishes the mean and percentile intake rates for inhalation, ingestion of water, consumption of homegrown fruits and vegetables, beef, milk,

eggs, and poultry based on various age ranges. Except for water ingestion rates, the intake rates are based on a "unit" body weight. EPA/600/R-09/052F also reports the body weight for various age groups which were utilized to calculate the mean intake rates for the representative person and are listed in Table 1.
The derivation of the percentile intake rates for the representative person exposure scenario are presented in Appendix B of CP-64491.

Table 1. Mean Intake Rates for Parameters of Interest

Percentile	Drinking Water (L/day)	Vegetables (kg/yr)	Beef (kg/yr)	Poultry (kg/yr)	Milk (L/yr)	Egg (kg/yr)
Mean	1.03	100.3	24.62	19.69	101.3	15.14

4.3.5 DOE O 435.1 Limited Sources Sensitivity Case

The input parameter selection for the base case flow and F&T simulations is provided in ECF-HANFORD-19-0119 and ECF-HANFORD-19-0120, respectively. Alterations to input data files for the limited source sensitivity case include the continuing source of contaminants from the vadose zone to the saturated zone. These changes were the only required alterations for the limited source sensitivity case. More detailed information regarding assumptions and inputs can be found in ECF-HANFORD-22-0006.

5 Software Applications

The following sections document the utility calculation software tool used in this ECF complies with requirements of Central Plateau Cleanup Company's (CPCCo) controlled software management procedure.

5.1 Approved Software

The tools used to calculate the dose results (ca-dosecalc, ca-sumdoseDB, and ca-maxdoseDB) are approved utility calculation software. The software complies with CPCCo's controlled software management procedure that implements DOE quality assurance requirements including DOE O 414.1D, *Quality Assurance*. The software is a set of utility codes included in CHRPC-04032, *Composite Analysis/Cumulative Impact Evaluation (CACIE) Utility Codes Integrated Software Management Plan*. The utility codes were tested and qualified for use comply with requirements specified in CHPRC-04032. The codes are documented in the consolidated tool package attachments. Software log files for the base, inventory, recharge, and DOE O 435.1 limited sources sensitivity cases can be found in Appendix B of this ECF.

5.1.1 Description

The following information identifies the approved utility calculation software used for the calculation of dose documented in this ECF for each of the sensitivity cases.

5.1.1.1 CA Base Case

- **Composite Analysis/Cumulative Impact Evaluation Utility Codes Hanford Information Systems Inventory Entry:** 4503

Dose Calculator (ca dosecalc)

- **Software Version**: v1.1
- **Software Git SHA**: 1cc4d017c7afdad176e4f6df077aad74b76a3398
- **Git Repository Version**: 5.20
- **Git Repository SHA**: 779f46d929f56329a5124cf6dc4016bf2e89a7d0

Sum Dose Calculator (ca sumdoseDB)

- **Software Version**: v1.1
- **Software Git SHA**: 96a676aa748be44788529527e046420e13812957
- **Git Repository Version**: 5.20
- **Git Repository SHA**: 779f46d929f56329a5124cf6dc4016bf2e89a7d0

Max Dose Calculator (ca-maxdoseDB)

- **Software Version**: v1.0
- **Software Git SHA**: 327f1bdd340a5b3b887102df4e76f04db66656b1
- **Git Repository Version**: 5.20
- **Git Repository SHA**: 779f46d929f56329a5124cf6dc4016bf2e89a7d0

5.1.1.2 Inventory, Recharge, and DOE O 435.1 Limited Sources Sensitivity Case

- **Composite Analysis/Cumulative Impact Evaluation Utility Codes Hanford Information Systems Inventory Entry:** 4503

Dose Calculator (ca dosecalc)

- **Software Version**: v1.1
- **Software Git SHA**: 1cc4d017c7afdad176e4f6df077aad74b76a3398
- **Git Repository Version**: 5.21
- **Git Repository SHA**: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b.

Sum Dose Calculator (ca sumdoseDB)

- **Software Version**: v1.1
- **Software Git SHA**: 96a676aa748be44788529527e046420e13812957
- **Git Repository Version**: 5.21
- **Git Repository SHA**: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b

Max Dose Calculator (ca-maxdoseDB)

- **Software Version**: v1.0
- **Software Git SHA**: 327f1bdd340a5b3b887102df4e76f04db66656b1
- **Git Repository Version**: 5.21
- **Git Repository SHA**: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b

5.1.2 Software Installation and Checkout

Verification that the utility calculation software specified in Section 5.1.1 is qualified for use is documented in the log files maintained as output in the Integrated Computational Framework (ICF) for each work product generated as documented in this ECF. The log files document the tool used, software and repository versioning, quality assurance status of the code, and software user, workstation, and operating platform. The software installation and checkout form can be found in Appendix C of this ECF.

5.1.3 Statement of Valid Software Application

The preparers of this calculation attest that the software identified and used for this calculation is appropriate for the application and has been used within the range of intended uses for which it was tested and accepted.

6 Calculation

Total and analyte-specific doses were calculated for five sensitivity cases using the methodologies and inputs documented in Sections 3 and 4 of this ECF for all-pathway representative person exposure scenario. All model files were reviewed, checked, and will be archived in Environmental Model Management Archive along with this ECF and any additional supporting files.

The maximum total and analyte-specific dose calculations are presented in the below sections for each of the five sensitivity cases.

6.1 Inventory Sensitivity Case

The following section of this ECF presents the results of the original projected maximum dose calculations for each of three potential compliance boundaries and two required timeframes for the inventory sensitivity case. The original calculations were verified independently by utilizing the methodology, assumptions and inputs described in Sections 3 and 4.

6.1.1 Original Calculation

For each of the 96 groundwater flow simulations, three different dose calculator tools, (ca-dosecalc, ca-sumdoseDB, and ca-maxdoseDB) were used to calculate the highest projected total annual doses at each of the three compliance boundaries within two compliance time periods (from calendar year [CY] 2070 to CY 3070 and from CY 3070 to CY 12070). The results of the calculations are presented in Section 7.

6.1.2 Verification of Original Calculation

Verification calculations were performed independently using the methodology described in Sections 3 and 4 of this ECF. The files have been archived under this ECF number in the ICF.

6.1.3 Results of Comparison between Original and Verification Calculations

Review of the original and verification of the calculation results did not identify any errors associated with the maximum dose calculation for groundwater pathway at the three compliance boundaries for the two timeframes.

6.2 Recharge Sensitivity Case

The following section of this ECF presents the results of the original projected maximum dose calculations for each of three potential compliance boundaries and two required timeframes for the recharge sensitivity case. The original calculations were verified independently by utilizing the methodology, assumptions and inputs described in Sections 3 and 4.

6.2.1 Original Calculation

For each of the 96 groundwater flow simulations, three different dose calculator tools, (ca-dosecalc, ca-sumdoseDB, and ca-maxdoseDB) were used to calculate the highest projected total annual dose at the three compliance boundaries within two compliance time periods (from CY 2070 to CY 3070 and from CY 3070 to CY 12070). The results of the calculations are presented in Section 7.

6.2.2 Verification of Original Calculation

Verification calculations were performed independently using the methodology described in Sections 3 and 4 of this ECF. The files have been archived under this ECF number in the ICF.

6.2.3 Results of Comparison between Original and Verification Calculations

Review of original and verification calculation results did not identify any error associated with the maximum dose calculation for groundwater pathway at three compliance boundaries and two timeframes.

6.3 FGR No. 15 Sensitivity Case

GW_Unit_Dose_Factor_CA-FGR15_Burbank_Loamy.xlxs and GW_Unit_Dose_Factor_CA-FGR15_Ephrata_Sandy.xlxs files were used to calculate the UDFs for Burbank loamy sand and Ephrata Sandy soil, respectively. The results of the dose calculations are presented in Section 7.

6.4 Central Tendency Sensitivity Case

GW_Unit_Dose_Factor_CA-Mean_Intake_Burbank_Loamy.xlxs and GW_Unit_Dose_Factor_CA-Mean_Intake_Ephrata_Sandy.xlxs files were used to calculate the UDFs for Burbank loamy sand and Ephrata Sandy soil, respectively. The results of the dose calculations are presented in Section 7.

6.5 DOE O 435.1 Limited Sources Sensitivity Case

The following section of this ECF presents the results of the original projected maximum dose calculations for each of three potential compliance boundaries and two required timeframes for the DOE O 435.1 limited sources sensitivity case. The original calculations were verified independently by utilizing the methodology, assumptions and inputs described in Sections 3 and 4.

6.5.1 Original Calculation

For each of the 96 groundwater flow simulations, three different dose calculator tools, (ca-dosecalc, ca-sumdoseDB, and ca-maxdoseDB) were used to calculate the highest projected total annual dose at

the three compliance boundaries within two compliance time periods (CY 2070 to CY 3070 and CY 3070 to CY 12070).

6.5.2 Verification of Original Calculation

Verification calculations were performed independently using the methodology described in Sections 3 and 4 of this ECF. The files have been archived under this ECF number in the ICF.

6.5.3 Results of Comparison between Original and Verification Calculations

Review of the original and verification of the calculation results did not identify any errors associated with the maximum dose calculation for groundwater pathway at three compliance boundaries for the two timeframes.

