ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Billy Reid, Site Executive
Cellphone: 865-384-6789
Email: breid@northstar.com

3F1222-01
December 12, 2022

10 CFR 50.90
10 CFR 50.82 (a)(9)

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Docket No. 50-302, Operating License Number DPR-72
Crystal River Unit 3 Nuclear Power Station
License Amendment Request 262
Addition of License Condition 2.C.21, "License Termination Plan"

Dear Commissioners and Staff,

In accordance with 10 CFR 50.90 and 10 CFR 50.82(a)(9), ADP CR3, LLC (ADP CR3) hereby submits the enclosed application requesting an amendment to Facility Operating License, No. DPR-72, for Crystal River Unit 3 Nuclear Power Station (CR3). The enclosed License Amendment Request (LAR) proposes to add License Condition 2.C.21 that approves the License Termination Plan (LTP) and adds a license condition that establishes the criteria for determining when changes to the LTP require prior NRC approval. The LTP demonstrates that the remaining decommissioning activities will be performed in accordance with 10 CFR 50, will not be adverse to the common defense and security or to the health and safety of the public, and will not have an adverse effect on the quality of the environment.

Enclosure 1 provides a description and evaluation of the changes proposed in this LAR. Enclosure 2 contains the proposed wording change to the license. In accordance with 10 CFR 50.82(a)(9)(i), Enclosure 3 contains the LTP that is being submitted to the NRC at least 2 years prior to planned license termination, and upon NRC approval, will become a supplement to the CR3 Defueled Safety Analysis Report (DSAR). ADP CR3 is submitting the additional enclosed technical documents and reports to aid in the review of the License Termination Plan:

Enclosure 4 Crystal River Nuclear Power Station, "*Historical Site Assessment for Crystal River 3,*" June 2016

Enclosure 5 "*Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection for DCGL Development,*" June 21, 2021

Enclosure 6 "*Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations in Support of the Final Status Survey at VYNPS and CR3,*" *Rev 3* August 14, 2022

Enclosure 7 *"Gross Activity DCGL in Support of the Final Status Survey at CR3,"* October 21, 2021

Enclosure 8 BHI Energy Engineering Calculation ENG-CR3-001, "*RESRAD-Onsite Input Parameter Sensitivity Analysis – Crystal River 3*," Revision 0, February 2022

Enclosure 9 BHI Energy Engineering Calculation ENG-CR3-002, "*RESRAD-Build Input Parameter Sensitivity Analysis – Crystal River 3,*" Revision 0, January 2022

Enclosure 10 BHI Energy Engineering Calculation ENG-CR3-003, "*Derived Concentration Guideline Levels Values for Soil – Crystal River 3,*" Revision 1, March 2022

Enclosure 11 BHI Energy Engineering Calculation ENG-CR3-004, "*Crystal River* 3 *Building Surface DCGL Values,*" Revision 0, March 2022

Enclosure 12 BHI Energy Engineering Calculation ENG-CR3-005, "*Area Factors for Use with Crystal River DCGL Values for Soil,*" Revision 0, April 2022

Enclosure 13 BHI Energy Engineering Calculation ENG-CR3-006, "*Area Factors for Use with CR3 DCGL Values for Buildings/Structures,*" Revision 0, April 2022

Enclosure 14 10 CFR 50.75(g) Table 2.2 List of Events/Issues Affecting ADP-CR3 Areas

Enclosure 15 "*CR3 SeaLand Reclassification Position Paper,*" September 2022

Enclosure 16 "*Crystal River Unit 3 DCGL Development Summary Report,*" Revision 0, May 2022

Enclosure 17 "*CR3 Site Remediation Equipment Methods and Techniques,*" November 2022

Enclosure 18 "*Crystal River Unit 3 (CR3) – Decommissioning End State Conditions,*" February 15, 2019

There are no new regulatory commitments contained within this letter.

ADP CR3 has evaluated the proposed License Amendment against the criteria of 10 CFR 50.92 and determined that no significant hazards consideration is involved.

In accordance with 10 CFR 50.91(b), ADP CR3 is providing a copy of this submittal to the State of Florida.

If you wish to discuss the information in the enclosures, please contact Mr. Billy Reid at (865) 384-6789.

I state under penalty of perjury that the foregoing is true and correct. Executed on December 12, 2022.

Sincerely,

Billy Reid, Site Executive

cc: Regional Administrator, Region 1
NMSS Project Manager
State of Florida

EVALUATION

1.0 DESCRIPTION

Crystal River Nuclear Power Station (CR3) is currently undergoing active decommissioning and spent fuel has been transferred to the onsite CR3 Independent Spent Fuel Storage Installation (ISFSI). As a result, ADP CR3 proposes to amend Facility Operating License DPR-72 for CR3, to add License Condition 2.C.21, "License Termination Plan (LTP)."

2.0 PROPOSED CHANGE

ADP CR3 proposes to add License Condition 2.C.21, which describes NRC approval of the LTP and provides criteria for making future changes to the LTP that require prior NRC approval. The proposed wording for License Condition 2.C.21 is contained in Enclosure 2 of this letter.

3.0 BACKGROUND

CR3 is part of the larger Crystal River Energy Complex (CREC), which is located on the Gulf of Mexico in Citrus County, Florida. Duke Energy Florida (DEF) is the owner of the complex with ADP CR3 assuming control of CR3. This site's location is approximately 7.5 miles northwest of the City of Crystal River, and 70 miles north of Tampa. In addition to CR3, other structures on the CREC include two fossil-fueled units, two large cooling towers, coal delivery and storage areas, ash storage area, office buildings, warehouses, barge handling docks, and a railroad. Additionally, located outside the licensed footprint is two newly constructed Combined Cycle units which were added to the CREC. CR3 is located at latitude 28° 57' 25.87"N and longitude 82° 41' 55.95" W.

CR3 is a single unit pressurized light-water reactor (PWR) supplied by Babcock & Wilcox. CR3 was initially licensed to operate at a maximum of 2,452 megawatt thermal (MWt). In 1981, 2002, and 2007, the NRC approved three DEF requests to increase the licensed core power level to a maximum power level of 2,609 MWt.

CR3 last produced power in September 2009, while shutting down for Refuel 16. During activities to replace steam generators, a portion of the containment concrete wall delaminated. While completing repairs additional delamination occurred. CR3 was officially retired on February 5, 2013.

On April 1, 2020, the NRC approved transfer of CR3 from Duke Energy Florida, LLC (DEF) to ADP CR3, LLC (ADP CR3) to commence decontamination, dismantlement, and demolition (ADAMS Accession No. ML20069A023). On October 1, 2020, closing took place and ADP CR3 became the Facility Licensee and the updated PSDAR became effective changing the plant decommissioning strategy from SAFSTOR to DECON.

ADP CR3 is currently conducting decontamination and decommissioning (D&D) activities at the CR3 site in accordance with CR3 procedures and approved work packages. Final decommissioning activities are being coordinated with the appropriate Federal and State regulatory agencies. This will allow for the performance of activities to prepare the site for license termination.

4.0 REGULATORY ANALYSIS

Pursuant to 10 CFR 50.82(a)(9), nuclear power reactor licensees are required to submit an LTP prior to, or along with, their application for termination of a license. This LTP will become a supplement to the CR3, DSAR. The LTP is required to be submitted at least 2 years before termination of the license.

ADP CR3 is submitting a proposed amendment to the CR3 license to satisfy the requirements of 10 CFR 50.82(a)(10) for approval of the CR3 LTP by license amendment. The change to the license will authorize the implementation of the LTP, allows the implementation of the method outlined in Chapter 5 of the LTP for site compliance with dose-based release criteria, and provides appropriate and necessary conditions when changes can be made without prior NRC review and approval.

ADP CR3 prepared the LTP using the guidance in:

- Regulatory Guide 1.179 "*Standard Format and Contents for License Termination Plans for Nuclear Power Reactors*," Revision 2, dated July 2019
- NUREG-1575 "*Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM*)," Revision 1, dated August 2000
- NUREG-1700 "*Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans,"* Revision 2, dated April 2018, and
- " NUREG-1757 "*Consolidated Decommissioning Guidance,"* Revision 2, dated July 2022

5.0 TECHNICAL ANALYSIS

The LTP includes a discussion on the following topics:

- Site Characterization to ensure that Final Status Surveys (FSS) cover all areas where contamination existed, remains, or has the potential to exist or remain,
- Identification of remaining dismantlement activities,
- Plans for site remediation,
- A description of the FSS plan to confirm that CR3 will meet the release criteria in 10 CFR 20, Subpart E,

- Dose-modeling scenarios that ensure compliance with the radiological criteria for license termination,
- An estimate of the remaining site-specific decommissioning costs, and
- A supplement to the DSAR and the Final Generic Environmental Impact Statement describing any new information or significant environmental change associated with proposed license termination activities.

This proposal gives the NRC the opportunity to review the CR3 LTP to ensure ADP CR3's planned activities and processes meet the criteria in 10 CFR 50.82(a)(9) and NUREG-1700. Additionally, in accordance with NUREG-1700, Revision 2, Appendix B, the license condition requires NRC approval for changes to the methodology that could result in increasing the amount of plant-related activity remaining at the time of license termination compared to the methodology the NRC reviewed in the proposed LTP.

Since the LTP is based on NRC guidance and establishes the methodology ADP CR3 will use to meet license termination criteria, this proposed license amendment is appropriate to allow completion of the CR3 decommissioning project and license termination.

6.0 ENVIRONMENTAL CONSIDERATION

No Significant Hazards Consideration

ADP CR3 has reviewed the proposed license amendment against each of the criteria in 10 CFR 50.92, "Issuance of amendment," and has concluded that the amendment request does not involve a significant hazards consideration. The following provides ADP CR3's analysis of the issue of no significant hazards consideration:

1. Does the proposed license amendment involve a significant increase in the probability or consequences of an accident previously evaluated?

No. The change allows for the approval of the LTP and provides the criteria for when changes to the LTP require prior NRC approval. This change does not affect possible initiating events for the decommissioning accidents previously evaluated in the CR3 DSAR, as updated, or alter the configuration or operation of the facility. Safety limits, limiting safety system settings, and limiting control systems are no longer applicable to CR3 in the permanently defueled mode, and are therefore not relevant.

The proposed change does not affect the boundaries used to evaluate compliance with liquid or gaseous effluent limits and has no impact on plant operations. Therefore, the proposed license amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed license amendment create the possibility of a new or different kind of accident from any accident previously evaluated?

No. The safety analysis for the facility remains accurate as described in the CR3 DSAR, as updated. There are sections of the LTP that refer to the decommissioning activities remaining (e.g., removal of large components, decontamination, etc.). However, these activities are performed in accordance with approved CR3 work packages/steps and undergo 10 CFR 50.59 screening prior to initiation.

The proposed amendment merely makes mention of these processes and does not bring about physical changes to the facility. Therefore, the facility conditions for which the postulated accidents have been evaluated are still valid and no new accident scenarios, failure mechanisms, or single failures are introduced by this amendment. The system operating procedures are not affected. Therefore, the proposed changes will not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed license amendment involve a significant reduction in the margin of safety?

No. There are no changes to the design or operation of the facility resulting from this amendment. The proposed change does not affect the boundaries used to evaluate compliance with liquid or gaseous effluent limits and has no impact on plant shutdown operations. Accordingly, neither the postulated accident assumptions in the DSAR, as updated, nor the Technical Specifications are affected. Therefore, the proposed change does not involve a significant reduction in the margin of safety.

Environmental Impact Consideration

This amendment request satisfies the criteria specified in 10 CFR 51.22(c)(9) for a categorical exclusion from the requirements to perform an environmental assessment or to prepare an environmental impact statement. The criteria of 10 CFR 51.22(c)(9) are addressed as follows:

(i) The amendment involves no significant hazards consideration.

As discussed in the No Significant Hazards Consideration section above, the proposed license amendment does not involve significant hazards consideration.

(ii) There is no significant change in the types or significant increase in the amounts of effluents that may be released offsite.

The proposed license amendment is consistent with the plant activities described in the DSAR. No changes in effluent system requirements or controls are proposed in this change. The environmental impacts associated with radiation dose to members of the public related to decommissioning activities and site release for unrestricted use were considered in NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of

Nuclear Facilities, Supplement 1", and NUREG-1496, "Generic Environmental Impact Statement in Support of the Rulemaking on Radiological Criteria for License Termination."

NUREG-0586 provides a generic environmental assessment of decommissioning a reference nuclear facility. Based on the findings in NUREG-0586, the NRC concluded a generic finding of "no significant (environmental) impact.

The NRC further concluded that no additional Environmental Impact Statement would need to be prepared in connection with decommissioning a particular nuclear site unless the impacts of a particular plant have site-specific considerations significantly different from those studied generically. LTP Chapter 8 provides an updated assessment of the environmental effects of decommissioning CR3.

The updated assessment also determined that the environmental effects from decommissioning CR3 are minimal and there are no adverse effects outside the bounds of NUREG-0586, Supplement 1. Based on the above, there will not be a significant change in the types or increase in the amounts of effluents released offsite for the remaining decommissioning activities. The release of effluents from the facility will continue to be controlled by site procedures throughout the remaining decommissioning, and the activities at CR3 will continue to be performed in accordance with the CR3 Offsite Dose Calculation Manual, as applicable.

(iii) There is no significant increase in individual or cumulative occupational exposure.

The attributes identified in NUREG-0586, Supplement 1 were compared with the remaining activities for CR3 and the following conclusions were made:

- ADP CR3 will maintain annual occupational radiation exposure to individuals as low as reasonably achievable. These exposures will be at, or below, the estimated values in Table 4-1 of NUREG-0586, Supplement 1. LTP Section 3.4 provides a dose estimate for CR3 decommissioning.
- ADP CR3 will maintain exposure to onsite workers and the offsite public from waste transportation well below the levels projected by NUREG-0586.

LTP Chapter 8 provides an updated assessment of the environmental effects of decommissioning CR3. The updated assessment also determined that the environmental effects from decommissioning CR3 are minimal and there are no adverse effects outside the bounds of NUREG-0586, Supplement 1.

Based on the above, there is no significant increase in individual or cumulative occupational exposure due to decommissioning CR3.

Conclusion

Based on the evaluations above: (1) there is reasonable assurance that the health and safety of the public will not be endangered by the conduct of activities in the proposed manner, and (2) such activities will be conducted in compliance with the NRC's regulations, and the proposed amendment will not be inimical to the common defense and security or the health and safety of the public.

Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR Part 51.22 (c)(9).

7.0 REFERENCES

7.1 Regulatory Guide 1.179, "*Standard Format and Contents for License Termination Plans for Nuclear Power Reactors,*" dated July 2019

7.2 NUREG-1575, "*Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," dated August 2000*

7.3 NUREG-1700, "*Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans,*" dated April 2018

7.4 NUREG-1757, "*Consolidated Decommissioning Guidance,*" dated July 2022

7.5 NUREG-0586, "*Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities,*" dated November 2002

7.6 NUREG-0586 Supplement 1, "*Regarding the Decommissioning of Nuclear Power Reactors,*" dated November 2002

7.7 NUREG-1496, "*Generic Environmental Impact Statement in Support of the Rulemaking on Radiological Criteria for License Termination,*" dated July 1997

7.8 10 CFR 50.82, "*Termination of License*"

THIS SPACE INTENTIONALLY LEFT BLANK

PROPOSED LICENSE CHANGE

New License Condition 2.C.21 is proposed as follows:

1. License Termination Plan (LTP)

   NRC License Amendment No. 262 approves the LTP. In addition to the criteria specified in 10 CFR 50.59 and 10 CFR 50.82(a)(6), a change to the LTP requires prior NRC approval if the change:

   (a) Increases the probability of making a Type I decision error above the level stated in the LTP

   (b) Increases the radionuclide-specific derived concentration guideline levels (DCGL) and related minimum detectable concentrations

   (c) Increases the radioactivity level, relative to the applicable DCGL, at which investigation occurs

   (d) Changes the statistical test applied other than the Sign Test or Wilcoxon Rank Sum Test.

   (e) Results in significant environmental impacts not previously reviewed.

   Reclassification of survey areas from a less to a more restrictive classification (e.g., from a Class 3 to a Class 2 area) may be done without prior NRC notification; however, reclassification to a less restrictive classification (Class 1 to Class 2 area) will require NRC notification at least 14 days prior to implementation.

THIS SPACE INTENTIONALLY LEFT BLANK

Enclosure 3

Crystal River Nuclear Power Station

License Termination Plan

BEGINS ON NEXT PAGE

Crystal River Unit 3 Nuclear Generating Plant
License Termination Plan

Revision 0
September 2022

Prepared by:

ADP CR3, LLC
15760 West Power Line Street
Crystal River, FL 34428

Created: September 2022

Crystal River Unit 3 Nuclear Generating Plant License Termination Plan

CR3 LTP Revision 0

Originated by: ______________________
Martin Erickson, FSS/LTP Consultant

Originated by: ______________________
Marshall H Blake, FSS Engineering Supervisor

Reviewed by: ______________________
John Jernigan, D&D Licensing Manager

Reviewed by: ______________________
Bryant Akins, Radiation Protection Manager

Approved by: ______________________
Billy Reid, Site Executive

ADP CR3, LLC
15760 West Power Line Street
Crystal River, FL 34428

Created: September 2022

EXECUTIVE SUMMARY

The CR3 LTP describes the process used to meet the requirements for partial termination of the 10 CFR Part 50 license and to release the site for unrestricted use. The LTP has been prepared in accordance with the requirements in 10 CFR 50.82(a)(9) and is submitted as a proposed supplement to the DSAR. The LTP submittal is accompanied by a proposed license amendment that establishes the criteria for when changes to the LTP require prior NRC approval.

On January 22, 2019, CR3 submitted a Partial Site Release request with the NRC to reduce the licensed footprint by releasing 3,854 acres of the non-impacted areas from the 4,738-acre site per 10 CFR 50.83. The NRC approved the release of the Phase I non-impacted areas. The new ~884-acre site, will also be phase released starting with Phase II which consist of ~550 acres. There will be one or more additional Phases as the decommissioning progresses.

The Florida Department of Environmental Protection issued a letter to CR3 dated February 15, 2019 on the Decommissioning End State Conditions. The following is a summary of those conditions:

- 25 mrem/year criteria dose limit for release of the site for unrestricted use
- Removal depth of subsurface structures to a resulting depth of three feet below final grade
- Allow usage of clean concrete from the demolition process and specifies that the final cover shall consist of 24-inch-thick soil layer, as well as other requirements such as associated grading and side slope requirements.

The chapters below provide a summary of the chapters of the LTP.

1. General Information – Provides a general description of the site to include:
    - Site location
    - Meteorology and climatology
    - Geology and seismology
    - Surface and groundwater hydrology
    - Environs and Natural Resources, and
    - Operational background
2. Site Characterization - LTP Chapter 2 discusses the site characterization that has been conducted to determine the extent and range of radioactive contamination on site prior to remediation, including structures that will remain at the time of license termination, soils, and ground water.
3. Identification of Remaining Site Dismantlement Activities - LTP Chapter 3 identifies the remaining site dismantlement and decontamination activities.
4. Remediation Plans - LTP Chapter 4 discusses the various remediation techniques that may be used during decommissioning to reduce residual contamination to levels that comply with the release criteria in 10 CFR 20.1402. This chapter also discusses the ALARA evaluation and the impact of remediation activities on the Radiation Protection Program.

5. Final Status Survey Plan - LTP Chapter 5 presents the Final Status Survey (FSS) Plan which will be used to develop the site procedures, survey packages and instructions to perform the FSS of the CR3 site. The FSS Plan describes the final survey process used to demonstrate that the CR3 facility and site comply with radiological criteria for unrestricted use specified in 10 CFR 20.1402 (i.e. annual dose limit of 25 mrem plus ALARA for all dose pathways).
6. Compliance with the Radiological Criteria for License Termination - LTP Chapter 6 presents the radiological information and methods used to demonstrate compliance with the radiological criteria for license termination and release of the site for unrestricted use.
7. Update of the Site-Specific Decommissioning Costs - LTP Chapter 7 provides an updated estimate of the remaining decommissioning costs for releasing the site for unrestricted use. This chapter also compares the estimated remaining cost with the funds currently available in the decommissioning trust fund.
8. Supplement to the Environmental Report - LTP Chapter 8 updates the environmental report for CR3 with new information and any significant environmental impacts associated with the site's decommissioning and license termination activities. This section of the LTP is prepared pursuant to 10 CFR 51.53(d) and 10 CFR 50.82(a)(9)(ii)(G).

THIS SPACE INTENTIONALLY LEFT BLANK

Terms and Acronyms

action level - The numerical value that will cause the decision maker to choose one of the alternative actions. It may be a regulatory threshold standard (e.g., Maximum Contaminant Level for drinking water), a dose- or risk-based concentration level (e.g., DCGL), or a reference-based standard.
ADP - Accelerated Decommissioning Partners
AF - Area Factor
AL - ALARA action Level
ALARA - "As Low As Reasonably Achievable," which means making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical.
alpha (α) - The specified maximum probability of a Type I error. This means the maximum probability of rejecting the null hypothesis when it is true. Alpha is also referred to as the size of the test. Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis.
ANL - Argonne National Laboratory
area of elevated activity - An area over which residual radioactivity exceeds a specified value $DCGL_{EMC}$
beta (β) - The probability of a Type II error, i.e., the probability of accepting the null hypothesis when it is false. The complement of beta (β) is referred to as the power of the test.
bgs - below grade surface
CFR - Code of Federal Regulations
characterization survey - A type of survey that includes facility or site sampling, monitoring, and analysis activities to determine the extent and nature of contamination. Characterization surveys provide the basis for acquiring necessary technical information to develop, analyze, and select appropriate cleanup techniques.
Class 1 area - An area that is projected to require a Class 1 final status survey.
Class 1 survey - A type of final status survey that applies to areas with the highest potential for contamination and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support reclassification as Class 2 or Class 3.
Class 2 area - An area that is projected to require a Class 2 final status survey.
Class 2 survey - A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.
Class 3 area - An area that is projected to require a Class 3 final status survey.
Class 3 survey - A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.
classification - The act or result of separating areas or survey units into one of three designated classes: Class 1 area, Class 2 area, or Class 3 area.
CoC - Chain of Custody refers to an unbroken trail of accountability to ensure the physical security of samples, data, and records.
conceptual site model - A description of a site and its environs and presentation of hypotheses regarding the contaminants present, their routes of migration, and their potential impact on sensitive receptors.
confirmatory survey - This is a type of survey that includes limited independent (third-party) measurements, sampling, and analyses to verify the findings of a final status survey.

control charts - A plot of the results of a quality control action that demonstrates control is being maintained within expected statistical variation or to indicate when control is or may be lost unless intervention occurs.

controlled area – as defined in the updated PSDAR controlled area is defined as the area within the current license boundary

cpm - counts per minute

CR3 - Crystal River Unit 3 Nuclear Generating Plant

CREC - Crystal River Energy Complex

critical group - The average group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

D&D - Decontamination & Decommissioning

Data Quality Assessment (DQA) - The scientific and statistical evaluation of data used to determine if the data are of the right type, quality, and quantity to support their intended use.

Data Quality Objective (DQO) - Qualitative and quantitative statements derived from the DQO process that clarify technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

DCF - Dose Conversion Factor

DCGL - Derived Concentration Guideline Level

$DCGL_{EMC}$ - A DCGL scaled, through the use of area factors, to obtain a DCGL that represents the same dose to an individual for residual radioactivity in a smaller area within a survey unit.

$DCGL_W$ - A DCGL for the average residual radioactivity in a survey unit. If there is no subscript associated with DCGL then it is understood to mean $DCGL_W$.

DECON - A method of decommissioning, in which structures, systems, and components that contain radioactive contamination are removed from a site and safely disposed at a commercially operated low-level waste disposal facility or decontaminated to a level that permits the site to be released for unrestricted use shortly after it ceases operation.

DEF - Duke Energy of Florida

delta (δ) - The amount that the distribution of measurements for a survey unit is shifted to the right of the distribution of measurements of the reference area. This term is used in the evaluation of elevated areas.

delta (Δ) - The width of the gray region. Δ divided by σ, the arithmetic standard deviation of the measurements, is the relative shift expressed in multiples of standard deviations.

Derived Concentration Guideline Levels (DCGLs) - Derived radionuclide specific activity concentration that corresponds to the release criterion (25 mrem/y) within a survey unit.

dpm - Disintegrations Per Minute

DQO - Data Quality Objective

DRP - Discrete Radioactive Particles

DSAR - Defueled Safety Analysis Report

Elevated Measurement Comparison (EMC) - This comparison is used to determine if there are any measurements that exceed a specified value $DCGL_{EMC}$.

EPA - U.S. Environment Protection Agency

ETD - Easy to detect (for this purpose, nuclides that are detectable by gamma analysis)

exposure scenario - A description of the future land uses, human activities, and behavior of the natural system as related to a future human receptor's interaction with (and therefore exposure to) residual radioactivity. In particular, the exposure scenario describes where humans may be exposed to residual radioactivity in the environment, what exposure group habits determine exposure, and how residual radioactivity moves through the environment.

ft^3 - cubic foot

FGEIS - Final Generic Environment Impact Statement

FGR - Federal Guidance Report

fluence rate - A fundamental parameter for assessing the level of radiation at a measurement site. In the case of in situ spectrometric measurements, a calibrated detector provides a measure of the fluence rate of primary photons at specific energies that are characteristic of a particular radionuclide.

FSS - Final Status Survey is measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release.

GEIS - Generic Environmental Impact Statement

gross activity DCGLs - DCGLs established, based on the representative radionuclide mix, for gross (non-radionuclide-specific) alpha/beta surface radioactivity measurements. Field assessments will typically consist of these gross radioactivity measurements.

GTCC - Greater Than Class C

Historical Site Assessment (HSA) - The identification of potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information for the purpose of classifying a facility or site, or parts thereof, as impacted, or non-impacted.

HPGe - High Purity Germanium

HTD - Hard to detect (for this purpose, nuclides that are not detectable by gamma analysis).

hypothesis - An assumption about a property or characteristic of a set of data under study. The goal of statistical inference is to decide which of two complementary hypotheses is likely to be true. The null hypothesis (H_0) describes what is assumed to be the true state of nature and the alternative hypothesis (H_a) describes the opposite situation.

impacted area - Any area that is not classified as non-impacted. Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.

Investigation level - A derived media-specific, radionuclide-specific concentration or activity level of radioactivity that: 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded.

independent assessment - An assessment performed by a qualified individual, group, or organization that is not part of the organization directly performing and accountable for the work being assessed.

indistinguishable from background - The term indistinguishable from background means that the detectable concentration distribution of a radionuclide is not statistically different from the background concentration distribution of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

inspection - An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic.

ISFSI - Independent Spent Fuel Storage Installation

judgmental measurement/biased measurement - A measurement performed at locations selected using professional judgment based on unusual appearance, location relative to known contaminated areas, high potential for residual radioactivity, general supplemental information, etc. Judgmental measurements are not included in the statistical evaluation of the survey unit data because they violate the assumption of randomly selected, independent measurements. Instead, judgmental measurements are individually compared to the DCGL.

LA - License Amendment

LAR - License Amendment Request

LHS - Latin Hypercube Sampling

LLD - Lower Limit of Detection

LLRW - Low-level Radioactive Waste

LLW - Low-level Waste

lower bound of the gray region (LBGR) - Refers to the minimum value of the gray region. The width of the gray region (DCGL-LBGR) is also referred to as the shift, Δ.

LTP - License Termination Plan

m^2 - square meter

m^3 - cubic meter

MARSSIM - The Multi-Agency Radiation Site Survey and Investigation Manual (NUREG-1575) is a multi-agency consensus manual that provides information on planning, conducting, evaluating, and documenting building surface and surface soil final status radiological surveys for demonstrating compliance with dose- or risk-based regulations or standards.

MCL - Maximum Contaminant Level

MDC - Minimum Detectable Concentration

MDCR - Minimum Detectable Count Rate

measurement - For the purpose of MARSSIM, the term is used interchangeably to mean:

(1) The act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated or,

(2) The quantity obtained by the act of measuring.

minimum detectable concentration (MDC) - The minimum detectable concentration (MDC) is the *a priori* activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The *MDC* is the detection limit, L_D, multiplied by an appropriate conversion factor to give units of activity.

minimum detectable count rate (MDCR) - The minimum detectable count rate is the a priori count rate that a specific instrument and technique can be expected to detect.

mrem/y (millirem per year) - One one-thousandth (0.001) of a rem per year.

NAVD88 - North American Vertical Datum 1988

NEI - Nuclear Energy Institute

NIST - National Institute of Standards and Technology

non-impacted Area - An area where there is no reasonable possibility (extremely low probability) for residual radioactivity to exist.

nonparametric test - A test based on relatively few assumptions about the exact form of the underlying probability distributions of the measurements. Consequently, nonparametric tests are generally valid for a fairly broad class of distributions. The Wilcoxon Rank Sum test and the Sign test are examples of nonparametric tests.

NRC - Nuclear Regulatory Commission

Null Hypothesis (H_0) - A statistical scenario set up to be nullified, refuted, or rejected (disproved statistically) in order to demonstrate compliance with the release criteria.

ODCM - Offsite Dose Calculation Manual

power (1-β) - This term refers to the probability of rejecting the null hypothesis when it is false. The power is equal to one minus the Type II error rate, i.e. (1- β).

PRCC - Partial Rank Correlation Coefficient

precision - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions, expressed generally in terms of the standard deviation.

probabilistic - Refers to computer codes or analyses that use a random sampling method to select parameter values from a distribution. Results of the calculations are also in the form of a distribution of values. The results of the calculation do not typically include the probability of the scenario occurring.

PSDAR - Post-Shutdown Decommissioning Activities Report

PWR - Pressurized light-Water Reactor

QA - Quality Assurance

QAPP - Quality Assurance Project Plan

QC - Quality Control

RA - Restricted Area

RASS - Remedial Action Support Survey, evaluates the effectiveness of remediation efforts, determine when a site or survey unit is ready for FSS, and/or provide updated estimates of site-specific parameters used for planning the FSS. Commonly known as Turnover Survey.

RCA - Radiological Control Area

reference area - Geographical area from which representative reference measurements are performed for comparison with measurements performed in specific survey units at remediation site. A site radiological reference area (background area) is defined as an area that has similar physical, chemical, radiological, and biological characteristics to the site area being remediated, but which has not been contaminated by site activities. The distribution and concentration of background radiation in the reference area should be the same as that which would be expected on the site if that site had never been contaminated. More than one reference area may be necessary for valid comparisons if a site exhibits considerable physical, chemical, radiological, or biological variability.

reference coordinate system - A grid of intersecting lines referenced to a fixed site location or benchmark. Typically, the lines are arranged in a perpendicular pattern dividing the survey location into squares or blocks of equal areas. Other patterns include three-dimensional and polar coordinate systems.

relative shift (Δ/σ) - Δ divided by σ, the standard deviation of the measurements.

release criterion - A regulatory limit expressed in terms of dose or risk.

REMP - Radiological Environmental Monitoring Program

replicate - A repeated analysis of the same sample or repeated measurement at the same location. Also commonly known as recount.

RESRAD ONSITE Code - A computer code developed by the U.S. Department of Energy and designed to estimate radiation doses and risks from RESidual RADioactive materials in soils.

RESRAD-BUILD Code - A computer code developed by the U.S. Department of Energy and designed to estimate radiation doses and risks from RESidual RADioactive materials in BUILDings.

restricted area - Any area to which access is limited by a licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

SAFSTOR - is a nuclear decommissioning method in which a nuclear power plant or facility governed by the United States Nuclear Regulatory Commission, is "placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use".
scanning - An evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation.
SCM - Site Conceptual Model (same as Conceptual)
scoping survey - An initial survey performed to evaluate: 1) radionuclide contaminants, 2) relative radionuclide ratios, and 3) general levels and extent of contamination.
Sign test - A nonparametric statistical test used to demonstrate compliance with the release criterion when the radionuclide-of-interest is not present in background or present in a small fraction of the DCGL, and the distribution of data is not symmetric.
single nuclide DCGL - A radionuclide-specific activity concentration that would result in an annual total effective dose equivalent (TEDE) of 25 mrem with no other radionuclides present.
source term - All residual radioactivity remaining at the *site*, including material released during normal operations, inadvertent releases, or accidents, and that which may have been buried at the site in accordance with 10 CFR Part 20.
split sample - A sample that has been homogenized and divided into two or more aliquots for subsequent analysis.
subsurface soil sample - A soil sample that reflects the modeling assumptions used to develop the DCGL for subsurface soil activity. An example would be soil taken deeper than 15 cm below the soil surface.
surface soil sample - A soil sample that reflects the modeling assumptions used to develop the DCGL for surface soil activity. An example would be soil taken from the first 15 cm of surface soil.
survey - A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.
survey area - An area established and classified based on a common radiological history, logical physical boundaries, and site landmarks for the purpose of documenting and conveying radiological information.
survey area report - A report including all the survey units within a survey area providing a complete and unambiguous record of the radiological status of each survey unit relative to the established DCGLs.
survey package - A document developed by the DQO process providing the methodology by which to perform the final status survey.
survey unit - A geographical area consisting of structures or land areas of specified size and shape at a site for which a separate decision will be made as to whether or not the unit attains the site-specific reference-based cleanup standard for the designated pollution parameter.
systematic error - An error of observation based on system faults which are biased in one or more ways, e.g., tending to be on one side of the true value more than the other.
TBD - Technical Basis Document
technical review - A documented critical review of work that has been performed within the state of the art. The review is accomplished by one or more qualified reviewers who are independent of those who performed the work but are collectively equivalent in technical expertise to those who performed the original work. The review is an in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification or validation for applicability, correctness, adequacy, completeness, and assurance, that established requirements are satisfied.

TEDE - (Total Effective Dose Equivalent) - The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (CEDE) (for internal exposures).

triangular sampling grid - A grid of sampling locations that is arranged in a triangular pattern.

turnover survey - A final operational radiological survey performed by the Radiation Protection (RP) Department after the completion of decommissioning activities in an area to verify that the area is ready for Final Status Survey.

Type I decision error - A decision error that occurs when the null hypothesis is rejected when it is true. The probability of making a Type I decision error is called alpha (α).

Type II decision error - A decision error that occurs when the null hypothesis is accepted when it is false. The probability of making a Type II decision error is called beta (β).

unity rule - A rule applied when more than one radionuclide is present at a concentration that is distinguishable from background and where a single concentration comparison does not apply. In this case, the mixture of radionuclides is compared against default concentrations by applying the unity rule. This is accomplished by determining: (1) the ratio between the concentration of each radionuclide in the mixture, and (2) the concentration for that radionuclide in an appropriate listing of default values. The sum of the ratios for all radionuclides in the mixture should not exceed 1.

unrestricted area - Any area where access is not controlled by a licensee for purposes of protection of individuals from exposure to radiation and radioactive materials including areas used for residential purposes.

unrestricted release - Release of a site from regulatory control without requirements for future radiological restrictions. Also known as unrestricted use.

VSP - Visual Sample Plan software used for plotting sample/measurement locations.

Wilcoxon Rank Sum (WRS) test - A nonparametric statistical test used to demonstrate compliance with the release criterion when the radionuclide-of-interest is present in background.

W_r - This represents the sum of the ranks of the adjusted measurements from the reference area, used as the test statistic for the Wilcoxon Rank Sum test.

W_s - The sum of the ranks of the measurements from the survey unit, used with the Wilcoxon Rank Sum test.

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

1.1 Description of the CR3 and Surrounding Areas.

1.1.1 Crystal River Unit 3 Nuclear Generating Plant (CR3) Site [NUREG-1700, Revision 2, Appendix A, Section A.1]

CR3 is part of the larger Crystal River Energy Complex (CREC), which is located on the Gulf of Mexico in Citrus County, Florida at 15485 West Powerline Street, Crystal River Florida, 34428. License Number: DPR-72, Docket Number: 50-302. Duke Energy of Florida (DEF) is the owner of the complex with Accelerated Decommissioning Partners, LLC (ADP) assuming control of CR3.

This site's location is approximately 7.5 miles northwest of the City of Crystal River, and 70 miles north of Tampa. In addition to CR3, other structures on the CREC include two fossil-fueled units, two large cooling towers, parking lots, coal delivery and storage areas, ash storage area, office buildings, warehouses, barge handling docks, and a railroad. Additionally, located outside the licensed footprint is two newly constructed Gas Combined Cycle units which were added to the CREC. CR3 uses approximately 27 acres of previously disturbed land within the 1,062-acre developed portion of the 4,738-acre CREC site.

There are no public access roads to areas adjacent to the plant site apart from the plant access road. Approximately four miles east of the plant, a dirt road crosses the site access road. The north and south side boundaries are bordered by woods and swamps and are generally inaccessible.

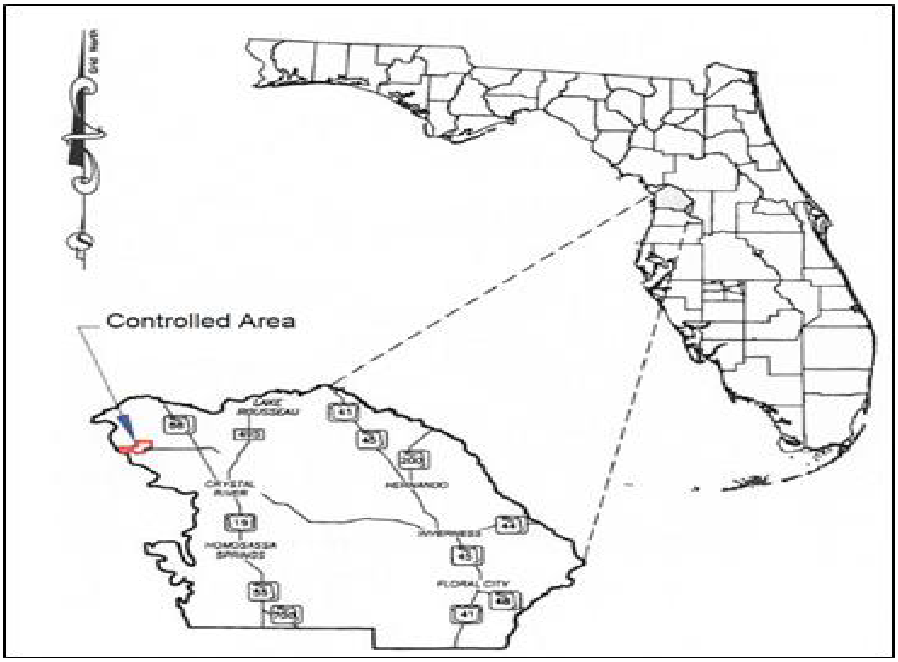
The Crystal River is located due south of the site and is used for commercial fishing and pleasure craft. Directly west of the plant is the Gulf of Mexico, from which the Crystal River plant site historically received its condenser cooling water. Fishing and pleasure craft have unrestricted access to the Gulf waters.

Company property extends to the Gulf of Mexico. Small crafts are prevented from entering the discharge canal by a blockade at the bulkhead line. This blockade was installed for safety concerns due to increased water turbulence caused by the mixing of reintroduced water to the canal from the helper cooling towers. DEF and ADP CR3 have no legal rights to any appurtenant structures which extend into the Gulf beyond the bulkhead line described previously.

The REMP program has 13 groundwater wells in a circle around the retricted area. There is also one control well loccated 3.7 miles east of the plant that is part of the REMP program. The wells are sampled and analyzed for tritium, hard-to-detect and gamma radionuclides as per site procedures.

There are three offsite drinking water wells that are also sampled quarterly for the same parameters. The drinking water wells are located: (1) ESE 7.4 miles from the facility, (2) ESE 6.0 miles from the facility, and (3) N 5.3 miles from the facility. (Reference 1-11) "*Groundwater Protection – Data Collection Questionnaire*", dated July 2006. CR3 is located at latitude 28° 57' 25.87" north and longitude 82° 41' 55.95" west. The CR3 Site Boundary is depicted in Figure 1-1.

Figure 1-1 CR3 Site Location



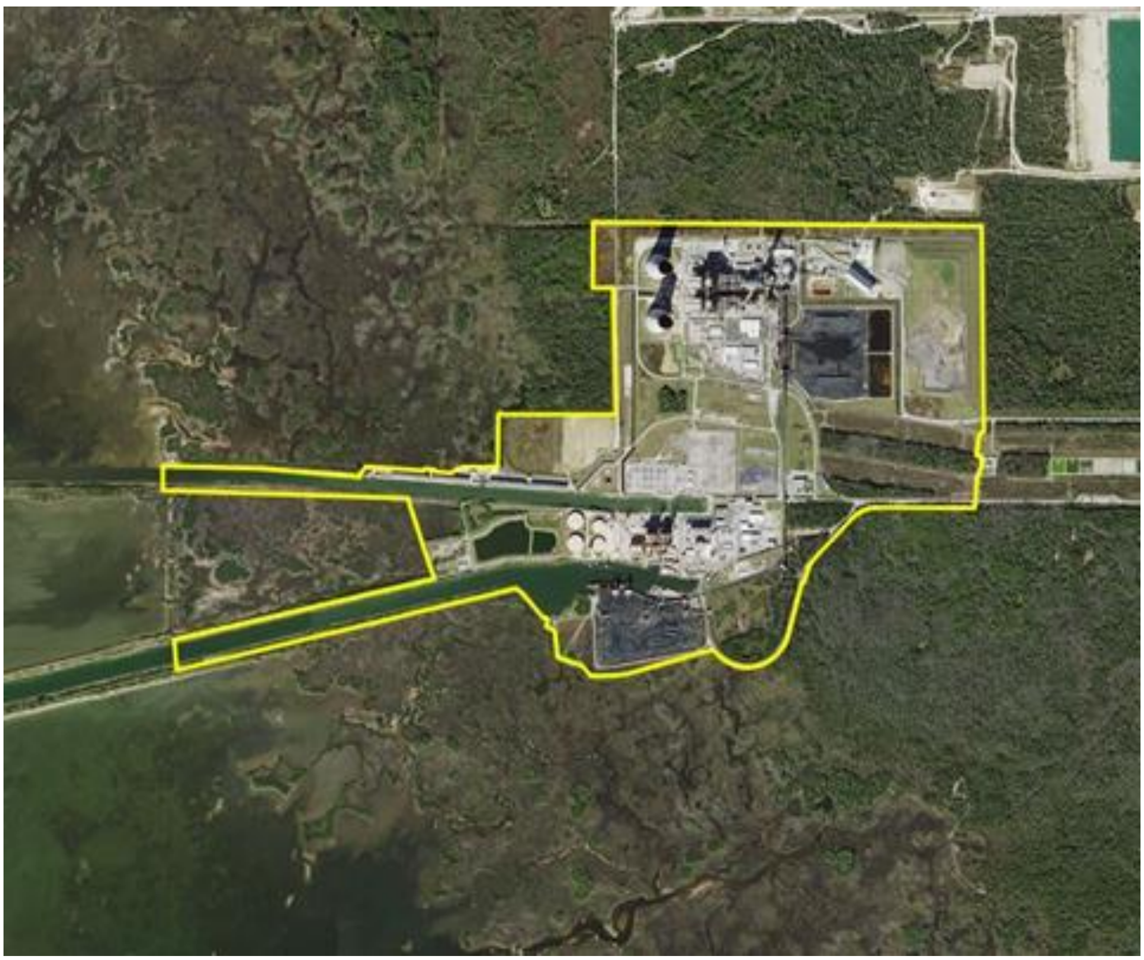
1.2 Historical Information
[NUREG-1700, Revision 2, Appendix A, Section A.1]

CR3 is a single unit pressurized light-water reactor (PWR) supplied by Babcock & Wilcox. CR3 was initially licensed to operate at a maximum of 2,452 megawatt-thermal (MWt). In 1981, 2002, and 2007, the Nuclear Regulatory Commission (NRC) approved three DEF requests to increase the licensed core power level to a maximum power level of 2,609 MWt. The reactor containment structure is a steel-lined, reinforced-concrete structure in the shape of a cylinder and capped with a shallow dome. The walls of the containment structure are approximately 3.5 feet thick. During operation, cooling water for CR3 was drawn from and returned to the Gulf of Mexico.

CR3 last produced power in September 2009, while shutting down for Refuel 16. During activities to replace steam generators, a portion of the containment concrete wall delaminated. While completing repairs additional delamination occurred. CR3 was officially retired on February 5, 2013.

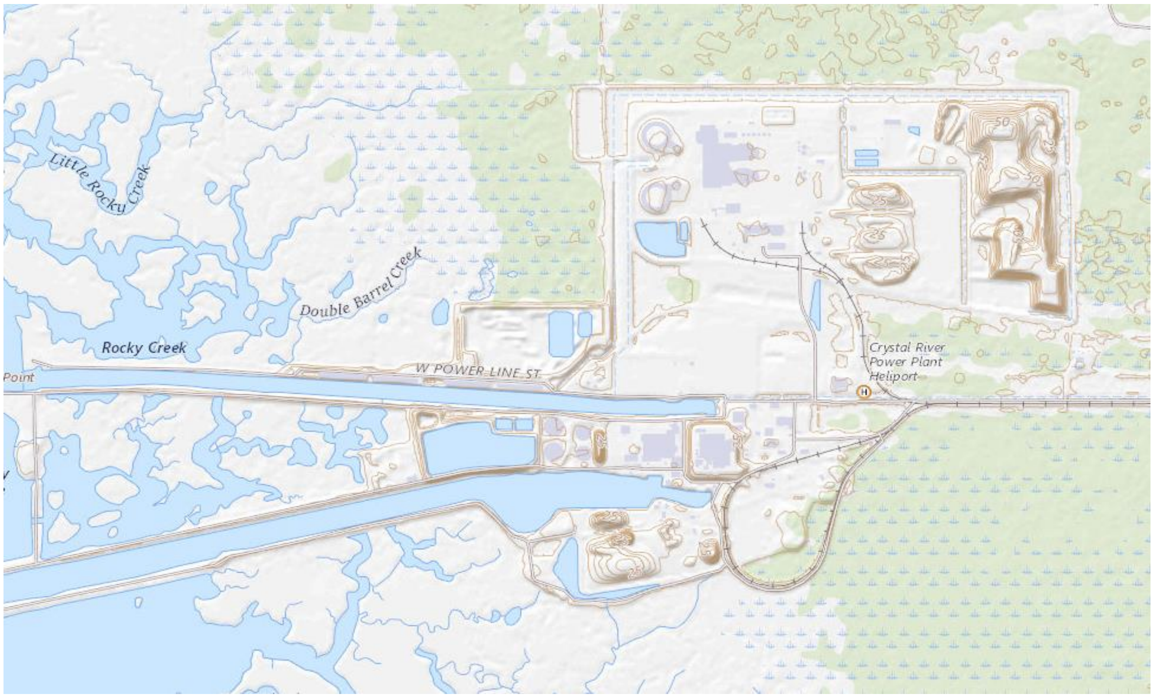
On January 22, 2019, CR3 submitted a Partial Site Release request with the NRC to reduce the licensed footprint by releasing 3,854 acres of the "non-impacted" areas from the 4,738-acre site per 10 CFR 50.83, Release of Part of a Power Reactor Facility or Site for Unrestricted Use (ADAMS Accession No. ML19022A076). As documented in NRC to CR3 letter dated January 2, 2020 (ADAMS Accession No. ML19339G509), the NRC approved the release of the non-impacted areas. The new ~884-acre Site, also referred to as the Controlled Area and defined by the new Site Boundary is depicted in Figure 1-2.

Figure 1-2 ~884 Acre Site Map



On April 1, 2020, the NRC approved transfer of CR3 from Duke Energy Florida, LLC (DEF) to ADP CR3, LLC (ADP CR3) to commence decontamination, dismantlement, and demolition (ADAMS Accession No. ML20069A023). On October 1, 2020, closing took place and ADP CR3 became the Facility Licensee and the updated PSDAR became effective changing the plant decommissioning strategy from SAFSTOR to DECON. A topo map of the CR3 area is shown in Figure 1-3 below.

Figure 1-3 CR3 Topo Map



1.3 Plan Summary

1.3.1 General Information
[NUREG-1700, Revision 2]

This License Termination Plan (LTP) has been prepared by ADP CR3 in accordance with the requirements of 10 CFR 50.82(a)(9). The LTP is being maintained as a supplement to the CR3 DSAR to support the application for a license amendment to meet 10 CFR 50.82(a)(9) and 10 CFR 50.90. Each of the CR3 LTP chapters required by 10 CFR 50.82(a)(9) are outlined in the subsections below.

1.3.2 HSA and Site Classification
[NUREG-1700, Revision 2, Appendix A, Section A.2]

The objectives of the site classification are:

1. To divide the site into survey areas for classification purposes,
2. To identify the potential and known sources of radioactive contamination in systems, on structures, in surface or subsurface soils, and in groundwater,
3. To determine the initial classification of each survey area, and
4. To develop the information to support Final Status Survey design including instrument performance standards and quality requirements.

The site classification is based upon the Historical Site Assessment (HSA). The HSA consisted of a review and compilation of the following types of information: historical records, plant and radiological incident files, operational survey records, and annual environmental reports to the NRC. Personnel interviews were conducted with present and former plant employees and contractors to obtain additional information regarding operational events that may have caused contamination in areas or systems not designed to contain radioactive or hazardous materials.

Information from previous surveys, including those in support of the previous Partial Site Release campaign, was reviewed for radiological conditions throughout the site. The radiological data collected during this process provide a basis for developing plans for remediation and Final Status Surveys. Operational radiation surveys and additional measurements and samples obtained during decommissioning activities will be used to confirm the area classification and effectiveness of the cleanup activities before completing the Final Status Survey.

As a result of the HSA, and site classification, approximately 4404 acres of the 4738-acre plant site has been identified as “non-impacted” as defined in MARSSIM. Upon review of the HSA and further review of the data collect during the Site Characterization, RP surveys, and interviews with the RPM the “SeaLand Container Storage Area” is being changed from a MARSSIM Class 3 to a non-impacted area.

1.3.3 Identification of Remaining Site Dismantlement Activities [NUREG-1700, Revision 2, Appendix A, Section A.3]

Following the preparations for decommissioning, physical decommissioning activities will take place. This includes the removal and disposal of contaminated and activated components and structures, leading to the termination of the 10 CFR 50 operating license. Physical decommissioning activities are currently taking place at CR3.

Although much of the radioactivity has decreased during the dormancy period due to decay of short-lived radionuclides, the internal components of the reactor vessel still exhibit high radiation dose rates that require remote sectioning under water. Portions of the biological shield wall may also be radioactive due to the presence of activated trace elements with longer half-lives (such as Eu-152 and Eu-154).

It is assumed that radioactive contamination on structures, systems, and component surfaces will not have decayed to levels that will permit unrestricted release. These surfaces will be surveyed, and items dispositioned in accordance with the existing radioactive release criteria.

Significant decommissioning activities in this phase include:

- Reconfiguration and modification of site structures and facilities, as needed, to support decommissioning operations. Modifications may also be required to the reactor or other buildings to facilitate movement of equipment and materials, support the segmentation of the reactor vessel and reactor vessel internals, and for large component removal,
- Design and fabrication of temporary and longer-term shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling,
- Procurement or leasing of shipping cask, cask liners, and industrial packages for the disposition of low-level radioactive waste (LLRW),
- Decontamination of components and piping systems, as required, to control (minimize) worker exposure,
- Disposition of systems and components,
- Removal of the reactor coolant pumps and associated piping for controlled disposal,
- Contaminated material will be characterized and segregated for additional offsite processing (disassembly, chemical cleaning, volume reduction, and waste treatment), and/or packaged for controlled disposal at a low-level radioactive waste disposal facility,
- Disassembly and segmentation of the reactor vessel internals. This will involve the use of remotely operated equipment within the reactor cavity filled with water. The cavity water level will need to be maintained to maximum extent possible during the work to maintain area dose rates ALARA. Some of this material will exceed Class C disposal requirements and will be packaged for transfer to the ISFSI facility where it will be stored.
- Segmentation of the reactor vessel, like the internals, may involve the use of remotely operated equipment,
- Removal of the steel liners from the refueling pool and spent fuel pool, disposing of the activated and/or contaminated sections as radioactive waste,
- Disposition of the activated and contaminated portions of the concrete biological shield and contaminated concrete surfaces that exceed the release criteria,
- Material likely to be free of contamination may be surveyed and released for unrestricted disposition, e.g., as scrap, recycle, or general disposal, or sent to an off-site NRC / Agreement State licensed processor for radiological evaluation and appropriate disposition,
- Remediation of contaminated surface soil or sub-surface media will be performed as necessary to meet the unrestricted use criteria in 10 CFR 20.1402, and

- Underground piping (or comparable items) and associated soil will be removed as necessary to meet license termination criteria.

Debris may be surveyed using site procedures and in accordance with the "no detectable radioactivity" criterion (consistent with the guidance in NRC Circular IEC 81-07, *"Control of Radioactively Contaminated Material*") or may be subjected to a final status survey using the DCGLs, as discussed in Chapter 6 of this LTP. Materials meeting the NRC Circular IEC 81-07 criterion may remain onsite and may be used as backfill or removed offsite for disposal.

1.3.4 Site Remediation Plans
[NUREG-1700, Revision 2, Appendix A, Section 2.4]

Chapter 4 of the LTP describes various methods that can be used during CR3 decommissioning to reduce radioactivity to levels meeting the NRC radiological release criteria. This means that levels of radioactivity will not exceed 25 mrem/yr Total Effective Dose Equivalent (TEDE) and will be as low as reasonably achievable (ALARA). This chapter describes the methodology that will be used to demonstrate that the residual radioactivity has been reduced to levels in compliance with the NRC requirements.

1.3.5 Final Status Survey Plan
[NUREG-1700, Revision 2, Appendix A, Section 2.5]

The primary objectives of the Final Status Survey are to:

- verify proper survey unit classification (or reclassify survey unit),
- demonstrate that the level of residual radioactivity for each survey unit is below the release criterion, and
- demonstrate that the potential doses from small areas of elevated activity are below the release criterion for each survey unit.

The purpose of the Final Status Survey Plan is to describe the methods that will be used in planning, designing, conducting, and evaluating Final Status Surveys at the CR3 site to demonstrate that the site meets the NRC's radiological criteria for unrestricted use.

Chapter 5 of the LTP describes the Final Status Survey Plan, which is consistent with the guidelines of MARSSIM. The plan also describes methods and techniques used to implement isolation controls that prevent re-contaminating previously remediated areas.

1.3.6 Compliance with the Radiological Criteria for License Termination [NUREG-1700, Revision 2, Appendix A, Section 2.6]

Chapter 6 together with Chapter 5, Final Status Survey Plan, describes the process that will be used to demonstrate that the CR3 site complies with the radiological criteria of 10 CFR 20.1402 for unrestricted use. ADP CR3 has selected the RESRAD-ONSITE computer code (Version 7.2) to model the dose from soils and volumetric concrete and its counterpart, RESRAD-BUILD (Version 3.5), to model the dose from structural surfaces.

Two scenarios have been selected for use with the RESRAD family of codes for calculating the radionuclide-specific derived concentration guideline levels (DCGLs). These scenarios are the resident farmer scenario for site soils and volumetric concrete. The building occupancy scenario is being used for surficial contamination in structures. DCGLs are the concentration and surface radioactivity limits that will be the basis for performing the Final Status Survey.

1.3.7 Update of the Site-Specific Decommissioning Costs [NUREG-1700, Revision 2, Appendix A, Section 2.7]

In accordance with 10 CFR 50.82 (a)(9)(ii)(F), Chapter 7 provides an updated, site-specific estimate of the remaining decommissioning costs. Chapter 7 also compares these estimated costs to the amount of funds presently set aside for decommissioning and describes the methods that will ensure sufficient funds for completing decommissioning.

1.3.8 Supplement to the Environmental Report [NUREG-1700, Revision 2, Appendix A, Section 2.8]

In accordance with 10 CFR 50.82 (a)(9)(ii)(G), Chapter 8 demonstrates that decommissioning activities will be accomplished with no significant adverse environmental impacts.

Supplement 1 to NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (FGEIS)" (Reference 1-9) provides an assessment of the aspects of decommissioning with the potential to affect the environment. This assessment includes an evaluation of the significance of the impact of the activity (SMALL, MODERATE, or LARGE), as well as its applicability (generic to all or to a group of plants or site-specific). Chapter 8 is focused on the evaluation of those aspects of decommissioning whose impacts could not be generically addressed (i.e., those determined to have site-specific impacts) and on whether remaining license termination activities and end use of the site are bounded by prior assessments.

1.4 Partial Site Release Process
[NUREG-1700, Revision 2, Appendix A, Section 2.1.1]

As discussed previously CR3 applied, and received approval, for a release of 3854 acres of non-impacted licensed property per 10 CFR 50.83(b). ADP CR3 anticipates that an additional 10 CRF 50.83(b) request will be submitted to the NRC for the remaining ~548 acres of non-impacted property as documented in the CR3 HSA(the size may change). Once an approval has been received, ADP CR3 will submit a License Amendment Request (LAR) requesting that all non-impacted property be removed from the CR3 license. ADP CR3 may choose to remove specific remaining areas from the license in a phased manner before license termination. The approach for phased release and removal from the license, after approval of the License Termination Plan, is as follows:

1. Following completion of decommissioning activities, CR3 will compile a report with the following information for NRC review:
    - A description and location of the survey unit or area being surveyed,
    - Certification that dismantlement/decommissioning activities, as described in the LTP, have been completed for the subject building or area,
    - An evaluation of the potential for possible recontamination of the area and a description of controls in place to prevent such recontamination,
    - Final Status Survey results for the survey unit or area, as demonstration of compliance with the LTP release criteria (not applicable to areas designated as "non-impacted"), and
    - Expected date of removal of the area from the 10 CFR 50 license.
2. CR3 will review and assess the impacts on the following programs and documents in preparation for removal of a survey unit or area from the license:
    - Defueled Safety Analysis Report and Technical Specifications,
    - Radiological Environmental Monitoring Program,
    - Offsite Dose Calculation Manual,
    - Defueled Emergency Plan,
    - Security Plan,
    - License Termination Plan,
    - Ground Water Monitoring Program,
    - 10 CFR 100 Siting Criteria, and
    - Decommissioning Environmental Report.

The reviews will include an assessment to ensure that the land area(s), and any associated building(s), to be released will have no adverse impact on the site's ability to meet Part 20, Subpart E, criteria for unrestricted release. The reviews will also include the impacts on the discharge of effluents and the limits of 10 CFR 20, as they pertain to the public.

1. A letter of intent to remove a portion of the property from the Part 50 license will be sent to the NRC, no later than sixty (60) days before the anticipated date for release of the subject survey area(s). This letter will contain a summary of the assessments performed, as described above, and, for areas designated as "impacted" will include the FSS report for the subject survey units(s) or area(s).
2. Once the land area(s), and any associated building(s), have been verified ready for release, no additional surveys or decontamination of the subject building or area will be required (beyond those outlined in Chapter 5 for isolation and controls) unless administrative controls to prevent recontamination are known or suspected to have been compromised. Following completion of the Final Status Survey and submittal of the associated report, the NRC will review the report and conduct, as appropriate, the applicable NRC confirmatory inspections.
3. Upon completion of the CR3 Decommissioning Project, a final report will be prepared to summarize the release of areas of the CR3 site from the 10 CFR 50 license.

1.5 Change Criteria for the License Termination Plan [10 CFR 50.71(e)]

ADP CR3 is submitting this License Termination Plan as a supplement to the DSAR. Accordingly, the License Termination Plan will be updated in accordance with 10 CFR 50.71(e). Once the LTP has been approved, the following change criteria will be used, in addition to those criteria specified in 10 CFR 50.59 and 10 CFR 50.82(a)(6). A change to the LTP requires NRC approval prior to being implemented if the change:

1. Increases the probability of making a Type I decision error above the level stated in the LTP
2. Increases the radionuclide-specific derived concentration guideline levels (DCGLs) and related minimum detectable concentrations
3. Increases the radioactivity level, relative to the applicable DCGL, at which investigation occurs
4. Changes the statistical test applied to one other than the Sign Test or Wilcoxon Rank Sum Test

Re-classification of survey areas from a less to a more restrictive classification (e.g., from a Class 3 to a Class 2 area) may be assigned without prior NRC notification; however, reclassification to a less restrictive classification (e.g., Class 1 to a Class 2 area) and/or subdivision of a survey area will require NRC notification at least 14 days prior to implementation.

1.6 License Termination Plan Information Contacts:

Contact 1
Billy Reid
NorthStar Vice President
15760 W Power Line St
Crystal River, FL, 34428

Contact 2
John Jernigan
Licensing Manager
15760 W Power Line Street
Crystal River, FL, 34428

Contact 3
Bryant Akins
Radiation Protection Manager
15760 W Power Line Street
Crystal River, FL, 34428

Contact 4
Martin Erickson
CR3 & VY FSS/LTP Consultant
15760 W Power Line St
Crystal River, FL, 34428

Contact 5
Marshall Blake
CR3 & VY FSS Engineering Supervisor
15760 W Power Line Street
Crystal River, FL, 34428

THIS SPACE INTENTIONALLY LEFT BLANK

1.7 References

1-1 Title 10 to the Code of Federal Regulations, Part 20.1402, *"Radiological criteria for unrestricted use."*

1-2 Title 10 to the Code of Federal Regulations, Part 50.82, *"Termination of license."*

1-3 Title 10 to the Code of Federal Regulations, Part 50.83, *"Release of part of a power reactor facility or site for unrestricted use."*

1-4 Title 10 to the Code of Federal Regulations, Part 50.90, *"Application for amendment of license, construction permit, or early site permit."*

1-5 Regulatory Guide 1.179, Revision 2, *"Standard Format and Content of License Termination Plans for Power Reactors,"* dated July 2019.

1-6 NUREG-1700, Revision 2, *"Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans,"* dated April 2018.

1-7 NUREG-1757, Volume 2, Revision 2, *"Consolidated NMSS Decommissioning Guidance,"* dated July 2022.

1-8 NUREG-1575, Revision 1, *"Multi-Agency Radiation Survey and Site Investigation Manual,"* Revision 1, dated August 2000.

1-9 Supplement 1 to NUREG-0586, *"Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities,"* dated November 2002.

1-10 CR3 PSDAR *"Post-Shutdown Decommissioning Activities Report,"* Revised June 2019.

1-11 "*Groundwater Protection – Data Collection Questionnaire*", dated July 2006.

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

2.0 SITE CHARACTERIZATION

2.1 Historical Site Assessment Summary [NUREG-1700, Revision 2, Appendix A, Section A.2]

2.1.1 Introduction

The Historical Site Assessment (HSA) (Reference 2-2) describes the site's physical configuration, identifies the radioactive constituents of the site contamination, assesses the migration of contaminants, identifies contaminated media, identifies non-impacted and impacted areas, and classifies impacted areas.

ADP-CR3 conducted the HSA of the Crystal River Nuclear Generating Station (CR3) site in accordance with the guidance of NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," (Reference 2-1) in support of the ultimate decommissioning and license termination of the facility. The HSA formally began in 2013, following several preliminary assessments of the impact of facility operations on the site. These preliminary assessments included interviewing current and former CR3 site personnel during the site inspection and via telephone communications. The HSA was formally compiled in 2016. Three addendums have since been added, one for characterization of groundwater for non-radiological contamination, one to document the removal of legacy large components stored outside of the Restricted Area and one for scoping survey of Coal Units 1&2 prior to demolition. An initial characterization survey was performed in 2020. The purpose of the HSA is to document a comprehensive investigation identifying, collecting, organizing, and evaluating historical information relevant to the ADP-CR3 site. The HSA focuses on open land areas and those structures that will remain at the time of FSS.

The HSA consisted of a review of the following items:

- Interviews of long tenured employees
- Records from the Florida Department of Environmental Protection (FDEP)
- Incident files (ARs, NCORs, PCs, etc.)
- Special survey and operational radiological survey records
- HP and Operator logs
- Reports of station inspections by American Nuclear Insurers (ANI)
- The CR3 file maintained in compliance with federal regulation 10 CFR 50.75(g), namely CR3 Procedure HPP0230
- The CR3 Offsite Dose Calculation Manual (ODCM), Rev. 36
- The CR3 Final Safety Analysis Report (FSAR), Rev. 35
- The CR3 Spill Prevention, Control and Countermeasures (SPCC) Plan
- The CR3 10 CFR 50.75(g) files

- The CR3 Storm Water Pollution Prevention Plan (SWPPP)
- The CR3 Annual Radioactive Effluent Release Reports and
- The CR3 Annual Radiological Environmental Monitoring Reports

Concurrent with the performance of the HSA was the initial segregation of the facility into individual specific, uniquely identified, survey areas. This provides the basis for development of area-specific site drawings and survey maps required to document the characterization, remediation, and final release survey process. A major output from the HSA process was the information used as the basis for the preliminary MARSSIM classifications of the initial survey areas.

The initial classification of the site areas was based on the historical information and site characterization data. Data from subsequent characterization may be used to change the original classification of an area up to the time of the FSS as long as the classification reflects the level of residual activity existing prior to any remediation in the area.

2.1.2 Objectives of the Historical Site Assessment

ADP-CR3 conducted the HSA of the CR3 site to meet the following objectives:

- Identify known and potential sources of radioactive material and radioactively contaminated areas, including systems, structures, and environmental media based on the investigation and evaluation of existing information.
- Identify radionuclides of concern.
- Identify areas of the site with no conceivable or likely potential for radioactive or hazardous materials contamination and assign a preliminary classification of Non-impacted while assigning a preliminary classification of Impacted to all remaining portions of the site.
- Develop the records to be used during the design of subsequent scoping, characterization, remediation, and the FSS.
- Provide preliminary information necessary to identify and segregate the site into survey areas evaluated against criteria specified in the MARSSIM guidelines for classification. This classification will designate the need for, and level of, remedial action required within a particular survey unit as well as the level of survey intensity required during the FSS.

2.2 Property Identification

Chapters 1 and 8 describe the ADP-CR3 site and environs.
[NUREG-1700, Revision 2, Appendix A, Section A.1]

2.2.1 HSA Methodology

[NUREG-1700, Revision 2, Appendix A, Section A.2]

2.2.1.1 Approach and Rationale

The primary objective of the HSA records search process was the identification of those events posing a significant probability of affecting the radiological characterization of the site. This included system, structure, or area contamination from system failures resulting in airborne releases, liquid spills or releases, or the loss of control over solid material management.

Each event identified that posed a realistic potential to impact the characterization of the site was further investigated. This investigation focused on the scope of the contaminant sampling and analysis, remedial actions taken to mitigate the situation, and any post-remedial action sampling, survey, and analysis in an attempt to identify the "as left" condition of the event location. The following items were included in the research associated with the development of the HSA:

- Relevant excerpts from written correspondences and reports
- Personnel interviews of current and former CR3 personnel employed during the time that Unit 3 was in operation
- Site inspection, using historical site drawings, photographs, prints, and diagrams to identify, locate, confirm, and document areas of concern

Information from this research was used in the HSA development, including the compilation of data, evaluation of results, documentation of findings, and the characterization and identification of survey areas.

2.2.1.2 Documents Reviewed

Records maintained to satisfy the requirements of 10 CFR Part 50.75(g)(1) (Reference 2-7) provided a major source of documentation for the HSA records review process.

Additional documents reviewed were (HSA Section 5.2):

- CR3 Radioactive Effluent Release Reports
- CR3 Annual Radiological Environmental Monitoring Reports

2.2.1.3 Site Reconnaissance

As allowed by MARSSIM Section 3.5, a formal site reconnaissance was not performed, based on the continuous occupancy of the site by the licensee, the detailed information available through the records and other documents, walkdowns and the personnel interviews performed.

Investigations were performed to verify locations and current conditions of questionable items or issues (radioactive liquid spills or spread of contamination) discovered during the review of historical records.

2.2.1.4 Personnel Interviews

Interviews of current or former long-time employees of CR3 were conducted during 2013 to 2015. The intent of the interviews was to provide a means of identifying areas where either radiological or non-radiological contamination may have occurred but that may not have been documented in plant records. Several station employees were consulted during the preparation of this HSA regarding information related to their work responsibilities and their recollection of historical contamination events that may have significance during plant decommissioning.

In general, results of the interviews corroborated information developed by record searches and plant tours and did not identify any Class 1 areas that had not been identified by other lines of investigation. A common comment was that interviewees were not aware of incidents that were not reported and recorded.

2.2.2 Operational History
[NUREG-1700, Revision 2, Appendix A, Section A.2]

2.2.2.1 Introduction

Construction of CR3 was authorized by the Atomic Energy Commission through issue of provisional construction permit CPPR-51 on September 25, 1968, in Docket 50-302. Construction of CR3 was completed and the operating license issued December 3, 1976. Fuel was loaded in 1976. CR3 last produced power in September 2009, while shutting down for Refuel 16. During activities to replace steam generators, a portion of the containment concrete wall delaminated. While completing repairs additional delamination occurred. CR3 was officially retired on February 5, 2013. In June 2019, ADP-CR3 issued a Revised Post Shutdown Decommissioning Activity Report (PSDAR). The plant is currently in DECON with active decommissioning activities ongoing. Table 2.1 summarizes the operational and post-operational history.

The protected area of the ISFSI, previously part of the plant protected area, was reduced to the ISFSI perimeter. The physical security plan and procedures were reviewed and modified, as necessary, to reflect spent fuel cask loading and transfer operations on site. After all spent fuel was moved to the ISFSI, the protected area security perimeter, fence, vehicle barrier, intrusion detection system, security plan, and procedures were modified, as required, to reflect that all nuclear material to be protected pursuant to 10 CFR 73.55 resides in the ISFSI.

LAR 321 was submitted to the NRC for these changes to the security plan. The NRC approved this change as Amendment No. 256. This is documented in the Crystal River Unit 3 Plant Operating Manual "*ISFS-212, ISFSI 10 CFR 72.212 REPORT*".

Table 2.1 Operational/Post-operational Chronological Summary

Construction Permit Issued:	September 25, 1968
Operating License Issued:	January 28, 1977
Commercial Operation:	March 13, 1977
Initial Operating License Expiration:	December 3, 2016
Final Reactor Shutdown:	September 26, 2009
Final Transfer of Fuel from Pool to ISFSI Pad	January 12, 2018

2.2.2.2 Regulatory Overview

NRC inspectors perform routine onsite inspection of ADP-CR3 site activities. The NRC is notified of any incidents onsite per the existing protocol established with NRC reporting regulations. The NRC headquarters reviews license amendment requests, exemption requests, and other submittals.

2.2.2.3 Waste Handling Procedures

The DSAR, Section 4.1, describes the systems and equipment for handling radioactive waste generated as a byproduct of prior plant operation and maintenance of the SFP. DSAR section 4.1 describes radioactive waste processing and disposal methods.

ADP-CR3 waste handling procedures are intended to contain, adequately treat, and dispose of these radioactive byproducts. The waste disposal system uses several basic methods to treat, and dispose of radioactive material:

- Package and shipment to a permitted disposal facility
- Filtration and ion exchange to remove radioactive constituents from liquids
- Dilution of low-activity liquid discharges and gaseous discharges

2.2.2.4 Current Site Usage

2.2.2.4.1 Description of Unit 3 Operations

Currently, site operations focus primarily on tasks and activities required to complete the dismantlement and decontamination of the facility.

2.2.2.4.2 Site Characterization

Characterizations of ADP-CR3 structures, soils, and sediments were performed on two separate occasions—one in 2020 and one in 2022. Section 2.3 explains the methodology employed for the characterization effort at ADP-CR3.

2.2.2.5 Radiological Sources

2.2.2.5.1 RA Contamination

All areas within the RA have been identified as having been radiologically affected by the operation of the facility, unplanned events, or subsequent decommissioning activities.

2.2.2.5.2 Areas Outside the RA Contamination

Areas outside the RA have been affected by radiological events, by the deposition of stack releases, or through routine radioactive effluent releases. The exception to these areas is identified in the HSA as non-impacted areas.

2.2.3 Event Descriptions
[NUREG-1700, Revision 2, Section 2.2]

Enclosure 14, Table 2.2 provided in the LAR list a summary of the 50.75(g) events.

2.3 Survey Unit Identification and Classification
[NUREG-1700, Revision 2, Appendix A, Section A.4]

2.3.1 Survey Areas

The entire CR3 site, except for the ISFSI, is divided into areas. Areas are typically larger physical sections of the site that may contain one or more survey units, depending on their classification. The ISFSI will remain under the Part 50 license until such time as the spent fuel is moved to a federal repository.

2.3.2 Survey Units

A Survey Unit is a physical area consisting of buildings, structures, or land areas of specifically defined shapes and sizes, for which a unique decision will be made regarding whether the presence of any residual radioactive material meets or exceeds the predetermined release criteria. A Survey Unit is a single contiguous area, where size is dependent upon its physical characteristics (open land vs. structural building) and radiological conditions, and where operational conditions are reasonably consistent with the exposure modeling used to determine the classification.

2.3.3 Initial Designation of Areas

Using reasonable and available physical and documented references, originally per the HSA, 14 areas were identified and assigned a unique Survey Area identification. Upon further review of the characterization data, the SeaLand Survey Area was reclassified as a non-impacted area and removed from this list (Reference 2-8). Current Survey Area designations are depicted in Figure 2-1 and summarized in Table 2.2.

Figure 2-1 Survey Area Locations

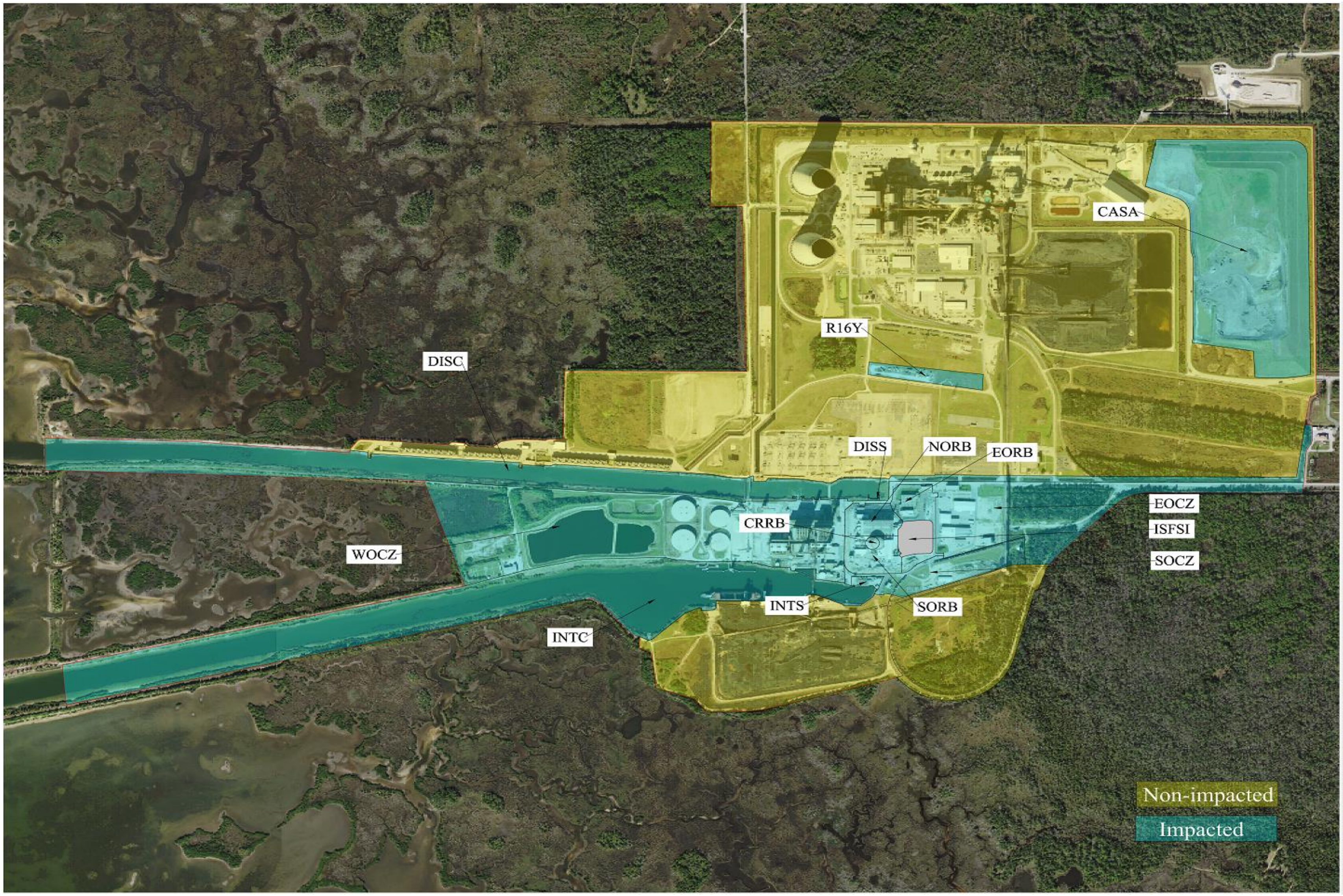


Table 2.2 Survey Area Summary Information

AREA	Definition	Area (Square meters)	Classification
CASA	Unit 4/5 Coal Ash Storage Area	268,845	3
CRRB	Crystal River Reactor Building	1,271	1
DISC	Discharge Canal	234,563	3
DISS	Discharge Structure	250	2
EOCZ	East of the Contaminated Zone	132,560	3
EORB	East of the Reactor Building	18,430	2
INTC	Intake Canal	317,234	3
INTS	Intake Structure	3,006	3
NORB	North of the Reactor Building	15,850	2
R16Y	R16 Shipping Yard	15,444	3
SOCZ	South of the Contaminated Zone	37,737	2
SORB	South of the Reactor Building	18,451	1
WOCZ	West of the Contaminated Zone	283,082	3

2.4 Area Radiological Impact Summaries
[NUREG-1700, Revision 2, Appendix A, Section A.2]
Structures

2.4.1 CRRB – Crystal River Reactor Building

The Reactor Building and all SSCs within it are preliminarily classified as a MARSSIM Class 1 structure since the building has been an RCA throughout the operating years, has a high potential for containing residual radioactive material, and the presumption that if residual radioactivity is present could exceed the acceptance criteria.

2.4.2 DISS – Discharge Structure

The Discharge Structure is preliminarily classified in the CR3 HSA as a MARSSIM Class 2 structure due to the fact plant radioactive liquid effluent discharges are sent through the Circulating Water System discharge to provide dilution. There is a potential that residual radioactive material may have accumulated in the structure from years of radioactive liquid effluent discharges.

2.4.3 INTS – Intake Structure

Since plant derived material has been identified in the storm water drains, several of which discharge to the Intake Canal through an outfall, there is a possibility, albeit small because of dilution, that contamination has accumulated in the Intake Structure. The Intake Structure is preliminarily classified in the CR3 HSA as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the release criterion.

Soils

2.4.4 NORB – North of the Reactor Building

Six samples were analyzed for gamma emitters and sample 005 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. No CR3 plant-derived radioisotopes for HTD or ETD radionuclides were identified for all the samples taken.

2.4.5 SORB – Open Land Area South of the Reactor Building

Six samples were analyzed for gamma emitters and sample 002 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. No CR3 plant-derived radioisotopes for HTD or ETD radionuclides were identified for all the samples taken.

2.4.6 EORB – East of the Reactor Building

Six samples were analyzed for gamma emitters and sample 004 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. Gamma results are provided in the table below. Gamma results for samples 004 and 006 were positive for Cs-137 an shown in Table 2.3 below. The remainder of the samples gamma results did not indicate any plant derived radioisotopes.

Table 2.3 EORB Characterization Results

Sample Number	Activity (pCi/g)
EORB-CHAR-01-004-F	3.38E-01
EORB-CHAR-01-006-F	7.69E-02

2.4.7 WOCZ – Open Land Area West of the Contaminated Zone

Nine samples were analyzed for gamma emitters and sample 005 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. No CR3 plant-derived radioisotopes for HTD or ETD radionuclides were identified for all the samples taken.

2.4.8 SOCZ – Open Land Area South of the Contaminated Zone

Eight samples were analyzed for gamma emitters and sample 004 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. Gamma results for samples 002, 003, and 004 were positive for Cs-137 an shown in Table 2.4 below. The remainder of the samples gamma results did not indicate any plant derived radioisotopes.

Table 2.4 SOCZ Characterization Results

Sample Number	Activity (pCi/g)
SOCZ-CHAR-01-002-F	1.36E-01
SOCZ-CHAR-01-003-F	5.74E-02
SOCZ-CHAR-01-004-F	3.96E-02

2.4.9 DISC – Open Land Area Discharge Canal

For the reasons outlined in Section 2.4.2, the discharge canal has a low probability for residual activity exceeding a small percentage of the release criterion.

2.4.10 INTC – Open Land Area Intake Canal

For the reasons outlined in Section 2.4.3, the intake canal has a low probability for residual activity exceeding a small percentage of the release criterion.