7 Results/Conclusions

The dose assessments for the five sensitivity cases are presented in the following sections. The maximum total doses for the base case were compared against the maximum total doses for the five sensitivity cases to determine the impact of the modified parameters. Table 2 presents the maximum total dose for the base case at three compliance boundaries for two timeframes that were used as comparison. Sections 7.1 and 7.2 present the maximum total dose for the inventory and recharge sensitivity cases, respectively. Section 7.3 highlights the radionuclide-specific UDFs and displays the maximum total dose for the FGR No. 15 sensitivity case. The central tendency sensitivity cases are summarized in Section 7.4.
The DOE O 435.1 limited sources sensitivity case is given in Table 9. Also, the I-129 and Tc-99 dose realizations for the DOE O 435.1 limited sources sensitivity case for the compliance and postcompliance periods are presented in Section 7.5.

7.1 Inventory Sensitivity Case

The maximum total dose did not change between the inventory sensitivity case and the CA base case as presented in Table 3. Maximum total dose did not vary from the CA base case for any of the three compliance boundaries (Inner, Outer, or 1998 CA Compliance) or timeframes (CY 2070 - CY 3070 and CY 3070 - CY 12070). Since the maximum total dose did not change between the two sensitivity cases, it suggests that activity contributions from the vadose zone to the saturated zone for selected WMAs had minimal impact on dose.

7.2 Recharge Sensitivity Case

The maximum total dose did not change between the recharge sensitivity and the CA base case except for the Inner Area during the compliance period (CY 2070 – CY 3070) as presented in Table 4. The increase in the maximum total dose for the Inner Area during the compliance period is driven by Tc-99. The source of Tc-99 contamination is likely the result of discharge to the BC cribs and trenches.

The maximum total dose for the recharge sensitivity case did not vary from the CA base case for the two compliance boundaries (Outer and 1998 CA Compliance) and CY 3070 - CY 12070 timeframe. By the postcompliance period (CY 3070 - CY 12070), the maximum total dose is the same as the base case indicating that the amount of recharge assigned as a boundary condition to the vadose zone models for selected WMAs had minimal impact on dose during the postcompliance period.

Table 2. Results of Base Case Dose Assessment for All-Pathways Representative Person Scenario

Compliance Boundary	Timeframe	Soil Type	C-14	H-3	I-129	Sr-90	Tc-99	Sum Dose
			mrem/yr					
Inner	2070-3070	Burbank Loamy Sand	89	--	--	--	0.6	89.6
Outer		Burbank Loamy Sand	--	0.3	8.5	--	--	8.8
1998 CA		Ephrata Sandy Loam	--	--	--	19	--	19
Inner	3070-12070	Burbank Loamy Sand	2,421	--	--	--	19	2,440
Outer		Burbank Loamy Sand	--	--	6.6	--	--	6.6
1998 CA		Burbank Loamy Sand	--	--	6.6	--	--	6.6

-- Denotes the radionuclide dose was below its minimum threshold value thus excluded from the model and no longer reported.

CA = composite analysis

Table 3. Comparison of the CA Base Case and the Inventory Sensitivity Case Maximum Total Dose All-Pathways Representative Person Scenario

Compliance Boundary	Start Year	End Year	Cell Layer	Cell Row	Cell Column	Model Date	I-129	Tc-99	H-3	C-14	Sr-90	Total Maximum Dose
										mrem/yr		
Inventory Sensitivity Case												
Inner	2070	3070	3	49	140	01/09/3070	--	0.6	--	89	--	89.6
Outer	2070	3070	4	96	213	01/01/2070	8.5	--	0.3	--	--	8.8
1998 CA	2070	3070	5	30	141	01/01/2070	--	--	--	--	19	19
Inner	3070	12070	3	49	140	01/11/3370	--	19	--	2,421	--	2,440
Outer	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	6.6
1998 CA	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	6.6
CA Base Case												
Inner	2070	3070	3	49	140	01/09/3070	--	0.6	--	89	--	89.6
Outer	2070	3070	4	96	213	01/01/2070	8.5	--	0.3	--	--	8.8
1998 CA	2070	3070	5	30	141	01/01/2070	--	--	--	--	19	19
Inner	3070	12070	3	49	140	01/11/3370	--	19	--	2,421	--	2,440
Outer	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	6.6
1998 CA	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	6.6

-- Denotes the radionuclide dose was below its minimum threshold value thus excluded from the model and no longer reported.

CA = composite analysis

Table 4. Comparison of the CA Base Case and the Recharge Sensitivity Case Maximum Total Dose All-Pathways Representative Person Scenario

Compliance Boundary	Start Year	End Year	Cell Layer	Cell Row	Cell Column	Model Date	I-129	Tc-99	H-3	C-14	Sr-90	U-234	U-238	Total Maximum Dose
							mrem/yr							
Recharge Sensitivity Case														
Inner	2070	3070	2	87	128	01/08/2970	0.1	189	--	1.0	--	0.2	0.9	191.3
Outer	2070	3070	4	96	213	01/01/2070	8.5	--	0.3	--	--	--	--	8.8
1998 CA	2070	3070	5	30	141	01/01/2070	--	--	--	--	19	--	--	19
Inner	3070	12070	3	49	140	01/11/3370	--	19	--	2,421	--	--	--	2,440
Outer	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	--	6.6
1998 CA	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	--	6.6
CA Base Case														
Inner	2070	3070	3	49	140	01/09/3070	--	0.6	--	88.9	--	--	--	89.6
Outer	2070	3070	4	96	213	01/01/2070	8.5	--	0.3	--	--	--	--	8.8
1998 CA	2070	3070	5	30	141	01/01/2070	--	--	--	--	19	--	--	19
Inner	3070	12070	3	49	140	01/11/3370	--	19	--	2,421	--	--	--	2,440
Outer	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	--	6.6
1998 CA	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	--	6.6

-- Denotes the radionuclide dose was below its minimum threshold value thus excluded from the model and no longer reported.

CA = composite analysis

7.3 FGR No. 15 Sensitivity Case

Table 5 presents the UDFs for Burbank loamy and Ephrata Sandy soil based on FGR No. 15 DCFs and FGR No. 12 DCFs in addition to their ratios. Table 6 presents the results of maximum dose assessment at three compliance boundaries (Inner, Outer, or 1998 CA Compliance) for two timeframes (CY 2070 to CY 3070 and CY 3070 to CY 12070). The tables indicate there were minimal differences in UDFs and maximum dose for all the radionuclides evaluated during the FGR No. 15 sensitivity case.

Table 5. Ratios of Radionuclide-Specific UDFs for Burbank Sand and Ephrata Sandy Soils based on FGR No. 12 DCFs and FGR No. 15 DCFs

	Burbank Loamy			Ephrata Sandy		
Radionuclide	FGR12_Adult* DCF	FGR15_Adult* DCF	Ratio	FGR12_Adult* DCF	FGR15_Adult* DCF	Ratio
C-14	3.50E-03	3.50E-03	1.00E+00	3.54E-03	3.54E-03	1.00E+00
Cl-36	1.31E-02	1.31E-02	1.00E+00	2.00E-02	2.00E-02	1.00E+00
H-3	2.14E-04	2.14E-04	1.00E+00	2.4E-04	2.4E-04	1.00E+00
I-129	1.17E+00	1.17E+00	1.00E+00	1.17E+00	1.17E+00	1.00E+00
Np-237	4.53E-01	4.53E-01	1.00E+00	4.53E-01	4.53E-01	1.00E+00
Ra-226	1.84E+00	1.84E+00	9.97E-01	1.85E+00	1.84E+00	9.97E-01
Re-187	3.79E-05	3.79E-05	1.00E+00	3.80E-05	3.80E-05	1.00E+00
Sr-90	4.95E-01	5.02E-01	1.01E+00	4.97E-01	5.03E-01	1.01E+00
Tc-99	3.71E-03	3.72E-03	1.00E+00	4.16E-03	4.16E-03	1.00E+00
Th-230	1.26E+00	1.26E+00	1.00E+00	1.26E+00	1.26E+00	1.00E+00
U-232	2.40E+00	2.40E+00	1.00E+00	2.40E+00	2.40E+00	1.00E+00
U-233	2.19E-01	2.19E-01	1.00E+00	2.20E-01	2.20E-01	1.00E+00
U-234	2.12E-01	2.12E-01	1.00E+00	2.12E-01	2.12E-01	1.00E+00
U-235	2.02E-01	2.02E-01	1.00E+00	2.02E-01	2.02E-01	1.00E+00
U-236	1.99E-01	1.99E-01	1.00E+00	2.00E-01	2.00E-01	1.00E+00
U-238	2.08E-01	2.08E-01	1.00E+00	2.08E-01	2.09E-01	1.00E+00

*Denotes Age-Weighted Adult per Section 2.3

DCF = dose conversion factor

Table 6. Results and Comparison of Maximum Dose Assessments for Base Case and FGR No. 15 Sensitivity Case

Compliance Boundary	Timeframe	Soil Type	Dose (mrem/yr) (Base Case – FGR No. 12 DCFs)	Dose (mrem/yr) (FGR No. 15 Sensitivity Case – FGR No. 15 DCFs)	%Reduction
Inner	2070-3070	Burbank Loamy Sand	90	90	0%
Outer		Burbank Loamy Sand	8.8	8.8	0%
1998 CA		Ephrata Sandy Loam	19.2	19.4	-1%
Inner	3070-12070	Burbank Loamy Sand	2,440	2,440	0%
Outer		Burbank Loamy Sand	6.6	6.6	0%
1998 CA		Burbank Loamy Sand	6.6	6.6	0%

CA = composite analysis
DCF = dose conversion factor

7.4 Central Tendency Sensitivity Case

Table 7 presents the ratios of UDFs based on mean intake rates to the 95th percentile intake rates for Burbank loamy and Ephrata Sandy soils. Table 8 present the results of maximum dose at the three compliance boundaries (Inner, Outer, or 1998 CA Compliance) for two timeframes (CY 2070 to CY 3070 and CY 3070 to CY 12070). As expected, the use of the mean intake rate in lieu of the 95th percentile reduced radionuclide UDFs and maximum dose anywhere from 40 to 60 percent.