2.4.11 EOCZ – Open Land Area East of the Contaminated Zone

Nine samples were analyzed for gamma emitters and sample 002 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. No CR3 plant-derived radioisotopes for HTD or ETD radionuclides were identified for all the samples taken.

2.4.12 R16Y – Open Land Area R16 Shipping Yard Area

Eight samples were analyzed for gamma emitters and sample 001 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. Gamma results for samples 001, 005, and 007 were positive for Cs-137 an shown in Table 2.5 below. The remainder of the samples gamma results did not indicate any plant derived radioisotopes.

Table 2.5 R16Y Characterization Results

Sample Number	Activity (pCi/g)
R16Y-CHAR-01-001-F	4.84E-02
R16Y-CHAR-01-005-F	2.90E-02
R16Y-CHAR-01-007-F	2.81E-02

2.4.13 CASA – Open Land Area Unit 4/5 Coal Ash Storage Area

Nine samples were analyzed for gamma emitters and sample 005 was sent offsite and counted for site-specific HTD radionuclides. No HTD radionuclide was identified greater than the MDA for that analysis. Gamma results for 007 was positive for Cs-137 an shown in Table 2.6 below. The remainder of the samples gamma results did not indicate any plant derived radioisotopes.

Table 2.6 CASA Characterization Results

Sample Number	Activity (pCi/g)
CASA-CHAR-01-007-B	5.24E-02

2.5 HSA Findings
[NUREG-1700, Revision 2, Appendix A, Section A.2]

2.5.1 Potential Contaminates
CR3 Technical Based Document "*Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection for DCGL Development*" was developed to determine the radionuclide suite that would be potentially present in the environs at the CR3 site. The predominate radionuclides present on structures and in soils are Cs-137, Co-60 and H-3.

2.5.2 HSA Conclusions

The HSA was completed in accordance with guidance provided in NUREG-1575 (MARSSIM). As expected, operational activities at CR3 from initial power generation in March 1977 to the present have resulted in areas that have been impacted with radiological and/or non-radiological contaminants.

A general conclusion that can be drawn from the record reviews, personnel interviews, and site walk-downs that were part of HSA development is that CR3 had an excellent operating history that has resulted in very low radiological and non-radiological impacts to the environment beyond the RA. No identified areas of contamination are a current or expected threat to human health or the environment that would warrant immediate corrective action or appear to present a significant challenge for decommissioning.

In most cases, contamination was remediated immediately at the time of its discovery. Some incidents of contamination were not completely remediated at the time of discovery for one or more of the following reasons:

- The source of contamination was removed, and residual contaminant concentrations were very low,
- Screening data indicated that the measured contaminant levels did not present a risk to human health or the environment,
- The contamination was contained and managed within a structure,
- The contamination was inaccessible,
- The contaminants were not mobile in soil.

The following conclusions are presented for consideration and to clearly state important observations.

- Known incidents of contamination were remediated immediately to reduce the risk to human health and the environment.
- As part of decommissioning planning, each area identified as potentially impacted will require further characterization as it becomes more accessible during decommissioning to determine the extent to which it may have been impacted, if at all.
- In order to reduce the size of the licensed footprint of the site, FSS quality surveys may be performed of the buildings/areas in accordance with MARSSIM guidance and regulatory awareness.
- No new impacted areas that were not previously known have been identified by this HSA.
- Where lead-based paint, ACM, or components containing mercury are present the areas are located within buildings, are not exposed to the environment and are being managed in accordance with site procedures. The current management practices for these areas are sufficient to ensure the safety of site workers until the materials of concern are permanently removed from the station.
- The large transformers located in transformer bays on the North Berm outside the Turbine Building have been drained of their dielectric oil and removed and therefore do not pose a continuing risk of non-radiological contamination.
- CR3 has implemented the guidance prescribed by NEI 07-07 (the Industry Groundwater Protection Initiative) and has established an on-going groundwater monitoring program.
- A hydrogeological investigation was undertaken in 2006 to install groundwater monitoring wells, determine groundwater gradients and probable flow paths, and characterize near-surface groundwater quality. These initiatives further strengthen the groundwater monitoring program.
- The horizontal component of groundwater flow in both unconsolidated sediments and bedrock beneath the site is generally to the southwest toward the Gulf of Mexico. The knowledge of groundwater flow patterns supports future decommissioning planning in terms of both managing groundwater intrusion to deep excavations and in evaluating the potential migration of plant-related radionuclides.
- Tritium, at very low levels, is the only plant-related radionuclide that has been identified in groundwater at CR3. Although this conclusion will be verified during future soil characterization activities, the absence of other plant-related radionuclides in groundwater indicates there has not been significant migration of plant-related radionuclides in on-site soils.

2.6 Hydrogeological Investigations
[NUREG-1700, Revision 2, Section 2.2]

2.6.1 Previous Reports and Studies

Historical subsurface studies at the CR3 site have ranged in purpose and specific area and/or depth of interest. Types of exploration include borings for geotechnical, hydrogeologic and installation of groundwater monitoring wells for contamination detection and monitoring. The following subsurface studies and documents were considered most relevant available:

Haley & Aldrich, *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station, Crystal River, Florida, August 2020*

2.6.2 Groundwater Monitoring

Table 2.7 CR3 Groundwater Monitoring Wells

Well ID	Installation Date	Total Boring Depth (ft bgs)	Screened Interval (ft bgs)	Reference Elevation (ft)	July 2020 Depth to Groundwater from Reference Point (ft)	July 2020 Groundwater Elevation (ft)
MW-01	6/25/2020	34	24-34	27.90	26.55	1.35
MW-02	6/10/2020	14	4-14	8.76	5.57	3.19
MW-03	6/26/2020	34	24-34	27.94	26.78	1.16
MW-04	6/30/2020	14	4-14	8.03	6.48	1.55
MW-05	6/11/2020	14	4-14	6.97	4.50	2.47
MW-06	6/11/2020	14	4-14	7.04	4.40	2.64
MW-07	6/17/2020	25	15-25	6.46	4.79	1.67
CR3-1S	--	30	20-30*	8.07	4.96	3.11
CR3-1D	--	70	60-70*	8.23	5.05	3.18
CR3-2	--	30	20-30*	8.25	5.35	2.90
CR3-3S	--	30	20-30*	8.62	5.53	3.09
CR3-3D	--	75	65-75*	7.9	5.75	2.15
CR3-4	--	30	20-30*	9.05	6.15	2.90
CR3-5	--	30	20-30*	9.08	7.36	1.72
CR3-6S	--	25	15-25*	10.22	8.32	1.90
CR3-6D	--	77	67-77*	10.18	8.53	1.65
CR3-7	--	30	20-30*	8.87	6.30	2.57
CR3-8	--	30	20-30*	10.51	7.25	3.26
CR3-9	--	30	20-30*	9.96	6.75	3.21
CR3-10	--	30	20-30*	8.72	5.99	2.73
CR3-14	--	33.5	23.5-33.5*	26.36	26.18	0.18
CR3-15	--	35	25-35*	–	26.80	–
CR3-13	--	35	25-35*	26.55	26.70	-0.15
MWC-1	--	--	--	7.32	NM	–
MWC-7R	--	--	--	8.62	NM	–
MWC-16	--	33	23-33*	13.99	12.05	1.94
MWC-27	--	13	3-13*	11.31	9.05	2.26
MWC-21R	--	--	--	10.39	NM	–
MWC-29	--	--	--	11.72	NM	–
MWC-1F2	--	17.5	7.5-17.5*	11.79	9.65	2.14
MW-POS-22	--	--	--	–	NM	–
CCRW-2	--	--	--	12.09	NM	–
CCRW-3	--	--	--	21.30	NM	–
CCRW-7	--	--	--	9.45	NM	–

ABBREVIATIONS AND NOTES:
NM: Not measured
ND: Not determined/unknown
ft bgs: Feet below ground surface
Reference Elevation: Elevation from top of well PVC riser,
*: Assumption that the Well Screen is the bottom 10' of Monitoring Well, boring logs for existing wells unable to be located

2.6.3 Groundwater Monitoring Results

Reference 2-9 provide the results and well locations of groundwater monitoring for 2020.

2.7 Site Characterization Surveys
[NUREG-1700, Revision 2, Section 2.2 & Appendix A, Section A.2]

2.7.1 Soil and Building Sampling

The objective of the 2020 and 2022 radiological surveys were to assess the nature, degree, and extent of radiological contamination in sediments, structures and soils at CR3. The primary purpose of the surveys was to provide a decision-making basis for developing remediation requirements and cost estimates leading to the future decommissioning of CR3. Additional objectives of the site characterization surveys included the following:

- Confirming and updating survey unit classifications
- Providing a basis for development of data quality objectives for the final survey

2.7.1.1 Methodology

2020 Survey

The 2020 survey was performed to determine the waste characterization for the Turbine building, Auxiliary building and the Intermediate building. Removable (smears) and dose rates were collected as well as reviews of Part 61 sampling.

2022 Survey

The 2022 characterization survey was performed to close the open-land soil data gaps in the CR3 HSA. Soil samples were taken in the impacted survey areas and were counted with the on-site HPGe system as well as samples were sent to the off-site laboratory for Hard-to-Detect analysis.

2.8 Continuing Characterization
[NUREG-1700, Revision 2, Section 2.2], [U.S. NUCLEAR REGULATORY COMMISSION REGULATORY GUIDE 1.179, REVISION 2, Part C, Section 2]

Characterization data will be collected as necessary throughout the project. Results of future characterization sample analysis will be evaluated to determine the impact, if any, on the radionuclide identities, nuclide fractions, and the classification of structures, soils and other site media.

2.9 Summary

The characterization data collected and analyzed to date are of sufficient quantity and quality to provide the basis for the initial classification of survey areas, planning remedial activities, estimating radiological waste types and volumes, and for the development of the DCGLs. However, characterization is an ongoing process that will continue as necessary during decommissioning.

2.10 References

2-1 NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," August 2000
2-2 CR3, "Historical Site Assessment for Crystal River 3" June 2016
2-3 CR3 Plant Operation Reports
2-4 Annual Radiological Environmental Operating Report, 2020
2-5 10 CFR 50.75, "Reporting and recordkeeping for decommissioning planning"
2-6 CR3 DSAR, "Defueled Safety Analysis report Crystal River Unit 3 Revision 8, 2021
2-7 CR3 PSDAR "Revised Crystal River Post-Shutdown Decommissioning Activities Report," Revised June 2019
2-8 *"CR3 SeaLand Reclassification Position Paper,"* dated September 2022
2-9 "ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT 2020"

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

3.0 IDENTIFICATION OF REMAINING DECOMMISSIONING ACTIVITIES [NUREG-1700, Revision 2, Section 2.3]

3.1 Introduction

In accordance with 10 CFR 50.82 (a)(9)(ii)(B), the License Termination Plan (LTP) must identify the major remaining dismantlement activities. This chapter was written following the guidance of NUREG-1700, *"Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans,"* (Reference 3-1) and Regulatory Guide 1.179, *"Standard Format and Content of License Termination Plans for Nuclear Power Reactors,"* (Reference 3-2) and will discuss those remaining dismantlement activities.

Information is presented to demonstrate that these activities will be performed in accordance with 10 CFR 50 and will not be detrimental to the common defense and security or to the health and safety of the public pursuant to 10 CFR 50.82(a)(10). Information that demonstrates that these activities will not have a significant effect on the quality of the environment is provided in LTP Chapter 8, Supplement to the Environmental Report. The information includes those areas and equipment in need of further remediation, and an estimate of radiological conditions that may be encountered. Included are estimates of associated occupational radiation dose and projected volumes of radioactive waste. CR3's primary goals are to decommission CR3 safely and successfully terminate the CR3 license with the exception of the Independent Spent Fuel Storage Installation (ISFSI).

The DECON alternative, as described in NUREG-0586, *"Final Generic Environmental Impact Statement*" (FGEIS) (Reference 3-3) will be used to perform decontamination and dismantlement (D&D) activities at the CR3 site in accordance with CR3 procedures and approved work packages. D&D activities will also be in compliance with the CR3 PSDAR, Radiation Protection Program, existing 10 CFR Part 50 license, and the requirements of 10 CFR 50.82(a)(6) and (a)(7). Completion of the DECON option is contingent upon access to one or more low-level waste (LLW) disposal sites. Currently, CR3 has access to the disposal facilities at Waste Control Specialists, LLC (WCS) in Texas. If an activity requires prior NRC approval under 10 CFR 50.59(c)(2) or a change to the CR3 Technical Specifications or license, a submittal will be made to the NRC for review and approval prior to implementation of the activity in question. The activities listed in Section 3.3, "Future Decommissioning Activities," include activities up to future partial release of the site. This section provides an overview of the major remaining decommissioning activities. Information related to the remaining D&D tasks is provided in section 3.3. Section 3.4 includes an estimate of the radioactive material to be disposed, a description of proposed control mechanisms to ensure dispositioned areas are not re-contaminated, estimates of occupational exposures, characterization of radiological conditions to be encountered and the types and quantities of radioactive waste.

This information provided above supports the assessment of impacts considered in other sections of the LTP and provides sufficient detail to identify inspections or technical resources needed during the remaining dismantlement activities. Some of these activities will require coordination with other federal, state, or local regulatory bodies. The D&D activities described in Section 3.3 also provide the NRC the information to support license termination pursuant to 10 CFR 50.82(a)(11)(i). The final state of the CR3 site will be an open land area returned to Duke Energy for use. The decommissioning activities will reduce residual radioactivity to a level less than 25 mrem/year and as low as reasonably achievable (ALARA) from all potential pathways to the average member of the critical group (Residential Farmer).

3.2 Completed Decommissioning Activities and Tasks

3.2.1 Spent Fuel Storage

Transfer of all 1,243 spent nuclear fuel assemblies from the spent fuel pool to dry horizontal storage modules (HSM's) on the ISFSI pad was completed in January 2018. The fuel is contained in dry storage canisters (DSC's). The ISFSI pad is adjacent and east of the former power block. In addition, two HSM's on the ISFSI pad will contain DSC's with Greater Than Class C waste.

3.2.2 Spent Fuel Pool Activities

- The spent fuel racks have been removed and shipped for disposal.
- The spent fuel pool has been cleaned, dewatered and a sealant applied for contamination control.

3.2.3 Reactor Building

- Large components have been removed and shipped for disposal. This includes the RCS piping, steam generators, reactor coolant pumps and motors, pressurizer, and portions of the reactor head (e.g., PI tubes and CRDM's)

3.2.4 Auxiliary Building

- Except for the liquid radwaste processing system and ventilation system, all other systems have been deactivated.
- 143': Spent fuel system piping, spent fuel heat exchangers, spent fuel filters, Aux Building supply fans, chemical addition piping and tanks, air radiation monitors, and electrical components.
- 119': Spent fuel pumps, Makeup tank, Boric acid storage tanks, seal return cooler, makeup pre and post filters, system piping, and electrical components.
- 95': SW heat exchangers, DC heat exchangers, Dc pumps, Dc surge tanks, Service water tank, service water pumps, raw water pumps, makeup pumps, waste and RC evaporators, Neutralizer tank, waste gas compressors, misc. system piping and valves, and electrical components
- 75': Building Spray Pumps, Decay Heat Pumps, Decay heat exchangers

3.2.5 Turbine Building

- 145': Removed all major equipment including MSRs, Deaerator, Main Turbines and Generator, and Main Feedwater Pumps
- 119': LP Feedwater Heater #3A/B, Condensate Demineralizers
- 95': Removed all major equipment including Feedwater Pumps, Condensate Demineralizers, SC Heater Exchangers, Turbine Lube Oil, Condensate Pumps, water boxes, and electrical components

3.2.6 Miscellaneous Structures

- Miscellaneous structures are currently being demolished. The old steam generators and reactor head have been shipped for disposal.
- The Emergency Diesel Generators and buildings, Maintenance Support Building, and Emergency Feed Tank Buildings have all been demolished.
- Fossil Units 1 & 2 along with their respective stacks are demolished.
- Firing range building demo and site remediation
- G Warehouse Building Demo
- Settling pond remediation

3.3 Future Decommissioning Activities
[NUREG-1700, Revision 2, Section 2.3]

3.3.1 Remaining Activities

Table 3.1 lists the remaining major activities associated with the decommissioning of CR3 and their projected completion date:

Table 3.1 Remaining Major Decommissioning Activities

Activity	Projected Completion Date*
Large Component Removal	December 2023
Turbine Building Removal	August 2023
Auxiliary Building	December 2024
Intermediate Building	July 2025
Reactor Building above grade removal	May 2025
Site restoration	December 2026
FSS activities	December 2026

*Estimated

3.3.2 Control Mechanisms to Ensure no Re-contamination

Due to the large scope of remaining structures and systems to be decontaminated and the need for some FSS activities to be performed in parallel with dismantlement activities, a systematic approach to controlling areas is established.

Upon commencement of the FSS for survey areas where there is a potential for re-contamination, implementation of one or more of the following control measures will be implemented:

- Personnel training
- Installation of barriers to control access to surveyed areas and prevent the migration of contamination from adjacent areas
- Installation of postings requiring personnel to perform contamination monitoring prior to surveyed area access
- Installation of tamper-evident labels or seals
- Upon completion of FSS, the area will be placed under periodic routine surveillance survey by the FSS department to ensure no re-contamination occurs. If re-contamination is identified, an investigation will be initiated that could result in corrective actions up to and including reperformance of the FSS for that area.

3.4 Occupational Exposure
[NUREG-1700, Revision 2, Section 2.3.1]

Table 3.2 provides CR3 cumulative site dose and estimates for the decommissioning project. These estimates were developed to provide site management ALARA goals. The goals are verified by summation of actual site dose, as determined by appropriate dosimetry. Exposure estimates are a compilation of radiation work permit estimates for the period. The total nuclear worker exposure during decommissioning is currently estimated to be less than 120 person-rem. This estimate is below the 308-664 person-rem estimate of the GEIS for immediate dismantlement. The exposures for years 2013 through 2021 have been verified by the dose of record from each individual radiation worker.

Table 3.2 CR3 Cumulative Site Exposure

Year	Exposure (person-rem)
2013	0.794
2014	0.696
2015	0.700
2016	14.746
2017	4.133
2018	1.215
2019	0.022
2020	2.287
2021	16.812
2022*	21
2023*	35
2024*	5
2025-2027*	15

*Estimated Exposure

3.4.1 Public Exposure
[NUREG-1700, Revision 2, Section 2.3.1], [10 CFR Part 20 and 10 CFR Part 50]

Continued application of CR3's current and future Radiation Protection and Radiological Effluent Programs ensures public protection in accordance with 10 CFR Part 20 and 10 CFR Part 50, Appendix I. Sections 3.4.3 and 3.4.4 conclude that the public exposure as a result of decommissioning activities is bounded by the evaluation in the GEIS, which concludes the impact is small.

3.4.2 Estimate of Quantity of Radioactive Material for Disposal.
[NUREG-1700, Revision 2, Section 2.3.1]

Table 3.3 Solid Waste Effluent Release Report Summary

Year	Volume (m^3)	Total Curies
2013	3.81E+02	8.18E+01
2014	6.56E+02	1.54E+02
2015	1.16E+02	8.48E+00
2016	6.62E+01	1.60E+00
2017	2.47E+02	9.89E-02
2018	3.72E+01	2.89E+03
2019	9.25E+01	9.30E-02
2020	5.50E+02	2.91E-01
2021	3.39E+03	1.33E+01
2022*	3.50E+03	2.0E+01
2023*(1)	3.50E+03	4.0E+01
2024*	3.50E+03	4.0E+01
2025-2027*	10.50E+3	1.20E+02

*Estimated
(1) This estimate does not include the estimated 40,000 curies for the reactor vessel and internals.

THIS SPACE INTENTIONALLY LEFT BLANK

3.4.3 Liquid Waste Activity and Volume
[NUREG-1700, Revision 2, Section 2.3.1]

Table 3.4 Liquid Waste Effluent Releases

Year	Tritium Release (Ci)	Dissolved and Entrained Gas Release (Ci)	Alpha Release (Ci)	Volume of Dilution Water (Liters)
2013	1.91E+01	0	0	9.12E+11
2014	3.40E+01	0	0	9.39E+11
2015	1.35E+00	0	0	1.40E+12
2016	3.62E-02	0	0	6.93E+11
2017	1.41E-01	0	0	7.48E+11
2018	3.64E+00	0	0	8.61E+11
2019	1.33E-01	0	0	1.73E+11
2020	5.64E-04	0	0	9.23E+10
2021	3.63E-01	0	0	4.92E+10
2022*	2.00E-01	0	0	4.92E+10
2023*	2.00E-01	0	0	4.92E+10
2024*	2.00E-01	0	0	4.92E+10
2025-2027*	2.00E-01	0	0	4.92E+10

*Estimated

3.4.4 Gaseous Waste Activity and Volume
[NUREG-1700, Revision 2, Section 2.3.1]

Table 3.5 Gaseous Waste Effluent Releases

Year	Fission and Activation Gas Release (Ci) – all are zero** [Tritium values below]	Iodine's (Ci)	Particulates (Ci)
2013	[3.62E+00]	0	7.99E-08
2014	[1.72E-01]	0	7.65E-08
2015	[9.80E-01]	0	4.17E-07
2016	[6.90E-01]	0	4.68E-07
2017	[3.70E-01]	0	7.01E-07
2018	[6.67E-01]	0	2.04E-07
2019	[2.81E-02]	0	0
2020	[1.60E-01]	0	1.31E-07
2021	[3.04E-01]	0	2.68E-06
2022*	[2.00E-01]	0	2.50E-06
2023*	2.00E-01	0	2.50E-06
2024*	2.00E-01	0	2.50E-06
2025-2027*	1.00E-01	0	2.50E-07

*Estimated
** All fission and activation products are less than the detection sensitivity with the exception of tritium.

3.5 Site Description after License Termination
[NUREG-1700, Revision 2, Section 1.3]

The ISFSI – including the Security Building - is the only area inside the restricted area scheduled to remain at the time of license termination. All other above-grade structures will be removed, and the site graded. The remaining licensed property outside the restricted area will be surveyed and released back to Duke Energy.

3.6 Coordination with Outside Entities
[10 CFR Part 52]

The decommissioning and partial termination of CR3's 10 CFR Part 50 license involves, among others, the U.S. NRC, and several state regulatory agencies.

Chapter 8, "Supplement to the Environmental Report," discusses some of the related requirements.

3.7 References

3-1 U.S. Nuclear Regulatory Commission NUREG-1700, *"Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans",* Revision 2, April 2018

3-2 U.S. Nuclear Regulatory Commission Regulatory Guide 1.179, *"Standard Format and Content of License Termination Plans for Nuclear Power Reactors", Revision 2,* July 2019

3-3 U.S. Nuclear Regulatory Commission NUREG-0586, *"Final Generic Environmental Impact Statement (FGEIS) on Decommissioning of Nuclear Facilities",* November 2002, Supplement 1

3-4 2019 CR3 Annual Radioactive Effluent Release Report, May 6, 2020

3-5 2020 CR3 Annual Radioactive Effluent Release Report May 5, 2021

3-6 2021 CR3 Annual Radioactive Effluent Release Report 2022

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

4.0 SITE REMEDIATION PLAN
[NUREG-1700, Revision 2, Section 2.4]

4.1 Remediation Actions and ALARA Evaluations

This chapter of the LTP describes various remediation and decontamination actions that may be used during the decommissioning of Crystal River Nuclear Generating Plant. Additionally, described are the methods used to reduce residual contamination to levels that comply with the NRC's annual dose limit of 25 mrem, and As Low As Reasonably Achievable (ALARA).

4.2 Remediation Actions

Remediation actions are performed throughout the decommissioning process. The remediation action taken is dependent on the material contaminated. The principal materials that may be subjected to remediation are hardened structural surfaces and soils. Activities performed solely to accommodate FSS measurements (e.g., wiping down of surfaces, shaving concrete to allow for proper instrument probe geometries) will not be evaluated for ALARA.

4.2.1 Structures
[Structures are discussed in Enclosure 17, "*CR3 Site Remediation Equipment Methods and Techniques," November 2022, (Reference 4-6)*]

4.2.1.1 Remediation Equipment, Methods, Techniques, and Additional Remedial Actions

Remediation Equipment, Methods, Techniques, and Additional Remedial Actions are discussed in Enclosure 17, "CR3 Site Remediation Equipment Methods and Techniques," November 2022, (Reference 4-6)]

4.2.2 Soil
[NUREG-1700, Revision 2, Section 2.4.1]

Soil contamination above the site specific DCGL that is removed will be disposed as radioactive waste. Operational constraints and dust control will be addressed in site excavation and soil control procedures. In addition, work package instructions for remediation of soil may include additional constraints and mitigation or control methods. The site characterization process established the location and extent of soil contamination. As needed, additional investigations will be performed to ensure that any changing soil contamination profile during the remediation actions is adequately identified and addressed. It should also be noted that soil remediation volume estimates in the LTP may vary from section to section, as appropriate, depending on their use (e.g., decommissioning cost estimates, ALARA evaluations, or dose assessment). Chapter 5 discusses soil sampling and survey methods.

Soil remediation equipment will include, but not be limited to, shovels, backhoe and trackhoe excavators. As practical, when the remediation depth approaches the soil interface region between unacceptable and acceptable contamination, a squared edge excavator bucket design or similar technique may be used.

This simple methodology minimizes the mixing of contaminated soils with acceptable lower soil layers as would occur with a toothed excavator bucket. Remediation of soils will include the use of established Excavation Safety and Environmental Control procedures.

Additionally, work package instructions will augment the previous guidance and procedural requirements to ensure adequate erosion, sediment, and air emission controls during soil remediation. Characterization data available to date indicates that no remediation of surface or ground waters will be required at the CR3 to meet the site release criteria.

4.3 Remediation Activities Impact on the Radiation Protection Program [NUREG-1700, Revision 2, Section 2.4.1]

The Radiation Protection Program used for decommissioning is similar to the program in place during power operation. During power operations, contaminated structures, systems, and components were decontaminated in order to perform maintenance or repair actions. The techniques used during operations are the same or similar to the techniques used during decommissioning to reduce personnel exposure to radiation and contamination and to prevent the spread of contamination from established contaminated areas. Decommissioning planning allows radiation protection personnel to focus on each area of the site and plan each activity well before execution of the remediation technique. The Decommissioning Organization is experienced in and capable of applying these remediation techniques on contaminated systems, structures, or components during decommissioning. The existing Radiation Protection Program is adequate to control the radiological aspects of remediation work safely.

4.4 ALARA Evaluation [NUREG-1700, Revision 2, Section 2.4.1], [NUREG-1757, Volume 2, Revision 2, Section 6, Appendix N]

In order to terminate the NRC 10 CFR 50 license, CR3 must demonstrate that the dose criteria in 10 CFR 20, Subpart E, have been met, and should demonstrate whether it is feasible to further reduce the levels of residual activity to below those necessary to meet the dose criteria (i.e., to levels that are ALARA). For the CR3 decommissioning, the ALARA cleanup levels are established at one of two levels: a pre-defined generic ALARA screening, or a survey unit specific ALARA evaluation. In either case, an ALARA action level (AL) is applied.

The AL corresponds to a residual activity concentration at which the averted radiation dose converted into dollars is equal to the costs of remediation. An ALARA analysis ensures that the efforts to remove residual contamination are commensurate with the risk that exists from leaving the contamination in place. "Reasonably achievable" is judged by considering the state of technology and the economics of improvements in relation to all the benefits from these improvements. However, a comprehensive consideration of risks and benefits will also include risks from non-radiological hazards. An action taken to reduce radiation risks should not result in a significantly larger risk from the other hazards. NUREG-1757, Volume 2, Revision 2, *"Consolidated Decommissioning Guidance"* (Reference 4-3) recognizes that remediation of soils beyond the DCGLs is not likely to be cost-beneficial due to the high costs of waste disposal. For CR3, if remediation of soils beyond the DCGL is determined not to be cost-beneficial, then residual activity in soils that meet the DCGL will be considered ALARA. A copy of the Generic ALARA evaluation is in Attachment 1 of this chapter.

Similarly, if residual radioactivity on remaining structures is below a pre-determined generic ALARA screening level or a unit specific level, then the levels associated with the structure will be considered ALARA. The methodology and equations used are consistent with those provided in NUREG-1757.

4.5 Unit Cost Estimates
[NUREG-1757, Volume 2, Revision 2, Section 6, Appendix N]

In order to effectively perform ALARA evaluations and remediation actions, unit cost values are required. These values are used to perform the NUREG-1757, Cost-Benefit Analysis.

4.5.1 Calculation of Total Cost

When performing a fairly simple evaluation, the costs generally include the monetary costs of: (1) the remediation action being evaluated, (2) transportation and disposal of the waste generated by the action, (3) workplace accidents that occur because of the remediation action, (4) traffic fatalities resulting from transporting the waste generated by the action, (5) doses received by workers performing the remediation action, and (6) doses to the public from excavation, transport, and disposal of the waste. Other costs that are appropriate for the specific case may also be included. Values of some standard parameters are contained in Table 4-1.

The total cost, ($Cost_T$), which is balanced against the benefits, has several likely components, and may be evaluated according to Equation N-3 of NUREG-1757, Appendix N:

Equation N-3 of NUREG-1757

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$$

Where:

$Cost_R$ = monetary cost of the remediation action (may include "mobilization" costs);

$Cost_{WD}$ = monetary cost for transport and disposal of the waste generated by the action;

$Cost_{ACC}$ = monetary cost of worker accidents during the remediation action;

$Cost_{TF}$ = monetary cost of traffic fatalities during transportation of the waste;

$Cost_{WDose}$ = monetary cost of dose received by workers performing the remediation action and transporting waste to the disposal facility;

$Cost_{PDose}$ = monetary cost of dose to the public from excavation, transport, and disposal of the waste; and

$Cost_{other}$ = other costs as appropriate for the particular situation.

4.5.1.1 Remedial Action Costs

Calculations of the incremental remedial action costs include the standard manpower and mechanical costs. Lower concentrations may change sampling and survey requirements. Increased survey costs can be considered in the remedial action (e.g., confined spaces, difficult to access areas, ceilings, and walls above 6 feet) and will raise standard remediation costs due to the increase in man-hours but note that these are the incremental costs of surveying below the dose limit.

4.5.1.2 Transport and Disposal of the Waste

The cost of waste transport and disposal ($Cost_{WD}$) may be evaluated according to Equation N-4 of NUREG-1757, Appendix N:

Equation N-4 of NUREG-1757

$$Cost_{WD} = V_A \times Cost_V$$

Where:

V_A = volume of waste produced, remediated in units of m^3; and

$Cost_V$ = cost of waste disposal per unit volume, including transportation cost, in units of $\$/m^3$

4.5.1.3 Non-radiological Risks

The cost of non-radiological workplace accidents ($Cost_{ACC}$) may be evaluated using Equation N-5 of NUREG-1757, Appendix N:

Equation N-5 of NUREG-1757

$$Cost_{ACC} = V_{SL}\ (\$9{,}000{,}000)\ x\ F_W\ x\ T_A$$

Where:

V_{SL} = monetary value of a statistical life (or fatality) (see *"Reassessment of NCR's Dollar per Person-Rem Conversion Factor Policy,"* NUREG-1530, Revision 1, February 2022) (Reference 4-4)—this value is subject to periodic revision, so it is important to verify the current value from NUREG-1530 when performing an analysis on non-radiological workplace accidents;
F_W = workplace fatality rate in fatalities/hour worked; and
T_A = worker time required for remediation in units of worker-hours.

4.5.1.4 Transportation Risks

The cost of traffic fatalities incurred during the transportation of waste ($Cost_{TF}$) may be evaluated using Equation N-6 of NUREG-1757, Appendix N:

Equation N-6 of NUREG-1757

$$Cost_{TF} = V_{SL}(\$9{,}000{,}000) \times \left(\frac{V_A}{V_{SHIP}}\right) \times F_T \times D_T$$

Where:

V_{SL} = monetary value of a statistical life (or fatality) (see *"Reassessment of NCR's Dollar per Person-Rem Conversion Factor Policy,"* NUREG-1530, Revision 1, February 2022) (Reference 4-4)—this value is subject to periodic revision, so it is important to verify the current value from NUREG-1530 when performing an analysis on non-radiological workplace accidents;
V_A = volume of waste produced in units of m^3;
F_T = fatality rate per truck-kilometer (km) traveled in units of fatalities/truck-km;
D_T = distance traveled in km; and
V_{SHIP} = volume of a truck shipment in m^3.

4.5.1.5 Worker Dose Estimates

Calculate the cost of the remediation worker dose, ($Cost_{WDose}$) may be evaluated using Equation N-7 of NUREG-1757, Appendix N:

Equation N-7 of NUREG-1757

$$Cost_{WDose} = V_{AD}\ (\$5{,}200)\ x\ D_R\ x\ T$$

Where:

V_{AD} = value of incurred dose, which is a conversion factor for the monetary value of radiation dose (dollars ($) per person-rem, see NUREG/BR-0058);
D_R = total effective dose equivalent (TEDE) rate to remediation workers in units of rems/hr; and
T = time worked (site labor) to remediate the area in units of person-hour.

4.5.1.6 Loss of Economic Use of Property

A cost in the "other" category could include the fair market rental value or economic use for the site during the time the additional remediation work is being performed.

4.5.1.7 Parameters

For performing these calculations, acceptable values for some of the parameters are shown in Table 4.1 below:

Table 4.1 Parameter Values for use in ALARA Analysis

Parameter	Value	Reference and Comments
Workplace accident fatality rate, F_w	1.8×10^{-8}/hr Based on 2019 data	U.S. Bureau of Labor Statistics: Census of Fatal Occupational Injuries Summary (ML22059A215) Change to Hours-Based Fatality Rates in the Census of Fatal Occupational Injuries (ML22059A217)
Transportation fatality rate, F_T	Trucks: 1.85×10^{-9}/km Based on 2019 data for large trucks	Bureau of Transportation Statistics: Truck Occupant Safety Data (ML22059A218 and ML22059A220)
Value of averted dose, V_{AD}, and value of statistical life, V_{SL} (Dollars per person-rem)	$5,200	NUREG/BR-0058, NUREG-1530. It is important to verify the current values
Monetary discount rate, r	0.03/y and 0.07/y discount rates, with special considerations for	NUREG/BR-0058

Parameter	Value	Reference and Comments
	intergenerational consequences	
Number of years of exposure, N	Buildings: 70 years Soil: 1,000 years	NUREG-1496, Volume 2, Appendix B, Table A.1
Population density, P_D	Building:0.09 person/m^2 Land:0.0004 person/m^2	NUREG-1496, Volume 2, Appendix B, Table A.1
Excavation, monitoring, packaging, and handling soil	1.62 person-hours/m^3 of soil	NUREG-1496, Volume 2, Appendix B, Table A.1
Waste shipment volume, V_{SHIP}	Truck: 13.6 m^3/shipment	NUREG-1496, Volume 2, Appendix B, Table A.1

4.5.2 Calculation of Benefits

In the simplest form of the analysis, the only benefit estimated from a reduction in the level of residual radioactivity is the monetary value of the collective averted dose to future occupants of the site. For buildings, the collective averted dose from residual radioactivity is based on the occupational scenario. For land, the averted dose is based on the resident farmer scenario. In general, the ALARA analysis should use the same critical group scenario that is used for the compliance calculation. The benefit from collective averted dose (B_{AD}) is calculated by determining the present worth of the future collective averted dose and multiplying it by a factor to convert the dose to a monetary value using Equation N-1 of NUREG-1757, Appendix N:

Equation N-1 of NUREG-1757

$$B_{AD} = V_{AD}\ (\$5{,}200)\ x\ PW(AD_{Collective})$$

Where:

B_{AD} = benefit from an averted dose for a remediation action, in current U.S. dollars
V_{AD} = (\$5,200) value of averted dose, which is a conversion factor for the monetary value of radiation dose (dollars (\$) per person-rem, see NUREG/BR-0058). This conversion factor is applied to averted dose and to dose incurred.
$PW(AD_{collective})$ = present worth of a future collective averted dose in person-rem

An acceptable value for a collective dose is \$5,200 per person-rem averted, discounted for a dose averted in the future (see Section 4.3.3 of *"Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,"* NUREG/BR-0058, Revision 5, April 2017 and NUREG-1530, Rev. 1).

The present worth of the future collective averted dose can be estimated from Equation N-2 of NUREG-1757, Appendix N, for relatively simple situations:

Equation N-2 of NUREG-1757

$$PW(AD_{collective}) = P_D \times A \times 0.025 \times F \times \frac{Conc}{DCGL_W} \times \frac{1 - e^{-(r+\lambda)^N}}{r + \lambda}$$

Where:

P_D = population density for the critical group scenario in people/m^2;

A = area being evaluated in square meters (m^2);

0.025 = annual dose to an average member of the critical group from residual radioactivity at the DCGL concentration in rem/y;

F = effectiveness, or fraction of the residual radioactivity removed by the remediation action;

Conc = average concentration of residual radioactivity in the area being evaluated in units of activity per unit area for buildings or activity per unit volume for soils;

DCGL = derived concentration guideline level equivalent to the average concentration of residual radioactivity that would give a dose of 0.25 mSv/y (25 mrem/y) to the average member of the critical group, in the same units as "Conc";

r = monetary discount rate in units per year;

λ= radiological decay constant for the radionuclide in units per year; and

N = number of years over which the collective dose will be calculated.

The present worth of the benefit calculated by Equation N-2 assumes that the peak dose occurs in the first year. This is usually true for the building occupancy scenario, but not always true for the residential scenario, where the peak dose can occur in later years. When the peak dose occurs in later years, Equation N-2 would overestimate the benefit. A more exact calculation may be used that avoids this overestimation of the benefit of remediation by calculating the dose during each year of the evaluation period and then calculating the present worth of each year's dose. The DCGL used should be the same as the DCGL used to show compliance with the 25 mrem/y dose limit. The population density, P_D, should be based on the dose scenario used to demonstrate compliance with the dose limit. Thus, for buildings, the estimate P_D for the occupational scenario should be used. For soil, P_D should be based on the resident farmer scenario. The factor at the far right of the equation, which includes the exponential terms, accounts for both the present worth of the monetary value and radiological decay. If more than one radionuclide is present, the total benefit from a collective averted dose, B_{AD} is the sum of the collective averted dose for each radionuclide.

4.5.3 Residual Radioactivity Levels that are ALARA

The residual radioactivity level that is ALARA is the concentration ($Conc_{ALARA}$) at which the benefit from removal equals the cost of removal.

If the total cost ($Cost_T$) is set equal to the present worth of the collective dose averted in Equation N-2, the ratio of the concentration ($Conc_{ALARA}$) to the DCGL can be determined by using Equation N-8 of NUREG-1757, Vol. 2, Appendix N below:

Equation N-8 of NUREG-1757

$$\frac{Conc_{ALARA}}{DCGL_W} = \frac{Cost_T}{V_{AD}\$(\$5{,}200) \times P_D \times 0.025 \times F \times A} \times \frac{r+\lambda}{1-e^{-(r+\lambda)^N}}$$

All the items in Equation N-8 are as previously defined.

Since P_D, N, and r are constants that have generic values for all locations on the site for each scenario, CR3 only needs to determine the total cost, $Cost_T$, and the effectiveness, F, for a specific remediation action for a specific area. If the concentration at a location exceeds $Conc_{ALARA}$, it may be cost effective to remediate the location by a method whose total cost is $Cost_T$. Note that the concentration, $Conc_{ALARA}$, which is ALARA, can be higher or lower (more or less stringent) than the DCGL, although the DCGL must be met in order to meet the criteria for license termination.

4.6 Radionuclides Considered for ALARA Calculations [NUREG-1757, Volume 2, Revision 2, Section 6, Appendix N]

As discussed in Chapter 6 of the CR3 LTP, the site-specific suite of radionuclides identified for use at CR3 contains 19 radionuclides. Only two of these radionuclides have been identified above minimum detectable concentration (MDC) levels in soil samples and structural surface samples. For purposes of the ALARA calculations, only Cs-137 and Co-60 are used along with their associated DCGL values.

4.7 References

4-1 U.S. Nuclear Regulatory Commission, NUREG-1496, Volume 2, *"Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities,"* July 1997

4-2 U.S. Nuclear Regulatory Commission, NUREG-1757, Volume 2, Revision 2, Final Report, *"Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria,"* July 2022

4-3 U.S. Nuclear Regulatory Commission, NUREG-1530, Revision 1, *"Reassessment of NRC's Dollar per Person-Rem Conversion Factor Policy,"* February 2022

4-4 U.S. Nuclear Regulatory Commission, NUREG-1496, Volume 1, Final Report, *"Final Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC- Licensed Nuclear Facilities,"* July 1997

4-5 U.S. Nuclear Regulatory Commission, NUREG/BR-0058, Revision 5, *"Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,"* April 2017

4-6 License Amendment Request 262

Attachment 1
CR3 GENERIC ALARA EVALUATION

BEGINS ON NEXT PAGE

NorthStar ADP-CR3 ALARA POSITION PAPER

CRYSTAL RIVER NUCLEAR GENERATING PLANT GENERIC ALARA EVALUATION

August 12, 2022

Martin Erickson

Marshall H Blake

Gordon Madison

Approved By: Gordon Madison
CR3/VY Special Projects Lead LTP/FSS Manager

Approved By: Bryant Akins
CR3 Radiation Protection Manager

NorthStar ADP-CR3 ALARA POSITION PAPER

Contents

NorthStar ADP-CR3 ALARA POSITION PAPER

INTRODUCTION

Chapter 5 of the Crystal River Nuclear Generating Plant (CR3) License Termination Plan (LTP) states that a unit specific or generic ALARA evaluation will be developed to determine if the cleanup of soils and/or building surfaces beyond the DCGLs will be cost-beneficial for NorthStar. Chapter 4 of the LTP provides an equation and default values for this calculation. This process will be followed, assuming that the building surface is at the DCGL and using conservative estimates of costs, distances and other inputs that the worksheet requires. The equation will calculate an action level (AL) that represents the ratio of concentration to the DCGL that would be cost-beneficial to remediate. If that ratio is greater than 1, remediation is not cost-beneficial. This calculation is meant to apply to areas of any MARSSIM Classification and size. In a Class 1 area, where values of residual contamination may exceed the $DCGL_W$ in limited areas, the mean concentration may never exceed the $DCGL_W$. Since it is assumed that the entire volume of building material removed is at $DCGL_W$, the assumed mean will be at $DCGL_W$. Therefore, the assumed case will be bounding.

ALARA

ALARA, as defined in 10 CFR 20.1003, means:

> *Making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.*

DISCUSSION

The total cost ($Cost_T$) will be calculated using LTP equation:

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$$

These terms are defined, and their values calculated as follows:

EVALUATION OF COST-BENEFIT ANALYSIS

The cost-benefit analysis provided in this paper follows the same approach as that presented in Appendix N of NUREG-1757 Volume 2 Revision 2. To compare the benefits and costs of a remediation action, it is necessary to use a comparable unit of measure. The unit of measure used here is the dollar; if possible, all benefits and costs are given a monetary value. Table 1 provides examples of various benefits and costs. Other than Collective Dose Averted, the additional benefits listed are generally only important in comparisons between alternatives that address whether the licensee can pursue restricted release. The value of any benefit or cost can be negative in some cases.

Table 1 Possible Benefits and Costs Associated with Decommissioning

Possible Benefits	Possible Costs
Collective dose averted Regulatory Costs Avoided Changes in land value Esthetics Reduction in public opposition	Remediation Costs (including waste disposal costs) Additional Occupational/Public Dose Occupational Non-radiological Risks Transportation Direct Costs and Implied Risks Environmental Impacts Loss of Economic Use of Site/Facility

CALCULATION OF BENEFITS

Collective Dose Averted

In the simplest form of the analysis, the only benefit estimated from a reduction in the level of residual radioactivity is the monetary value of the collective averted dose to future occupants of the site. The collective averted dose is based the same exposure scenario used for the compliance calculations.

To calculate the benefit from collective averted dose, B_{AD}, determine the present worth of the future collective averted dose and multiply it by a factor to convert the dose to monetary value, as shown in the Equation below.

$$B_{AD} = V_{AD} \times PW(AD_{Collective})$$

Where:

B_{AD} = benefit from an averted dose for a remediation action, in current U.S. dollars

V_{AD} = value of averted dose, which is a conversion factor for the monetary value of radiation dose (dollars ($) per person-rem, see NUREG/BR-0058). This conversion factor is applied to averted dose (as in this case) and to dose incurred (as in the case of dose to workers or the public discussed in Section N.2.3 of NUREG-1757).

$PW(AD_{collective})$ = present worth of a future collective averted dose in person-rem

The present worth of the future collective averted dose can be estimated from the following equation:

$$PW(AD_{Collective}) = P_D \times A \times 0.025 \times F \times \frac{Conc}{DCGL_W} \times \frac{1 - e^{-(r+\lambda)N}}{r + \lambda}$$

Where:

P_D = population density for the critical group scenario in people/m^2;

A = area being evaluated in square meters (m^2);

0.025 = annual dose to an average member of the critical group from residual radioactivity at the derived concentration guideline level (DCGL) concentration in rem/y;

F = effectiveness, or fraction of the residual radioactivity removed by the remediation action;

Conc = average concentration of residual radioactivity in the area being evaluated in units of activity per unit area for buildings or activity per unit volume for soil;

DCGL= derived concentration guideline equivalent to the average concentration of residual radioactivity that would give a dose of 0.25 mSv/y (25 mrem/y) to the average member of the critical group, in the same units as "Conc";

r = monetary discount rate in units per year;

λ = radiological decay constant for the radionuclide in units per year; and

N = number of years over which the collective dose will be calculated.

Regulatory Costs Avoided

This benefit usually occurs in ALARA analyses of restricted release versus unrestricted release decommissioning goals. By releasing the site with no restrictions, the licensee may avoid the various costs associated with restricted release.

These costs can include:

- additional licensing fees for safety reviews and for developing an Environmental Impact Statement,
- financial assurance for necessary control and maintenance of a site (10 CFR 20.1403(c), see NUREG-1757, Volume 3, Section 4),
- costs (including NRC-related) associated with public meetings or the community review committee (10 CFR 20.1403(d)(2)), and
- future liability.

Since the decommissioning goal for ADP-CR3 is unrestricted release, the Regulatory costs avoided is not applicable.

Changes in Land Value

Any expected change in the value of the site or facility or surrounding land caused by the different decommissioning options should be considered. Since reducing the ALARA dose will have no impact on the CR3 land value, this can be deemed not applicable.

Esthetics/Reduction in Public Opposition

These can be very difficult to quantify. NorthStar evaluated the effect of the available decommissioning options with respect to the overall esthetics (including the decommissioning activities themselves) of the site and surrounding area as well as the potential reduction in opposition, if there is any, to the decommissioning activities or goal it is attempting to propose. NorthStar found no real benefit in either the esthetics or reduction in public opposition.

CALCULATION OF COSTS

NorthStar evaluated the costs of the selected alternative remediation actions being evaluated. When performing a fairly simple evaluation, the costs generally include the monetary costs of:

- the remediation action being evaluated,
- transportation and disposal of the waste generated by the action,
- workplace accidents that occur because of the remediation action,
- traffic fatalities resulting from transporting the waste generated by the action,
- doses received by workers performing the remediation action, and
- doses to the public from excavation, transport, and disposal of the waste. The licensee may also include other costs that are appropriate for the specific case.

The total cost, $Cost_T$, which is balanced against the benefits, has several likely components.

$$Cost_T = Cost_R + Cost_{WD} + Cost_{ACC} + Cost_{TF} + Cost_{WDose} + Cost_{PDose} + Cost_{other}$$

Where:

$Cost_R$ = monetary cost of the remediation action (may include "mobilization" costs);

$Cost_{WD}$ = monetary cost for transport and disposal of the waste generated by the action;

$Cost_{ACC}$ = monetary cost of worker accidents during the remediation action;

$Cost_{TF}$ = monetary cost of traffic fatalities during transporting of the waste;

$Cost_{WDose}$ = monetary cost of dose received by workers performing the remediation action and transporting waste to the disposal facility;

$Cost_{PDose}$ = monetary cost of the dose to the public from excavation, transport, and disposal of the waste; and

$Cost_{other}$ = other costs as appropriate for the particular situation.

Remedial Action Costs

Calculations of the incremental remedial action costs include the standard manpower and mechanical costs. Lower concentrations may change sampling/survey requirements. Increased survey costs can be considered in the remedial action (e.g., confined spaces, difficult to access areas, ceilings and walls above 6 feet) and will raise standard remediation costs due to the increase in man-hours but note that these are the incremental costs of surveying below the dose limit.

Transport and Disposal of the Waste

The cost of waste transport and disposal ($Cost_{WD}$) may be evaluated according to Equation N-4 of NUREG-1757, Vol. 2 Appendix N:

$$Cost_{WD} = V_A \times Cost_V$$

Where:

V_A = volume of waste produced, remediated in units of m^3

$Cost_V$ = cost of waste disposal per unit volume, including transportation cost, in units of $\$/m^3$

Non-radiological Risks

The cost of non-radiological workplace accidents ($Cost_{ACC}$) may be evaluated using Equation N-5 of NUREG-1757, Vol. 2 Appendix N:

$$Cost_{Acc} = \$9{,}000{,}000 \times F_W \times T_A$$

\$9,000,000 = monetary value of a fatality equivalent to \$5,200 Person-Rem (see page 24 of *"Reassessment of NCR's Dollar per Person-Rem Conversion Factor Policy,"* NUREG-1530, Revision 1 February 2022).

F_W = workplace fatality rate in fatalities/hour worked

T_A = worker time required for remediation in units of worker-hours

Transportation Risks

The cost of traffic fatalities incurred during the transportation of waste ($Cost_{TF}$) may be evaluated using Equation N-6 of NUREG-1757, Vol. 2, Appendix N:

$$Cost_{TF} = \$9{,}000{,}000 \times \left(\frac{V_A}{V_{SHIP}}\right) \times F_T \times D_T$$

Where:

V_A = volume of waste produced in units of m^3

F_T = fatality rate per truck-kilometer (km) traveled in units of fatalities/truck-km

D_T = distance traveled in km

V_{SHIP} = volume of a truck shipment in m^3

Worker Dose Estimates

The cost of the remediation worker dose ($Cost_{WDose}$) may be evaluated using Equation N-7 of NUREG-1757, Vol. 2 Appendix N:

$$Cost_{WDose} = \$5{,}200 \times D_R \times T$$

Where:

D_R = total effective dose equivalent (TEDE) rate to remediation workers in units of rem/hr

T = time worked (site labor) to remediate the area in units of person-hour

Loss of Economic Use of Property

A cost in the "other" category could include the fair market rental value or economic use for the site during the time the additional remediation work is being performed.

NorthStar ADP-CR3 ALARA POSITION PAPER

PARAMETERS

For performing these calculations, acceptable values for some of the parameters are shown in Table 2 below:

Table 2 Parameter Values for use in the ALARA Analysis

Parameter	Value	Reference and Comments
Workplace accident fatality rate, F_w	1.8×10^{-8}/hr Based on 2019 data	U.S. Bureau of Labor Statistics: Census of Fatal Occupational Injuries Summary (ML22059A215) Change to Hours-Based Fatality Rates in the Census of Fatal Occupational Injuries (ML22059A217)
Transportation fatality rate, F_T	Trucks: 1.85×10^{-9} /km Based on 2019 data for large trucks	Bureau of Transportation Statistics: Truck Occupant Safety Data (ML22059A218 and ML22059A220)
Value of averted dose, V_{AD}, and value of statistical life, V_{SL} (Dollars per person-rem)	$5200 note: value is updated periodically	NUREG/BR-0058, NUREG-1530. It is important to verify the current values (see Section N.3.2.1)
Monetary discount rate, *r*	0.03/y and 0.07/y discount rates, with special considerations for intergenerational consequences (as discussed in Section N.3.2.1)	NUREG/BR-0058
Number of years of exposure, *N*	Buildings: 70 years Soil: 1,000 years	NUREG-1496, Volume 2, Appendix B, Table A. 1
Population density, P_D	Building:0.09 person/m^2 Land:0.0004 person/m^2	NUREG-1496, Volume 2, Appendix B, Table A.1
Excavation, monitoring, packaging, and handling soil	1.62 person-hours/m^3 of soil	NUREG-1496, Volume 2, Appendix B, Table A.1
Waste shipments volume, V_{SHIP}	Truck: 13.6 m^3/shipment	NUREG-1496, Volume 2, Appendix B, Table A.1

Attachment 1 CR3 GENERIC ALARA Evaluation

Survey Area:	**Survey Unit:**

A. Estimation of Total Cost ($Cost_T$)

1. Cost of performing remediation work (*$Cost_R$*) $14.00	$14.00
2. Cost of waste disposal ($Cost_{WD}$) = (2.a) x (2.b) a. estimated waste volume 1 m3 b. cost of waste disposal $215.38 $/m3	$215.38
3. Cost of workplace accident ($Cost_{ACC}$) = $9,000,000 person · 1.8 x 10^{-8}/h · (3.a) a. time to perform remediation action 1 person-hours	$0.16
4. Cost of traffic fatality ($Cost_{TF}$) = {$9,000,000 · 1.85 x 10^{-8}/km · (2.a) · (4.a)}/(4.b) a. total distance traveled per shipment 2250 km (WCS - Andrews, Texas) b. waste volume per shipment 13.6 m^3, if unknown, use 13.6m^3 as a default value	$2.75
5. Cost of worker dose ($Cost_{WDose}$) = $5,200 per person-rem · (5.a) · (5.b) a. worker TEDE rate 0.001 Rem/hr b. remediation exposure time 10 person-hour	$52.00
$Cost_T$	*$284.30*

B. Survey Unit Radiological Information

	Radionuclide	*Average Concentration*	*Relative Fraction*[a]	*Half-life (y)*	*Decay Constant*[b] *(y-1)*
1.	Cs-137	a. 14.39	b. 9.14E-01	c. 30.25	d. 0.02
2.	Co-60	a. 1.35	b. 8.57E-02	c. 5.27	d. 0.13
3.		a.	b.	c.	d.
4.		a.	b.	c.	d.
5.		a.	b.	c.	d.
6.		a.	b.	c.	d.
7.		a.	b.	c.	d.
8.		a.	b.	c.	d.

Total Concentration: 1.57E+01

[a] Relative fraction = average concentration divided by the total concentration.

[b] Decay constant = 0.693 divided by half-life.

C. Survey Unit Radiological Information

1. Removable fraction for remediation action being evaluated: 1
2. Monetary discount rate: 0.07 y^{-1}
3. Number of years over which the collected dose is calculated: 1000 y
4. Population density for the critical group: 0.0004 person/m^2 or people/m^2
5. Survey unit area: 1 m^2

6. AL for each radionuclide-of-interest:

a. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.1.d)/(1-EXP(-1*(C.2+B.1.d · C.3} · {B.1.b} =	508
b. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.2.d)/1-EXP(-1*(C.2+B.2.d) · C.3} · {B.2.b} =	1102
c. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.3.d)/1-EXP(-1*(C.2+B.3.d) · C.3} · {B.3.b} =	
d. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.4.d)/1-EXP(-1*(C.2+B.4.d) · C.3} · {B.4.b} =	
e. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.5.d)/1-EXP(-1*(C.2+B.5.d) · C.3} · {B.5.b} =	
f. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.6.d)/1-EXP(-1*(C.2+B.6.d) · C.3} · {B.6.b} =	
g. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.7.d)/1-EXP(-1*(C.2+B.7.d) · C.3} · {B.7.b} =	
h. AL = {CostT/($5200 · C.1 · 0.025 ·C.4 · C.5)} · {(C.2 + B.8.d)/1-EXP(-1*(C.2+B.8.d) · C.3} · {B.8.b} =	
7. Sum of ALs (=ALARA AL) =	1610

D. ALARA Evaluation

	Radionuclide	*DCGL*		*DCGL Fraction*[a]
1.	*Cs-137*	*a.* *18.4*	*b. (B.1.a)/(D.1.a) =*	*0.782*
2.	*Co-60*	*a.* *5.13*	*b. (B.2.a)/(D.2.a) =*	*0.263*
3.		*a.*	*b. (B.3.a)/(D.3.a) =*	
4.		*a.*	*b. (B.4.a)/(D.4.a) =*	
5.		*a.*	*b. (B.5.a)/(D.5.a) =*	
6.		*a.*	*b. (B.6.a)/(D.6.a) =*	
7.		*a.*	*b. (B.7.a)/(D.7.a) =*	
8.		*a.*	*b. (B.8.a)/(D.8.a) =*	
9.			Sum of DCGL Fractions =	*1.05*

a DCGL fraction = average residual concentration in survey unit (from Section B) divided by the DCGL.

10. Comparison of the sum of the DCGL fractions (D.9) to ALARA AL (C.7):
Check one: Sum of the DCGL Fractions < ALARA AL ☑ Sum of the DCGL Fractions > ALARA AL ☐

11. **Decision Criteria:** If the sum of the DCGL fractions < AL, then additional remediation is not cost beneficial. If the sum of the DCGL fractions is > AL, then additional remediation is cost beneficial.

Check One:

Additional remediation **IS NOT** cost beneficial. ☑

Additional remediation **IS** cost beneficial. ☐

Prepared by: Marshall H Blake *Marshall Blake* Date: 09/23/2022
FSS Engineer (Print Name/Sign)

Prepared by: Chuck Burtoff *Chuck Burtoff* Chuck Burtoff (Sep 26, 2022 05:52 EDT) Date: 09/26/2022
FSS Engineer (Print Name/Sign)

Reviewed by: Bryant Akins *Bryant Akins* Date: 09/26/2022
Resident CHP (Print Name/Sign)

Reviewed by: Martin Erickson *Marty Erickson* Date: 09/26/2022
FSS Engineer (Print Name/Sign)

Excel spreadsheet V&V by: Gordon Madison *Gordon Madison* Gordon Madison (Sep 26, 2022 07:02 EDT) Date: 09/26/2022
Site Closure Manager (Print Name/Sign)

Table of Contents

5.0 FINAL STATUS SURVEY PLAN [NUREG-1700, Revision 2, Section 2.5]

5.1 Introduction to the Final Status Survey Plan [NUREG-1700, Revision 2, Section 2.5]

The Crystal River Unit 3 Nuclear Power Station (CR3) Final Status Survey (FSS) Plan has been prepared using the applicable regulatory and industry guidance as listed in previous chapters. Survey results are documented by survey unit in corresponding survey packages.

5.1.1 Purpose

The FSS Plan describes the final survey process used to demonstrate that the CR3 facility and site comply with radiological criteria for unrestricted use specified in 10 CFR 20.1402 (i.e., annual dose limit of 25 millirem as well as ensure dose will be As Low As Reasonably Achievable (ALARA) for all dose pathways). Nuclear Regulatory Commission (NRC) regulations applicable to radiation surveys are found in 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 50.82(11)(ii), and 10 CFR 20.1501(a) and (b).

5.1.2 Scope

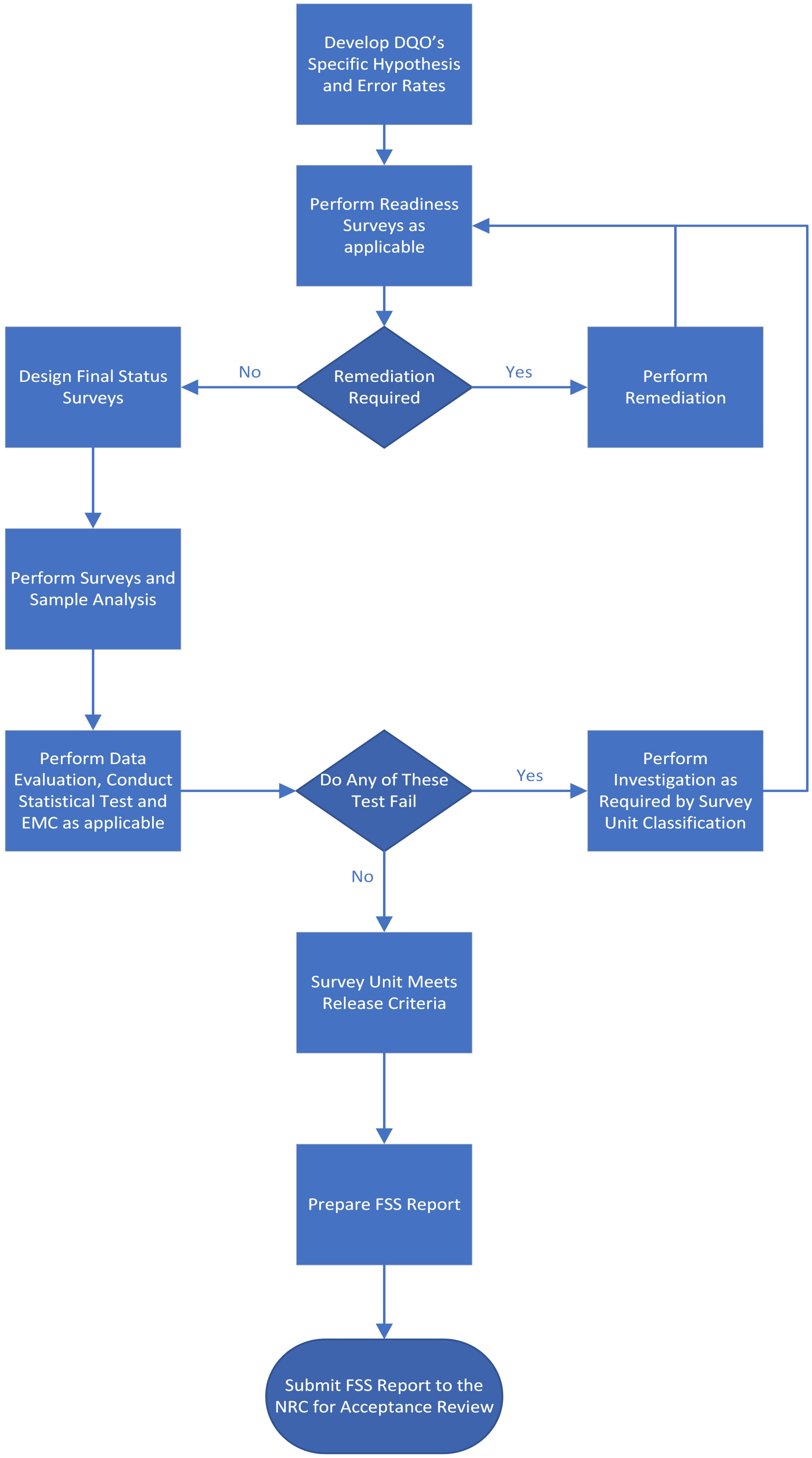
ADP-CR3 intends to release site land from the 10 CFR Part 50 license. An Independent Spent Fuel Storage Installation (ISFSI) located on the site will remain under the 10 CFR Part 50 license until such time the spent fuel is transferred to an approved national repository. This Plan addresses facilities and land areas identified as contaminated or potentially contaminated (impacted) resulting from CR3 plant operations, as well as non-impacted CR3 areas.

5.1.3 Final Status Survey Preparation and Implementation Overview

The FSS Plan contained in this chapter will be used as the basis for developing FSS procedures and applying existing procedures to the FSS process (Figure 5-1). Section 5.1.4 contains a list of regulatory documents used in preparing the FSS Plan. Quality assurance requirements, which are outlined in Section 5.8, apply to activities associated with FSS.

An FSS Package will be produced for each survey unit; the survey package is a collection of documentation detailing survey design, survey implementation, and data evaluation for the FSS. The following sections describe specific elements of the organization, preparation, and implementation of the CR3 FSS. All processes associated with final status surveys will be conducted in accordance with approved site procedures.

Figure 5-1 FSS Process Overview



5.1.3.1 FSS Organization

The general FSS organization will consist of the Site Radiation Protection Manager, the CR3/VY FSS Engineering Supervisor, FSS Engineers, FSS Foreman, and FSS technicians. Since the License Termination organization has not been fully implemented at the time of License Termination Plan (LTP) development, it is expected that specific job titles may vary over the period of project execution. These titles are used within this document to describe various functional areas of responsibility. Section 5.8.1.1 outlines the basic responsibilities and functions of the FSS organization.

5.1.3.2 Survey Preparation

Survey preparation is the first step in the FSS process and occurs after any necessary remediation or other area preparation has been completed. In areas where remediation is required, a remediation survey or equivalent evaluation will be performed to confirm that remediation was successful prior to initiating FSS activities. Remediation surveys, turnover surveys, or equivalent evaluation for areas not requiring remediation may be performed by a qualified senior RP or FSS technician using the same process and controls as FSS so that data from these surveys may be used as part of the FSS data. In order for survey data to be used for FSS, it will be designed and collected in compliance with approved procedures and in accordance with Sections 5.3 through 5.5 or as specified by the License.

Additionally, the area will be controlled in accordance with approved procedures. Any surveys performed prior to the NRC approval of the LTP are understood to have been performed "at risk.” Survey design and the data collected will be carefully evaluated to ensure the intent of the LTP and associated procedures were met before using the data. Following turnover/remediation surveys (if required) or post-remediation evaluation, the FSS is performed. Areas to be surveyed are isolated and/or controlled to ensure that radioactive material is not reintroduced into the area from ongoing activities nearby and to maintain the "as left" condition of the area. Section 5.2 addresses specific survey preparation requirements and considerations. All tools and equipment that would impede the survey must be removed, all decommissioning activities must be complete, the area must be free of decommissioning debris, and other obstructions to the survey, and the area must be in a condition that will allow FSS activities.

Routine access, material storage, and worker transit through the area are not allowed, unless authorized in writing by the FSS Engineering Supervisor, or designee. An inspection of the area is conducted by FSS personnel to ensure that work is complete, and the area is ready for final status survey.

Approved procedures provide isolation and control measures until the area is released for unrestricted use. After FSS activities are complete, the area can be backfilled if needed.

5.1.3.3 Survey Design

The survey design process establishes the methods and performance criteria used to conduct the survey. Survey design assumptions are documented in Survey Packages for each survey unit in accordance with approved procedures.

The site land, structures, and systems are organized into survey areas and classified by contamination potential as Class 1, Class 2, Class 3, or non-impacted in accordance with Section 5.2.2. See Chapter 2 for illustrative representations of the CR3 survey areas. Survey unit size is based on the assumptions in the dose assessment models in accordance with the guidance provided in NUREG-1757, Volume 2, *"Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, Final Report."* The percent coverage for scan surveys is determined in accordance with Section 5.3.2.

The number and location of structure surface measurements (and structure volumetric samples, if required) and soil samples are established in accordance with Sections 5.3.3 and 5.3.5. Investigation levels are established in accordance with Section 5.3.6. A survey map is prepared for each survey unit and a reference grid is superimposed on the map to allow use of an (x, y) coordinate system, or a map is generated using Visual Sample Plan (VSP) software with the survey locations identified. Random numbers between 0 and 1 are generated, which are then multiplied by the maximum x and y axis values of the sample grid. This provides coordinates for each random sample location, or a random start location for a systematic grid, as appropriate. Grid points may be automatically designated on the map, with grid locations, if generated, using VSP. The measurement and sample locations are plotted on the map. Each measurement/sample location is assigned a unique identification code, which identifies the measurement/sample by survey area, survey unit, and sequential number. The appropriate instruments and detectors, instrument operating modes, and survey methods used to collect and analyze data are also specified.

Replicate measurements are performed as part of the quality process established to identify, assess, and control errors and uncertainty associated with sampling, survey, or analytical activities. This quality control process, described in Section 5.8.1, provides assurance that the survey data meet the accuracy and reliability requirements necessary to support the decision to release or not release a survey unit.

Written survey instructions that incorporate the requirements set forth in the survey design and direction are provided, as applicable to survey design, for selection of instruments, count times, instrument modes, survey methods, required documentation, investigation set points, investigative actions, background requirements, and other appropriate instructions. In conjunction with the survey instructions, survey data forms may be prepared to assist in survey documentation as well as using the data-logging capabilities of the instruments.

The survey design is reviewed, and quality verification steps applied to ensure that appropriate instruments, survey methods, and sample locations have been properly identified. A two-tiered review process will be used with a review by a peer Engineer and a review and approval by the FSS Engineering Supervisor, or designee.

5.1.3.4 Survey Data Collection

After preparation of a survey package, the FSS data are collected. Trained and qualified personnel will perform the necessary measurements using calibrated instruments in accordance with approved procedures and instructions contained in the survey package. Section 5.5 addresses FSS data collection requirements. Survey areas and/or locations are identified by gridding, markings, or flags as appropriate. An FSS Engineer, or qualified designee, performs a pre-survey briefing with the survey technicians during which the survey instructions are reviewed, and additional survey unit considerations are discussed (e.g., safety).

The technicians gather instruments and equipment as indicated and perform surveys in accordance with the appropriate procedures and survey package specifications. Technicians are responsible for documenting survey results and maintaining custody of samples and instrumentation. At the completion of surveys, technicians return instruments and prepare samples for analysis. Survey instruments provided to the technicians are prepared in accordance with approved site procedures and the survey instructions.

Instrument calibration, except for onsite lab instrumentation, is performed either onsite or by an offsite vendor and performance checks are conducted in accordance with applicable site procedures.

Data are reviewed to flag any measurements that exceed investigation criteria so that appropriate investigation surveys can be performed, and any required remediation can be planned and performed as necessary. Corrective action documents will be initiated as necessary to document problems and to implement appropriate corrective actions.

If a survey unit has been selected to receive a Quality Control (QC) survey (replicate surveys, etc.), a QC survey package is developed and implemented. QC measurement results are compared to the original measurement results. If QC results do not reach the same conclusion as the original survey, an investigation is then performed.

5.1.3.5 Data-Assessment

Survey data assessment is performed to verify that the data are sufficient to demonstrate that the survey unit meets the unrestricted use criterion. Statistical analyses are performed on the data and compared to predetermined investigation levels (see Section 5.3.6). Depending on the results of the data assessment and any required investigation, the survey unit may either be released or require further remediation, reclassification, and/or resurvey. Assumptions and requirements in the survey package are reviewed for applicability and completeness; additional data needs are identified during this review.

Specific data assessment requirements are contained in Section 5.6. A review is performed of survey data and sample counting reports to verify completeness, legibility, and compliance with survey design and associated instructions.

As directed by the FSS Engineering Supervisor, or designee, the following types of activities may be performed:

- Convert data to reporting units
- Calculate mean, median and range of the data set
- Review the data for values that vary more than three standard deviations from the data mean
- Calculate the standard deviation of the data set
- Calculate Minimum Detectable Concentration (MDC) for each survey type performed
- Create posting, frequency, and quartile plots for visual interpretation of data

Computer programs may be used for these activities if they have been approved by the FSS Engineering Group, or designee. FSS personnel include data quality verifications in their evaluations of statistical calculations. Integrity and usefulness of the data set and the need for further data or investigation are also included in the evaluations. The FSS Engineering Group, or designee, will review the data for statistical evaluation. The results of the data evaluation are documented and filed in the survey package.

5.1.3.6 Final Status Survey Package Completion

Survey results are documented by survey unit in corresponding survey packages. The data are reviewed, analyzed, and processed and the results documented in the FSS Package. This documentation file provides a record of the information necessary to support the decision to release the survey units for unrestricted use. The FSS Reports will be prepared to provide the necessary data and analyses from FSS packages for submittal to the NRC. Section 5.7 addresses FSS reporting and conclusions.

5.1.4 Regulatory Requirements and Industry Guidance

This FSS Plan has been developed using the guidance listed in Section 5.9. ADP-CR3 anticipates that the NRC may choose to conduct confirmatory measurements during FSS activities to make a determination that the FSS and associated documentation demonstrate that the site is suitable for release in accordance with the criteria in 10 CFR Part 20 Subpart E.

5.2 Development of the Survey Plan
[NUREG-1700, Revision 2, Section 2.5 and Appendix A, Section A.4], [NUREG-1757, Volume 2, Revision 2, Section 4, and Section 5]

5.2.1 Radiological Status

The following sections provide a summary of site characterization and dose modeling results applicable to development of the CR3 FSS Plan.

5.2.1.1 Identification of Radiological Contaminants

A site-specific suite of radionuclides potentially present at CR3 has been developed. This suite contains 19 radionuclides that are potentially present in CR3 environs, structures, and systems/components. Development of this site-specific suite of radionuclides is described in Chapter 6, "Compliance with the Radiological Criteria for License Termination," Section 6.2.

ADP-CR3 has conducted radiological characterization of the site property to identify and document residual contamination resulting from nuclear plant operation and decommissioning activities. The effort included reviews of historical information as well as physical measurements of onsite soils, structures, and systems during scoping and characterization surveys. Chapter 2, Site Characterization, contains a detailed discussion of this effort.

5.2.1.2 Dose Modeling Summary

Dose models allow the translation of residual radioactivity levels into potential radiation doses to the public. For the CR3 site, dose models have been developed based on the guidance found in NUREG/CR-5512, Volumes 1, 2, and 3. The dose modeling summary is addressed in Chapter 6.

Table 5.1 provides a list of significant radionuclides that may be present in onsite soils and on structural surfaces along with their corresponding single nuclide DCGL values derived in Chapter 6. The DCGL values have been rounded down to two significant figures.

Table 5.1 DCGLs by Radionuclide and Medium Type

Nuclide	Building Surface (dpm/100 cm^2)	Soils (pCi/g)
Am-241	1.70E+03	2.00E+02
C-14	6.40E+06	7.00E+01
Cm-243	2.40E+03	7.60E+01
Cm-244	3.00E+03	2.60E+02
Co-60	1.40E+04	5.10E+00
Cs-137	4.70E+04	1.80E+01
Eu-152	2.70E+04	1.10E+01
Eu-154	2.60E+04	1.00E+01
Fe-55	3.80E+07	7.30E+04
H-3	2.10E+08	4.40E+04
Nb-94	2.60E+04	7.80E+00
Ni-59	3.40E+07	1.10E+04
Ni-63	1.60E+07	4.00E+03
Pu-238	1.90E+03	1.70E+02
Pu-239	1.70E+03	1.40E+02
Pu-240	1.70E+03	1.40E+02
Pu-241	6.80E+04	6.20E+03
Sr-90	8.10E+04	1.40E+01
Tc-99	5.00E+06	2.30E+02

5.2.1.3 Surrogate Ratio DCGLs

Because of the potential variability of radionuclide concentrations across the CR3 site, and the difficulty to ascertain consistent nuclide ratios, ADP-CR3 does not expect to employ surrogate DCGLs.

5.2.1.4 Post-Remediation Surveying

Post-remediation surveying will be accomplished utilizing instrumentation and methodologies consistent with FSS surveying:

- Field screening will be performed using a Ludlum Model 2241, or equivalent instruments with NaI detectors. Scanning rates will be determined so that activity at the DCGL will be detected. Scanning may be performed using the In Situ Object Counting System (ISOCS) provided the assay sensitivity allows for the detection of activity at the DCGL.

- Field sampling analysis will be performed to the MDC criteria addressed in Section 5.5.3.

The remedial action support survey relies on a simple radiological parameter, such as direct radiation near the surface (i.e., surface scans using a Model 44-10 NaI detector or equivalent), as an indicator of effectiveness.

The investigation level (the level below which there is an acceptable level of assurance that the established DCGLs have been attained) is determined and used for immediate in-field decisions. There will be radionuclides and media that cannot be evaluated at the DCGL using field monitoring techniques. For these cases, field samples will be collected, analyzed, and compared to the release DCGLs. Characterization surveys will be performed of the remediated areas to the rigors of FSS to determine if the area is ready for a FSS (i.e., the area will pass an FSS).

5.2.1.5 Gross Activity DCGLs

As a rule, gross activity DCGLs ($DCGL_{GA}$) are developed and applied to structures and plant systems with surface residual radioactivity where multiple radionuclides are present at concentrations that exceed 10 percent of their respective DCGLs. The $DCGL_{GA}$ is determined in a manner similar to surrogate DCGLs, taking into account nuclide detectability to enable field measurement of gross activity, rather than the determination of individual radionuclide activity, for comparison to the radionuclide specific DCGL. The $DCGL_{GA}$**,** for all surfaces with multiple radionuclides are calculated using the following Equation 5-1.

Equation 5-1 Gross Activity DCGL Calculation

$$DCGL_{GA} = \frac{1}{\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \cdots \frac{f_n}{DCGL_n}}$$

Where:

f_n= fraction of the total activity contributed by n^{th} radionuclide
$DCGL_n$ = DCGL for n^{th} radionuclide

Different radionuclides or radionuclide combinations may exist on different portions of the site and require the calculation of one or more site-specific $DCGL_{GA}$. $DCGL_{GA}$ are calculated using the relative nuclide fractions determined from samples of building surface or plant system material, as appropriate, prior to remediation. For areas where the radionuclide distribution has not been determined, the most conservative distribution resulting in the lowest DCGL of those specified areas will be used. The distributions are based on the radionuclides identified in samples collected from the specific areas prior to FSS.

If new radionuclide distribution data are obtained and determined to be more appropriate for use, the $DCGL_{GA}$ may be reevaluated and altered during the course of the FSS; however, the single nuclide DCGLs will not be revised without NRC approval.

5.2.2 Classification of Areas

Prior to beginning the FSS, a characterization of the radiological status and historical review of the site was performed. Additional data may be collected and evaluated throughout the decommissioning. The methods and results from site characterization are described in Chapter 2. Based on the characterization results, the structures and open land areas were classified following the guidance in Appendix A, of NUREG-1757, Volume 2 and Section 4.4 of NUREG-1575. Area classification ensures that the number of measurements and the scan coverage is commensurate with the potential for residual contamination to exceed the unrestricted use criteria.

Initial classification of site areas is based on historical information and site scoping and characterization data. Data from operational surveys performed in support of decommissioning, routine surveillance, or any other applicable survey data may be used to change the initial classification of an area up to the time of commencement of the FSS for that area as long as the classification reflects the levels of residual radioactivity that existed prior to remediation.

Once the FSS of a given survey unit begins, the basis for any reclassification will be documented, requiring a redesign of the survey unit package, if required (e.g., a Class 3 to a Class 2) and the initiation of a new survey using the redesigned survey unit package. If during the conduct of a FSS, sufficient evidence is accumulated to warrant an investigation and reclassification of the survey unit, in accordance with Section 5.3.6, the FSS may be terminated without completing the current survey unit package.

Reclassification to a more restrictive classification will be performed in accordance with Section 5.3.6.4 of the LTP. New DQOs will be developed with a new survey plan. Reclassification to a more restrictive classification does not require prior NRC notification provided that the Type I error is not increased. The reclassification will be addressed in the new survey plan, as well as the final report on the survey area.

5.2.2.1 Non-impacted Areas

Non-impacted areas have no reasonable potential for residual contamination because there was no demonstrable impact from site operations. These areas are not required to be surveyed beyond what has already been completed as a part of the Historical Site Assessment (HSA) as described in Chapter 2, or scoping/site characterization surveys performed to confirm the area's non-impacted classification.

5.2.2.2 Impacted Areas

Impacted areas may contain residual radioactivity from licensed activities. Based on the levels of residual radioactivity present, impacted areas are further divided into Class 1, Class 2, or Class 3 designations. The following definitions are from NUREG-1757, Volume 2, Page A-2.

- **Class 1 Areas**: Class 1 areas are impacted areas that are expected to have concentrations of residual radioactivity that exceed the derived concentration guideline level or $DCGL_W$ (average concentrations over a wide area).
- **Class 2 Areas**: Class 2 areas are impacted areas that are not likely to have concentrations of residual radioactivity that exceed the $DCGL_W$.
- **Class 3 Areas**: Class 3 areas are impacted areas that have a low probability of containing residual radioactivity.

If the available information is not sufficient to designate an area as a particular class, the area will either be classified as Class 1 or be further characterized. Areas that are considered to be on the borderline between classes will receive the more restrictive classification.

5.2.2.3 Initial Classification of Structural Surfaces and Land Areas

All land areas and structural surfaces to remain after decommissioning were assigned an initial classification. Characterization was performed and reported by initial survey area designation.

The area designations developed for the characterization process were used, for the most part, to delineate and classify areas for FSS. This allows characterization data to be efficiently used for final survey area classification and for estimating the sigma value for sample size determination. For operational efficiency, each of the final survey areas listed in Chapter 2, Table 2.3, may be subdivided into multiple survey units. The classification of all subdivided survey units will be the same as indicated in Chapter 2, Table 2.3, unless reclassified in accordance with this LTP.

No individual survey unit will have more than one classification. Areas within the Restricted Area (RA) will require further characterization once demolition activities are in progress.

5.2.2.4 Changes in Classification

Data from operational surveys performed in support of decommissioning, routine surveillance, and any other applicable survey data may be used to change the initial classification of an area up to the time of commencement of the FSS for that area as long as the classification reflects the levels of residual radioactivity that existed prior to remediation.