Table 7. Ratios of Radionuclide-Specific UDFs for Burbank Sand and Ephrata Sandy Soils based on 95th Percentile and Mean Intake Rates

	Burbank Loamy			Ephrata Sandy		
Radionuclide	95th Percentile	Mean	Ratio	95th Percentile	Mean	Ratio
C-14	3.50E-03	1.38E-03	3.95E-01	3.54E-03	1.40E-03	3.95E-01
Cl-36	1.31E-02	4.98E-03	3.80E-01	2.00E-02	7.57E-03	3.78E-01
H-3	2.14E-04	1.19E-04	5.57E-01	2.4E-04	1.3E-04	5.40E-01
I-129	1.17E+00	6.60E-01	5.65E-01	1.17E+00	6.60E-01	5.65E-01
Np-237	4.53E-01	1.80E-01	3.98E-01	4.53E-01	1.80E-01	3.98E-01
Ra-226	1.84E+00	7.81E-01	4.23E-01	1.85E+00	7.82E-01	4.24E-01
Re-187	3.79E-05	1.47E-05	3.87E-01	3.80E-05	1.47E-05	3.87E-01
Sr-90	4.95E-01	1.92E-01	3.88E-01	4.97E-01	1.93E-01	3.88E-01
Tc-99	3.71E-03	1.44E-03	3.86E-01	4.16E-03	1.61E-03	3.86E-01
Th-230	1.26E+00	4.95E-01	3.92E-01	1.26E+00	4.95E-01	3.92E-01
U-232	2.40E+00	9.37E-01	3.90E-01	2.40E+00	9.38E-01	3.91E-01

Table 7. Ratios of Radionuclide-Specific UDFs for Burbank Sand and Ephrata Sandy Soils based on 95th Percentile and Mean Intake Rates

	Burbank Loamy			Ephrata Sandy		
Radionuclide	95th Percentile	Mean	Ratio	95th Percentile	Mean	Ratio
U-233	2.19E-01	8.53E-02	3.89E-01	2.20E-01	8.54E-02	3.89E-01
U-234	2.12E-01	8.24E-02	3.89E-01	2.12E-01	8.24E-02	3.89E-01
U-235	2.02E-01	7.90E-02	3.90E-01	2.02E-01	7.91E-02	3.90E-01
U-236	1.99E-01	7.75E-02	3.89E-01	2.00E-01	7.76E-02	3.89E-01
U-238	2.08E-01	8.10E-02	3.89E-01	2.08E-01	8.11E-02	3.89E-01

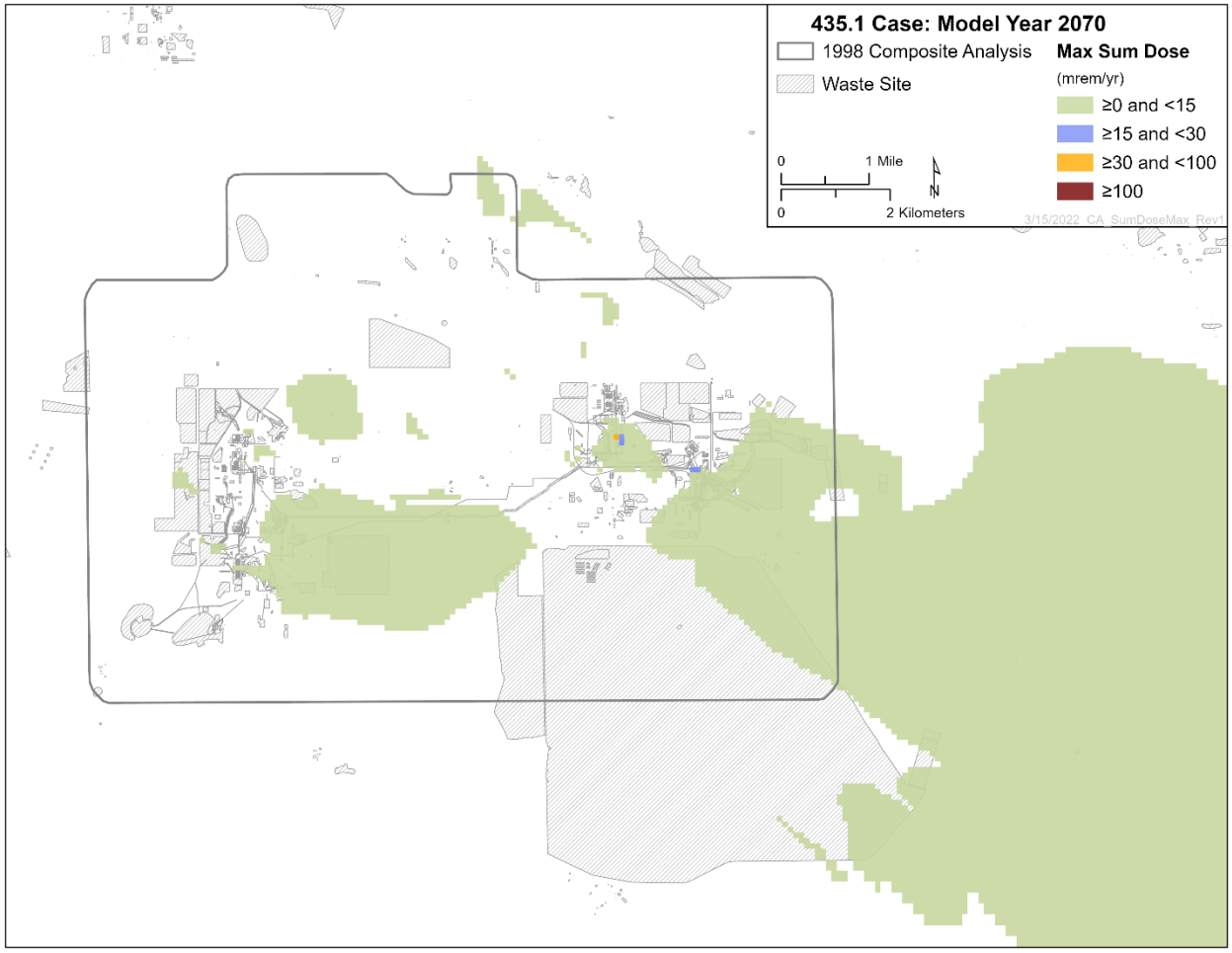
Table 8. Results and Comparison of Maximum Dose Assessments for Base Case and Central Tendency Sensitivity Case

Compliance Boundary	Timeframe	Soil Type	Dose (mrem/yr) (Base Case – 95th Percentile Intakes)	Dose (mrem/yr) (Central Tendency Sensitivity Case – Mean Intake)	% Reduction
Inner	2070-3070	Burbank Loamy Sand	89	35	61
Outer		Burbank Loamy Sand	8.8	5.0	44
1998 CA		Ephrata Sandy Loam	19	7.4	61
Inner	3070-12070	Burbank Loamy Sand	2,440	963	61
Outer		Burbank Loamy Sand	6.5	3.7	44
1998 CA		Burbank Loamy Sand	6.5	3.7	44