Survey units within initial survey areas may be upgraded in classification due to future requirements for lay down and storage areas during demolition activities or incorrect initial classification. If during FSS, sufficient evidence is accumulated to warrant an investigation and reclassification of the survey unit in accordance with Section 5.3.6, the survey may be terminated without completing the current survey unit package.

5.2.3 Establishing Survey Units

The survey units contained within the survey areas are divisions that have similar characteristics and contamination levels. Survey units are assigned only one classification. The site is surveyed and evaluated on a survey unit basis. The site is released on a survey area basis (i.e., through survey area FSS reports).

5.2.3.1 Survey Unit Size

Survey unit sizes will be selected based on area classification, survey execution logistics, and applicable regulatory guidance documents. Typical survey unit sizes for structural surfaces and open land area soil are listed in Table 5.2.

Survey unit sizes are consistent with NUREG-1575. Class 1 and 2 areas provided in Chapter 2, Table 2.3, may be further subdivided into smaller areas to meet the guidelines present in Table 5.2. If a survey unit area is larger than the Class 1 or 2 area sizes in Table 5.2, a technical evaluation will be presented in the FSS Package for the specific survey unit justifying the survey unit size.

Table 5.2 Suggested Survey Unit Sizes

Class	Structural Surfaces*	Open Land Soil Area
1	100 m^2	2,000 m^2
2	100 to 1,000 m^2	2,000 to 10,000 m^2
3	No Limit	No Limit

*Based on floor area

5.2.3.2 Reference Coordinate System for Open Land Areas (Reference Grid)

A reference coordinate system is used for impacted areas to facilitate the identification of sample points within the survey unit. The reference coordinate system is basically an X-Y plot of the site area referenced to a fixed structure(s) on the site (e.g., the corner of a building) or by the utilization of a Global Positioning System (GPS) referenced to Florida State Plane Coordinate System (SPCS). The metadata used is North American Datum (NAD83). Elevations are in North American Vertical Datum (NAVD88). Once the reference points are established, grids may be overlaid parallel to lines of latitude and longitude.

5.2.4 Access Control Measures

5.2.4.1 Turnover

Due to the scope of decommissioning activities, it is anticipated that some surveys will be performed in parallel with dismantlement activities. This will require a systematic approach to be established to turn over the survey areas. Prior to acceptance of a survey unit for FSS, the following conditions must be satisfied in accordance with applicable procedures:

- Decommissioning activities having the potential to contaminate a survey unit shall be complete or measures taken to eliminate such potential.
- Tools and equipment that would impede the FSS of the survey must be removed, and housekeeping and cleanup shall be complete.
- Decontamination activities in the area shall be complete.
- Decommissioning activities in the area should be completed and all decommissioning debris removed from the area before turning the area over for survey.
- Access control or other measures to prevent recontamination must be implemented.
- Turnover or remediation surveys may be performed and documented to the same standards as FSS to allow that data to be used for the FSS.

When an area is turned over for FSS, an FSS Area Turnover Sheet will be initiated. The Radiation Protection Manager (RPM), FSS Engineering group, or designee will ensure all decommissioning activities in areas either adjacent to the area to be isolated, or that could otherwise impact it, are either complete or deemed not to have the potential to spread plant-related radioactive material to the area.

The RPM, or designee will determine what combination of measures will be employed to prevent recontamination of the FSS area in accordance with CR3 procedure NS-FSS-04.

A combination of personnel training (General Employee Training), postings (NS-FSS-04) and periodic surveillance surveys (NS-FSS-13) are some of the measures routinely employed.

5.2.4.2 Walkdown

The principal objective of the walkdown is to assess the physical scope of the survey unit. The walkdown ensures that the area has been left in the necessary configuration for FSS or that any further work has been identified. The walkdown provides detailed physical information for survey design. Details such as structural interferences or areas requiring special survey techniques can be determined.

Specific requirements will be identified for accessing the survey area and obtaining support functions necessary to conduct FSS, such as interference removal or dewatering. Industrial safety and environmental concerns will also be identified during this walkdown.

5.2.4.3 Transfer of Control

Once a walkdown has been performed and the turnover requirements have been met, access control becomes the responsibility of the FSS group. Access control and isolation methods are described in the following subsection.

5.2.4.4 Isolation and Control Measures

Since all site decommissioning activities will not be completed prior to the start of the FSS, measures will be implemented to protect survey units from contamination during and subsequent to the FSS.

Decommissioning activities creating a potential for the spread of contamination will be completed within each survey unit prior to the FSS. Additionally, decommissioning activities that create a potential for the spread of contamination to adjacent areas will be evaluated and controlled.

Upon commencement of the FSS for survey units where there is a potential for recontamination, implementation of control measures will be required as needed for appropriate area control. To include but not limited to installation of barriers and postings to control access to surveyed areas to prevent the migration of contamination from adjacent or overhead areas from water runoff, etc.

Periodic surveillance/inspection to monitor and verify adequacy of isolation and control measures and Installation of postings restricting the introduction of radioactive materials into the area. Periodic surveillance/inspections will not be required for open land areas that are not normally occupied and are unlikely to be impacted by decommissioning activities.

If the periodic surveillance/inspection indicates that the adequacy of isolation and control measures has been compromised with the potential for recontamination of the area, post-FSS radiation survey locations will be selectively determined for survey, based on technical or site-specific knowledge and current conditions present in or near the survey area.

The selected locations will be surveyed using the same instruments and techniques used for the FSS, and the results will be compared with those obtained during the FSS to determine whether the area had been re-contaminated. The primary function of these surveys is to detect the potential migration of contaminants from decommissioning activities taking place in adjacent areas.

5.3 Survey Design and Data Quality Objectives
[NUREG-1700, Revision 2, Section 2.5.1 and Appendix A, Section A.4], [NUREG-1757, Volume 2, Revision 2, Section 3.2]

This section describes the methods and data required to determine the number and location of measurements or samples in each survey unit and the coverage fraction for scan surveys. The design activities described in this section will be documented in a survey package for each survey unit. Survey design considers the following:

- Type I and II Errors
- Scan Survey Coverage
- Sample Size Determination
- Instrumentation and Required Minimum Detectable Concentrations MDCs
- Sample Location
- DCGL and $DCGL_{EMC}$ ($DCGL_{EMC}$ is defined in Section 5.3.6.3)

5.3.1 Data Quality Objectives (DQOs)

The appropriate design for a given survey area is developed using the DQO process as outlined in MARSSIM, Appendix D. These seven steps are:

1. State the problem
2. Identify the decision
3. Identify inputs to the decision
4. Define the study boundaries
5. Develop a decision rule
6. Specify limits on decision errors
7. Optimize the design for obtaining data

The DQO process will be used for designing and conducting all final status surveys at CR3. Each survey package will contain the appropriate information, statistical parameters, and contingencies to support the DQO process.

5.3.2 Scan Survey Coverage

The area covered by scan measurement is based on the survey unit classification as described in NUREG-1757, and as shown in Table 5.3. The accessible area scan required of Class 1 survey units will be 100 percent.

For Class 2 survey units, the emphasis will be placed on scanning the higher risk areas such as soils, floors, and lower walls. Scanning percentage of Class 3 survey units will be performed on likely areas of contamination based on the judgment of the FSS Engineer. The FSS Engineer has the discretion to increase the scan coverage beyond 10 percent, if desired.

Table 5.3 Scan Survey Coverage Requirements

	Class 1	Class 2	Class 3
Scan Coverage	100%	10-100%*	Judgmental (1-10%)

* For Class 2 Survey Units, the amount of scan coverage will be proportional to the potential for finding areas of elevated activity or areas close to the release criterion in accordance with MARSSIM Section 5.5.3.

Accordingly, CR3 will use historical information and the results of individual measurements collected during characterization to correlate this activity potential to scan coverage levels.

5.3.3 Sample Size Determination

NUREG-1757, Volume 2, Appendix A, describes the process for determining the number of survey measurements necessary to ensure a data set sufficient for statistical analysis. Sample size is based on the relative shift, the Type I and II errors, standard deviation, and the specific statistical test used to evaluate the data.

5.3.3.1 Determining Which Statistical Test Will Be Used

Appropriate tests will be used for the statistical evaluation of survey data. Tests such as the Sign test and Wilcoxon Rank Sum (WRS) Test will be implemented using unity rules, surrogate methodologies, or combinations of unity rules and surrogate methodologies, as applicable, as described in MARSSIM and NUREG-1505 Chapters 11 and 12.

If the contaminant is not in the background or constitutes a small fraction of the DCGL, the Sign Test will be used. If background is a significant fraction of the DCGL, the WRS Test will be used.

5.3.3.2 Establishing Decision Errors

The probability of making decision errors is controlled by hypothesis testing. The survey results will be used to select between one condition of the environment (the null hypothesis) or an alternate condition (the alternative hypothesis). These hypotheses, chosen for MARSSIM Scenario A, are defined as follows:

- Null Hypothesis (H_o): The survey unit does not meet the release criteria.
- Alternate Hypothesis (H_a): The survey unit does meet the release criteria.

CR3 will use the Null Hypothesis concept in the design of all final status surveys.

A Type I decision error would result in the release of a survey unit containing average residual radioactivity above the release criteria. The Type I decision error occurs when the Null Hypothesis is rejected when it is true. The probability of making this error is designated as "α".

A Type II decision error would result in the failure to release a survey unit when the average residual radioactivity is below the release criteria. This occurs when the Null Hypothesis is accepted when it is not true. The probability of making this error is designated as "β".

Appendix E of NUREG-1757, Volume 2, recommends using a Type I error probability (α) of 0.05 and states that any value for the Type II error probability (β) is acceptable. Following the NUREG-1757, Volume 2, guidance, α will be set at 0.05 and β of 0.05 will be selected initially, based on site-specific considerations. The β may be modified, as necessary, after weighing the resulting change in the number of required survey measurements against the risk of unnecessarily investigating and/or remediating survey units that are truly below the release criteria.

5.3.3.3 Relative Shift

The relative shift (Δ /σ) is calculated. Delta (Δ) is equal to the DCGL minus the Lower Boundary of the Gray Region (LBGR). Calculation of sigma (σ) is discussed in Section 5.3.3.5. The sigma values used for the relative shift calculation may be recalculated based on the most current data obtained from post-remediation or post-demolition surveys or from background reference areas, as appropriate. The LBGR is initially set at 0.5 times the DCGL, but may be adjusted to obtain an optimal value, normally between 1 and 3 for the relative shift.

5.3.3.4 Lower Boundary of the Gray Region

The LBGR is the point at which the Type II (β) error applies. The default value of the LBGR is set initially at 0.5 times the DCGL. If the relative shift is greater than 3, then the number of data points, N, listed for the relative shift values of 3 from Table 5.5 or Table 5.3 in MARSSIM, will normally be used as the minimum sample size. If the minimum sample size results in a sample density less than the required minimum density, the sample size will be increased accordingly.

5.3.3.5 Standard Deviation (Sigma)

Sigma values (estimate of the standard deviation of the measured values in a survey unit and/or reference area) were initially calculated from characterization data or, if data are not available, use a coefficient of variation of 30% per MARSSIM. These sigma values can be used in FSS design or more current post-remediation sigma values can be used. The use of the sigma values from the characterization data will be conservative for the sample size determination since the post-remediation sigma values are expected to be smaller.

5.3.3.6 Wilcoxin Rank Sum (WRS) Test Sample Size

The number of data points, *N*, to be obtained from each reference area or survey unit are determined using Table 5.3 in MARSSIM. This table includes the recommended 20 percent adjustment to ensure an adequate sample size.

5.3.3.7 Sign Test Sample Size

The number of data points is determined from Table 5.5 in MARSSIM for application of the Sign Test. This table includes the recommended 20 percent adjustment to ensure an adequate sample size.

5.3.3.8 Elevated Measurement Comparison Sample Size Adjustment

If the Scan MDC is greater than the DCGL, the sample size will be calculated using Equation 5-2 (NUREG-1757, Equation A-8) provided below. If N_{EMC} exceeds the statistically determined sample size (N), N_{EMC} will replace N.

Equation 5-2 Elevated Measurement Sample Size Calculation

$$N_{EMC} = \frac{A}{A_{EC}}$$

Where:
N_{EMC} = the elevated measurement sample size
A = the survey unit area
A_{EC} = the area corresponding to the area factor calculated using the MDC concentration

5.3.4 Background Reference Area

Background reference area measurements are required when the WRS test is used, and background subtraction may be used with the Sign Test under certain conditions such as those described in Chapter 12 of NUREG-1505. Reference area measurements, if needed, will be collected using the methods and procedures required for Class 3 final survey units. For soil, reference areas will have a soil type as similar to the soil type in the survey unit as possible.

When there is a reasonable choice of possible soil reference areas with similar soil types, consideration will be given to selecting reference areas that are most similar in terms of other physical, chemical, geological, and biological characteristics. For structure survey units that contain a variety of materials with markedly different backgrounds, a reference area will be selected containing similar materials.

If one material is predominant, or if there is not a large variation in background among materials, a background from a reference area containing a single material is appropriate when it is demonstrated that the selected reference area will not result in underestimating the residual radioactivity in the survey unit.

It is understood that background reference areas should have physical characteristics (including soil type and rock formation) similar to the site and shall not contain areas contaminated by site activities. Offsite areas (outside the Owner Controlled Area) should be chosen to serve as background reference areas.

Should significant variations in background reference areas be encountered, appropriate evaluations will be performed to define the background concentration. As noted in NUREG-1757, Appendix A, Section A.4.4, the Kruskal-Wallis test can be conducted in such circumstances to determine that there are no significant differences in the mean background concentrations among potential reference areas. CR3 will consider this and other statistical guidance in the evaluation of apparent significant variations in background reference areas. If material background subtraction is performed, the sigma value used will account for the variability of the material background.

5.3.5 Reference Grid and Sample Location

Sample location is a function of the number of measurements required, the survey unit classification, and the contaminant variability.

5.3.5.1 Reference Grid

The reference grid is primarily used for reference purposes and is illustrated on sample maps. Physical marking of the reference grid lines in the survey unit will be performed only when necessary. For the sample grid in Class 1 and Class 2 survey units, a randomly selected sample start point will be identified.

Beginning at the random starting coordinate, a row of points is identified, parallel to the X-axis, at intervals of L. A second row of points is then developed, parallel to the first row, at a distance of 0.866 x L from the first row.

The sample and reference grids are illustrated on sample maps and may be physically marked in the field. For Class 3 survey units, all sample locations are randomly selected, based on the reference grid point(s).

GPS instruments will be used in open land areas to determine reference or sample grid locations within the survey area. Locations within a survey area also may be tied to a site United States Geological Survey (USGS) survey benchmark.

Digital cameras may be employed to provide a record of survey locations within the survey unit and will be used extensively at CR3.

5.3.5.2 Measurement Locations

Measurement locations within the survey unit are clearly identified and documented for the purpose of reproducibility. Actual measurement locations are identified by tags, labels, flags, stakes, paint marks, geopositioning units, or photographic records. An identification code matches a survey location to a particular survey unit.

Sample points for Class 1 and Class 2 survey units are positioned in a systematic pattern or grid throughout the survey unit by first randomly selecting a start point coordinate. A random number generator is used to determine the start point of the grid pattern. The grid spacing, L, is a function of the area of the survey unit as shown in Equation 5-3 (MARSSIM Equation 5-5) for a triangular grid:

Equation 5-3 Grid Spacing

$$L = \sqrt{\frac{A}{0.866\, n_{EA}}}$$

Where:
A = Area of the survey unit
n_{EA} = Calculated number of survey locations

Beginning at the random starting coordinate, a row of points is identified, parallel to the X-axis, at intervals of L. A second row of points is then developed, parallel to the first row, at a distance of 0.866 x L from the first row. Software may be used to generate grid patterns and sample/measurement locations (i.e., Visual Sample Plan (VSP)). Random measurement patterns are used for Class 3 survey units. Sample location coordinates (x and y) are randomly picked using a random number generator or VSP.

Measurement locations selected using either a random selection process or a randomly started systematic pattern that do not fall within the survey unit or that cannot be surveyed due to site conditions are replaced with other measurement locations as determined by the FSS Engineering Supervisor, FSS Engineers, FSS Foreman, or designee.

5.3.6 Investigation Levels and Elevated Areas Test

During survey unit measurements, levels of radioactivity may be identified that warrant investigation. Depending on the results of the investigation, the survey unit may require no action, remediation, and/or reclassification and resurvey. The following subsections describe the investigation process and investigation levels.

5.3.6.1 Investigation Process

During the survey process, locations with potential residual activity exceeding investigation levels are documented and marked for further investigation. The elevated survey measurement is verified by resurvey.

For Class 1 areas, size and average activity level in the elevated area is acceptable if it complies with the area factors and other criteria that may apply to evaluation of the DCGL for elevated measurements $DCGL_{EMC}$.

As discussed in Section 5.3.6.3, the $DCGL_{EMC}$ is applicable only for Class 1 areas. If any location within a Class 2 area exceeds the DCGL, scanning coverage in the vicinity is increased in order to determine the extent and level of the elevated reading(s) and the area is evaluated for reclassification.

If the elevated reading occurs in a Class 3 area, the scanning coverage is increased, and the area is evaluated for reclassification and resurvey under the criteria of the new classification. All survey unit investigations will be conducted in accordance with the applicable FSS DQOs.

Investigations should address the following items:

- The assumptions made in the survey unit classification
- The most likely or known cause of the contamination
- The effects of summing multiple areas with elevated activity within the survey unit

Depending on the results of the investigation, a portion of the survey unit may be reclassified or combined with an adjacent area with similar characteristics if there is sufficient justification. Either action would result in a resurvey of the (new) area(s). The results of the investigation process are documented in the survey package. Section 5.6 provides additional discussion regarding potential reclassification of the survey unit.

5.3.6.2 Investigation Levels

Technicians will respond to all instrument indications of elevated activity while surveying. Upon receiving an indication, the technician will stop and resurvey the last square meter of area surveyed to verify the increase. Technicians are cautioned, in training, about the importance of the verification survey and are given specific directions in the procedure as to survey extent and scan speed. If the indication is verified, the technician will mark the area with a flag or other appropriate means. Each area marked will be addressed in an investigation survey instruction prepared for the survey unit.

The instruction will specify the required actions, such as a rescan of the area, direct measurements, and collection of a soil sample (for land surveys). Each investigation will be evaluated and reported in the FSS survey area report. Investigation levels are shown in Table 5.4.

Table 5.4 Investigation Levels

Classification	Scan Investigation Levels	Direct Investigation Levels
Class 1	> $DCGL_{EMC}$	>$DCGL_{EMC}$ or >DCGL and > than a statistical parameter-based value (i.e., 3 times the σ)
Class 2	>DCGL or >MDC_{SCAN} if MDC_{SCAN} is greater than the DCGL	> DCGL
Class 3	Detectable over Background	> 0.5 DCGL

In Class 1 areas, the size and average activity level in the elevated area is determined to demonstrate compliance with the area factors. If any location in a Class 2 area exceeds the DCGL, scanning coverage in the vicinity is increased in order to determine the extent and level of the elevated reading(s).

If the elevated reading occurs in a Class 3 area, the scanning coverage is increased, and reclassification of the area will be considered.

5.3.6.3 Elevated Measurement Comparison

5.3.6.3.1 Open Land Areas and Structural Surfaces

The elevated measurement comparison is applied to Class 1 survey units when one or more verified scans or static measurement exceeds the investigation level. As stated in MARSSIM, the EMC is intended to flag potential failures in the remediation process and should not be considered the primary means to identify whether or not a survey unit meets the release criterion. The EMC provides assurance that unusually large measurements receive the proper attention and that any area having the potential for significant dose contribution is identified.

Locations identified by scan methodology or soil sample analyses measurements with levels of residual radioactivity that exceed the $DCGL_{EMC}$ are subject to additional surveys to determine compliance with the elevated measurement criteria. The size of the area containing the elevated residual radioactivity and the average level of residual activity within the area are determined. The average level of activity is compared to the $DCGL_W$ based on the actual area of elevated activity. An a priori $DCGL_{EMC}$ for the area between direct measurements (the likely size of an elevated area) is established during the survey design and is calculated as follows:

Equation 5-4 DCGL$_{EMC}$

$$DCGL_{EMC} = \text{Area Factor x DCGL}$$

The area factor is the multiple of the DCGL that is permitted in the area of elevated residual radioactivity without remediation. The area factor is related to the size of the area over which the elevated activity is distributed. The actual area is generally bordered by levels of residual radioactivity below the DCGL, and its size is determined during the investigation process. Area factor calculations are described in Chapter 6 and summarized in Tables 5.5 and 5.6. The actual area of elevated activity is determined by investigation surveys and the area factor is adjusted for the actual area of elevated activity. The product of the adjusted area factor and the DCGL determines the *a posteriori* DCGL$_{EMC}$. Additional measurements are made to determine the average activity of the elevated area, if necessary.

If the DCGL$_{EMC}$ is exceeded, the area is remediated and resurveyed. The results of the elevated area investigations in a given survey unit that are below the DCGL$_{EMC}$ limit are evaluated using Equation 5-4. If more than one elevated area is identified in a given survey unit, the unity rule with Equation 5-5 is used to determine compliance. If the formula value is less than unity, no further elevated area testing is required, and the EMC test is satisfied.

Table 5.5 Soil Area Factors

	Area Factor for Area Contaminated Zone (m^2)							
ROC	2000	1000	500	100	50	10	5	1
Am-241	1	1	2	5	7	13	18	40
C-14	1	1	4	45	124	1235	3211	25923
Cm-243	1	1	1	2	2	3	5	14
Cm-244	1	1	2	9	15	40	53	79
Co-60	1	1	1	1	1	2	4	11
Cs-137	1	1	1	1	1	2	4	12
Eu-152	1	1	1	1	1	2	3	11
Eu-154	1	1	1	1	1	2	3	11
Fe-55	1	1	3	14	28	136	264	1113
H-3	1	1	2	10	20	69	99	225
Nb-94	1	1	1	1	1	2	3	11
Ni-59	1	1	2	12	25	123	246	1203
Ni-63	1	1	2	12	25	123	246	1208
Pu-238	1	1	2	9	15	40	53	79
Pu-239	1	1	2	9	15	40	53	80
Pu-240	1	1	2	9	15	41	54	80
Pu-241	1	1	2	6	8	15	21	44
Sr-90	1	1	2	10	19	84	160	716
Tc-99	1	1	2	10	20	100	199	990

Table 5.6 Building Surface Area Factors

Area (m^2)	Area Factor Values: Am-241	C-14	Cm-243	Cm-244	Co-60	Cs-137	Eu-152	Eu-154	Fe-55	H-3
64	1	1	1	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1	1	1
10	6	6	6	6	2	2	2	2	6	6
5	13	12	12	13	3	3	3	3	13	13
2.5	25	25	24	26	5	6	5	5	26	26
1	63	62	59	64	11	12	11	11	64	64
Area (m^2)	Area Factor Values: Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90	Tc-99	
64	1	1	1	1	1	1	1	1	1	
50	1	1	1	1	1	1	1	1	1	
10	2	6	6	6	6	6	6	6	6	
5	3	13	13	13	13	13	13	12	12	
2.5	5	26	26	26	26	26	26	23	24	
1	11	64	64	64	64	64	64	57	58	

Equation 5-4 applies to a single radionuclide contaminant. When multiple radionuclides are present, the calculation in Equation 5-5 is made with a unitized DCGL.

Equation 5-5 EMC Test

$$\frac{\delta}{DCGL} + \frac{(CONC_{AVE} - \delta)}{(Area\ Factor)(DCGL)} < 1$$

Where:

δ = Estimate of average concentration of residual radioactivity, and
$CONC_{AVE}$ = average concentration in elevated area.
If more than one elevated area exists in the survey unit, a separate term will be included for each in Equation 5-5 (refer to Section 5.6.2.2).

5.3.6.3.2 Embedded/Buried Piping

DCGLs for CR3 embedded and buried piping will be in accordance with CR3 Technical Basis Documents (TBDs). The CR3 embedded/buried piping DCGL TBD will be submitted to NRC for approval prior to implementation.

5.3.6.4 Remediation and Reclassification

As shown in Table 5.7, Class 1 areas of elevated residual activity above the $DCGL_{EMC}$ are remediated to reduce the residual radioactivity to acceptable levels. Based on survey data, it may be necessary to remediate an entire survey unit or only a portion of it. If an individual survey measurement (scan or direct measurement) in a Class 2 survey unit exceeds the DCGL, the survey unit or a portion of it may be evaluated for a change of classification to a Class 1 survey unit and the survey redesigned and re-performed accordingly.

If an individual survey measurement in a Class 3 survey unit exceeds 0.5 DCGL, the survey unit, or portion of a survey unit, will be evaluated, and if necessary, reclassified to a Class 2 survey unit and the survey redesigned and re-performed accordingly.

Table 5.7 Investigative Actions for Individual Survey Units

Area Classification	Action if Investigation Results exceed:		
	$DCGL_{EMC}$	DCGL	0.5 DCGL
Class 1	Remediate and re-survey as necessary	Acceptable*	N/A
Class 2	Remediate, reclassify portions as necessary, and investigate**	Reclassify portions as necessary and investigate**	N/A
Class 3	Remediate, reclassify portions as necessary, and investigate**	Reclassify portions as necessary, increase scan coverage, and investigate**	Reclassify portions as necessary, increase scan coverage, and resurvey

*For individual measurements above DCGL, the Sign Test will be conducted on the survey unit and an EMC evaluation performed.

**Requires an investigation of the initial classification process and a survey unit evaluation of sufficient intensity to satisfy the requirements of new classification status.

5.3.6.5 Resurvey

Following an investigation, if a survey unit is reclassified to a more restrictive classification or if remediation activities were performed, a resurvey is performed in accordance with approved procedures. If a Class 2 area had contamination greater than the DCGL, the area should be reclassified to a Class 1 area.

If the average value of Class 2 direct survey measurements was less than the DCGL, the Scan MDC was sensitive enough to detect the $DCGL_{EMC}$ and there were no areas greater than the $DCGL_{EMC}$, the survey redesign may be limited to obtaining a 100 percent scan without having to re-perform the static measurements or soil sample analyses. This condition assumes that the sample density meets the requirements for a Class 1 area.

5.4 Survey Methods and Instrumentation

[NUREG-1700, Revision 2, Appendix A, Section A.4]

5.4.1 Survey Measurement Methods

Survey measurements and sample collection are performed by personnel trained and qualified in accordance with the applicable CR3 procedures. The techniques for performing survey measurements or collecting samples are specified in approved CR3 procedures. FSS measurements include surface scans, direct surface measurements, and gamma spectroscopy of volumetric materials. Advanced Survey Technologies, not specifically described in this LTP also may be used for final status surveys.

If so, CR3 will give NRC 30 days' notice to provide an opportunity to review the associated technical basis document. Onsite, as well as offsite, laboratory facilities are used for gamma spectroscopy, liquid scintillation, and gas proportional counting in accordance with applicable procedures. "Approved" off-site facilities, as required by Section 5.8, are used as necessary. No matter which facilities are used, analytical methods will be administratively established to detect levels of radioactivity at 10 percent to 50 percent of the DCGL value for radionuclides.

5.4.2 Structures

Structures will receive scan surveys, direct measurements, and, when necessary, volumetric sampling.

5.4.2.1 Scan Surveys

Scanning is performed in order to locate small, elevated areas of residual activity above the investigation level. Structures are scanned for beta/gamma radiation with appropriate instruments such as those listed in Table 5.8.

The measurements will typically be performed at a distance of 1 cm or less from the surface and at a nominal scan speed of 5 cm/sec for hand-held instruments. Adjustments to scan speed and distance may be made in accordance with approved technical guidance.

5.4.2.2 Direct Measurements

Direct measurements are performed to detect surface activity levels. Direct measurements are conducted by placing the detector on or very near the surface to be counted and acquiring data over a predetermined count time. A count time of one minute is typically used for CR3 surface measurements and generally provides detection levels well below the DCGL (the count time may be varied provided the required detection level is achieved).

5.4.2.3 Concrete with Activated Radionuclides

Activated concrete that does not meet FSS criteria at CR3 will be removed and shipped to a suitable burial site.

5.4.2.4 Volumetric Concrete Measurements

Volumetric sampling of contaminated concrete, as opposed to direct measurements, may be necessary if the efficiency or uncertainty of the gross beta measurements is too high. In this case, the surface layer is removed from the known area by using a commercial stripping agent (coated surfaces) or by physically abrading the surface.

The removed coating material is analyzed for activity content and the level converted to appropriate units (i.e., dpm/100 cm^2) for comparison with surface activity DCGLs. Direct measurements can then be performed on the underlying surface after removal of the coating. The thickness of the layer of building surface to be removed as a sample should be consistent with the development of the CR3 site model and the DCGLs (i.e., less than 10 mm in depth).

Input parameters in the RESRAD-BUILD model assumes all the activity is at the surface (LTP, Chapter 6, Appendix B), therefore it would be appropriate to posit that the activity is less than 10 mm in depth. For the radionuclides-of-concern, a 10 mm thickness provides a minimal degree of shielding.

5.4.3 Soils

Soil will receive scan surveys at the coverage level described in Table 5.3 and volumetric samples will be taken at designated locations. Surface soil samples will normally be taken at a depth of 0 to 15 cm. Samples will be collected and prepared in accordance with approved procedures.

5.4.3.1 Scans

Open land areas are scanned for gamma emitting nuclides. The gamma emitters are used as surrogates for the HTD radionuclides. Sodium iodide detectors are typically used for scanning. For detectors such as the Ludlum 44-10, the detector is held within 2.5 to 7.5 cm off the ground surface and is moved at a speed of 0.5 m/sec, traversing each square meter three times. The area covered by scan measurements is based on the survey unit classification, as described in Section 5.3.2.

5.4.3.2 Volumetric Samples

Soil materials are analyzed by gamma spectroscopy. Soil samples of approximately 1,500 grams are normally collected from the surface layer (top 15 cm). Sample preparation includes removing extraneous material, homogenizing, and drying the soil for gamma isotopic analysis. Separate containers are used for each sample and each container is moved through the analysis process following site procedures. Samples are split, when required, by the CR3 FSS Quality Assurance Project Plan (QAPP). If a survey area has already been excavated and remediated to the soil DCGL, this area will be treated as surface soil, and the FSS will be performed on the excavated area. Soil samples will be collected to depths at which there is high confidence that deeper samples will not result in higher concentrations.

Alternatively, a sodium-iodide detector or in situ object counting system (ISOCS) of sufficient sensitivity to detect DCGL concentrations may be used to identify the potential presence of subsurface contamination (i.e., greater than 15 cm in depth) triggering an investigation.

All subsurface sampling will be performed in accordance with the guidance in Section G.3.1 of NUREG-1757, Volume 2. The sample size for subsurface samples will be determined using the same methods described for surface soil. Per NUREG-1757, Volume 2, scanning is not applicable to subsurface areas; however, CR3 FSS will employ scanning techniques commensurate with the survey unit classification. Scanning subsurface soils, where accessible as an excavated surface, will be used for characterization data.

Soil sample depth will be determined during the DQO phase of the survey design. Surface soil samples will normally be taken at a depth of 0 to 15 cm. Areas of potential subsurface soil contamination (e.g., areas identified where spills were present, areas found to contain contamination during remediation, etc.) may require sampling at a depth exceeding 15 cm up to a depth of 1 meter. If contamination below 15 cm is suspected, split spoon sampling or similar methods will be used for the final survey.

The advantage of a conservative statistical MARSSIM approach for surficial soils may be lessened by potential waste migration along channels or lineation to subsurface sites. Areas where subsurface activity exists at levels challenging the release criteria will require additional geological and historical assessments or additional sampling, as identified in the DQO process. If CR3 intends to use subsurface samples for FSS compliance purposes, potential complications will be considered in the DQO process, and additional subsurface soil sampling/assessment details will be provided to the NRC on a case-by-case basis to ensure that sampling and evaluation methods are appropriate.

5.4.3.3 Alternative Survey Plan in Excavations

Over the course of the decommissioning project at CR3, there may be instances where deep excavations are made. These may be necessary to remove radiologically contaminated soils and to remove both clean and contaminated foundations and underground utilities. Due to the instability of the soils, shoring or trench boxes will be required for personnel access to ensure safety to personnel entering the excavation. The shoring and/or trench boxes will prevent the survey of 100% of the surface areas in Class 1 survey areas, primarily the walls of steep excavations. In order to assess the residual activity present in these areas safely the following methodology will be utilized:

- The excavations will be remediated until soil characterization indicates values are less than the release criteria. The contaminated media removed will be disposed of as waste material.
- Soil that must be removed below the excavated depth may be removed and either surveyed as a Class 1 material (i.e., 100% survey) at 6-inch lifts or surveyed by a bulk monitor system for reuse. A TBD will be developed for the bulk assay system and submitted to the NRC prior to being used.
- FSS will be performed on the bottom of the excavation prior to any backfill.
- Side wall soils where shoring or trench boxes limit safety of scanning will be assessed by combinations of soils removed from within the trench, soils attached to the exterior of the boxes/shoring as removed, or specific depth sampling of soils behind shoring on a case-by-case basis.

Note: Where known contaminated systems may exist below the remediated soils level or unidentified underground utilities are encountered and deemed to be potentially contaminated, additional measurements will be taken during the excavation to provide for appropriate remediation.

5.4.4 Specific Survey Area Considerations

5.4.4.1 Pavement-Covered Areas and Shallow Concrete Slabs

A survey of paved areas will be required along the roadways providing ingress and egress to CR3. The survey design of paved/concrete areas will be based on soil survey unit sizes since they are outdoor areas where the exposure scenario is most similar to direct radiation from surface soil. The applicable DCGL will be the soil DCGL. Scan and static gamma and beta-gamma surveys are determined by the survey unit design. Samples will be obtained of not only the asphalt/concrete, but of the soil present under the asphalt/concrete. Paved areas may be separate survey units, or they may be incorporated into surveys of adjacent open land areas of like classification.

5.4.4.2 Bulk Materials

Controls will be instituted to prevent mixing of soils from different survey areas prior to evaluation. Soils satisfying the criteria for unrestricted release may be stockpiled for use as onsite backfill material. (Class 2 material could be used in either Class 1 or 2 areas and Class 1 material could only be used in Class 1 areas.)

The radiological evaluation of soils resulting from minor trenching and digging efforts in Class 3 defined areas (no reasonable potential for subsurface contamination) will be performed by characterization survey in accordance with site procedures. Excavated soils that demonstrate residual radioactivity consistent with Class 3 status may be released for use as onsite excavation backfill.

5.4.4.3 Embedded Piping and Buried Piping

Embedded and buried piping may remain after decommissioning CR3. Separate FSS survey plans will be developed for embedded/buried piping, which will include survey unit DQOs. These FSS plans will include the following items:

- Radionuclides of interest and chosen surrogate, if used
- Levels and distribution of contamination
- Internal surface condition of the piping
- Internal residues and sediments and their radiation attenuation properties
- Removable and fixed surface contamination
- Instrument sensitivity and related scan and fixed MDC's
- Piping geometry and presence of internally inaccessible areas/sections
- Instrument calibration

Accessible internal surfaces are surveyed the same as other structural surfaces. Scale and sediment samples will be obtained, if appropriate, as well as smears and wipes to assist in the identification of the total radionuclide deposits within the piping. The activity of the internal surfaces will be compared to the building surface DCGLs, which is a conservative measure.

If the amount of activity observed on the internal surfaces is so great as to fail a survey unit, specialized embedded piping DCGLs will be developed in a technical basis document. Some buried piping, storm drains, sewer systems, plumbing and floor drains may be free released or radiologically assessed. In accordance with the Florida Department of Environmental Protection (FDEP) all remaining embedded and buried pipes and other spaces with void space that are 3 feet below ground surface and allowed to be left in place shall be filled with concrete or other material as necessary to ensure stability of the ground above unless it is to be used as an active system (e.g., drainage piping).

5.4.4.4 Cracks, Crevices, Wall-to-Floor Interfaces, and Small Holes

Surface contamination on irregular structure surfaces (e.g., cracks, crevices, and holes) is difficult to survey directly. Where no remediation has occurred and residual activity has not been detected above background, these surface blemishes may be assumed to have the same level of residual activity as that found on adjacent surfaces. The accessible surfaces are surveyed in the same manner as other structural surfaces and no special corrections or adjustments are required. In situations where remediation has taken place or where residual activity has been detected above background, a representative sample of the contamination within the crack or crevice may be obtained or an adjustment for instrument efficiency may be made.

If an instrument efficiency adjustment cannot be justified based on the depth of contamination or other geometry factors, volumetric samples will be collected. As an alternative method, radionuclide specific analysis, coupled with application of the unity rule, may be used.

Volumetric samples analyzed by gamma spectroscopy will detect the presence of radioactivity below the surface. Typically, such sampling is performed following removal of paint and other surface coatings during remediation. After analysis, the data may be converted to equivalent surface activity. The accessible surfaces on irregular structure surfaces are surveyed in the same manner as other structure surfaces except that they are included in areas receiving judgmental scans when scanning is performed over less than 100 percent of the area.

5.4.4.5 Paint covered Surfaces

Painted surfaces will be evaluated prior to the start of the FSS for that survey unit. In the event of suspected activity beneath painted surfaces, the coating will be removed prior to performing the survey. No special consideration will be given to wall or ceiling areas painted before plant startup and which have not been subjected to repeated exposure to materials that would have penetrated the painted surface. If the thickness of the coating can be determined with certainty, then a source efficiency correction may be applied to the measurement as described in NUREG-1507.

5.4.4.6 Exterior Surfaces of Building Foundations

Exterior surfaces of below-grade foundations (3 feet and below) will be evaluated using the historical site assessment and other pertinent records to determine the potential for sub-surface contamination on the exterior surfaces of below-grade foundations. One method available to evaluate the exterior surfaces is the use of core bores through foundation or walls and the taking of soil samples at locations having a high potential for the accumulation and migration of radioactive contamination to sub-surface soils. These biased locations for soil and concrete assessment could include stress cracks, floor and wall interfaces, penetrations through walls and floors for piping, run-off from exterior walls, and leaks or spills in adjacent outside areas, etc. If the soil is found to be free of residual radioactivity at the biased locations, it will be assumed that the exterior surface of the foundation is also free of residual activity. Otherwise, additional sampling may be necessary to determine the extent of decontamination and remediation efforts. Another method available for evaluating the exterior surfaces of below-grade foundations is gamma well logging. Soil in biased locations next to the exterior of the buildings may be evaluated using this technique. This technique can provide for rapid isotopic analysis of soils without sampling.

5.4.4.7 Groundwater

Assessments of any residual activity in groundwater at CR3 will be via groundwater monitoring wells. The wells will monitor groundwater at both deep and shallow depths. Chapter 2 describes the groundwater monitoring conducted. The data collected from the monitoring wells will be used to ensure that the concentration of well water available, based upon the well supply requirements assumed in Section 6 for the resident farmer (i.e., resident farmer's well), is below the U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) (e.g., 20,000 pCi/L for H-3). This will ensure that the dose contribution from groundwater is a small fraction of the limit in 10 CFR 20.1402.

5.4.4.8 Discrete Radioactive Particles (DRPs)

Historically, CR3 has not had a Hot Particle/DRP problem. If, during the course of decommissioning, hot particles, or DRPs, are identified, CR3 will review the DQOs and adjust the survey plan(s) as necessary to address additional survey measures that may be needed. Additionally, the NRC will be notified and included in the communications regarding the changes or additions to the survey methodology.

5.4.5 Instrumentation

Radiation detection and measurement instrumentation for the FSS is selected to provide both reliable operation and adequate sensitivity to detect the radionuclides identified at the site at levels sufficiently below the DCGL. The instrumentation will, to the extent practicable, use data logging. Commercially available portable and laboratory instruments and detectors typically are used to perform the three basic survey measurements:

1) Surface scanning
2) Direct surface contamination measurements
3) Spectroscopy of soil and other bulk materials, such as concrete.

CR3 procedures control the issuance and use of instrumentation. Records supporting the instrumentation program are maintained in accordance with CR3 procedures.

5.4.5.1 Instrument Selection

Radiation detection and measurement instrumentation is selected based on the type and quantity of the radiation to be measured. The instruments used for direct measurements are capable of detecting the radiation of concern below the applicable DCGL.

MDCs of less than 50 percent of the DCGL allow detection of residual activity in Class 3 survey units at an investigation level of 0.5 times the DCGL. Instruments used for scan measurements in Class 1 areas are required to be capable of detecting radioactive material at the $DCGL_{EMC}$.