CA = composite analysis

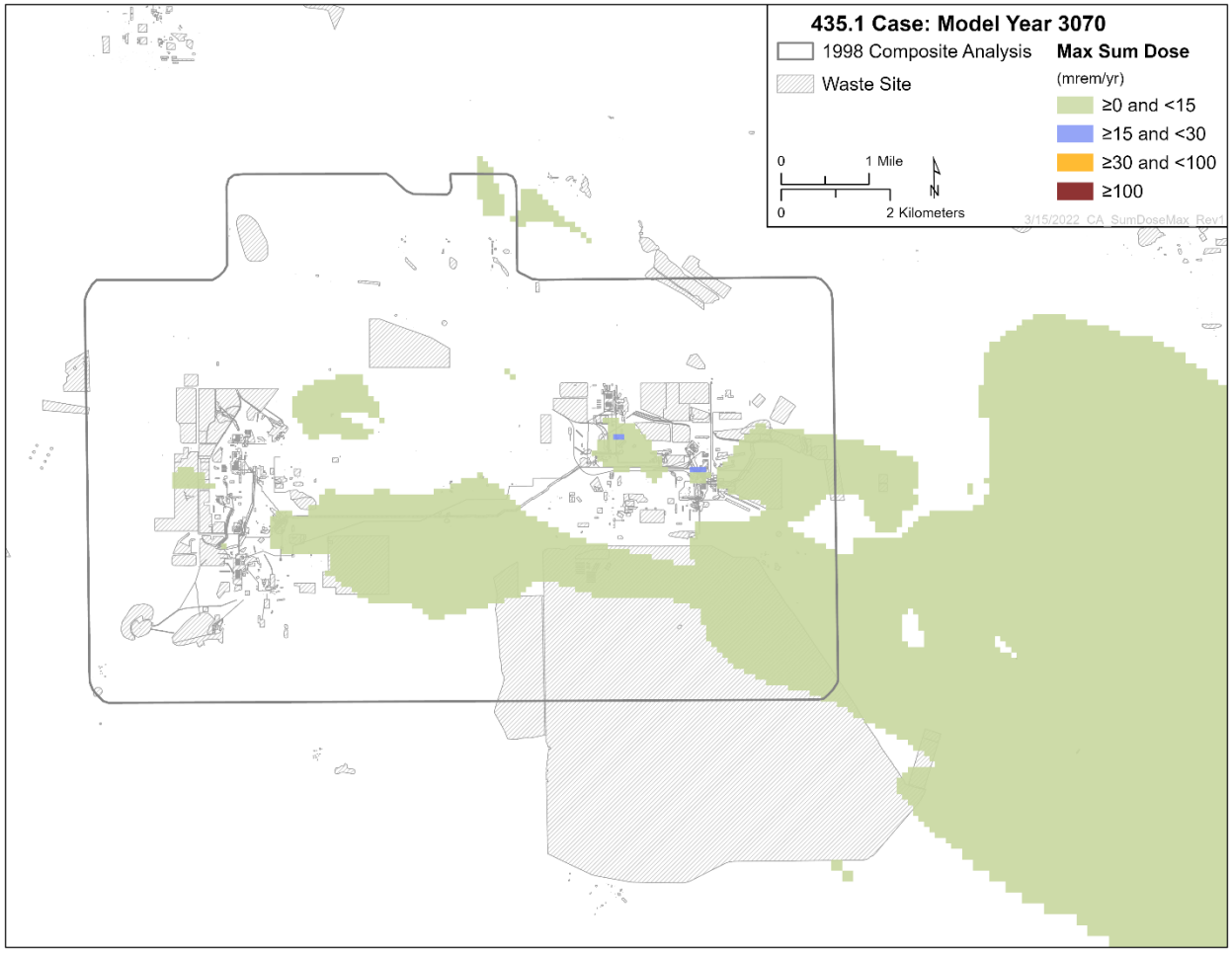
7.5 DOE O 435.1 Limited Sources Sensitivity Case

Figure 1 and Figure 2 depict the maximum total dose for only three radionuclides, I-129, Tc-99, and U-238, at the start of the compliance period (CY 2070) and the start of the postcompliance period (CY 3070), respectively. Figure 1 shows the locations where the maximum total dose is up to 30 mrem/yr or less than 15 mrem/yr. Figure 2 illustrates the minimal impacts DOE O 435.1 sources have on the maximum total dose of I-129, Tc-99, and U-238 which is less than 15 mrem/yr at CY 3070. Both figures demonstrate the impact of reducing the number of continuing sources released from the vadose zone is minimal and does not impact total maximum dose of I-129, Tc-99, and U-238.



Note: Maximum Total Dose Calculation includes contributions from only I-129, Tc-99, and U-238.

Figure 1. Graphical Presentation of Maximum Total Dose for I-129, Tc-99, and U-238 at CY 2070



Note: Maximum Total Dose Calculation includes contributions from only I-129, Tc-99, and U-238.

Figure 2. Graphical Presentation of Maximum Total Dose for I-129, Tc-99, and U-238 at CY 3070

The maximum total dose did not change between the DOE O 435.1 limited sources sensitivity and the CA base case as presented in Table 9. Please note that Table 9 includes additional radionuclides in the calculation of the maximum total dose. The additional radionuclides were included for comparison purposes to the CA base case. The maximum dose did not vary from the CA base case for any of the three compliance boundaries (Inner, Outer, or 1998 CA Compliance) or timeframes (CY 2070 to CY 3070 and CY 3070 to CY12070). Since the maximum total dose did not change between the CA base case and the DOE O 435.1 limited sources sensitivity case, it suggests the impact of reducing the number of continuing sources released from the vadose zone is minimal and does not impact dose.

Table 9. Comparison of the CA Base Case and the DOE O 435.1 Limited Source Sensitivity Case Maximum Total Dose All-Pathways Representative Person Scenario

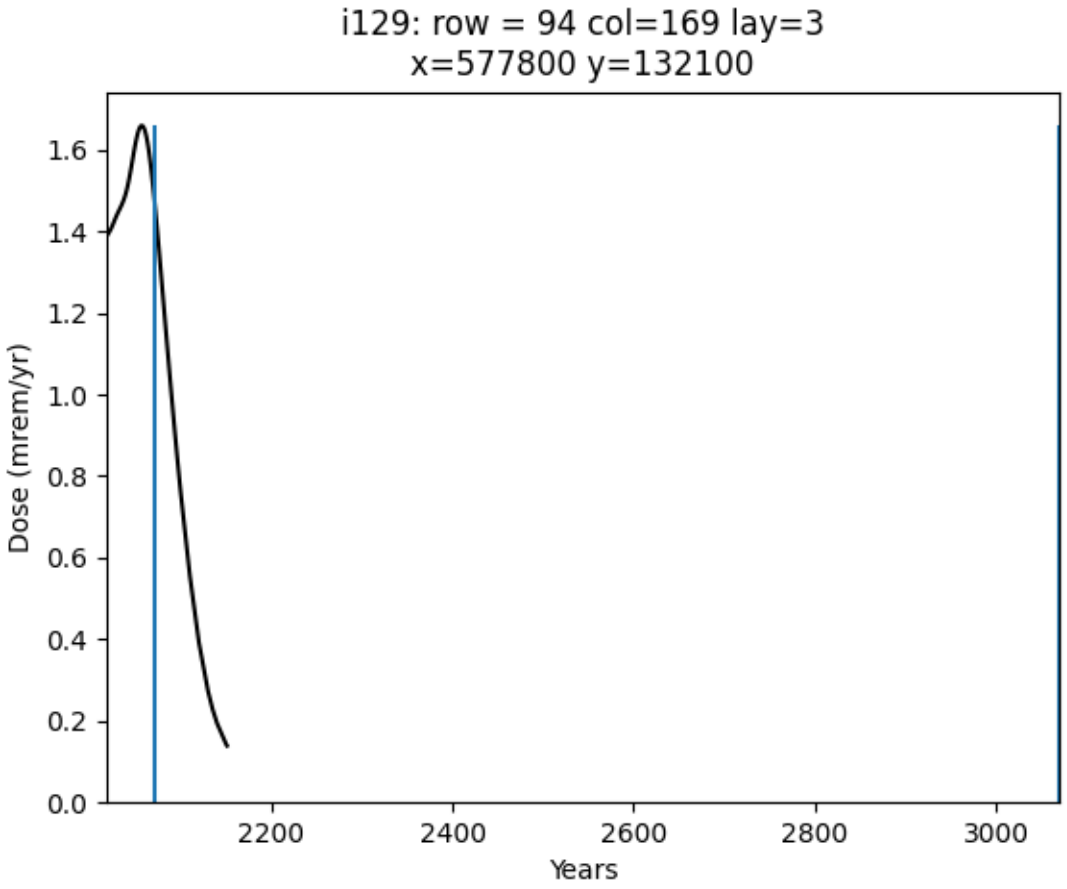
Compliance Boundary	Start Year	End Year	Cell Layer	Cell Row	Cell Column	Model Date	I-129	Tc-99	H-3	C-14	Sr-90	U-238	Total Maximum Dose
							mrem/yr						
DOE O 435.1 Limited Sources Sensitivity Case*													
Inner	2070	3070	3	49	140	01/09/3070	--	0.7	--	89	--	--	89.7
Outer	2070	3070	4	96	213	01/01/2070	8.5	--	0.3	--	--	--	8.8
1998 CA	2070	3070	5	30	141	01/01/2070	--	--	--	--	19	--	19
Inner	3070	12070	3	49	140	01/11/3370	--	19		2,421	--	--	2,440
Outer	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	6.6
1998 CA	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	6.6
CA Base Case													
Inner	2070	3070	3	49	140	01/09/3070	--	0.6	--	89	--	--	89.6
Outer	2070	3070	4	96	213	01/01/2070	8.5	--	0.3	--	--	--	8.8
1998 CA	2070	3070	5	30	141	01/01/2070	--	--	--	--	19	--	19
Inner	3070	12070	3	49	140	01/11/3370	--	19	--	2,421	--	--	2,440
Outer	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	6.6
1998 CA	3070	12070	5	95	214	01/09/3070	6.6	--	--	--	--	--	6.6

* C-14, Sr-90, and H-3 were included in the maximum total dose calculation even though they were not included in the DOE O 435.1, *Radioactive Waste Management* Limited Sources Sensitivity Case. The additional radionuclides were included for the sole purpose of comparison to the CA Base Case.

-- Denotes the radionuclide dose was below its minimum threshold value thus excluded from the model and no longer reported.

CA = composite analysis

To gain a better understanding of the contribution of I-129 to maximum total dose, specific locations were selected to evaluate I-129 dose over time that were known or suspected contributors. The location along the southeastern corner of CA compliance boundary (x = 577800; y = 132100) was selected to perform dose realizations because it is one of the largest contributors to I-129 dose. Figure 3 shows that I-129 had a maximum dose of 1.6 mrem/yr prior to the start of the compliance period (CY 2070 to CY 3070). The peak dose rapidly declines through the early part of the compliance period until reaching 0.1 mrem/yr, the minimum threshold concentration at which I-129 is excluded from the model and no longer reported, at approximately CY 2190.

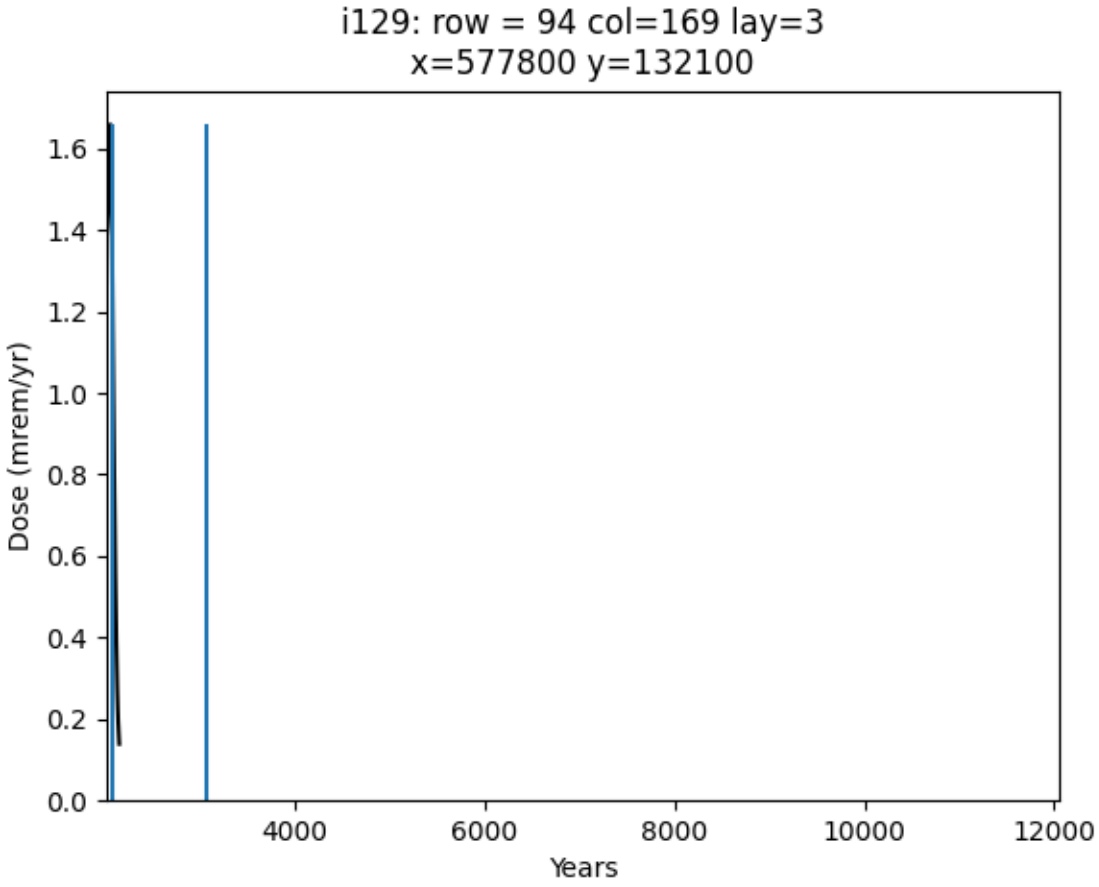


Note: Compliance period indicated by vertical lines.

Figure 3. Dose Realizations from DOE O 435.1 Limited Sources Sensitivity Case for I-129 at the Selected Location for the Compliance Period (CY 2070 to CY 3070)

Figure 4 shows the I-129 peak dose for the DOE O 435.1 limited dose sensitivity case. Figure 4 is the same as Figure 3 but the later extends throughout the compliance (CY 2070 to CY 3070) and postcompliance period (CY 3070 to CY 12070). As previously mentioned, the specific location along the southeastern corner of CA compliance boundary (x = 577800; y = 132100) was selected since it is one of the largest contributors to I-129 dose. I-129 had a maximum dose of 1.6 mrem/yr prior to the start of the compliance period (CY 2070 to CY 3070) (Figure 3). The peak dose rapidly declines through the early part of the compliance period until reaching 0.12 mrem/yr, the concentration at which I-129 is excluded from the model and no longer reported, at approximately CY 2190. After CY 2190, I-129 does

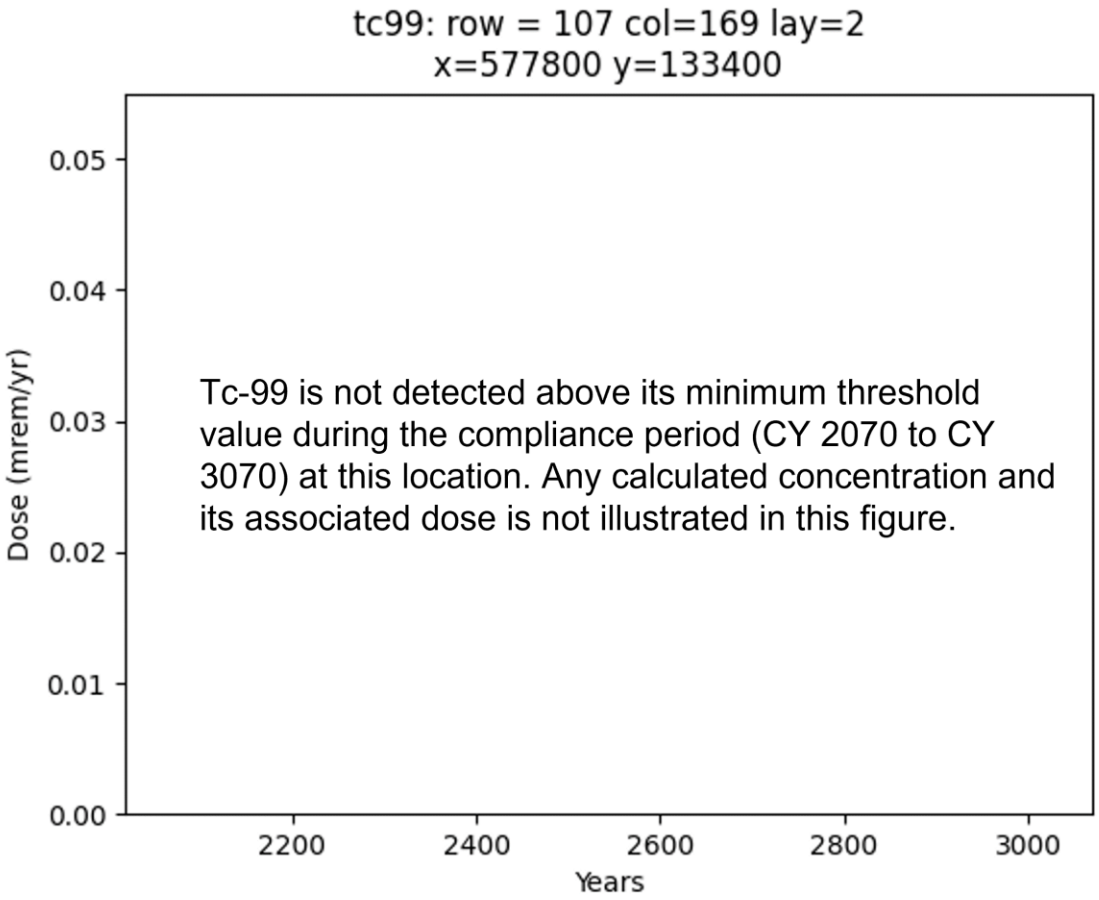
not exceed the minimum threshold of 0.12 mrem/yr indicating that the DOE O 435.1 sources are insignificant contributors to I-129 dose (Figure 4).



Note: Compliance period indicated by vertical lines.

Figure 4. Dose Realizations from DOE O 435.1 Limited Sources Sensitivity Case for I-129 at the Selected Location for Compliance (CY 2070-3070) and the Postcompliance Period (CY 3070 to CY 12070)