Instrumentation currently proposed for use in the CR3 FSS is listed in Table 5.8. Instrument MDCs are discussed in Section 5.4.5.4 and nominal MDC values are listed in Table 5.9. Other measurement instruments or techniques may be used. The acceptability of any alternate technologies for use in the FSS Program will be justified in a technical basis evaluation document.

Technical basis evaluations for Advanced Survey Technologies will be provided for NRC review 30 days prior to use. An instrument technical analysis will include the following:

- Description of the conditions under which the method would be used
- Description of the measurement method, instrumentation, and criteria
- Justification that the technique would provide the required sensitivity for the given survey unit classification in accordance with Table 5.10

Demonstration that the instrument provides sufficient sensitivity for measurement below the release criteria with Type I error equivalent to 5 percent or less.

Table 5.8 Typical FSS Instrumentation

Measurement Type	Detector Type	Effective Detector Area and Window Density	Instrument and Model	Detector Model
Alpha Scan	Scintillation	100 cm^2 1.2 mg/cm^2 Mylar	Ludlum 2360	Ludlum 43-93
Beta-gamma static and scan	Scintillation	100 cm^2 1.2 mg/cm^2 metalized polyester	Ludlum 2360	Ludlum 43-93
Gamma scan	Scintillation	2” diameter x 2” length NaI	Ludlum 2241	Ludlum 44-10
Soil, structure surface and bulk material	High purity germanium	N/A	Canberra and off-site laboratory	N/A

Table 5.9 Typical FSS Detection Sensitivities

Instruments and Detectors	Radiation	Background Count Time (Minutes)	Background (cpm)	Instrument Efficiency (2Π)	Count Time (Minutes)	Static MDC (dpm/100 cm^2)	Scan MDC (dpm/100 cm^2)
Model 43-93	Alpha Beta-gamma	1 1	3 300	0.1393 α 0.1203 β	1 1	515 2286	N/A N/A
Model 44-10	Gamma	1	4000	0.0350	0.04	N/A	See Table 5.12 for E_i
HPGe	Gamma	Up to 60	N/A	0.40 Relative	10-60	0.15*	N/A
Tennelec low-bkgd counter	Alpha Beta	20 20	0.175 3.9	0.348 0.377	3 3	<11 <16	N/A N/A

*pCi/g

5.4.5.2 Calibration and Maintenance

Instruments and detectors are calibrated for radiation types and energies of interest at the site. Approved suppliers will calibrate instruments, as necessary, under their approved Quality Assurance Program, as described in Section 5.8. The calibration source for beta survey instruments is Tc-99, because the average beta energy approximates, and is slightly lower than the beta energy of the radionuclides found on surfaces at CR3. The alpha calibration source is Am-241 that has an appropriate alpha energy for plant-specific alpha emitting nuclides.

Radioactive sources used for calibration are traceable to the National Institute of Standards and Technology (NIST). When characterized High Purity Germanium (HPGe) detectors are used, using approved procedures, suitable NIST-traceable sources are used for onsite calibration, and the software is set up appropriately for the desired geometry.

5.4.5.3 Response Checks

Instrumentation response checks are conducted to ensure proper field survey instrument response and operation. An acceptable response for field instrumentation is an instrument reading within plus or minus 20 percent of the established check source value as documented on a control chart. Response checks are performed daily before instrument use and again at the end of use, prior to the end of the work shift.

Check sources contain the same type of radiation that is being measured in the field and are held in fixed geometry jigs for reproducibility. If an instrument fails a response check, it is tagged "Out of Service" to prevent inadvertent use and is removed from service until the problem is corrected in accordance with applicable CR3 procedures. Measurements made between the last acceptable check and the failed check will be evaluated to determine if they should remain in the data set.

5.4.5.4 Minimum Detectable Concentration

The MDC is determined for the instruments and techniques used for final status surveys (Table 5.9). The MDC is the concentration of radioactivity that an instrument can be expected to detect 95 percent of the time.

5.4.5.4.1 Static MDC for Structure Surfaces

For static (direct) surface measurements, with conventional detectors, such as those listed in Table 5.8, the MDC is calculated by Equation 5-6 as follows:

Equation 5-6 Static MDC for Structure Surfaces

$$MDC_{static} = \frac{3 + 4.65\sqrt{B}}{(K)(t)}$$

Where:

3 = Poisson probability sum for α and β squared and corrected to 3, NUREG 1507-1, (Brodsky 1992)

MDC_{static} = minimum detectable concentration for direct counting (dpm/100 cm^2)

B = number of background counts during the count interval t

t = count interval (for paired observations of sample and blank, usually 1 minute)

K = calibration constant (counts/min per dpm/100 cm^2) The value of K includes correction factors for efficiency (e_i and e_s). The value of e is dependent on the material type. Corrections for radionuclide absorption have been made.

5.4.5.4.2 Structural Surface Beta-Gamma Scan MDCs

Following the guidance of Section 6 of NUREG- 1507, MDCs for surface scans of structural surfaces for beta and gamma emitters will be computed by Equation 5-7.

For determining Scan MDCs, a rate of 95 percent of correct detections is required and a rate of 60 percent of false positives is determined to be acceptable: therefore, a sensitivity index value of 1.38 was selected from Table 6-1 of NUREG-1507 and Equation 5-7 becomes:

Equation 5-7 Beta-Gamma Scan MDCs for Structural Surfaces

$$MDC_{structural\ surface\ scan}(dpm/100\ cm^2) = \frac{1.38\sqrt{B}}{\sqrt{p}\ e_i\ e_s\ \left(\frac{A}{100}\right)\ t}$$

Where:

B = number of background counts during the count interval t
p = surveyor efficiency
e_i = instrument efficiency (2π) for the emitted radiation (cpm per dpm)
e_s = source efficiency (intensity) in emissions per disintegration
A = sensitive area of the detector (cm^2)
t = time interval of the observation while the probe passes over the source (minutes)

The numerator in Equation 5-7 represents the minimum detectable count rate that the observer would "see" at the performance level represented by the sensitivity index. The surveyor efficiency (p) will be taken to be 0.5, as recommended by Section 6.2.2 of NUREG-1507. The factor of 100 corrects for probe areas that are not 100 cm^2.

In the case of a scan measurement, the counting interval is the time the probe is actually over the source of radioactivity. This time depends on scan speed, the size of the source, and the fraction of the detector's sensitive area that passes over the source, with the latter depending on the direction of probe travel. The source efficiency term (e_s) in Equation 5-7 may be adjusted to account for effects such as self-absorption, as appropriate.

5.4.5.4.3 Total Efficiency (e_t) and Source Efficiency (e_s) for Concrete Contamination

The source term inventory on contaminated concrete appears to be primarily located within the top few millimeters of the concrete surface. The practical application of choosing the proper instrument efficiency may be determined by averaging the surface variation (peaks and valleys narrower than the length of the detector) and adding 0.5 inches, the spacing that should be maintained between the detector and the highest peaks of the surface.

The source-to-detector distance was evaluated using a Ludlum 43-93 scintillation detector with a 1.2 mg/cm^2 window for Tc-99 and Am-241. Five 1-minute measurements were made on contact and at distances of 0.5, 1, and 2 centimeters. Measurement results are contained in Appendix B of the Instrument Efficiency TBD. Selection of the source to detector distance is based on Table 5.10 that best reflects the predetermined geometry.

Table 5.10 Source-to-Detector Distance Effects on Instrument Efficiency for α-β Emitters

Source to Detector Distance (cm)	**Instrument Efficiency (e_i)**	
	Tc-99 Distributed	**Am-241 Distributed**
Contact	1	1
0.5	0.9111	0.9179
1.0	0.8255	0.7737
2.0	0.6520	0.2821

5.4.5.4.4 Source (or surface) Efficiency (e_s) Determination

Source efficiency (e_S) reflects the physical characteristics of the surface and any surface coatings. The source efficiency is the ratio between the number of particles emerging from surface and the total number of particles released within the source. The source efficiency accounts for attenuation and backscatter. e_s is nominally 0.5 (no self-absorption/attenuation, no backscatter) backscatter increases the value, self-absorption decreases the value. Source efficiencies may either be derived experimentally or simply selected from the guidance contained in ISO 7503-1.

The document takes a conservative approach by recommending the use of factors to correct for alpha and beta self-absorption/attenuation when determining surface activity. However, this approach may prove to be too conservative for radionuclides with max beta energies that are marginally lower than 0.400 MeV, such as Co-60 with a β_{max} of 0.314 MeV.

In this situation, it may be more appropriate to determine the source efficiency by considering the energies of other beta emitting radionuclides. Using this approach, it is possible to determine weighted average source efficiency. For example, a source efficiency of 0.375 may be calculated based on a 50/50 mix of Co-60 and Cs-137. The source efficiencies for Co-60 and Cs-137 are 0.25 and 0.5 respectively, since the radionuclide fraction for Co-60 and Cs-137 is 50% for each, the weighted average source efficiency for the mix may be calculated in the following manner:

Equation 5-8 Weighted Average Source Efficiency

$$(.25)(.50) + (.50)\ (.50) = 0.375$$

Table 5.11 Source Efficiencies as Listed in ISO 7503-1

	<0.400 MeV_{max}	**≥0.400 MeV_{max}**
Beta Emitters	$e_s = 0.25$	$e_s = 0.5$
Alpha Emitters	$e_s = 0.25$	$e_s = 0.25$

The total efficiency for any given condition can now be calculated from the product of the instrument efficiency e_i and the source efficiency e_s.

Equation 5-9 Total Efficiency

$$e_{total} = (e_i)\ (e_s)$$

Where:

e_{total} = Total efficiency
e_i = Instrument efficiency
e_s = Source efficiency

5.4.5.4.5 Structural Surfaces Alpha Scan MDCs

In cases where alpha scan surveys are required, MDCs must be quantified differently from those for beta-gamma surveys because the background count rate from a typical alpha survey instrument is nearly zero (1 to 3 counts per minute, typically). Since the time that an area of alpha activity is under the probe varies and the background count rates of alpha survey instruments is so low, it is not practical to determine a fixed MDC for scanning. Instead, it is more useful to determine the probability of detecting an area of contamination at a predetermined DCGL for given scan rates.

For alpha survey instrumentation with a background around 1 to 3 counts per minute, a single count will give a surveyor sufficient cause to stop and investigate further. Thus, the probability of detecting given levels of alpha emitting radionuclides can be calculated by use of Poisson summation statistics (see MARSSIM Section 6.7.2.2 and Appendix J for details).

Doing so, one finds that the probability of detecting an area of alpha activity of 300 dpm/100 cm^2 at a scan rate of 3 cm per second (roughly 1 inch per second) is 90 percent if the probe dimension in the direction of the scan is 10 cm. If the probe dimension in the scan direction is halved to 5 cm, the detection probability is still 70 percent. Choosing appropriate values for surveyor efficiency, instrument and surface efficiencies will yield MDCs for alpha surveys for structure surfaces. If for some reason lower MDCs are desired, then scan speeds may be adjusted, within practicable limits, via the methods of Section 6.7.2.2 and Appendix J of MARSSIM.

5.4.5.4.6 Open Land Area Gamma Scan MDCs

In addition to the minimum detectable count rate (MDCR) and detector characteristics, the Scan MDC (in pCi/g) for land areas is based on extent of the elevated area, depth of the elevated area, and the radionuclide (i.e., energy and yield of gamma emissions).

Scan measurements are performed by passing a 2-inch x 2-inch NaI (TI) gamma scintillation detector in gross count rate mode across the land surface under investigation. The centerline of the detector is maintained at a source-to-detector distance of approximately 6 cm and moved from side to side in a 1-meter-wide pattern at a rate of 0.5 m/sec. This serpentine scan pattern is designed to cross each survey cell (one square meter) a minimum of three times in approximately 10 seconds, with a maximum separation of less than 150 cm between one pass.

The audible signal is monitored for detectable increases in count rate. An observed count rate increase results in further investigation to verify findings and define the level and extent of residual radioactivity. This method represents the Stage 1 and Stage 2 surface scanning process for land areas defined in NUREG-1507 and is the basis for calculation of the scanning detection sensitivity (Scan MDC). The sensitivity is only slightly affected by the relative amounts of Cs-137 and Co-60 in the soil, giving typical Scan MDC values in the range of 5 to 6 pCi/g for instrument backgrounds of 8,000 to 10,000 cpm. Alternative methods of sufficient sensitivity for the identification of small areas of elevated radioactivity may be used where appropriate.

An *a priori* determination of scanning sensitivity is performed to ensure that the measurement system is able to detect concentrations of radioactivity at levels below the regulatory release limit. Expressed in terms of scan MDC, this sensitivity is the lowest concentration of radioactivity for a given background that the measurement system is able to detect at specified performance level and surveyor efficiency. The Scan MDC value (in pCi/g) for open land area surface scanning with a desired performance level of 95 percent correct detections and 60 percent false positive rate, the sensitivity index has a value of 1.38, resulting in the following MDCR:

Equation 5-10 MDCR

$$MDCR = 1.38\sqrt{b_i} \times \left(\frac{60\ sec}{1\ min}\right)$$

Where:
b_i = background counts in the observation interval
Introducing the human factor performance element of surveyor efficiency, the surveyor minimum detectable count rate becomes:

Equation 5-11 MDCR Surveyor

$$MDCR_{surveyor} = \frac{MDCR}{\sqrt{p}}$$

Where:
$MDCR_{surveyor}$ = Minimum detectable surveyor count rate (cpm),
p = Surveyor efficiency = 0.5

A corresponding minimum detectable exposure rate can be determined for a specified detector and radionuclide by dividing the $MDCR_{surveyor}$ value by the detector manufacturer's count rate to exposure rate ratio (cpm per uR/h) to give a minimum detectable exposure rate in units of uR/h.

The minimum detectable exposure rate then is used to determine the minimum detectable radionuclide concentration (i.e., the Scan MDC) by modeling a specified small area of elevated activity using MegaShield to yield a conversion factor (E_i) of cpm per pCi/g. The minimum detectable exposure rate is then divided by the MegaShield conversion factor to give a Scan MDC in units of pCi/g.

Table 5.12 provides the E_i for predominant gamma emitting radionuclides as determined by NorthStar Technical Base Document (TBD) *Instrument Efficiency Determination for use in Minimum Detectable Concentration Calculations in Support of the Final Status Survey at VYNPS and CR3*.

Table 5.12 Efficiency for Photon Emitting Isotopes

Isotope	E_i (cpm/pCi/g)
Co-60	306
Nb-94	347
Cs-137	150
Eu-152	261
Eu-154	242

5.4.5.4.7 HPGe Spectrometer Analysis

The onsite chemistry laboratory maintains gamma isotopic spectrometers that are calibrated to various sample geometries, including 1-liter Marinelli geometry for soil analysis. These systems are calibrated using a National Institute of Standards and Technology (NIST) traceable mixed gamma source using approved procedures.

The detectors are manufactured by Canberra Industries. Approved off-site laboratories may also be used to perform gamma analyses. Laboratory counting system count times are set to meet a maximum MDC of 10 percent of the DCGL for CR3 radionuclides.

5.4.5.4.8 Pipe Survey Instrumentation

Accessible portions of any remaining embedded/buried piping will be surveyed to ensure residual remaining activity is less than the DCGL. Pipe survey instruments proposed for use at CR3 are scintillation detectors and/or Geiger-Mueller (GM) arrays.

Pipe survey instruments proposed for use will have a level of sensitivity adequate to detect residual activity below the embedded piping DCGLs. Class 1 piping will be surveyed at 1-foot intervals with 100 percent coverage. Inaccessible portions will be made accessible by cutting access ports in the piping. In Class 2 and Class 3 piping where 100 percent coverage is not required, an evaluation will be performed as to the percent of survey.

5.5 Data Collection and Processing
[NUREG-1700, Revision 2, Section 2.5 and Appendix A, Section A.4]

This section describes data collection, review, validation, and record keeping requirements for final status surveys.

5.5.1 Sample Handling and Record Keeping

A Chain-Of-Custody (COC) record will accompany each sample from the collection point through obtaining the final results to ensure the validity of the sample data. COC records are controlled and maintained in accordance with applicable procedures.

Each survey unit has an associated document package that covers the design and field implementation of the survey requirements. Survey unit records are considered quality records.

5.5.2 Data Management

Survey data are collected from several sources during the data life cycle and are evaluated for validity throughout the survey process. QC replicate measurements are not used as FSS data. Measurements performed during turnover and investigation surveys can be used as FSS data if they were performed according to the same requirements as the FSS data, as follows:

- Survey data shall reflect the as-left survey unit condition (i.e., no further remediation required).
- The application of isolation measures to the survey unit to prevent recontamination and to maintain final configuration are in effect.
- The data collection and design were in accordance with FSS methods and procedures, (e.g., Scan MDC, investigation levels, survey data point number and location, statistical tests, and EMC tests).

Measurement results stored as final status survey data constitute the final survey of record and are included in the data set for each survey unit used for determining compliance with the site release criteria. Measurements are recorded in units appropriate for comparison to the applicable DCGL. Numerical values, even negative numbers, are recorded.

Measurement records include, at a minimum, the surveyor's name, the location of the measurement, the instrument used, measurement results, the date and time of the measurement, any surveyor comments, and records of applicable reviews.

5.5.3 Data Verification and Validation

The FSS data are reviewed prior to data assessment to ensure that they are complete, fully documented, and technically acceptable. The review criteria for data acceptability will include at a minimum, the following items:

- The instrumentation MDC for fixed or volumetric measurements are less than 10% of the DCGL (preferable) while MDCs up to 50% of the DCGL are acceptable.
- The instrument calibration was current and traceable to NIST standards.
- The field instruments were source checked with satisfactory results before and after use each day data were collected.
- The MDCs and assumptions used to develop them were appropriate for the instruments and techniques used to perform the survey.
- The survey methods used to collect data were appropriate for the types of radiation involved and for the media being surveyed.
- "Special methods" for data collection were properly applied to the survey unit under review. These special methods are described in this LTP section or will be the subject of an NRC notice of opportunity for review.
- The sample was controlled from the point of sample collection to the point of obtaining results.
- The data set is comprised of qualified measurement results collected in accordance with the survey design, which accurately reflects the radiological status of the facility.
- The data has been properly recorded.

If the data review criteria were not met, the discrepancy will be reviewed and the decision to accept or reject the data will be documented, reviewed, and approved by the FSS Engineering Group or designee.

5.5.4 Graphical Data Review

Survey data will be graphed to identify patterns, relationships, or possible anomalies that might not be apparent using other methods of review. A posting plot and a frequency plot will be made. Other special graphical representations of the data set will be made as the need dictates. The FSS Engineering Group will review all data for acceptance.

5.5.4.1 Posting Plots

Posting plots will be used to identify spatial variability in the data. The posting plot consists of the survey unit map with the numerical data shown at the location from which it was obtained. Posting plots can reveal areas of elevated radioactivity or local areas in which the DCGL is exceeded. Posting plots can be generated for background reference areas to point out spatial trends that might adversely affect the use of the data. Anomalies in the background data may be the result of residual, undetected activity, or may just reflect background variability.

5.5.4.2 Frequency Plots

Frequency plots will be used to examine the general shape of the data distribution. Frequency plots are basically bar charts showing data points within a given range of values. Frequency plots reveal such things as skewness and bimodality (having two peaks).

Skewness may be the result of a few areas of elevated activity or may be the result of very little activity present in the survey unit such as a log-normal data distribution.

Multiple peaks (bi-modal, tri-modal, etc.) in the data may indicate the presence of isolated areas of residual radioactivity or background variability due to soil types or differing materials of construction. Variability may also indicate the need to match background reference areas to survey units more carefully or to subdivide the survey unit by material or soil type. Frequency plots will be used to examine the general shape of the data distribution. Frequency plots are basically bar charts showing data points within a given range of values.

5.5.4.3 Contour and 3-D Surface Plots

Contour and 3-D surface plots may be used to represent graphically a trend in collected survey data. This can be an aid in visualizing the location of activity outside the area that affects the collected data. Contour and 3-D surface plots typically require that a plotting algorithm be applied to interpolate data at a predetermined frequency.

5.6 Data Assessment and Compliance
[NUREG-1700, Revision 2, Section 2.5 and Appendix A, Section A.4]

An assessment is performed on the FSS data to ensure that they are adequate to support the determination to release the survey unit. Simple assessment methods such as comparing the survey data to the DCGL or comparing the mean value to the DCGL are first performed. The statistical tests are then applied, as necessary, to the final data set and conclusions are made as to whether the survey unit meets the site release criterion.

5.6.1 Data Assessment Including Statistical Analysis

The results of the survey measurements are evaluated to determine whether the survey unit meets the release criteria. In some cases, the determination can be made without performing complex, statistical analyses.

5.6.1.1 Interpretation of Sample Measurement Results

An assessment of the measurement results is used to determine quickly whether the survey unit passes or fails the release criteria or whether one of the statistical analyses must be performed. The evaluation matrices are presented in Tables 5.13 and 5.14.

Table 5.13 Interpretation of Sample Measurements When the WRS Test is Used

Measurement Results	Conclusion
Difference between maximum survey unit concentration and minimum reference area concentration is less than DCGL	Survey Unit meets the release criteria
Difference of survey unit average concentration and reference average concentrations greater than DCGL	Survey Unit fails
Difference between any survey unit concentration and any reference area concentration is greater than DCGL. A difference of survey unit average concentration and reference area average concentration is less than DCGL	Conduct WRS test and elevated measurements test

Table 5.14 Interpretation of Sample Measurements When the Sign Test is Used

Measurement Results	Conclusion
All concentrations less than DCGL	Survey Unit meets the release criteria
Average concentration greater than DCGL	Survey Unit fails
Any concentration greater than DCGL and average concentration is less than DCGL	Conduct Sign test and elevated measurements test

When required, one of four non-parametric statistical tests will be performed on the survey data:

1. WRS Test
2. Sign Test
3. WRS Test Unity Rule
4. Sign Test Unity Rule

In addition, survey data are evaluated against the EMC criteria as previously described in Section 5.3.6.3 and as required by NUREG-1757, Volume 2.

The statistical test is based on the null hypothesis (H_o) that the residual radioactivity in the survey unit exceeds the DCGL. There must be sufficient survey data at or below the DCGL to reject the null hypothesis and conclude the survey unit meets the site release criterion for dose. Statistical analyses are performed using a specially designed software package or, if necessary, using hand calculations.

5.6.1.2 Wilcoxon Rank Sum Test

The WRS test, or WRS Unity Rule may be used when the radionuclide of concern is present in the background or measurements are used that are not radionuclide-specific. Using MARSSIM Section 8.4.3 and Appendix A, the WRS test is applied as outlined in the following six steps:

1. Obtain the adjusted reference area measurements, Z_i , by adding the $DCGL_W$ to each reference area measurement, X_i. $Z_i = X_i + DCGL_W$
2. The *m* adjusted reference sample measurements, Z_i , from the reference area and the *n* sample measurements, Y_i, from the survey unit are pooled and ranked in order of increasing size from 1 to *N*, where $N = m+n$.
3. If several measurements are tied (*i.e.,* have the same value), they are all assigned the average rank of that group of tied measurements.
4. If there are *t* "less than" values, they are all given the average of the ranks from 1 to t. Therefore, they are all assigned the rank t(t+1)/(2t) = (t+1)/2, which is the average of the first *t* integers. If there is more than one detection limit, all observations below the largest detection limit should be treated as "less than" values.[1]
5. Sum the ranks of the adjusted measurements from the reference area, W_r. Note that since the sum of the first *N* integers is $N(N+1)/2$, one can equivalently sum the ranks of the measurements from the survey unit, W_s, and compute $W_r = N(N+1)/2 - W_s$.
6. Compare W_r with the critical value given in Table I.4 of MARSSIM for the appropriate values of *n, m,* and α. If W_r is greater than the tabulated value, reject the hypothesis that the survey unit exceeds the release criterion.

The value of W_r is compared with the critical value in Table I.4 of MARSSIM. If W_r is greater than the critical value, the survey unit meets the site release dose criterion. If W_r is less than or equal to the critical value, the survey unit fails to meet the criterion.

[1] If more than 40 percent of the data from either the reference area or survey unit are "less than," the WRS test cannot be used. Such a large proportion of non-detects suggest that the DQO process be re-visited for this survey to determine if the survey unit was properly classified, or the appropriate measurement method was used. As stated previously, the use of "less than" values in data reporting is not recommended. Wherever possible, the actual result of a measurement, together with its uncertainty, should be reported.

5.6.1.3 Sign Test

The Sign test and Sign test Unity Rule are one-sample statistical tests used for situations in which the radionuclide of concern is not present in background or is present at acceptable low fractions compared to the DCGL. If present in background, the gross measurement is assumed to be entirely from plant activities.

This option is used when it can be reasonably expected that including the background concentration will not affect the outcome of the Sign test. The advantage of using the Sign test is that a background reference area is not necessary. The Sign test is applied as outlined in the following five steps as displayed in MARSSIM Section 8.3.2:

1. List the survey unit measurements, X_i , $i = 1, 2, 3..., N$.
2. Subtract each measurement, X_i, from the $DCGL_W$ to obtain the differences:
   $$D_i = DCGL_W - X_i \, , \, i = 1, 2, 3..., N$$
3. Discard each difference that is exactly zero and reduce the sample size, N, by the number of such zero measurements.
4. Count the number of positive differences. The result is the test statistic S+. Note that a positive difference corresponds to a measurement below the $DCGL_W$ and contributes evidence that the survey unit meets the release criterion.
5. Large values of S+ indicate that the null hypothesis (that the survey unit exceeds the release criterion) is false. The value of S+ is compared to the critical values in Table I.3 of MARSSIM. If S+ is greater than the critical value, k, in that table, the null hypothesis is rejected.

MARSSIM Table I.3 contains critical values for given values of N and α. The value of α is set at 0.05 during survey design. If S+ is greater than the critical value given in the table, the survey unit meets the site release criterion. If S+ is less than or equal to the critical value, the survey unit fails to meet the release criterion.

5.6.2 Unity Rule

5.6.2.1 Multiple Radionuclide Evaluations

The Cs-137 to Co-60 (or other gamma nuclide) ratio will vary in the final survey soil samples, and this will be accounted for using a "unity rule" approach as described in NUREG-1505 Chapter 11.

Unity Rule Equivalents will be calculated for each measurement result using the surrogate (if applicable) adjusted Cs-137 DCGL and the Co-60 DCGL, as shown in the following Equation 5-12.

Equation 5-12 Unity Rule Equivalent

$$\text{Unity Rule Equivalent } = \frac{Cs-137}{DCGL_{Cs-137(s)}} + \frac{Co-60}{DCGL_{Co-60}} + \cdots \frac{R_n}{DCGL_n} \leq 1$$

Where:

Cs-137 and *Co-60* are the gamma results
$DCGL_{Cs\text{-}137(s)}$ = the surrogate Cs-137 or DCGL, as applicable
$DCGL_{Co\text{-}60}$ the Co-60 DCGL
R_n = any other identified gamma emitting radionuclide
$DCGL_n$ = the DCGL for radionuclide N

The unity rule equivalent results will be used to demonstrate compliance, assuming the DCGL is equal to 1.0 using the criteria listed in Tables 5.13 and 5.14. If the application of the WRS or Sign test is necessary, these tests will be applied using the unity rule equivalent results and assuming that the DCGL is equal to 1.0. An example of a WRS test using the unity rule is provided in NUREG-1505, Page 11-3; Section 11.4. (If the WRS Test was used, or background subtraction was used in conjunction with the Sign Test, background concentrations also would be converted to Unity Rule Equivalents prior to performing test). The Sign Test will be used without background subtraction if background Cs-137 is not considered a significant fraction of the DCGL.

Note that the surrogate Cs-137 DCGL, if used, will be used for both the statistical tests and comparisons with the criteria in Tables 5.13 and 5.14. The same general surrogate and unity rule methods described previously for soil would be applied to other materials, such as activated concrete, where sample gamma spectroscopy is used for final survey as opposed to gross beta measurements.

Note that if surrogate ratios are to be used then a white paper will be generated and submitted to the NRC for prior approval.

5.6.2.2 Elevated Measurement Comparison Evaluations

During final surveys, areas of elevated activity may be detected, and they must be evaluated both individually and in total to ensure compliance with the release criteria. Each elevated area is compared to the specific $DCGL_{EMC}$ value calculated for the size of the specific elevated area. If the individual elevated area passes, then the elevated areas are combined and evaluated under the unity rule. The average activity of each elevated area is determined as well as the average value for the survey unit. The survey unit average value is divided by the DCGL, the survey unit average value is subtracted from the elevated area average activity value, and the result is divided by the elevated area $DCGL_{EMC}$.

Each elevated area net average activity is evaluated against its $DCGL_{EMC}$. The fractions are summed, and the result must be less than unity for the survey unit to pass. This is summarized in Equation 5-13.

Equation 5-13 $DCGL_{EMC}$ Evaluation

$$\frac{\delta}{DCGL} + \frac{C_{elevated} - \delta}{(Area\ Factor) \times DCGL} < 1$$

Where:
δ = average concentration outside the elevated area
$C_{elevated}$ = average concentration in the elevated area
A separate term will be used in the equation for each elevated area identified in a survey unit.

5.6.3 Data Conclusions

The results of the statistical tests, including application of the EMC, allow one of two conclusions to be made. The first conclusion is that the survey unit meets the site release dose criterion. The data provide statistically significant evidence that the level of residual radioactivity in the survey unit does not exceed the release criterion. The decision to release the survey unit is made with sufficient confidence and without further analysis. The second conclusion that can be made is that the survey unit fails to meet the release criterion.

The data are not conclusive in showing that the residual radioactivity is less than the release criterion. The data are analyzed further to determine the reason for the failure. If the power of the test is insufficient due to the number of measurements, additional samples may be collected as directed by procedure. A greater number of measurements increase the probability of passing if the survey unit actually meets the release criterion. Retrospective power analyses will be developed for each CR3 survey unit, regardless of if the unit passes FSS criteria or not. If failure was due to the presence of residual radioactivity in excess of the release criterion, the survey unit shall be remediated and as necessary, reclassified. Survey unit failure due to inadequate design or implementation shall require investigation and re-initiation of the FSS process.

5.6.4 Compliance

The FSS is designed to demonstrate licensed radioactive materials have been removed from the CR3 site to the extent that remaining residual radioactivity is below the radiological criteria for unrestricted release. The site-specific radiological criteria presented in this plan demonstrate compliance with the criteria of 10 CFR 20.1402.

If the measurement results pass the requirements of Section 5.6.1 and 5.6.1.2 and the elevated areas evaluated per Section 5.6.2.2 pass the elevated measurement comparison, the survey unit is suitable for unrestricted release.

If survey measurements do not meet the criteria specified in Table 5.4, an investigation will be performed. Investigations will include an evaluation of survey design, instrumentation use, and calculations, as necessary. Investigations of this nature will be documented in accordance with the CR3 FSS QA Plan.

5.7 Final Status Survey Reporting Format [NUREG-1700, Revision 2, Appendix A, Section A.4],

Survey results and a brief operating history are documented in the FSS Report. Other reports may be generated as requested by NRC.

5.7.1 Operating History

A brief operational history including relevant operational and decommissioning data is compiled. The purpose of the historical information is to provide additional, substantive data that form a portion of the basis for the survey unit classification, and hence, the level of intensity of the FSS. The historical information includes operating history that could affect radiological status, summarized scoping and site characterization data, and other relevant information, as deemed necessary.

5.7.2 Final Status Survey Report

Survey results will be described in a written report for each Survey Area and submitted to the NRC. Upon completion of each survey area the FSS report provides a summary of the survey results and the overall conclusions that demonstrate that the CR3 site meets the radiological criteria for unrestricted use.

Information such as the number and type of measurements, basic statistical quantities, and statistical analysis results are included in the report. The level of detail is sufficient to describe clearly the FSS program and to certify the results. The format of the final report will contain, as a minimum, the following topics:

- Overview of the results
- Discussion of changes to FSS
- FSS Methodology
    - Survey unit sample size
    - Justification for sample size
- FSS Results
    - Number of measurements taken
    - Survey maps
    - Sample concentrations
    - Statistical evaluations
    - Judgmental and miscellaneous data sets

- Anomalous data
- Conclusion for each survey unit
- Any changes from initial assumptions on extent of residual activity

The final report will provide the unit specific or generic ALARA evaluation as well as any investigation performed, regardless of whether the survey unit failed or not.

5.7.3 Other Reports

Other reports relating to FSS activities may be prepared and submitted as necessary.

5.8 Final Status Survey Program Quality
[NUREG-1700, Revision 2, Section 2.5 and Appendix A, Section A.4]

Quality is built into each phase of the FSS Program and measures must be taken during the execution of the plan to determine whether the expected level of quality is being achieved.

The FSS Program will ensure that the site will be surveyed, evaluated, and determined to be acceptable for unrestricted release if the residual activity results in an annual TEDE to the average member of the critical group of 25 mrem/year or less for all pathways and is ALARA. The following sections provide a description of applicable CR3 quality programs and specific quality elements of the FSS Program.

5.8.1 FSS Quality Assurance Project Plan (QAPP)

The objective of the FSS QAPP (NorthStar Procedure NS-FSS-19) is to ensure the survey data collected are of the type and quality needed to demonstrate with sufficient confidence the site is suitable for unrestricted release.

The objective is met through use of the DQO process for FSS design, analysis, and evaluation. The plan ensures the following items are accomplished:

- The elements of the FSS plan are implemented in accordance with approved procedures and survey instructions.
- Surveys are conducted by trained personnel using calibrated instrumentation.
- The quality of the data collected is adequate.
- All phases of package design and survey are properly reviewed, with management oversight provided.
- Corrective actions, when identified, are implemented in a timely manner and are determined to be effective.

The following sections describe the basic elements of the FSS QAPP.

5.8.1.1 Project Management and Organization

Compliance with the QAPP and the LTP shall be the responsibility of all personnel involved with FSS activities. The CR3 staff performs the following specific responsibilities. Outside vendors may be contracted to perform specific review activities such as the following:

- Perform surveillance of the implementation of the FSS
- Performing periodic audits of the FSS program
- Perform conformance reviews of selected FSS implementing procedures
- Perform conformance reviews of selected FSS reports

The CR3 FSS Organization is responsible for the quality of those activities necessary to achieve a final status of unrestricted use for the CR3 site.

The following are key FSS positions. The responsibilities for the key positions and responsibilities may be assigned to a designee as appropriate.

- CR3 RP Manager
- FSS/LTP Technical Consultant
- CR3/VY FSS Engineering Supervisor
- FSS Engineers
- FSS Foreman

Figure 5-2 provides an organizational chart of the projected CR3 License Termination Organization.

5.8.1.2 Program Controls

Program Controls shall be established for performing specific FSS activities. Activities will be accomplished using suitable instructions, procedures, and drawings that incorporate appropriate regulatory and industry guidance.

Personnel conducting activities shall be appropriately trained and qualified. Training, qualification, and any appropriate maintenance of proficiency requirements shall be defined in administrative procedures or instructions. Professional resumes, other verifiable credentials, and/or discrete certification packages, as applicable, shall be used to document personnel qualifications.

5.8.1.3 Design Controls

Design control requirements are established to ensure that the applicable regulatory bases, codes, technical standards, and quality standards are identified in the FSS. Design controls also include independent verification and design interface control.

These design controls will be implemented to determine the DCGLs, MDCs, area factors, and other DQO and FSS elements.

5.8.1.4 Procurement Document Control

Procurement documents related to the FSS shall be prepared in accordance with approved procedures and instructions. These procedures and instructions shall contain provisions to ensure that procurement documents include or reference applicable regulatory requirements and any other requirement necessary to guarantee adequate quality for the purchased service, equipment, or material.

5.8.1.5 Instructions, Procedures, and Drawings

The performance of the FSS will require procedures for personnel training, survey implementation, data collection, COC, instrument calibration and maintenance, verification, and record storage. These procedures will ensure compliance with the LTP and will meet applicable quality requirements. These quality requirements include the development and approval in accordance with the site controls.

5.8.1.6 Document Control

Instructions, Procedures, and Drawings shall be controlled as described in approved procedures or instructions. Controlled copies shall be available for use by personnel performing activities affecting the FSS Program. These controls shall ensure that only current information is issued and used. The results of the FSS will be retained at least for the duration of the 10 CFR 50 facility license.

5.8.1.7 Control of Purchased Material, Items, and Services

Vendors may be used for the performance of the FSS and laboratory activities. Quality related services, such as laboratory analysis, are procured from qualified vendors whose internal QA program is subject to approval in accordance with approved procedures.

Additionally, audits and surveillance of these contractors should be performed to provide an adequate level of assurance that the quality activities are being effectively performed and conform to the requirements of the procurement document.

5.8.1.8 Control of Special Processes

Procedures will be developed to implement any special processes that may be used in support of FSS implementation. The special processes used will be validated and implemented by trained, qualified individuals using approved procedures.

5.8.1.9 Inspections

Inspections and verification activities will be delineated in implementing procedures. These programs and procedures will be used to verify that sampling and surveying protocols are appropriately performed. Appropriate members of the line organization that are qualified, or an independent organization as described in administrative procedures, may perform these inspections.

5.8.1.10 Control of Measuring and Test Equipment

Approved procedures will be developed for the control, use, calibration, and testing of the equipment used for the FSS, including both laboratory and field use equipment. These procedures will ensure confidence in the data obtained. Instrument calibrations will be performed periodically in accordance with appropriate industry standards.

5.8.1.11 Handling, Storage and Shipping

Some of the material samples will be transported to offsite laboratories for analysis. The process for controlling this material will be sufficient to ensure that a COC is maintained. Measures shall be established to ensure that samples are received, handled, stored, packaged, and shipped in accordance with approved procedures or instructions. These procedures or instructions shall be responsive to applicable industry or manufacturer's requirements and include controls for the "shelf life" of sensitive products. Additionally, protocols must be established to ensure there is no cross-contamination between samples and sample packaging. Appropriate controls will be defined in administrative procedures to ensure that sample integrity is maintained.

5.8.1.12 Control of Nonconformance

During the performance of the FSS, non-conforming conditions may be identified with equipment or services. The data associated with the non-conforming condition will be controlled until such time that it is accepted, rejected, or reworked in accordance with an appropriate procedure. Nonconforming equipment will not be used until conformance with applicable requirements has been established.

5.8.1.13 Corrective Action Program

The existing CR3 Corrective Action Program will be used for the FSS Program to ensure conditions adverse to quality are promptly identified and corrected.

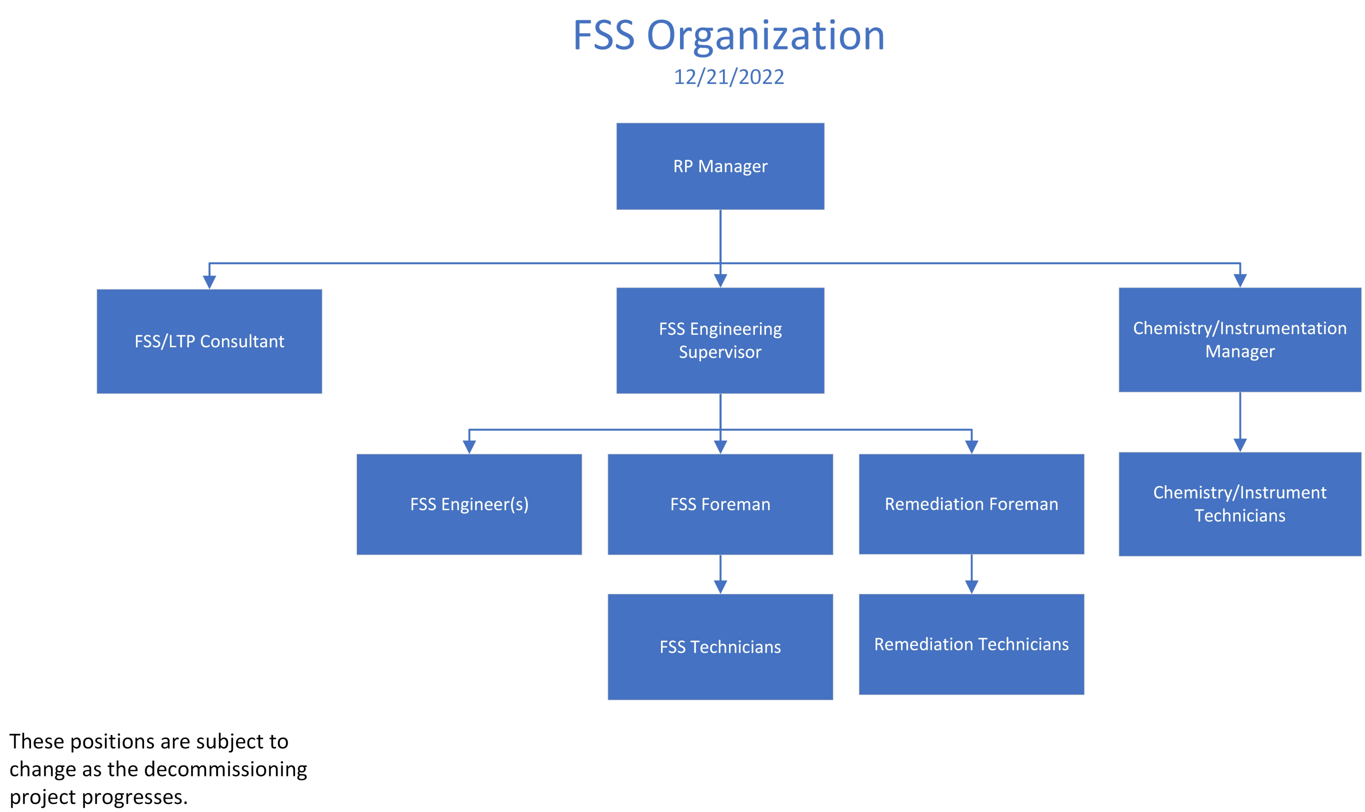
5.8.1.14 Records

Measures have been established to ensure that FSS records are maintained as quality records. These measures also include procedures by which the records are reviewed and approved, and procedures that ensure the records can be retrieved within a reasonable period. The controls shall also provide for the protection of the records to ensure they are not lost or subject to degradation over time.