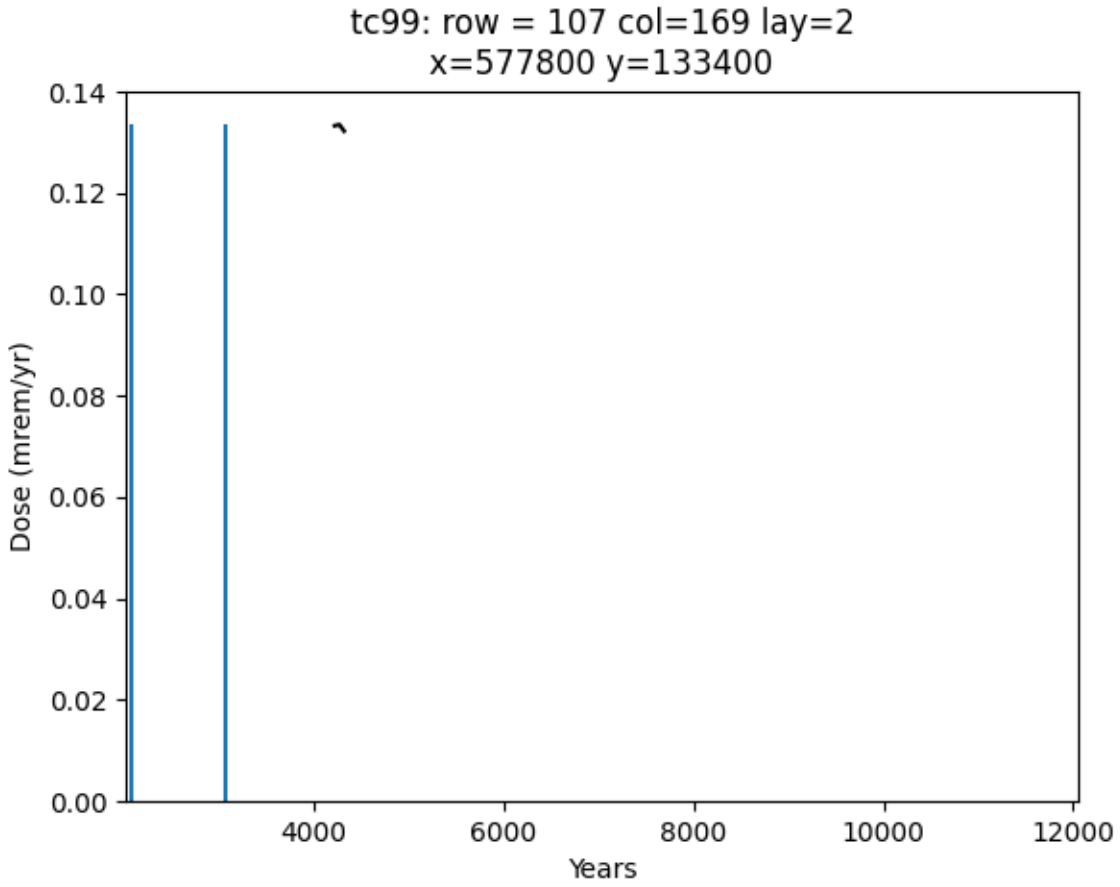
To gain a better understanding of the contribution of Tc-99 to maximum total dose, specific locations were selected to evaluate Tc-99 dose over time that were known or suspected contributors. The location along the southeastern corner of the CA compliance boundary where it intersects the high conductivity zone (x = 577800; y = 133400) was selected as it was a major contributor to Tc-99 dose. Tc-99 was not detected above its minimum threshold value of 0.13 mrem/yr during the compliance period (CY 2070 to CY 3070) (Figure 5). The minimum threshold value is the concentration at which the radionuclide is excluded from the model and no longer reported. Therefore, any calculated concentration and its associated dose is not illustrated in Figure 5 indicating that the DOE O 435.1 limited sources are insignificant contributors to Tc-99 dose during the compliance period.



Note: Compliance period indicated by vertical lines.

Figure 5. Dose Realizations from DOE O 435.1 Limited Sources Sensitivity Case for Tc-99 at the Selected Location for the Compliance Period (CY 2070 to CY 3070)

Figure 6 shows the Tc-99 peak dose for the DOE O 435.1 limited sources sensitivity case. Figure 6 is the same as Figure 5 but the later extends throughout the compliance (CY 2070 to CY 3070) and postcompliance period (CY 3070 to CY 12070). As previously mentioned, this specific location along the southeastern corner of the CA compliance boundary where it intersects the high conductivity zone (x = 577800; y = 133400) was selected because it is one of the largest contributors to Tc-99 dose. Tc-99 has a peak dose of 0.13 mrem/yr at approximately CY 4200 (Figure 6). During the rest of the postcompliance period (CY 3070 to CY 12070), Tc-99 is not detected above its minimum threshold value of 0.13 mrem/yr. Therefore, any calculated concentration and its associated dose is not illustrated in Figure 6 indicating that the DOE O 435.1 sources are insignificant contributors to Tc-99 dose.



Note: Compliance period indicated by vertical lines.

Figure 6. Dose Realizations from DOE O 435.1 Limited Sources Sensitivity Case for Tc-99 at the Selected Location for Compliance (CY 2070-3070) and the Postcompliance Period (CY 3070 to CY 12070)

8 References

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Appendix A

Derivation of External Dose Conversion Factors Based on FGR No. 15

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Table A.1. Dose Conversion Factors Used for External Exposure That Incorporate the Effects of Progeny based on FGR No. 15 Adult DCFs

Radionuclide	Progeny Considered	Half-Life	Branching Fraction	DCF (Sv per Bq s m^{-3}) [Table 4-5 of FGR No. 15 Adult]	DCF with Progenies (Sv per Bq s m^{-3}):	DCF with Progenies (mrem yr^{-1} g pCi^{-1})*
C-14	C-14	5700 yr	1	3.14E-20	3.1E-20	6.49E-03
Cl-36	Cl-36	--	1	4.21E-19	4.2E-19	8.70E-02
H-3	H-3	12.32 yr	1	3.41E-23	3.4E-23	7.05E-06
I-129	I-129	1.57E+07 yr	1	7.88E-20	7.9E-20	1.63E-02
Np-237	Np-237	2.144E+06 yr	1	3.73E-19	5.8E-18	1.21E+00
	Pa-233	26.967 days	1	5.46E-18		
Ra-226	Ra-226	1600 yr	1	1.72E-19	5.7E-17	1.18E+01
	Rn-222	3.8235 day	1	1.13E-20		
	Po-218	3.1 min	1	1.21E-23		
	Pb-214	26.8 min	1	6.97E-18		
	Bi-214	19.9 min	1	5.02E-17		
	Po-214	1.64E-4 sec	1	2.56E-21		
Re-187	Re-187	--	--	--	0.00E+00	0.00E+00
Sr-90	Sr-90	28.79 yr	1	2.64E-19	2.5E-18	5.21E-01
	Y-90	64.1 hr	1	2.26E-18		
Tc-99	Tc-99	2.111E+05 yr	1	1.01E-19	1.0E-19	2.09E-02
Th-230	Th-230	75380 yr	1	6.21E-21	6.2E-21	1.28E-03
U-232	U-232	68.9 yr	1	3.96E-21	5.1E-17	1.05E+01
	Th-228	1.9116 yr	1	3.98E-20		
	Ra-224	3.66 days	1	2.63E-19		
	Rn-220	55.6 sec	1	1.84E-20		
	Po-216	0.145 sec	1	4.72E-22		
	Pb-212	10.64 hr	1	3.48E-18		
	Bi-212	60.55 min	1	4.37E-18		
	Po-212	2.99E-07 sec	0.6406	0		
	Tl-208	3.053 min	0.3594	1.18E-16		
U-233	U-233	1.592E+05 yr	1	4.93E-21	4.9E-21	1.02E-03
U-234	U-234	2.455E+05 yr	1	1.88E-21	1.9E-21	3.88E-04

Table A.1. Dose Conversion Factors Used for External Exposure That Incorporate the Effects of Progeny based on FGR No. 15 Adult DCFs

Radionuclide	Progeny Considered	Half-Life	Branching Fraction	DCF (Sv per Bq s m^{-3}) [Table 4-5 of FGR No. 15 Adult]	DCF with Progenies (Sv per Bq s m^{-3}):	DCF with Progenies (mrem yr^{-1} g pCi^{-1})*
U-235	U-235	7.04E+08 yr	1	3.78E-18	4.0E-18	8.33E-01
	Th-231	25.52 hr	1	2.51E-19		
U-236	U-236	2.342E+07 yr	1	9.32E-22	9.3E-22	1.93E-04
U-238	U-238	4.468E+09 yr	1	9.2E-22	2.7E-18	5.64E-01
	Th-234	24.1 days	1	1.6E-19		
	Pa-234m	1.17 min	0.997	2.39E-18		
	Pa-234	6.7 hr	4.16E-03	4.44E-17		

* To convert from SI units (Sv per Bq s m^{-3}) to conventional units (mrem yr^{-1} g pCi^{-1}), multiply table entries by 1.868 x 1E23 x 10^{-6} x (1,600/ Density, kg m^{-3}).

-- Data not available

DCF = dose conversion factor

Appendix B

Software Log Files

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A.1 Log File (ca-maxdoseDB: Inventory Sensitivity Case)

INFO--03/04/2022 12:13:03 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:13:03 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:13:03 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:13:03 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:13:03 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:13:03 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/sumDose/ --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:13:03 PM--Username:root Computer:b5e6a826ae6c Platform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:13:21.431041

Total for 2 files 4e43e2a05c82fd029e9354924f0d95088ea80d56e86945b348af4d7f29074057

/home/ca/output/sumDose/.gitignore
4bb38be6d6d9ef0d2f9bcc339850ff48d821eccfa739369402b354c9ba946ea2

/home/ca/output/sumDose/totalDose.csv
8fe94eaea94cbcc0cd05dd1c82378ea3f534a109c9c3d27341b32dc5c5a3a6c3

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/04/2022 12:13:21 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:13:21 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:13:21 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:13:21 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:13:21 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:13:21 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:13:21 PM--Username:rootComputer:b5e6a826ae6cPlatform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:13:21.852368

/home/ca/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv d25c34065652eab6fb7500cc33f742fa798917062c35d0c06758bde03ba421e4

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/04/2022 12:13:21 PM--Starting CA-CIE Tool Runner.Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:13:22 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:13:22 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:13:22 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:13:22 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:13:22 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:13:22 PM--Username:rootComputer:b5e6a826ae6cPlatform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:13:22.313076

/home/ca/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv 0a60b30df9d5d41a22e885b354e5fa36b973c7c57950fd98341ced6847fe4df8

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/04/2022 12:13:22 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:13:22 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:13:22 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:13:22 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:13:22 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:13:22 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:13:22 PM--Username:rootComputer:b5e6a826ae6cPlatform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:13:22.692653

/home/ca/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv 5d5f5f798a07d4b1b165aeedb4aab45908a5dd0ca7ed316fe2772320aad07229

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/04/2022 12:13:22 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:13:22 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:13:22 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:13:22 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:13:22 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:13:22 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/inputs/maxSumDose/maxsumdose-controlFile.json --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:13:22 PM--Username:root Computer:b5e6a826ae6c Platform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:13:23.007447

/home/ca/inputs/maxSumDose/maxsumdose-controlFile.json
364287bfebe46ac8b98ab9010886c35959d4bd91cbbb12cfcef9edfcf613d1a5

###Finished Process###

###Executing MaxSumDose Tool###

INFO--03/04/2022 12:13:23 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:13:23 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:13:23 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/camaxdose/maxDoseDB.py<--327f1bdd340a5b3b887102df4e76f04db66656b1

INFO--03/04/2022 12:13:23 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:13:23 PM--QA Status: QUALIFIED : /home/tools/pylib/camaxdose/maxDoseDB.py

INFO--03/04/2022 12:13:23 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/camaxdose/maxDoseDB.py /home/ca/inputs/maxSumDose/maxsumdose-controlFile.json"

INFO--03/04/2022 12:13:23 PM--Username:rootComputer:b5e6a826ae6cPlatform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

###Finished Process###

###Executing Fingerprint Tool###

Starting CA-CIE Tool Runner.Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:20:46 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:20:46 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:20:46 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:20:46 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:20:46 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:20:46 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/maxSumDose/max_dose.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:20:46 PM--Username:rootComputer:b5e6a826ae6cPlatform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:20:46.483120

/home/ca/output/maxSumDose/max_dose.csv
122edf758b99594f0951f368e736011544444bb188b0800970fe7fea5a5a63a5

###Executing Fingerprint Tool###

INFO--03/04/2022 12:20:46 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/04/2022 12:20:46 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/04/2022 12:20:46 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/04/2022 12:20:46 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/04/2022 12:20:46 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/04/2022 12:20:46 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/maxSumDose/max_dose_timeseries.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/04/2022 12:20:46 PM--Username:root Computer:b5e6a826ae6c Platform:Linux 5.10.60.1-microsoft-standard-WSL2 #1 SMP Wed Aug 25 23:20:18 UTC 2021

Fingerprint generated at 2022-03-04 12:20:46.966322

/home/ca/output/maxSumDose/max_dose_timeseries.csv
cb87d7911a697b3ee4136db9ed6cb262f5176ba404c2efa64d5067d1e1dee32c

###Finished running MaxSumDose Processes###

A.2. Log Files (ca-maxdoseDB: Recharge Sensitivity Case)

INFO--03/05/2022 01:52:41 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:52:41 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:52:41 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:52:41 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:52:41 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:52:41 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/sumDose/ --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:52:41 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:52:51.273109

Total for 1 files b7349cf485bf8bd89ccd820b90065e68c4de54c1da6043b7e4afb958d440441f

/home/ca/output/sumDose/totalDose.csv
0c1fc207cf0cefcf9bc4cbb26270d2dd9859fe0dbcda896162a9c4c7f5ce49b1

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/05/2022 01:52:51 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:52:51 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:52:51 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:52:51 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:52:51 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:52:51 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:52:51 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:52:51.666227

/home/ca/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv d25c34065652eab6fb7500cc33f742fa798917062c35d0c06758bde03ba421e4

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/05/2022 01:52:51 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:52:51 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:52:51 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:52:51 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:52:51 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:52:51 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:52:51 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:52:52.052718

/home/ca/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv 0a60b30df9d5d41a22e885b354e5fa36b973c7c57950fd98341ced6847fe4df8

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/05/2022 01:52:52 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:52:52 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:52:52 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:52:52 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:52:52 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:52:52 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:52:52 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:52:52.515854

/home/ca/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv
5d5f5f798a07d4b1b165aeedb4aab45908a5dd0ca7ed316fe2772320aad07229

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/05/2022 01:52:52 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:52:52 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:52:52 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:52:52 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:52:52 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:52:52 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/inputs/maxSumDose/maxsumdose-controlFile.json --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:52:52 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:52:52.791217

/home/ca/inputs/maxSumDose/maxsumdose-controlFile.json
364287bfebe46ac8b98ab9010886c35959d4bd91cbbb12cfcef9edfcf613d1a5

###Finished Process###

###Executing MaxSumDose Tool###

INFO--03/05/2022 01:52:52 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:52:52 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:52:52 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/camaxdose/maxDoseDB.py<--327f1bdd340a5b3b887102df4e76f04db66656b1

INFO--03/05/2022 01:52:52 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:52:52 AM--QA Status: QUALIFIED : /home/tools/pylib/camaxdose/maxDoseDB.py

INFO--03/05/2022 01:52:52 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/camaxdose/maxDoseDB.py /home/ca/inputs/maxSumDose/maxsumdose-controlFile.json"

INFO--03/05/2022 01:52:52 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

###Finished Process###

###Executing Fingerprint Tool###

Starting CA-CIE Tool Runner.Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:59:08 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:59:08 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:59:08 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:59:08 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:59:08 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:59:08 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/maxSumDose/max_dose.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:59:08 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:59:08.743178

/home/ca/output/maxSumDose/max_dose.csv
5e8e8b2b322d21e610ee7586e59b04eb6c7c3d2f989a6097dccfc059787d9772

###Executing Fingerprint Tool###

INFO--03/05/2022 01:59:08 AM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/05/2022 01:59:08 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/05/2022 01:59:08 AM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/05/2022 01:59:08 AM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/05/2022 01:59:08 AM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/05/2022 01:59:08 AM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/maxSumDose/max_dose_timeseries.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/05/2022 01:59:08 AM--Username:root Computer:93d7125851eb Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-05 01:59:08.924614

/home/ca/output/maxSumDose/max_dose_timeseries.csv
abf2e5c792807a6bd8fed6b27aeb3ba6150926ca2c1a8e89f7c23d3368d1b459

###Finished running MaxSumDose Processes###

A.3. Log Files (ca-maxdoseDB: 435.1 Limited Sources Sensitivity Case)

INFO--03/07/2022 06:17:14 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:17:14 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:17:14 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:17:14 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:17:15 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:17:15 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/sumDose/ --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:17:15 PM--Username:root Computer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:17:25.289615

Total for 4 files f8d75a5c7cd1e5b210e79849b869fd319bf3c326f78a200db76d6fad0b9e5332

/home/ca/output/sumDose/.gitignore
4bb38be6d6d9ef0d2f9bcc339850ff48d821eccfa739369402b354c9ba946ea2

/home/ca/output/sumDose/sumdose-report.txt
759a44950edb809029d14f0c124aee7840df7bda1bab3f7c6b953a7d58be502b

/home/ca/output/sumDose/sumdose-runlog.txt
e5a1c1b91daaa01d8a743f29753b768ab59f973d403c6c941088c4c7bf21cfde

/home/ca/output/sumDose/totalDose.csv
a6ff898b4f1af02d71c1b8b5fee32c090b75249ee5155160334d91a5493d25d6

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/07/2022 06:17:25 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:17:25 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:17:25 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:17:25 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:17:25 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:17:25 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:17:25 PM--Username:root Computer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:17:25.659854

/home/ca/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv d25c34065652eab6fb7500cc33f742fa798917062c35d0c06758bde03ba421e4

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/07/2022 06:17:25 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:17:25 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:17:25 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:17:25 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:17:25 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:17:25 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:17:25 PM--Username:root Computer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:17:26.006590

/home/ca/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv 0a60b30df9d5d41a22e885b354e5fa36b973c7c57950fd98341ced6847fe4df8

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/07/2022 06:17:26 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:17:26 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:17:26 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:17:26 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:17:26 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:17:26 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:17:26 PM--Username:rootComputer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:17:26.372324

/home/ca/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv 5d5f5f798a07d4b1b165aeedb4aab45908a5dd0ca7ed316fe2772320aad07229

###Finished Process###

###Executing Fingerprint Tool###

INFO--03/07/2022 06:17:26 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:17:26 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:17:26 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:17:26 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:17:26 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:17:26 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/inputs/maxSumDose/maxsumdose-controlFile.json --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:17:26 PM--Username:rootComputer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:17:26.654496

/home/ca/inputs/maxSumDose/maxsumdose-controlFile.json
364287bfebe46ac8b98ab9010886c35959d4bd91cbbb12cfcef9edfcf613d1a5

###Finished Process###

###Executing MaxSumDose Tool###

INFO--03/07/2022 06:17:26 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:17:26 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:17:26 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/camaxdose/maxDoseDB.py<--327f1bdd340a5b3b887102df4e76f04db66656b1

INFO--03/07/2022 06:17:26 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:17:26 PM--QA Status: QUALIFIED : /home/tools/pylib/camaxdose/maxDoseDB.py

INFO--03/07/2022 06:17:26 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/camaxdose/maxDoseDB.py /home/ca/inputs/maxSumDose/maxsumdose-controlFile.json"

INFO--03/07/2022 06:17:26 PM--Username:rootComputer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