5.8.1.15 Audits

Audits of FSS activities will be performed periodically, in accordance with approved procedures or instructions, to verify the implementation of quality activities.

Figure 5-2 Projected CR3 FSS Organizational Chart



5.9 References

5-1 U.S. Nuclear Regulatory Commission NUREG-1757, Volume 2, Revision 2, "*Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, Final Report,"* July 2022

5-2 U.S. Nuclear Regulatory Commission NUREG-1575, Revision 1, "*Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),"* August 2000

5-3 U.S. Nuclear Regulatory Commission NUREG-1505, Revision 1, "*A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys,*" June 1998 Draft

5-4 U.S. Nuclear Regulatory Commission NUREG-1507, Revision 1, "*Minimum Detectable Concentrations with Typical Radiation Survey for Instruments for Various Contaminants and Field Conditions,"* August 2020

5-5 U.S. Nuclear Regulatory Commission NUREG-1700, Revision 2, "*Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans,"* April 2018

5-6 U.S. Nuclear Regulatory Commission Regulatory Guide 1.179, Revision 2, "*Standard Format and Content of License Termination Plans for Nuclear Power Reactors,"* July 2019

5-7 U.S. Nuclear Regulatory Commission NUREG/CR-5512, "*Residual Radioactive Contamination From Decommissioning: User's Manual DandD Version 2.1*," Volume 2, April 2001

5-8 International Organization for Standardization, ISO 7503-1, "*Evaluation of Surface Contamination - Part 1: Beta Emitters and Alpha Emitters (first edition)*," 1988

5-9 International Organization for Standardization, ISO 7503-1, "*Measurement of radioactivity — Measurement and evaluation of surface contamination — Part 1: General Principles*," 2016

5-10 Brodsky, A, 1992 "*Exact Calculation of Probabilities of False Positives and False Negatives for Low Background Counting,*" Health Physics 63(2): 198-204

5-11 CR3 TBD, "*Crystal River 3 Nuclear Power Plant Radionuclide Selection for DCGL Development,"* Revision 0, June 2021

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

6.0 COMPLIANCE WITH THE RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION
[NUREG-1700, Revision 2, Section 2.6 and Appendix A, Section A.5]

6.1 Site Release Criteria
[NUREG-1700, Revision 2, Section 2.6 and Appendix A, Section A.5]

6.1.1 Radiological Criteria for Unrestricted Use

The U.S. Nuclear Regulatory Commission (NRC) has established radiological criteria for the unrestricted established by 10 CFR 20.1402 (Reference 6-1).

> *A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25mSv) per year, including that from groundwater sources, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially results from decontamination and waste disposal*.

The site-specific derived concentration guideline (DCGL) values developed for the Crystal River Unit 3 (CR3) site correspond to the dose criterion in 10 CFR 20.1402; that is, a total effective dose equivalent (TEDE) equal to 25 mrem per year. They are tools to demonstrate compliance that "residual radioactivity that is distinguishable from background radiation" at the CR3 site meets the 10 CFR 1402 dose criterion. The NRC's definition of background radioactivity in 10 CFR 20.1003 (Reference 6-2) can assist licensees with identifying residual radioactivity from plant operations:

> *Background radiation means radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission*.

The CR3 DCGL values to support assessments of residual plant-related radioactive contamination in site soil and on building structures have been determined for each radionuclide-of-concern (ROC) that may be present at the time of license termination for CR3 and release of the site.

The use of the CR3 DCGL values provides a regulatory-acceptable means for demonstrating compliance with the site release criteria in 10 CFR 20.1402.

6.1.2 Conditions Satisfying the Site Release Criteria

For NRC licensees, compliance with 10 CFR 20.1402 is demonstrated when the following conditions are met:

- The concentration of residual radioactivity distinguishable from background is less than the applied DCGL value. For contamination with a mixture of radionuclides, the sum of the fractions of the contaminant's concentration over the contaminant's DCGL value must be less than one.
- An individual survey measurement representing a small area of residual contamination within a survey area that exceeds the DCGL value but does not exceed the elevated measurement comparison DCGL ($DCGL_{EMC}$) and the average concentration of residual radioactivity passes statistical testing (i.e., either the Wilcoxon Rank Sum Test or the Sign Test recommended in NUREG/CR-1575, "*Multi-Agency Radiation Survey and Site Investigation Manual,"* MARSSIM (Reference 6-3).

Remediation activities are performed in contaminated areas where ALARA considerations require reductions of the levels of residual radioactive contamination.

6.2 Dose Modeling Approach

[Dose Modeling Approach is provided in Enclosure 16, "*Crystal River Unit 3 DCGL Development Summary Report*," Revision 0, May 2022, (Reference 6-4)]

6.3 Modeling for Soil DCGLs

[Dose Modeling Approach is provided in Enclosure 16, "*Crystal River Unit 3 DCGL Development Summary Report*," Revision 0, May 2022, (Reference 6-4)]

6.4 Modeling for Building Surface DCGLs

[Dose Modeling Approach is provided in Enclosure 16, "*Crystal River Unit 3 DCGL Development Summary Report*," Revision 0, May 2022, (Reference 6-4)]

6.5 Computer Code Selection

[Dose Modeling Approach is provided in Enclosure 16, "*Crystal River Unit 3 DCGL Development Summary Report*," Revision 0, May 2022, (Reference 6-4)]

6.6 Probabilistic Analyses for Input Parameters

[Soil and Building Input Parameters are provided in Enclosure 8 BHI Energy Engineering Calculation ENG-CR3-001, "*RESRAD-Onsite Input Parameter Sensitivity Analysis," – Crystal River 3*, Revision 0, February 2022 and Enclosure 9 BHI Energy Engineering Calculation ENG-CR3-002, "*RESRAD-Build Input Parameter Sensitivity Analysis," – Crystal River 3,* Revision 0, January 2022, respectively, (Reference 6-4)]

6.7 Calculation of Derived Concentration Guidelines

[Soil and Building Derived Concentration Guideline Level Calculations are provided in Enclosure 10 BHI Energy Engineering Calculation ENG-CR3-003, "*Derived Concentration Guideline Levels for Soil Crystal River 3,"* Revision 1, March 2022 and Enclosure 11 BHI Energy Engineering Calculation ENG-CR3-004, "*Crystal River Building Surface DCGL Values,"* Revision 0, March 2022, respectively, (Reference 6-4)]

6.8 Calculation of Area Factors

[Soil and Building Area Factor Calculations are provided in Enclosure 12 BHI Energy Engineering Calculation ENG-CR3-005, "*Area Factors for Use with Crystal River DCGL Values for Soil,"* Revision 0, April 2022 and Enclosure 13 BHI Energy Engineering Calculation ENG-CR3-006, "*Area Factors for Use with CR3 DCGL Values for Buildings/Structures,"* Revision 0, April 2022, respectively, (Reference 6-4)]

6.9 References

6-1 Code of Federal Regulations, Title 10, Section 20.1402, "*Radiological Criteria for Unrestricted Uses"*

6-2 Code of Federal Regulations, Title 10, Section 20.1003, "*Definitions"*

6-3 NUREG-1575, "*Multi-Agency Radiation Survey and Site Investigation Manual,"* MARSSIM, Revision 1, dated August 2000

6-4 License Amendment Request 262

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

7.0 UPDATE OF SITE-SPECIFIC DECOMMISSIONING COSTS
[NUREG-1700, Revision 2, Appendix A, Section 2.7]
[U.S. Nuclear Regulatory Guide 1.179, Revision 2, Section 7]

In accordance with 10 CFR 50.82(a)(9)(ii)(F) and Regulatory Guide 1.179, Revision 2, "*Standard Format and Content of License Termination Plans for Nuclear Power Reactors*," (Reference 7-1) the site-specific Crystal River Unit 3 Nuclear Power Station (CR3) decommissioning cost estimate and funding plans are provided in this chapter. U.S. Nuclear Regulatory Guide 1.179 provides guidance with respect to the information to be presented.

In support of the proposed transfer of the Duke Energy Florida, LLC (DEF) Operating License to Accelerated Decommissioning Partners, LLC, a revised PSDAR which included a revised Decommissioning Cost Estimate (DCE) was submitted to the NRC (Reference 7-2). The financial aspects to ensure sufficient funds were available to perform D&D and terminate the license were material to the review and approval of the proposed license transfer. It is noted that the revised DCE was based upon a series of Firm Fixed Price and Fixed Unit Price subcontracts to minimize the overall cost and schedule risk of the project. Following the license transfer, ADP CR3, LLC submitted annually to the NRC a report on the status of their decommissioning financial assurance per 10 CFR 50.75(f)(1).

In addition, 10 CFR 50.82(a)(8)(v) & (vii) requires that after a licensee has submitted a site-specific decommissioning cost estimate pursuant to 10 CFR 50.82(a)(4)(i), the licensee must annually submit to the NRC a report on the status of its decommissioning expenditures, remaining costs, and funding assurance levels, as well as a report on the status of its funding for managing irradiated fuel.

ADP CR3, LLC has submitted the annual reports as required by the above discussed regulations and will continue to do so. To satisfy this section of the LTP, ADP CR3, LLC hereby incorporates by reference the following documents which provide assurance on an annual basis an updated site-specific estimate of the remaining decommissioning costs:

- Letter, ADP CR3, LLC to NRC "*Crystal River 3 – Annual Decommissioning and Irradiated Fuel Management Financial Status Report for 2021*," (3F0322-01), dated March 30, 2022 (ADAMS Accession No. ML22089A163)
- Letter, ADP CR3, LLC to NRC "*Crystal River 3 – Notification of Revised Decommissioning Cost Estimate*," (3F0522-03), dated May 26, 2022 (ADAMS Accession No. ML22148A001)
- Letter, NRC to ADP CR3, LLC. "*U.S. NUCLEAR REGULATORY COMMISSION'S ANALYSIS OF ADP CR3, LLC'S DECOMMISSIONING FUNDING STATUS REPORT FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT, DOCKET NO. 50-302*," dated September 26, 2022 (ADAMS Accession No. ML22265A019)

In the Staff's annual analysis of the facilities site-specific decommissioning cost estimate (Reference 7-3), the NRC documented that "ADP CR3, LLC has satisfied the decommissioning funding assurance requirements of 10 CFR 50.82, for ADP CR3, LLC on September 26, 2022."

Via reference to ADP CR3, LLC's correspondence submitted in accordance with 10 CFR 50.82(a)(8)(v) & (vii) and 10 CFR 50.75(f)(1) which require documenting that adequate funds are available to complete the stations final radiation surveys and that residual radioactivity has been reduced to a level that permits termination of the license, ADP CR3, LLC hereby satisfies this section of the LTP.

7.1 References

7-1 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.179, *"Standard Format and Content of License Termination Plans for Nuclear Power Reactors,"* Revision 2, July 2019

7-2 Letter, ADP CR3, LLC to NRC "*Crystal River 3 – Notification of Revised Decommissioning Cost Estimate*," (3F0522-03), dated May 26, 2022 (ADAMS Accession No. ML22148A001)

7-3 Letter, NRC to ADP CR3, LLC. "*U.S. NUCLEAR REGULATORY COMMISSION'S ANALYSIS OF ADP CR3, LLC'S DECOMMISSIONING FUNDING STATUS REPORT FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT, DOCKET NO. 50-302*," dated September 26, 2022 (ADAMS Accession No. ML22265A019)

THIS SPACE INTENTIONALLY LEFT BLANK

Table of Contents

THIS SPACE INTENTIONALLY LEFT BLANK

8.0 SUPPLEMENT TO THE ENVIRONMENTAL REPORT
[NUREG-1700, Revision 2, Section 1.3, Section 2.8, and Appendix A, Section A.7]

8.1 Introduction and Purpose

8.1.1 Purpose

The purpose of this chapter of the License Termination Plan (LTP) is to update the environmental report for CR3 with new information and significant environmental changes associated with the site's decommissioning and license termination activities. This chapter of the LTP is prepared pursuant to both 10 CFR 51.53(d) and 10 CFR 50.82(a)(9)(ii)(G). LTP Chapter 8 documents an assessment of the environmental effects of decommissioning CR3. The assessment determined that the environmental effects from decommissioning CR3 are minimal, and no adverse effects are outside the bounds of NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors" (FGEIS; Reference 8-1).

The information contained in this chapter generally follows the guidance in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors" (Reference 8-2), and NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans" (Reference 8-3). Guidance contained in the FGEIS also was used during preparation of this chapter. The contents of this chapter have also been reviewed against the appropriate sections of NUREG-1757, "Consolidated NMSS Decommissioning Guidance Decommissioning Process for Materials Licensees" (Reference 8-4).

8.1.2 Background

This section is described in Chapters 1 and 2.

8.1.3 Environmental Effects of Decommissioning

A description of both the radiological and non-radiological environmental effects of decommissioning is provided in Section 8.5. Radiological impacts reviewed include evaluations of occupational and public doses, decommissioning accidents, low-level waste generation, transportation and disposal, and adherence to radiological criteria for license termination.

The non-radiological effects include potential impacts governed by federal, state, and local regulations. ADP-CR3 used the FGEIS as guidance in evaluating the non-radiological effects of decommissioning.

8.2 Site Description after Termination of the License

A main objective of the decommissioning project is to restore the land formerly occupied by CR3 to conditions that allow for unrestricted uses of the site. From a radiological standpoint, ADP-CR3 has chosen the conservative approach of remediating and surveying to the resident farmer scenario to allow for unrestricted release of the site upon termination of the 10 CFR 50 license. Clean-up of residual radiological contamination associated with the historical power production and other operations since CR3 shutdown is the primary objective for the project. From a non-radiological standpoint, ADP-CR3 will characterize and remediate soils to meet the Florida Department of Environmental Protection's Commercial/Industrial criteria and applicable groundwater criteria. On the basis of current efforts to characterize non-radiological contaminants, such as petroleum products, solvents, and heavy metals, the site soil and groundwater quality is typical of an established industrial power plant. No imminent threats to human health or the environment due to radiological or non-radiological constituents have been identified nor are they anticipated based on the existing investigation or characterization data.

The NRC is the lead agency over radioactive impacts and waste (such as spent nuclear fuel or byproduct materials, radioactive debris, and media). The Florida Department of Environmental Protection (FDEP) may assert jurisdiction over final site remediation standards as necessary to achieve full regulatory closure of the site and is the lead regulator for the chemical or non-radiological constituents detected in soils, sediments, and groundwater. Polychlorinated biphenyls (PCBs) have not been identified above concentrations that would invoke clean up under 40 CFR 761, therefore the United States Environmental Protection Agency (US EPA) defers the non-radiological to FDEP's regulatory authority. Site remediation and restoration efforts are expected to complete in 2026 with subsequent submittal of documentation for the Part 50 license termination in 2026. The spent nuclear fuel and the greater than Class C (GTCC) waste will remain in storage at the Independent Spent Fuel Storage Installation (ISFSI) until the Department of Energy transfers this waste to a federal repository.

8.3 Post-shutdown Decommissioning Activities Report

The Revised Post-Shutdown Decommissioning Activities Report (Revised PSDAR) for CR3 was to notify the NRC of changes in the actions and schedules previously described in the PSDAR for CR3 submitted on December 02, 2013 (available at ADAMS Accession No. ML14357A110) and accepted by the NRC by letter dated March 11, 2015 (ADAMS Accession No. ML13340A009). The 2013 PSDAR was submitted in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) "Termination of License" paragraph (a) (4)(i), and the Revised PSDAR updated the information previously provided as required by 10 CFR 50.82(a)(7).

The Revised PSDAR contained the following:

1. A description of the planned decommissioning activities along with a schedule for their accomplishment
2. A discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements
3. A site-specific decommissioning cost estimate (DCE), including the projected irradiated fuel management costs. The latest DCE table was updated in 2022 (ML22148A001)

8.4 CR3 Site Environmental Setting and Description

The PSDAR was submitted December 2013 with a revised PSDAR June 2019. ADP-CR3 reviewed the PSDAR, environmental reports and the guidance contained in the FGEIS to determine what new information needs to be included in this chapter of the LTP.

8.4.1 Geography and Demography

8.4.1.1 Site Location and Description

Site Location and Description are described in Chapter 1.

8.4.1.2 Population

Crystal River is a city located in Citrus County Florida. With a 2020 population of 3,396, it is the 256th largest city in Florida and the 6,023rd largest city in the US. Crystal River is currently growing at a rate of 0.53% annually and its population has increased by 4.15% since the most recent census, which recorded a population of 3,108 in 2010. Spanning over 8 miles, Crystal River has a population density of 432 people per square mile. (Reference 8-7) "*2020 Census*"

8.4.1.3 Site Access, Land, and Water Use

The site consists of 4,738 acres including the 1/4-mile-wide access strip provided for railroad, road, and transmission line right-of-way extending from the Plant to U.S. Highway 19. This strip is crossed by old U.S. Highway 19, 951 ft west of U.S. 19 and 2,224 ft east of the plant guard house and entrance. Agriculture is a major industry within 50 miles in the area east of Route 41. An agricultural belt extends south from Gainesville to Dade City in which the activities include the growing of citrus fruits, general farming and the raising of pigs, chickens, horses, and cattle.

The immediate 5-mile radius area has little land recreational activity. A minor undeveloped State Park is located along the north bank of the Crystal River; however, water-based recreation is extensive.

8.4.2 Climate

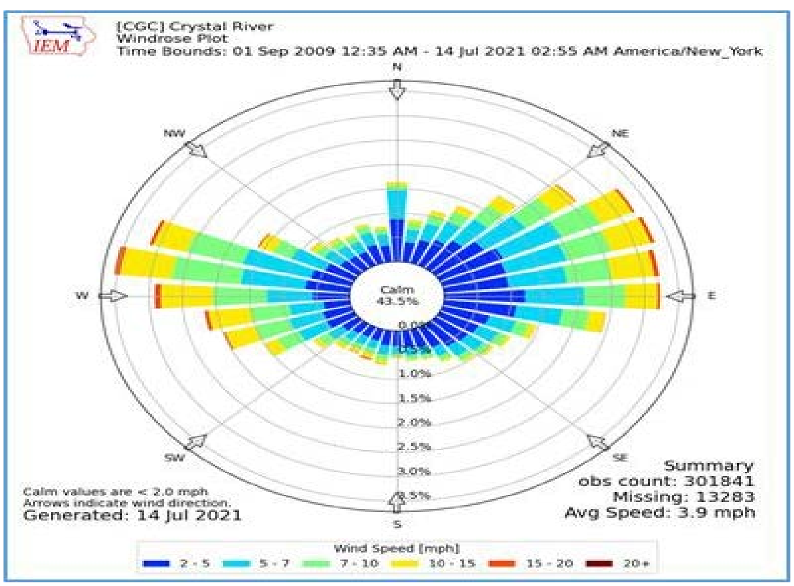
8.4.2.1 General Climatology

In Crystal River, the temperature typically varies from *45°F* to *90°F* and is rarely below *31°F* or above *94°F*. The summer or "*hot season"* lasts for approximately *5 months*, from mid-*May* to early *October*, with an average daily high temperature above *86°F*. The hottest month of the year in Crystal River is *August*, with an average high of *90°F* and low of *72°F*. The "*cool season"* lasts for approximately 3 *months*, from early *December* to later *February*, with an average daily high temperature below *73°F*. The coldest month of the year in Crystal River is *January*, with an average low of *45°F* and high of *69°F*. Crystal River Florida climatology taken from: "*Crystal River Climate, Weather By Month, Average Temperature (Florida, United States) - Weather Spark*" (Reference 8-8)

8.4.2.2 Extreme Winds

The average hourly wind speed in Crystal River experiences significant seasonal variation over the course of the year. The "*windier*" part of the year lasts for approximately 8 months, from late September to mid-May, with average wind speeds of more than 7.5 miles per hour. The windiest month of the year in Crystal River is February, with an average hourly wind speed of 8.9 miles per hour. The calmer time of year lasts for approximately 4 months, from mid-May to late September. The "*calmest*" month of the year in Crystal River is July, with an average hourly wind speed of approximately 6 miles per hour.

Figure 8-1 Annual wind rose for Crystal River Florida



8.4.2.3 Tornados

The site has a medium potential to experience tornadic activity during severe thunderstorms and "spin-off" tornados during a hurricane.

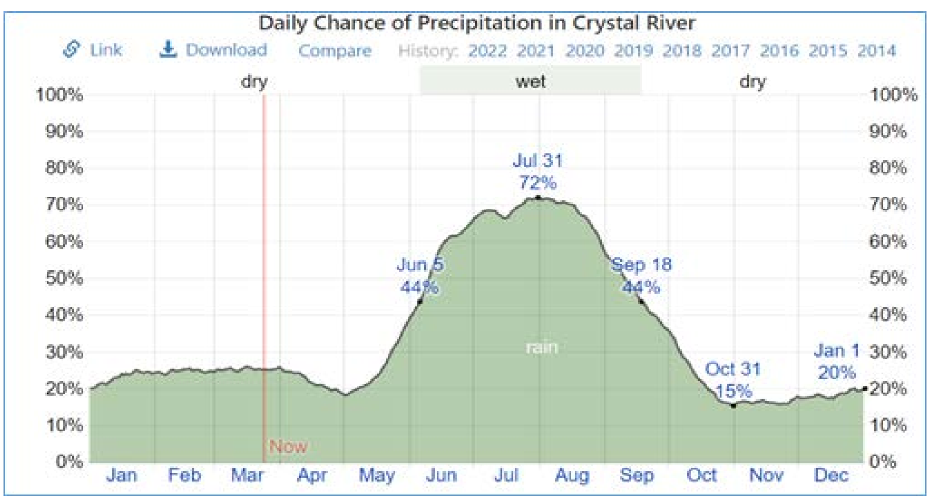
8.4.2.4 Tropical Storms and Hurricanes

Tropical storms and hurricanes are a potential during the hurricane season. Tropical storms have sustained winds average 39 to 73 mph. When sustained winds intensify to greater than 74 mph, the resulting storms are called hurricanes. Hurricanes are divided into five classes according to the Saffir-Simpson hurricane wind scale which uses wind speed as the principal parameter to categorize storm damage potential. While the average tropical cyclone affecting Citrus County is a tropical storm, the extent is Category 3, as the worst tropical cyclone recorded was Category 3 Hurricane Donna in 1960.

8.4.2.5 Precipitation Extremes

The average amount of precipitation for the year in Crystal River is 44.5" (1130.3 mm). The month with the most precipitation on average is July with 7.2" (182.9 mm) of precipitation. The month with the least precipitation on average is January with an average of 2.1" (53.3 mm). In terms of liquid precipitation, there are an average of 71.1 days of rain, with the most rain occurring in August with 11.0 days of rain, and the least rain occurring in November with 3.3 days of rain.

Figure 8-2 Rain Precipitation in Crystal River



8.4.2.6 Snow and Ice Storms

Crystal River, FL rarely experiences snow and ice due to the warm temperatures and lower altitudes.

8.4.2.7 Thunderstorms

During the wet season which spans June through October thunderstorms frequently occur in the afternoons.

8.4.2.8 Restrictive Dilution Conditions (Inversions)

Thermal inversions are more prevalent during the winter months when temperatures cause a cool air layer near the surface with warmer air above.

8.4.3 Geology and Seismology

The carbonate rocks beneath the site have been fractured in response to the Ocala Uplift, leaving the rocks susceptible to dissolution via the infiltration of rainwater. This is also referred to as karst systems. Subsurface data acquired from the exploration and grouting of the foundation for Crystal River Unit 2 show that the dissolution is most prevalent in the first 100 feet of section below the existing ground surface (RSCS, 2016). The geology of the site, and specifically the elevated area where CR3 is constructed is made up of fill. Outside of this area, a layer of surface fills averaging 3 to 5 ft thick covers the remaining portions of the Site.

Below the fill, native soil consists of thinly laminated, organic sandy silts and clays, interspersed with the Pamlico Terrace Formation, a Pleistocene marine deposit. These deposits vary in thickness but average approximately four feet across the site. Beneath these deposits lies a lime-rich soil unit originating from the decomposition of the underlying bedrock.

Bedrock at the site is encountered at approximately 20 feet below the existing ground surface (outside the CR-3 elevated areas) and consists of two distinct Eocene formations made of biogenic carbonates. The upper-most member, the Inglis Member of the Moody Branch Formation, overlies an unconformity consisting of dense silt, sands, and organic clays of variable thickness which represent an erosional surface known as the Jackson-Claiborne Unconformity. Surface is comprised of materials derived, in part, from reworked residual soils, formed from the underlying carbonate sequence (Avon Park Formation). The unconformity can be represented as an undulatory surface ranging from an elevation of -10 feet to an elevation of +20 feet (DEF, 2018).

8.4.3.1 Seismology

There were no significant confirmed earthquakes in or near Citrus County since 1900.

8.4.4 Hydrology and Hydrogeology

This area is located on the western coast of Florida, near the Gulf of Mexico. Groundwater at the site occurs under both unconfined (i.e., "water table") and confined (i.e., "confined") conditions. There are thirteen groundwater monitoring wells around the perimeter of the CR3 Protected Area (PA) which are sampled quarterly and analyzed for tritium and gamma-emitting radionuclides as part of the station's Radiological Environmental Monitoring Program (REMP).

Groundwater if first encountered at approximately 5.5 to 9 feet below the existing ground surface, and approximately 20 feet below the existing ground surface from the ground surface of the bermed areas of the ADP-CR3 plan. The direction of groundwater flow is generally to the west southwest, toward the Gulf of Mexico. The upper zone of the Floridian Aquifer is highly permeable, while the unfractured limestone that separates the upper and lower zones is much less permeable. The lower zone (40 to 60 ft below the existing ground surface) contains smaller voids created by dissolution that are not as transmissive as the upper zone. There is a general upward flow gradient in the Floridian Aquifer at the Site with a hydraulic gradient of the upper zones reported at approximately 1000 ft/day) (GHS, 2017).

8.4.5 Biota

8.4.5.1 Ecology of the Site

The CREC is located in Citrus County in west-central Florida between the mouths of the Withlacoochee and Crystal rivers and adjacent to the Gulf of Mexico. The site and associated transmission lines are within the Southern Coastal Plain Ecoregion, which consists of mostly flat plains, but also barrier islands, coastal lagoons, marshes, and swampy lowlands along the Gulf and Atlantic coasts (EPA, 2002). The region was once covered by a variety of forest communities that included longleaf pine (Pinus palustris), slash pine (P. elliottii), pond pine (P. serotina), American beech (Fagus grandifolia), sweetgum (Liquidambar styraciflua), large-flower magnolia (Magnolia grandiflora), white oak (Quercus alba), and laurel-leaf oak (Q. laurifolia), but is now predominantly slash and loblolly pine (P. taeda) (with oak-gum-cypress forest in some low lying areas), citrus groves, cattle pasture, and urban development.

Much of the area adjacent to the CREC is undeveloped wetland habitat, especially near the coast, but extensive areas of pine plantations and about 900 ac (360 ha) of quarry lakes also occur in the vicinity. Terrain in the northwestern portion of Citrus County, in which the CREC is located, rises gradually from mangrove swamp and coastal marshes along the coast to gently rolling hills about 16 mi (26 km) inland.

The CREC site and surrounding areas are about 2 to 5 ft (0.6 to 1.5 m) above mean sea level (AEC, 1973). Salt or tidal marshes occur on the westernmost portion of the site along the Gulf coast in a band about 0.75 mi (1.2 km) wide and are crossed by the intake and discharge canals associated with CR3. Salt marshes are wetland habitats that are tidally influenced and dissected by many naturally occurring tidal creeks or channels. Salt marshes of the site are dominated by smooth cordgrass (Spartina alterniflora) and Roemer's rush (Juncus roemerianus) (AEC, 1973).

8.4.5.2 Vegetative Patterns at CR3

The FWS National Wetland Inventory has mapped most of the undeveloped portions of the CREC site, where CR3 and associated facilities are located, as a wetland. Salt marsh habitat is classified by the FWS as estuarine intertidal emergent and shrub/scrub wetland. Hardwood hammocks are classified as palustrine forested evergreen and deciduous wetlands. Palustrine emergent wetlands exist as patches within these habitats and within pine flatwoods. Freshwater swamps within pine flatwoods are classified as palustrine forested evergreen and deciduous wetland.

8.4.5.3 Fauna at CR3

Salt marshes are used by many animal species, including wading birds such as egrets and herons (Ardeidae). The FES listed the following vertebrate animals as occurring in onsite salt marshes: great blue heron (Ardea herodias), white ibis (Eudocimus albus), mallard (Anas platyrhynchos), red-winged blackbird (Agelaius phoeniceus), marsh rice rat (Oryzomys palustris), round-tailed muskrat (Neofiber alleni), and American mink (Neovison vison).

According to the Florida Natural Areas Inventory (FNAI, 1990), typical animals of this community type include salt marsh snails (Littorinidae, Ellobiidae), periwinkle (Littorinidae), mud snails (Nassariidae), spiders, fiddler crabs (Uca spp.), marsh crab (Decapoda spp.), isopods, amphipods, diamondback terrapin (Malaclemys terrapin), saltmarsh snake (Nerodia clarkii), wading birds, waterfowl, osprey (Pandion haliaetus), rails (Rallus spp.), marsh wren (Cistothorus palustris), seaside sparrow (Ammodramus maritimus), round-tailed muskrat, and raccoon (Procyon lotor).

8.5 Environmental Effects of Decommissioning

The most significant potential environmental effects of decommissioning activities are associated with radiation exposure, structures demolition, and the disposal of radioactive waste. As described further herein, decommissioning CR3 is anticipated to have a minimal and insignificant adverse environmental impact.

Moreover, decommissioning is expected to have significant beneficial impacts, including eliminating the risks associated with a commercial nuclear facility.

The adverse effects associated with decommissioning include routine occupational radiation exposure and the commitment of land offsite for radioactive waste disposal. As discussed in the FGEIS, radiation exposure to the public is small, even when accidental airborne radioactive releases are considered. The low-probability, worst-case exposure to an individual from an accident involving a truck transporting radioactive waste to a disposal facility is small.

On the basis of the analysis contained in the FGEIS, ADP-CR3's evaluation of site-specific issues, and the supplemental analysis contained herein, ADP-CR3 continues to conclude that the CR3 decommissioning will be accomplished with no significant adverse environmental impacts.

By implementing the appropriate best management practices (BMP) and mitigating measures to minimize the impacts of decommissioning activities, no unique aspects of the plant or decommissioning techniques will invalidate or alter the following conclusions ADP-CR3 made on the basis of the FGEIS:

- Potential public and occupational doses are bounded by the FGEIS criteria and have been determined to be insignificant.
- Decommissioning does not constitute an imminent health or safety problem and will generally have a positive environmental impact, ultimately meeting the FDEP Commercial/Industrial criteria for environmental media.

8.5.1 Radiological Effects of Decommissioning

The occupational dose for complete decommissioning of CR3 considers (1) dose from all occupational activities required for the actual decommissioning of CR3 through 2026, and (2) occupational dose due to waste shipments. The occupational dose for CR3 decommissioning will meet the regulatory standards in 10 CFR 20 and is, therefore, bounded by the criteria in the FGEIS.

Public dose from decommissioning CR3 considers direct radiation exposure and exposure due to gaseous and liquid effluents. Direct exposure and effluents in gaseous and liquid discharges are not expected to exceed the design objectives of 10 CFR 50, Appendix I, nor the dose limits in 10 CFR 20 and 40 CFR 190. Therefore, the public dose from CR3 decommissioning is bounded by the criteria in the FGEIS.

On the basis of the previous discussions, ADP-CR3 continues to conclude that CR3 decommissioning will be accomplished with no significant adverse environmental impacts, and will be accomplished because of the following factors:

- By implementing appropriate BMPs and mitigating measures to minimize the impacts of decommissioning activities, there are no unique aspects of the plant or decommissioning techniques that would invalidate or alter the conclusions of the FGEIS;
- Public and occupational doses are bounded by the FGEIS criteria;
- Radiation dose to the public will be minimal; and
- Decommissioning does not constitute an imminent health or safety problem and will generally have a positive environmental impact.

8.5.1.1 Offsite Radiation Exposure and Monitoring

ADP-CR3 submits annual Radiological Environmental Monitoring Program (REMP) reports that contain results of both onsite and offsite sampling conducted under the REMP. Annual reports indicate that direct radiation from all sources was below the 40 CFR 190 limits at the CR3 site.

8.5.1.2 Environmental Effects of Accidents and Decommissioning Events

Hazardous materials handling and transportation for the project is regulated and controlled by numerous states, federal, and local agencies. The regulations for handling hazardous materials are sufficiently stringent to render the potential for release to the environment from spill or accidental breach of containment as less than significant. Modern engineering designs for containment, proven BMPs, and standards of care will minimize any accidental release of hazardous waste, whether within the project boundary or in transit to a disposal facility.

The potential for decommissioning activities to result in radiological releases not involving spent fuel (i.e., releases related to decontamination, dismantlement, and waste handling activities) will be minimized by use of procedures designed to minimize the likelihood and consequences of such releases. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on radiological accidents are small and are bounded by the previously issued GEIS.

8.5.1.3 Storage and Disposal of Low-level Radioactive Waste

Regulations that apply to the transportation of hazardous, mixed-waste, and radioactive material promulgated by the U.S. Department of Transportation are contained in 49 CFR 171-177. NRC regulations related to transportation of low-level waste are contained in 10 CFR 71, "*Packaging and Transportation of Radioactive Material.*"

These regulations contain requirements for transport vehicles, maximum radiation levels for packages and vehicles, special packaging requirements, driver training, vehicle and packaging inspections, marking, and labeling of packages, placarding of vehicles, and training of emergency personnel to respond to mishaps. Highway routing restrictions for certain shipments of low-level radioactive waste (LLRW) are also included in U.S. Department of Transportation regulations. NRC regulations contain performance requirements for certain types of transportation packages of radioactive material.

In addition, federal and state regulations govern the size and weight of conveyances. NRC assumes that equipment, materials, and waste transportation are conducted within applicable regulations.

On the basis of the nuclide concentrations, LLRWs are classified as Class A, Class B, or Class C. Waste above Class C levels is called “greater than Class C” (GTCC). It requires greater confinement disposal and is not suitable for near-surface disposal. CR3 GTCC waste is to be stored in its own container within the ISFSI facility until a geologic repository is available.

Wastewater, solid non-hazardous wastes, and liquid and solid hazardous wastes will be generated during project activities. All solid and liquid wastes generated at the project site must be classified as either hazardous or nonhazardous.

For the demolition of CR3, the demolition contractor, ADP-CR3’s radiological protection group, and/or ADP-CR3’s environmental coordinator will oversee the classification of the waste generated at the project site and will provide information needed to identify the appropriate disposal facility.

ADP-CR3 has additionally prepared a waste management plan for CR3s decommissioning, which is focused on managing radiological wastes. Waste generated during the demolition of CR3 will fall into one of the following seven categories (All demolition debris from CR3 is assumed to be potentially radioactively contaminated and is included in volume estimates listed for regulated wastes):

- Radiologically contaminated waste
- Mixed waste (both radiological and hazardous constituents)
- Universal waste
- Non-Resource Conservation and Recovery Act (RCRA) hazardous wastes (i.e., regulated wastes).
- RCRA hazardous waste
- Toxic Substances Control Act-regulated waste

8.5.1.4 Spent Fuel Storage

DEF has completed transfer of all spent nuclear fuel to the ISFSI. The canisters are seal-welded and, therefore, are considered leak tight, so that no leakage is expected during normal operation, off-normal conditions, or design basis accidents.

8.5.1.5 Radiological Criteria for License Termination

Chapter 6 of this LTP, Compliance with the Radiological Criteria for License Termination, provides the methodology for achieving unrestricted release of the CR3 site. Following decommissioning, residual radioactivity will be limited to 25 mrem/year and ALARA from all potential exposure pathways to the average member of the critical group (Resident Farmer).

8.5.2 Non-radiological Effects of Decommissioning

The following subsections provide an assessment of the non-radiological impacts of decommissioning and site release.

8.5.2.1 Onsite/Offsite Land Use

ADP-CR3 does not anticipate any changes in land use beyond the site boundary during decommissioning. CR3 has sufficient area onsite that has been previously disturbed (due to construction or operations activities) for use during decommissioning. Construction activities that would disturb greater than one acre of soil require application and approval from the FDEP prior to disturbing the soil. Construction projects are required to control sediment and erosion effect on water course and wetlands.

The GEIS concluded that the impacts on land use are not detectable or small for facilities having only onsite land use changes as a result of large component removal, structure dismantlement, and low-level waste packaging and storage. CR3 will be able to conduct all of these decommissioning activities on previously disturbed land. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on onsite/offsite land use are bounded by the previously issued GEIS.

8.5.2.2 Water Use

After plant shutdown, the operational demand for circulating water is eliminated. Additionally, makeup water and raw water use decreases dramatically. In accordance with the PSDAR, during Period 1, the demand for raw water will continue to decrease as the SFP heat load declines due to radioactive decay. Prior to entering Period 2, the need for raw water for cooling purposes will be eliminated by the installation of an alternate spent fuel cooling system.

During plant shutdown, the use of potable water will also decrease commensurate with the expected decrease in plant staffing levels. For these reasons, the GEIS concluded that water use at decommissioning nuclear reactor facilities is significantly smaller than water use during operation.

The GEIS also concluded that water use during the decontamination and dismantlement phase will be greater than that during the storage phase. There are no unique aspects associated with the decommissioning of CR3 and water use for such activities as flushing piping, hydrolazing, dust abatement, etc. Consequently, CR3 water use impacts were addressed by the evaluation of the reference facility in the GEIS. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on water use are bounded by the previously issued GEIS.

8.5.2.3 Water Quality

Programs and processes designed to minimize, detect, and contain spills will be maintained throughout the decommissioning process. Federal, State, and Local regulations and permits pertaining to water quality will remain in effect and no significant changes to water supply reliability are expected. The National Pollutant Discharge Elimination System (NPDES) permit, which regulates surface water discharges from the site, will remain in place. Also, during the planning and dormancy periods, storm water runoff and drainage paths will be maintained in their current configuration. ADP-CR3 concludes that the impacts of CR3 decommissioning on water quality are bounded by the previously issued GEIS.

8.5.2.4 Air Quality

Title V Air Operations Permit 0170004-035-AV was issued by the FDEP and regulates air emission sources by Duke to regulate the Crystal River Energy Complex emissions. However, once the CR3 license was transferred to ADP-CR3 the Emergency Diesel Generators were exempt, and a Notice of Intent (NOI) was filed. As new regulations are issued that impact these sources, these requirements will be addressed at the station. In addition, there are various other regulations that apply to air quality including hazardous air pollutants and indoor air quality. There are many types of decommissioning activities that have the potential to affect air quality.

These activities are listed in Section 4.3.4.3 of the GEIS. Based on the decommissioning activities delineated in Section 2, ADP-CR3 does not anticipate any activities beyond those listed in the GEIS Crystal River Unit 3 Post-Shutdown Decommissioning Activities Report 24 Revision 0 December 2013 that could potentially affect air quality. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on air quality are bounded by the previously issued GEIS.