###Finished Process###

###Executing Fingerprint Tool###

Starting CA-CIE Tool Runner.Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"INFO--03/07/2022 06:22:54 PM--Starting CA-CIE Tool Runner.Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:22:54 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:22:54 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:22:54 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:22:54 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:22:54 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/maxSumDose/max_dose.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:22:54 PM--Username:rootComputer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:22:54.425700

/home/ca/output/maxSumDose/max_dose.csv
c5336a9449a2acf7200c051ddc856fa0fa49cca19fbced3ed617371579616 6d6

###Executing Fingerprint Tool###

INFO--03/07/2022 06:22:54 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/output/maxSumDose/maxsumdose-report.txt"

INFO--03/07/2022 06:22:54 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/runner/runner.py<--1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--03/07/2022 06:22:54 PM--Code Version: 56869701bbe6826eb44753dcf5b9d32fd6ae7c4b v5.21: /home/tools/pylib/fingerprint/fingerprint.py<--e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--03/07/2022 06:22:54 PM--QA Status: QUALIFIED : /home/tools/pylib/runner/runner.py

INFO--03/07/2022 06:22:54 PM--QA Status: QUALIFIED : /home/tools/pylib/fingerprint/fingerprint.py

INFO--03/07/2022 06:22:54 PM--Invoking Command:"python3" with Arguments:"/home/tools/pylib/fingerprint/fingerprint.py /home/ca/output/maxSumDose/max_dose_timeseries.csv --output /home/ca/output/maxSumDose/maxsumdose-report.txt --outputmode a"

INFO--03/07/2022 06:22:54 PM--Username:rootComputer:716422cd8dd4 Platform:Linux 4.19.128-microsoft-standard #1 SMP Tue Jun 23 12:58:10 UTC 2020

Fingerprint generated at 2022-03-07 18:22:54.778436

/home/ca/output/maxSumDose/max_dose_timeseries.csv
c32f9a52b399467d82f18fd73da4843044d91da97566cfe425e1b69b8fe3f32e

###Finished running MaxSumDose Processes###

A.4. Log Files for CA Base Case

INFO--11/21/2021 10:01:19 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:19 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py<-- 1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--11/21/2021 10:01:19 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py<-- e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--11/21/2021 10:01:19 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py

INFO--11/21/2021 10:01:19 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py

INFO--11/21/2021 10:01:19 PM--Invoking Command:"python3" with Arguments:"/home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py /home/ca/dosecalc/source/CPCA98P2R/v1.0/data/Inner_Area/P2R_Cells_On_and_Outside_Inner_Area_Boundary.csv --outputmode a --output /home/ca/dosecalc/output/maxsumdose/2p0avg/fingerprint.txt"

INFO--11/21/2021 10:01:19 PM--Username:ca Computer:twotbbase Platform:Linux 4.15.0-162-generic #170-Ubuntu SMP Mon Oct 18 11:38:05 UTC 2021

Starting CA-CIE Tool Runner.Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:20 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:20 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py<-- 1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--11/21/2021 10:01:20 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py<-- e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--11/21/2021 10:01:20 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py

INFO--11/21/2021 10:01:20 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py

INFO--11/21/2021 10:01:20 PM--Invoking Command:"python3" with Arguments:"/home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py /home/ca/dosecalc/source/CPCA98P2R/v1.0/data/Outer_Area/P2R_Cells_On_and_Outside_Outer_Area_Boundary.csv --outputmode a --output /home/ca/dosecalc/output/maxsumdose/2p0avg/fingerprint.txt"

INFO--11/21/2021 10:01:20 PM--Username:ca Computer:twotbbase Platform:Linux 4.15.0-162-generic #170-Ubuntu SMP Mon Oct 18 11:38:05 UTC 2021

Starting CA-CIE Tool Runner.Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:20 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:20 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py<-- 1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--11/21/2021 10:01:20 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py<-- e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--11/21/2021 10:01:20 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py

INFO--11/21/2021 10:01:20 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py

INFO--11/21/2021 10:01:20 PM--Invoking Command:"python3" with Arguments:"/home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py /home/ca/dosecalc/source/CPCA98P2R/v1.0/data/CA98/P2R_Cells_On_and_Outside_CA98_Boundary.csv --outputmode a --output /home/ca/dosecalc/output/maxsumdose/2p0avg/fingerprint.txt"

INFO--11/21/2021 10:01:20 PM--Username:ca Computer:twotbbase Platform:Linux 4.15.0-162-generic #170-Ubuntu SMP Mon Oct 18 11:38:05 UTC 2021

Starting CA-CIE Tool Runner.Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:20 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:20 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py<-- 1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--11/21/2021 10:01:20 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py<-- e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--11/21/2021 10:01:20 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py

INFO--11/21/2021 10:01:20 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py

INFO--11/21/2021 10:01:20 PM--Invoking Command:"python3" with Arguments:"/home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py /home/ca/dosecalc/output/sumdose/2p0avg/totalDose.csv --outputmode a --output /home/ca/dosecalc/output/maxsumdose/2p0avg/fingerprint.txt"

INFO--11/21/2021 10:01:20 PM--Username:ca Computer:twotbbase Platform:Linux 4.15.0-162-generic #170-Ubuntu SMP Mon Oct 18 11:38:05 UTC 2021

Starting CA-CIE Tool Runner.Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:24 PM--Starting CA-CIE Tool Runner. Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

INFO--11/21/2021 10:01:24 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py<-- 1bcfd6779e9cbdb82673405873a8e5e81514ae27

INFO--11/21/2021 10:01:24 PM--Code Version: 779f46d929f56329a5124cf6dc4016bf2e89a7d0 5.20: /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py<-- e9692a4faec2ee264fe50417b6b6a516ba82b2f6

INFO--11/21/2021 10:01:24 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/runner/runner.py

INFO--11/21/2021 10:01:24 PM--QA Status: QUALIFIED : /home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py

INFO--11/21/2021 10:01:24 PM--Invoking Command:"python3" with Arguments:"/home/ca/dosecalc/CA-CIE-Tools/pylib/fingerprint/fingerprint.py /home/ca/dosecalc/runs/maxsumdose-2p0avg-controlFile.json --outputmode a --output /home/ca/dosecalc/output/maxsumdose/2p0avg/fingerprint.txt"

INFO--11/21/2021 10:01:24 PM--Username:ca Computer:twotbbase Platform:Linux 4.15.0-162-generic #170-Ubuntu SMP Mon Oct 18 11:38:05 UTC 2021

Starting CA-CIE Tool Runner.Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/runlog.txt"

Starting CA-CIE Tool Runner.Logging to "/home/ca/dosecalc/output/maxsumdose/2p0avg/maxsumdose-report.txt"

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Appendix C

Software Installation and Checkout Form

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SOFTWARE INSTALLATION AND CHECKOUT FORM

Software Owner Instructions:
Complete Fields 1-13, then run test cases in Field 14. Compare test case results listed in Field 15 to corresponding Test Report outputs. If results are the same, sign and date Field 19. If not, resolve differences and repeat above steps.

Software Subject Matter Expert Instructions:
Assign test personnel. Approve the installation of the code by signing and dating Field 21, then maintain form as part of the software support documentation.

GENERAL INFORMATION

1. Software Name: CACIE-UTILS Version No.: v5.21

EXECUTABLE INFORMATION

2. Executable Name *(include path)*:
[redacted]

3. Executable Size *(bytes)*:

COMPILATION INFORMATION

4. Hardware System *(i.e., property number or ID)*:
N/A

5. Operating System *(include version number)*:
N/A

INSTALLATION AND CHECKOUT INFORMATION

6. Hardware System *(i.e., property number or ID)*:
Intera's Office Richland, Washington: property #859 (psc-iron)

7. Operating System *(include version number)*:
Windows 10 build 19043.1526

8. Open Problem Report? ☐ Yes ☒ No PR/CR No.:

TEST CASE INFORMATION

9. Directory/Path:
[redacted]

10. Procedures:
[redacted]

11. Libraries:
[redacted]

12. Input Files:
[redacted]

13. Output Files:
[redacted]

14. Test Cases:
[redacted]

15. Test Case Results:
[redacted]

16. Test Performed By: Eugene O Powers

17. Test Results: ☒ Satisfactory, Accepted for Use ☐ Unsatisfactory

18. Disposition *(include HISI update)*:
Accepted; Installation noted in HISI

SOFTWARE INSTALLATION AND CHECKOUT FORM (Continued)

19. Prepared By *(Software Owner)*:

Chris Farrow
Print First and Last Name

CHRISTOPHER FARROW (Affiliate)
Digitally signed by CHRISTOPHER FARROW (Affiliate)
DN: C=US, O=U.S. Government, OU=Department of Energy, OID.0.9.2342.19200300.100.1.1=89001003727219 + CN=CHRISTOPHER FARROW (Affiliate)
Reason: I have reviewed this document
Location: your signing location here
Date: 2022.03.14 13:04:29-05'00'
Foxit PhantomPDF Version: 10.1.7
Signature / Date

20. Test Personnel:

Title: Software Engineer

Eugene O'Neil Powers
Print First and Last Name

Eugene O. Powers
Digitally signed by Eugene O. Powers
DN: cn=Eugene O. Powers, o=Intera, ou, email=epowers@intera.com, c=US
Date: 2022.03.14 10:55:23 -07'00'
Signature / Date

Title:

Print First and Last Name

Signature / Date

Title:

Print First and Last Name

Signature / Date

21. Approved By *(Software SME)*:

Print First and Last Name

Signature / Date