8.5.2.5 Aquatic Ecology

Aquatic ecology encompasses the plants and animals in Crystal Bay which is a shallow estuarine embayment of the Gulf of Mexico. Aquatic ecology also includes the interaction of those organisms with each other and the environment. The GEIS evaluates both the direct and indirect impacts from decommissioning on aquatic ecology. Appendix E of the GEIS describes the qualitative process for evaluating these potential environmental impacts.

Direct impacts can result from activities such as the removal of shoreline structures or the active dredging of canals. CR3's shoreline structures are similar to the plants listed in Table E-2 of the GEIS and there are no apparent discriminators based on the salient characteristics (size and location) listed in Table E-5 of the GEIS.

Removal of the intake and discharge facilities as well as other shoreline structures will be conducted in accordance with FDEP permits and best management practices (BMP) will be used. Intake canal dredging will no longer be required for CR3 due to the diminished residual heat removal requirements and the relocation of the spent fuel to the ISFSI. However, Duke Units 4 & 5 may still need to dredge for the coal barge navigation.

ADP-CR3 does not anticipate disturbance of lands beyond the current operational areas of the plant, so there should not be any new impacts to aquatic ecology from runoff associated with land disturbance activities. Additionally, any significant potential for sediment runoff or erosion on disturbed areas will be controlled. The need for raw water for cooling purposes is eliminated by the installation of an alternate spent fuel cooling system (ISFSI). This decreased the potential impacts from impingement and entrainment of aquatic species from what was considered in the GEIS.

Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on aquatic ecology are bounded by the previously issued GEIS.

8.5.2.6 Terrestrial Ecology

Terrestrial ecology considers the plants and animals in the vicinity of CR3 as well as the interaction of those organisms with each other and the environment. Evaluations of impacts to terrestrial ecology are usually directed at important habitats and species, including plant and animals that are important to industry, recreational activities, the area ecosystems, and those protected by endangered species regulations and legislation. The GEIS evaluates the potential impacts from both direct and indirect disturbance of terrestrial ecology.

Appendix E of the GEIS describes the qualitative process for evaluating these potential environmental impacts.

Direct impacts can result from activities such as clearing native vegetation or filling a wetland. ADP-CR3 does not anticipate disturbing habitat beyond the operational areas of the plant. All dismantlement, demolition, and waste staging activities are envisioned to be conducted within the industrial area of the site.

An objective of new facility construction, such as the ISFSI, will be to reuse previously disturbed land. Also, the FDEP controls significant impacts to the environment through regulation of construction activities and existing permits. Indirect impacts may result from effects such as erosional runoff, dust, or noise. BMPs require that construction projects are required to control sediment and the effects of erosion. Fugitive dust emissions will be controlled through the judicial use of water spraying. The basis for concluding that the environmental impacts of noise are bounded by the GEIS is discussed in Section 8.5.2.12.

The GEIS concludes that if BMP are used to control indirect disturbances and habitat disturbance is limited to operational areas, the potential impacts to terrestrial ecology are small. As discussed above, there are no unique disturbances to the terrestrial ecology anticipated during the decommissioning of CR3. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on terrestrial ecology are bounded by the previously issued GEIS.

8.5.2.7 Threatened and Endangered Species

Aquatic species that are Federally listed as threatened or endangered and that occur in the vicinity of CR3 are limited to two species of fish: Gulf sturgeon, smalltooth sawfish; five species of sea turtles: green turtle, hawksbill, Kemp's ridley, leatherback, loggerhead; one crocodilian species: American alligator, and one marine mammal: Florida manatee. (Reference 8-6)

A total of 32 terrestrial species (18 plants and 14 animals) that are listed by the State of Florida as endangered, threatened, or species of special concern are known to occur in Citrus County, the location of the CREC. However, there are only two State-listed species that are known to occur on the CREC site - the bald eagle (threatened) and the wood stork (endangered), while an additional three State-listed species can potentially occur at the CREC site - the gopher tortoise, the eastern indigo snake, and the piping plover.

The GEIS does not make a generic determination on the impact of decommissioning on threatened and endangered species. Rather it concludes that the adverse impacts and associated significance of the impacts must be determined on a site-specific basis. With respect to the threatened and endangered aquatic species, the environmental impacts during decommissioning are expected to be minimal. Removal of shoreline structures will be conducted in accordance with FDEP permits and BMP will be used.

Intake canal dredging is no longer expected to occur due to the diminished heat load. Shutting off the Circulating Water System reduces the effects of impingement, entrainment, and thermal discharges on aquatic species.

No reliance is placed on the Gulf of Mexico to cool CR3 heat loads and the Raw Water System no longer functions in this capacity. This further reduces the impacts of impingement, entrainment, and thermal discharges. One potential adverse impact from discontinuing the use of the CR3 Circulating and Raw Water Systems may be the reduction of a thermal refuge for manatees in the discharge canal. The environmental impacts during decommissioning are expected to be minimal on threatened and endangered terrestrial species. ADP-CR3 does not anticipate disturbing habitat beyond the operational areas of the plant for decommissioning and construction activities. Major construction activities are permitted by the FDEP and are required to control sediment and the effects of erosion.

The GEIS also suggests that care be exercised in conducting decommissioning activities after an extended SAFSTOR period because there is a greater potential for rare species to colonize the disturbed portion of the site. Prior to the start of and at all times during work activities, workers observe the surrounding conditions to maintain a safe environment, which includes the mitigation of a threat to wildlife. Work activities are stopped if unexpected conditions are present. Site environmental specialists support actions to transport or protect the wildlife, as necessary.

Based on the above, the planned decommissioning of CR3 will not result in a direct mortality or otherwise jeopardize the local population of any endangered or threatened species. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on endangered or threatened species are bounded by the previously issued GEIS.

8.5.2.8 Occupational Issues

Occupational issues are related to human health and safety. The GEIS evaluates physical, chemical, ergonomic, and biological hazards. The decommissioning approach outlined in Section 2 of the PSDAR poses no unique hazards from what was evaluated in the GEIS. ADP-CR3 will continue to maintain appropriate administrative controls and requirements to ensure occupational hazards are minimized and that applicable federal, state, and local occupational safety standards and requirements continue to be met. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on occupational issues are bounded by the previously issued GEIS.

8.5.2.9 Cost

A discussion of site project costs is presented in Chapter 7 of this LTP.

8.5.2.10 Socioeconomics

Decommissioning of CR3 is expected to result in negative socioeconomic impacts. As CR3 transitioned from an operating plant to a shutdown plant and into the different phases of decommissioning, an overall decrease in plant staff occurred. The lost wages of these plant staff resulted in decreases in revenues available to support the local economy and local tax authorities. Some laid-off workers relocated, thus potentially impacting the local cost of housing and availability of public services.

The GEIS evaluated changes in work force and population, changes in local tax revenues, and changes in public services. The evaluation also examined large plants located in rural areas that permanently shut down early and selected the SAFSTOR option. The GEIS determined that this situation is the likeliest to have negative impacts. The GEIS concluded that socioeconomic impacts are neither detectable nor destabilizing and that mitigation measures are not warranted. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on socioeconomic impacts are bounded by the previously issued GEIS.

8.5.2.11 Environmental Justice

Executive Order 12898 dated February 16, 1994, directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act. It is designed to ensure that low-income and minority populations do not experience disproportionately high and adverse human health or environmental effects because of Federal actions. The Draft Supplement Environmental Impact Statement (DSEIS) Sections 4.9.7.1 and 4.9.7.2 analyzed the census data within 50 miles of CR3 for minority and low-income populations, respectively.

The DSEIS analysis concluded that there are minority and low-income populations within 50 miles of CR3. According to the 2020 census data, 14.3% of the population identified themselves as minority individuals and 12.9% of the population were considered low income. The GEIS reviewed environmental justice decommissioning impacts related to land use, environmental, and human health. ADP-CR3 does not anticipate any offsite land disturbances during decommissioning, thus the land use impacts are not applicable for CR3.

Based on the radiological environmental monitoring data from CR3, the DSEIS found no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations (i.e., minority and/or low-income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on environmental justice are small and are bounded by the previously issued GEIS.

8.5.2.12 Cultural, Historical and Archaeological Resources

Based on a review of the Florida State Historic Preservation Office files, published literature, and information provided by the applicant, the NRC concluded in Section 4.9.6 of the DSEIS that the potential impacts from license renewal of CR3 on historic and archaeological resources would be small.

The NRC's conclusion was based on: 1) the results of archaeological surveys conducted prior to initial plant construction and during subsequent expansion activities; 2) the locations of existing archaeological sites within the CREC, including areas of high potential for additional discoveries, are located away from plant maintenance and operations activities in the protected area; and 3) the environmental protection procedures in use by the CR3 environmental staff during the environmental site visit.

The cultural, historic, and archeological impact evaluation conducted in the GEIS focused on similar attributes as the DSEIS. The GEIS evaluated direct effects such as land clearing and indirect effects such as erosion and siltation. The conclusion for the license renewal evaluation is also applicable to the decommissioning period because: 1) decommissioning activities will be primarily contained to disturbed areas located away from areas of existing or high potential for archaeological sites; 2) construction activities that disturb greater than one acre of soil need FDEP approval and are required to control sediment and the effects of erosion; and 3) environmental protection procedures pertaining to archaeological and cultural resources will remain in effect during decommissioning.

Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on cultural, historic, and archeological resources are small and are bounded by the previously issued GEIS.

8.5.2.13 Aesthetic Issues

The GEIS evaluated the aesthetic impacts such as noise and dust during decommissioning as well as changed appearance of the site after decommissioning is complete. During decommissioning, the impact of activities on aesthetic resources will be temporary and remain consistent with the aesthetics of an industrial plant. In most cases, the GEIS concludes that impacts such as dust, construction disarray, and noise would not easily be detectable offsite. This conclusion is applicable to CR3 because it is located within a 4,738-acre site and BMPs will be used to control potentially adverse impacts. After the decommissioning process is complete, site restoration activities will result in structures being removed from the site and the site being backfilled, graded, and landscaped as needed. The GEIS concludes that the removal of structures is generally considered beneficial to the aesthetic impacts of the site.

Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on aesthetic issues are bounded by the previously issued GEIS.

8.5.2.14 Noise

General noise levels during the decommissioning process are not expected to be any more severe than during refueling outages and are not expected to present an audible intrusion on the surrounding community. Some decommissioning activities may result in higher-than-normal onsite noise levels (i.e., some types of demolition activities). However, these noise levels would be temporary and given the distance to the property boundary, offsite individuals are not expected to experience an audible intrusion.

The GEIS indicates that noise impacts are not detectable or destabilizing and makes a generic conclusion that potential noise impacts are small. Based on the standard decommissioning approach proposed for CR3 and the distance to offsite individuals, ADP-CR3 concludes that the impacts of CR3 decommissioning on noise are bounded by the previously issued GEIS.

8.5.2.15 Transportation

The transportation impacts of decommissioning are dependent on the number of shipments to and from the plant, the types of shipments, the distance the material is shipped, and the radiological waste quantities and disposal plans.

The shipments to and from the plant would primarily result from shipments of radioactive wastes and non-radioactive wastes associated with dismantlement and disposal of structures, systems, and components.

ADP-CR3 must comply with applicable regulations when shipping radioactive waste from decommissioning. The NRC has concluded in Section 4.3.17 of the GEIS that these regulations are adequate to protect the public against unreasonable risk from the transportation of radioactive materials.

In addition, as most wastes will be transported via rail, shipments of non-radioactive wastes from the site are not expected to result in measurable deterioration of affected roads or a destabilizing increase in traffic density. Therefore, ADP-CR3 concludes that the impacts of CR3 decommissioning on transportation are bounded by the GEIS.

8.6 Overview of Regulations Governing Decommissioning Activities and Site Release

8.6.1 Federal Requirements

Federal requirements for decommissioning of the CR3 nuclear site are numerous. Additional requirements from the State of Florida and other public agencies are also extensive. The following information provides an overall summary of the applicable regulations but is not intended to be all-inclusive.

8.6.1.1 Nuclear Regulatory Commission

The lead agency for the overall 10 CFR 50 license termination project is the NRC. The NRC has jurisdiction over the handling and disposition of radiologically contaminated materials associated with decommissioning CR3. The NRC also regulates the radiological exposure to decommissioning workers and the members of the public, both on and off of the CR3 site.

The NRC has authorized ADP-CR3 to commence decommissioning activities in accordance with its PSDAR. The NRC will continue to monitor progress of the project through regular updates of the PSDAR, inspections by regionally based NRC inspectors, and regular correspondence with ADP-CR3.

8.6.1.2 U.S. Environmental Protection Agency

- The U.S. Environmental Protection Agency regulations are outlined in Title 40 CFR and apply as follows:
- Part 61 – Asbestos Handling and Removal
- Parts 122 through 125 – National Pollutant Discharge Elimination System
- Parts 129 through 132 – Clean Water Act

- Part 141 – Safe Drinking Water Standards
- Part 190 – Radiation Protection Standards for Nuclear Power Operations
- Parts 260 through 272 – RCRA
- Part 280 – Underground Storage Tanks
- Part 761 – Polychlorinated Biphenyls (PCBs)

8.6.2 State and Local Requirements

8.6.2.1 Florida Department of Environmental Protection

The Florida Department of Environmental Protection is the state's lead agency for environmental management and stewardship, protecting our air, water, and land. FDEP is divided into three primary areas:

- **Land and Recreation** programs acquire and protect lands for preservation and recreation. FDEP oversees 175 state parks and trails and more than 12 million acres of public lands and 4 million acres of coastal uplands and submerged lands.
- **Regulatory** programs safeguard natural resources by overseeing permitting and compliance activities that protect air and water quality and manage waste cleanups. Primarily, Chapters 62-780 and 62-777 of the Florida Administrative Code (F.A.C.)
- **Ecosystems Restoration** programs protect and improve water quality and aquatic resources including America's Everglades, Florida's iconic springs and Florida's world-renowned coastal resources. FDEP works with local communities, local governments and other agencies to protect and restore water quality and supply and to provide funding assistance for water restoration and infrastructure projects, as well as coordinates the protection of Florida's submerged lands and coastal areas.

The Florida Department of Environmental Protection issued a letter to CR3 dated February 15, 2019 on the Decommissioning End State Conditions. [Enclosure 18, "*Crystal River Unit 3 (CR3) – Decommissioning End State Conditions*," February 15, 2022, (Reference 8-9)] The following is a brief summary of those conditions. Enclosure 18 of the LAR.

- 25 mrem/year criteria dose limit for release of the site for unrestricted use
- Removal depth of subsurface structures to a resulting depth of three feet below final grade
- Allow usage of clean concrete from the demolition process and specifies that the final cover shall consist of 24-inch-thick soil layer, as well as other requirements such as associated grading and side slope requirements.

8.6.2.2 Occupational Safety and Health Administration (OSHA) Florida

Worker health and safety protection in Florida is regulated by OSHA. These regulations include requirements for respiratory protection, hearing, illumination, scaffolding, crane and rigging safety, chemical usage and release response, and cleanup operations.

ADP-CR3, along with their consultants, contractors, and visitors to the site, are required to have appropriate training and equipment to work within the OSHA guidelines and are committed to site safety.

8.7 Conclusion

Chapter 8 documents an assessment of the environmental effects of decommissioning the CR3 site. The assessment has determined that the environmental effects from decommissioning CR3 are being minimized to the extent practicable and no adverse effects are outside the bounds of those described in the FGEIS. Chapter 8 provides supplemental information to the November 2008 Environmental Report.

8.8 References

8-1 U.S. Nuclear Regulatory Commission NUREG-0586, "*Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors,"* November 2002.

8-2 U.S. Nuclear Regulatory Commission Regulatory Guide 1.179, "*Standard Format and Content of License Termination Plans for Nuclear Power Reactors*," July 2019.

8-3 U.S. Nuclear Regulatory Commission NUREG-1700, Rev. 2, "*Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans*," April 2018.

8-4 U.S. Nuclear Regulatory Commission NUREG-1757, Vol. 1, Rev. 2, "*Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees*," September 2006.

8-5 U.S. Environmental Protection Agency, AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Chapters 13.2.1 and 13.2.2, November 2006.

8-6 CR3 PSDAR *"Post-Shutdown Decommissioning Activities Report,"* Revised June 2019.

8-7 2020 Census *https://data.census.gov/cedsci/all?q=Crystal%20River%20city,%20Florida*, accessed on 9 August 2022

8-8 Crystal River Florida Climate and Average Weather. (2022, August 20). Retrieved from Weatherspark.com: https://weatherspark.com/y/16913/Average-Weather-in-Crystal-River-Florida-United-States-Year-Round

8-9 Enclosure 18, "Crystal River Unit 3 (CR3) – Decommissioning End State Conditions," February 15, 2019

Enclosure 4

Crystal River Nuclear Power Station

"Historical Site Assessment for Crystal River 3"

June 2016

BEGINS ON NEXT PAGE

Historical Site Assessment for Crystal River 3

Technical Support Document No. 16-015 Rev 00.

Prepared by

Radiation Safety & Control Services, Inc.
91 Portsmouth Avenue
Stratham, NH 03885-2468
1-800-525-8339
(603) 778-2871 (Outside USA)
www.radsafety.com

Created on: June 28, 2016

RSCS
Radiation Safety & Control Services

Historical Site Assessment for Crystal River 3

Technical Support Document No. 16-015 Rev 00.

Originated by: ______________________
David Scott, Professional Geologist, LEP

Originated by: ______________________
Robert Leddy, Health Physicist

Reviewed by: ______________________
Adam Kryskow, Certified Health Physicist

Reviewed by: ______________________
Greg Babineau, Director of Radiological Services

Approved by: ______________________
Eric Darois, Executive Director CHP

This report is meant to be distributed AND installed as an executable (.exe). The executable provides a directory structure containing all referenced and non-referenced supporting documents. In order for the hyperlinks contained within this document to properly link to the supporting documents, it is necessary that the installation process be correctly followed and that no changes be made directly to either this document or the accompanying directory structure. That is, the folders and files within the directory structure must not be deleted, renamed, or moved. Additionally, sharing this report without providing the executable will render all hyperlinks contained herein unusable.

Created on: June 28, 2016

RSCS
Radiation Safety & Control Services

Table of Contents

Table of Tables

Table of Figures

1 Executive Summary

This Historical Site Assessment (HSA) documents a comprehensive investigation that identifies and evaluates historical information pertaining to events that may have resulted in contamination during the operating history of the Crystal River 3 Nuclear Power Plant (CR3) owned by Duke Energy of Florida (DEF). The purpose of this assessment is to assist in planning for the decommissioning of the power plant. Given the current decommissioning strategy is the Safe Storage (SAFSTOR) option, use of the information in the HSA for future decommissioning planning will need to be evaluated with respect to the impact that the elapsed time has on the intended use of the information.

The information developed by this HSA differentiates impacted from non-impacted areas of the site. Areas determined to be impacted, based on preliminary information, have been further classified as Class 1, Class 2, or Class 3, in accordance with guidance provided in NUREG-1575, Rev. 1, "Multi-Agency Radiological Survey and Site Investigation Manual" (MARSSIM) [1]. Class 1 areas have the greatest potential for contamination to exceed applicable site closure criteria and, therefore, have received the highest degree of effort to adequately characterize them.

If operating experience suggests that an area is not likely impacted and data exist to confirm that the area is indeed non-impacted, no further characterization of the area is required because it has been demonstrated to have no plausible potential for residual contamination. If insufficient data are available to confirm a classification of non-impacted, the area has been classified conservatively as Class 3 until sufficient characterization data are obtained to support a classification of non-impacted. [1]

For purposes of classifying areas potentially impacted with non-radiological contaminants, the same methodology described in MARSSIM for radiological contaminants has been applied. For these non-radiological classifications, the Florida groundwater standards [2], federal maximum contaminant levels (MCLs) or risk-based concentrations (RBCs) have been substituted for MARSSIM's Derived Concentration Guideline Levels (DCGLs), which are the site-specific radiological criteria for release of an area for unrestricted use. These Non-Radiological classifications are differentiated from the radiological classifications by using an "NR" prefix.

All areas and structures with recognized conditions of concern have been given a preliminary classification based on available survey data, knowledge of historical site operations, and results of employee surveys and interviews. The classification of an area or subsection of an area may be revised between now and the time of site closure or license termination when additional characterization data become available.

Historical information was reviewed and compiled into this HSA to identify areas where contamination existed, remains, or has the potential to exist. This information was primarily derived from the following sources (the full list of information sources is described in Section 5.2):

- interviews of long-tenured employees;
- records from the Florida Department of Environmental Protection (FDEP);
- incident files (ARs, NCORs, PCs, etc.);
- special survey and operational radiological survey records;
- HP and Operator logs;
- engineering reports of subsurface investigations;
- reports of station inspections by American Nuclear Insurers (ANI);
- the CR3 file maintained in compliance with federal regulation 10 CFR 50.75(g) [3], namely HPP0230;
- the CR3 Offsite Dose Calculation Manual (ODCM), Rev. 36;
- the CR3 Final Safety Analysis Report (FSAR), Rev. 35;
- the CR3 Spill Prevention, Control and Countermeasures (SPCC) Plan;
- the CR3 Storm Water Pollution Prevention Plan (SWPPP);
- the CR3 Annual Radioactive Effluent Release Reports; and
- the CR3 Annual Radiological Environmental Monitoring Reports

Beginning in 2013, a survey was distributed to long-tenured employees of CR3 prior to termination of their employment. Additionally, a few current and retired employees were interviewed in December of 2015. The intent of the employee survey and interviews was to capture the institutional knowledge of those familiar with plant operation before it was lost through reductions in force. This effort provided a means of identifying areas at the station where either radiological or non-radiological contamination may have occurred but that may not have been documented in plant records.

Employees who were at the station for many years, particularly during plant construction and/or early operation, were sought because spill reporting and documentation of contamination incidents during this period may not be as complete compared to the later years. For example, federal regulation 10 CFR 50.75(g), which requires compilation of records of contamination incidents that may have significance during decommissioning, did not exist prior to 1988.

Regulation 10 CFR 50.75(g) requires compilation of "records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site". While the regulation does not explicitly distinguish between radiological and non-radiological contamination most operators of commercial nuclear power stations, including the operators of CR3, have interpreted it to refer exclusively to radiological contamination. For this reason, other forms of plant record-keeping, such as Condition Reports, Nonconforming Operations Reports, and Precursor Cards, as well as employee's memories must be relied upon to identify historical incidents of non-radiological contamination. [3]

Based on responses to the employee survey and the discussions held in December 2015, there do not appear to be any undocumented incidents of contamination at the station that would be significant for its decommissioning. None of the identified impacted areas are an imminent threat to human health or the environment, or appear to present a significant challenge to the decommissioning process. When leaks or spills occurred they were immediately remediated by removal of the accessible contaminating material until sampling results indicated that the material was not detectable or remained at background levels. Nevertheless, in some locations inaccessible contamination may remain. It should be noted that operational surveys generally lack the rigor associated with the survey regimen associated with MARSSIM guidelines.

Most issues identified were the result of spills, leaks, or accumulation over time of low levels of radioactive material that were released from the facility at concentrations less than those that could be detected by real-time monitoring methods employed at the station. Those monitoring methods at the time were state-of-the-art and comparable to methods used throughout the nuclear industry.

The dominant plant-related radioactive contaminants identified in the Protected and Owner-Controlled Areas are Cobalt-60 (Co-60), Cesium-137 (Cs-137), and tritium (H-3). Contaminated media include primarily soil, sediment, water, concrete, asphalt and steel. Additionally, some components such as insulation, sealants, filters, and pipes conveying radioactive liquids or gases potentially may be contaminated.

The information developed by this HSA suggests that the areas and structures with a high probability of requiring remediation (Class 1) are located within the Radiation Control Area (RCA). The migration of surface contamination from the RCA appears to be limited as has been determined from frequent site surveys conducted inside the Protected Area (PA).

CR3 has implemented guidance prescribed by NEI 07-07, the Industry Groundwater Protection Initiative (GPI) [4]. A hydrogeological investigation was completed in 2007 to install thirteen groundwater monitoring wells and characterize groundwater flow gradients primarily within the power block area of the station.

The thirteen groundwater monitoring wells are sampled quarterly as part of the station Radiological Environmental Monitoring Program (REMP). The samples are analyzed for tritium, gamma-emitting radionuclides, and hard-to-detect radionuclides if gamma-emitters are detected. Very low levels of tritium have been detected in five of the monitoring wells. No gamma-emitting or hard-to-detect radionuclides have been detected, with the exception of trace levels of gross alpha, which is naturally occurring in the local limestone bedrock.

2 Glossary

AC: Alternating Current.
ACM: Asbestos Containing Material.
AEC: Atomic Energy Commission.
ALARA: As Low As Reasonably Achievable.
Am: Americium.
ANI: American Nuclear Insurers.
AR: Action Request.
AST: Aboveground Storage Tank.
AUP: Area Under Probe.
BEST: Backup Engineering Safeguards Transformer.
BWST: Borated Water Storage Tank.
CCB: Conference and Cafeteria Building.
CDT: Condensate Storage Tank.
CFS: Cubic Feet per Second.
Ci: Curie.
cm: Centimeter.
Co: Cobalt.
CPM: Counts Per Minute.
CR: Crystal River.
CR1/2: Crystal River Units 1 and 2.
CR3: Crystal River 3 Nuclear Power Plant.
CRDM: Control Rod Drive Mechanism.
CRDMSS: Control Rod Drive Mechanism Service Structure.
CREC: Crystal River Energy Center.
Cs: Cesium.
CSM: Conceptual Site Model.
CTMT: Containment.
DAW: Dry Active Waste.
DCGLs: Derived Concentration Guideline Levels.
DEF: Duke Energy Florida.
DMRs: Discharge Monitoring Reports.
DPM: Disintegrations Per Minute.
DQOs: Data Quality Objectives.
DRO: Diesel Range Organics.
EPA: Environmental Protection Agency.
EPRI: Electric Power Research Institute.
EU: Europium.
FDEP: Florida Department of Environmental Protection.
Fe: Iron.
FSAR: Final Safety Analysis Report.
FSS: Final Status Survey.
GPI: Groundwater Protection Initiative.

GTCC: Greater Than Class C.
GWS: Groundwater Standards.
H: Hydrogen.
H-3: Tritium.
HP: Health Physics.
HSA: Historical Site Assessment.
HTD: Hard to Detect.
ISFSI: Independent Spent Fuel Storage Installation.
kg: kilogram.
KVA: Kilovolt Amps.
LLD: Lower Limit of Detection.
LSA: Low Specific Activity.
MARSSIM: Multi-Agency Radiation Survey and Site Investigation Manual NUREG-1575.
MCL: Maximum Contaminant Level.
MDA: Minimum Detectable Activity.
mg: Milligram.
mph: Miles per Hour.
mrem: Millirem.
MSB: Maintenance Support Building.
MU: Makeup System.
MW: Megawatt.
MWt: MegaWatts thermal.
NAB: Nuclear Administration Building.
NCOR: Nonconforming Operations Reports.
NEI: Nuclear Energy Institute.
Ni: Nickel.
NSSI: Nuclear Service Seawater Intake Structure.
NR: Prefix denoting Non-Radiological classifications.
NRC: Nuclear Regulatory Commission.
NSOC: Nuclear Security Operations Center.
NSSS: Nuclear Steam Supply System.
ODCM: Off-site Dose Calculation Manual.
OTSG: Once Through Steam Generator.
PA: Protected Area.
PAB: Plant Administration Building.
PC: Precursor Card.
PCB: Polychlorinated Biphenyl.
ppm: Parts per Million
Pu: Plutonium.
PWR: Pressurized Water Reactor.
RAM: Radioactive Material.
RBC: Risk Based Concentration.
RCA: Radiation Control Area.
RCRA: Resource Conservation and Recovery Act.
REMP: Radiological Environmental Monitoring Program.

RMSW: Radioactive Material Storage Warehouse.
ROCs: Radionuclides of Concern.
RS: Radiological Survey.
RW: Radioactive Waste.
SAB: Site Administration Building.
SAFSTOR: Safe Storage.
SCTL: Soil Cleanup Target Levels.
SDT-1: Station Drain Tank.
SPCC: Spill Prevention, Control and Countermeasures.
SSCs: Systems, Structures, or Components.
SWPPP: Storm Water Pollution Prevention Plan.
TRU: Transuranic.
TSC: Technical Support Center.
UOER: Unusual Operating Event Report.
USAR: Updated Safety Analysis Report.
UST: Underground Storage Tank.
V&V: Verification and Validation.

3 Introduction

CR3 is a single-unit pressurized light-water reactor (PWR) supplied by Babcock & Wilcox. CR3 was initially licensed to operate at a maximum of 2,452 megawatt-thermal (MWt). In 1981, 2002, and 2007, the Nuclear Regulatory Commission (NRC) approved three requests to increase the licensed core power level to a maximum power level of 2,609 MWt. The reactor containment structure is a steel-lined, reinforced-concrete structure in the shape of a cylinder and capped with a shallow dome. The walls of the containment structure are approximately 3.5 feet thick. Cooling water for CR3 is drawn from and returned to the Gulf of Mexico.

A brief history of the major milestones related to CR3 construction and operational history is as follows:

- Construction Permit Issued: September 25, 1968
- Operating License Issued: December 3, 1976
- Commercial Operation: March 13, 1977
- Initial Operating License Expiration: December 3, 2016
- Final Reactor Shutdown: September 26, 2009
- Final Removal of Fuel from Reactor Vessel: May 28, 2011

On February 20, 2013, DEF provided the NRC with the certification required by 10 CFR 50.82(a)(1)(i) and (ii), that operation had permanently ceased and that all fuel had been permanently removed from the reactor vessel at CR3. Upon docketing of these certifications pursuant to 10 CFR 50.82(a)(2), the 10 CFR Part 50 license for CR3 no longer authorized operation of the reactor or placement or retention of fuel in the reactor vessel. On March 13, 2013, the NRC acknowledged the DEF certification of permanent cessation of power operation and permanent removal of fuel from the vessel. [5]

The purpose of this Historical Site Assessment (HSA) is to identify and catalog existing information describing operational occurrences at CR3 that may have resulted in either radiological or non-radiological contamination. Any such occurrences will require characterization and possibly remediation before decommissioning of the station can be completed and the site operating license terminated. The scope of the HSA encompasses the site history from the beginning of site construction to present day. The HSA identifies potential, likely, and known sources of radioactive and non-radioactive contamination within systems, structures, components (SSCs), and environs based on existing or derived information.

The HSA provides an assessment of the likelihood of contaminant migration, information useful for scoping and characterization surveys, and initial impacted and non-impacted classifications. The classification process is guided by MARSSIM [1].

The information developed by this HSA has been evaluated to differentiate impacted from non-impacted areas of the site. The HSA provides preliminary classifications for each impacted area as Class 1, 2, or 3. The preliminary classifications of each SSC or environ is used to guide subsequent scoping, characterization, and remediation efforts. The level of effort required to complete the Final Status Survey (FSS) of each impacted SSC or environ is based upon the preliminary classification and the results of the scoping and characterization surveys. The HSA describes the site physical configuration, identifies contaminated media, and assesses the potential for migration of contaminants.

The HSA reflects the current radiological and non-radiological status of the site. Because the chosen decommissioning strategy is SAFSTOR, the information contained in the HSA will need to be re-evaluated with respect to the period of time that has elapsed when the next stages of decommissioning are initiated. As an example, the initial MARSSIM classification of SSCs and the bases for those classifications will need to be re-evaluated if characterization and FSS planning activities are initiated 40 years from now.

As part of this HSA effort, DEF requested some assistance in redefining the licensed portion of the property. Currently, the area of the site defined in the license is a circle of land with a radius of 4,400 feet from the centerline of the Reactor Building. This area encompasses all or portions of the four fossil plants on the site as well as major portions of the intake and discharge canals. A meeting was held on February 25, 2016 where this topic was discussed, and recommendations were presented. The specific structures and areas discussed in the meeting were:

- Settling Ponds located west of Units 1/2
- Radioactive Material Storage Warehouse (RMSW) 'D'
- Units 1/2
- Sewage Treatment Plant
- RMSW 'G' and surrounding area
- Industrial Area located inside the Railroad Loop
- Once Through Steam Generator (OTSG) and Reactor Vessel Closure Head (RVCH) Storage Facilities
- R16 Storage Yard located between CR3 and Crystal River 4/5
- Unit 4 and 5 Coal Ash Storage Area
- Intake Structure
- Other structures and land areas located outside the CR3 PA

The conclusions and recommendations are presented in Sections 7 and 8 of this report, respectively. Summary tables, Table 8 and Table 9, are presented in Appendices A and B.

The HSA report methodology is discussed in Sections 4 and 5. The assessment findings are presented in Section 6 and are subdivided into information pertaining to non-radiological (Section 6.2) and radiological impacts (Section 6.3). The non-radiological and radiological findings are broken down by area wherever possible. Each section or area includes information source files under an additional subheading titled 'Supporting Documents'. These files are provided as clickable hyperlinks (Ctrl + Mouse Click to open in a new window). In order for the hyperlinks contained within this document to properly link to the supporting documents, it is necessary that the installation process (following the prompts of the provided executable) be correctly followed and that no changes be made directly to either this document or the accompanying directory structure. That is, the folders and files within the directory structure must not be deleted, renamed, or moved. Additionally, sharing this report without providing the executable will render all hyperlinks contained herein unusable.

4 Property Identification

CR3 is located at 15760 West Powerline Street, Crystal River, Florida, 34428, with coordinates of latitude 28^{O} 57' 25.87" north and longitude 82^{O} 41' 55.95" west. The site is located approximately 7.5 miles northwest of the City of Crystal River, and 70 miles north of Tampa.

The station is part of the larger Crystal River Energy Center (CREC), which is located on the Gulf of Mexico in Citrus County, Florida. In addition to CR3, other structures on the CREC include four fossil-fueled power plants (Units 1, 2, 4 and 5), two large natural draft cooling towers, coal delivery and storage areas, ash storage areas, office buildings, warehouses, barge handling docks, and a railroad.

CR3 uses approximately 27 acres of previously disturbed land within the 1,062-acre developed portion of the 4,738-acre CREC site. The CREC site is surrounded by Freshwater Forested/Shrub and Estuarine and Marine wetlands designated in the U.S. Fish and Wildlife Service National Wetland Inventory [6]. Access to CREC is by way of an approximately 5-mile access road (West Powerline Street) that runs west from U.S. Route 19. The location of the CREC site is shown in Figure 1. Figure 2 identifies some of the principal features of the CREC and the location of CR3 within it. Figure 3 shows the locations of the CR3 facilities in and around the PA. A few CR3 facilities more distant from the PA are shown in Figure 2. Figure 4 shows the locations of Berm segments within the PA. Petroleum storage locations at CR3 are shown in Figure 5 and storm drain locations within the PA are shown in Figure 6. Figure 2 through Figure 6 are reproduced in Figure 7 through Figure 14 to show the distribution of radiological and non-radiological impacts across the site. Figure 7 shows the preliminary classifications of non-radiological impacts in the outlying areas of the station. Figure 8 shows the preliminary classifications of non-radiological impacts in the vicinity of the PA. Figure 9 shows the preliminary classifications of non-radiological impacts in the vicinity of the CR3 storage tanks and transformers. Figure 10 shows the preliminary classifications of non-radiological impacts in the storm drain system.

Figure 11 shows the preliminary classifications of radiological impacts in the outlying areas of the station. Figure 12 shows the preliminary classifications of radiological impacts in the vicinity of the PA. Figure 13 shows the preliminary classifications of radiological impacts in the berm areas. Figure 14 shows the preliminary classifications of radiological impacts in the storm drain system.

DEF is the majority owner of CR3 with minority ownership held by City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of Ocala, Orlando Utilities Commission, Seminole Electric Cooperative, and City of New Smyrna Beach.

<u>Property Identification Supporting Documents</u>

Site Picture CR3 Buildings and Structures.pdf
Site Picture For Licensing Discussion.pdf
Site Picture Wetlands.pdf

4.1 Environmental Setting

4.1.1 Physiography

The following discussion is derived from "Geology of Citrus County, Florida", a Guidebook of the Southeastern Geological Society [7].

Florida lies entirely within the Coastal Plain Physiographic Province and is the only state in the United States that falls completely within the Coastal Plain. Much of the surface of Florida shows the influence of the marine processes that transported and deposited Tertiary, Quaternary and Holocene sediments. Fluvial processes, although more predominant in the panhandle, have helped sculpt the entire state, particularly during low stands of sea level during the Pleistocene, redistributing the marine sediments.

The Florida Platform extends southward from the continental United States, separating the Gulf of Mexico from the Atlantic Ocean. The exposed portion of the landform, the Florida Peninsula, constitutes approximately one-half of the Florida Platform measured between the 600-foot depth contour of the continental shelves. The axis of the platform extends northwest to southeast approximately along the present-day west coast of the peninsula. From the St. Mary's River to Key West the Florida Peninsula measures nearly 450 miles. From the Alabama-Florida line to the Atlantic coastline is approximately 370 miles.

Karst processes have had a dramatic effect on the Florida landscape due to the near-surface occurrence of soluble carbonate rocks. Middle Eocene to Pleistocene carbonate sediments are affected by karstification over large areas of the state, including the vicinity of CREC.

More than 700 springs are recognized in Florida, with the major springs occurring within the karstic areas of the state. Most of the springs are located in the Ocala Karst District (within which CR3 is located), the Central Lake District and the Dougherty Karst Plain District. Kings Bay Spring, whose outflow forms the Crystal River, is a first order spring (flow of greater than 100 cubic feet per second). Other large springs within several miles of CR3 include Homosassa Spring (first order), whose outflow forms the Homosassa River, and Citrus Blue Spring (second order spring flowing greater than 10 cubic feet per second), whose outflow enters the Withlacoochee River.

The general geomorphology of Florida is that of east-west trending highlands in the northern and western portions of the state and north-south trending highlands extending approximately two-thirds the length of the peninsula. Coastal lowlands occur between the highlands and the eastern and western coastlines. The highest point in the state, 345 feet above sea level, occurs in the Western Highlands near the Alabama-Florida state line in Walton County.

4.1.2 Climatology

The discussion in Subsections 4.1.2, 4.1.3 and 4.1.4 is derived from the CR3 FSAR [8]. The climate of the region around the Crystal River site is humid subtropical, which is characterized by relatively dry winters and rainy summers, a high annual percentage of sunshine, a long growing season, and high humidity. The terrain is generally flat and featureless with the Gulf of Mexico being the major climatic influence. Snowfall is virtually non-existent, but rainfall averages about 50 to 60 inches per year, with more than 50% of the total rainfall occurring during the months of June through September associated with thunderstorms.

Temperatures in the site region (modified by the waters of the Gulf of Mexico) seldom exceed 90°F or fall below 32°F. Fog has a high frequency of occurrence at night during the winter season. Prevailing winds are somewhat erratic because the coastal regions experience frequent local circulations caused by the land-sea breeze. The coastal location of the site also results in vulnerability to tropical storms and hurricanes. In addition, tornadoes occur quite frequently in this region.

4.1.3 Meteorology

The present onsite meteorological program, which began on January 1, 1975, consists of two meteorological towers on site with one tower designated as primary and the other as an alternate. The primary tower, approximately 195 feet in height, has sensors mounted at 33-foot and 175-foot elevations. The alternate tower, approximately 60 feet high, has sensors mounted at the 33-foot elevation.

Monthly and annual wind roses with associated average wind speeds for the 33-foot and 175-foot levels are provided in the CR3 FSAR. The wind roses were derived from onsite measurements for the period January 1, 1975 through December 31, 1975. The prevailing winds on an annual basis were from the east-northeast and east for both the 33-foot and 175-foot levels. These data are in good agreement with onsite wind data measured for the period January 1, 1972 through December 31, 1972.

For the period January 1, 1975 through December 31, 1975 the average wind speed for the on-site 33-foot and 175-foot levels was 7.9 and 11.6 mph, respectively. This compares to 7.1 mph for the 35-foot level and 10.4 mph for the 150-foot level for the period January 1, 1972 through December 31, 1972.

4.1.4 Hydrology

The major streams in the general vicinity of the site are the Withlacoochee River, the Homosassa River and the Crystal River. The Withlacoochee River is the major stream, having a drainage area at its entrance into the Gulf of Mexico of approximately 2,000 square miles. The discharge of the Withlacoochee due to rain runoff is augmented by a base flow of groundwater runoff and artesian spring discharges. The Crystal River is much smaller than the Withlacoochee River, with its major discharge consisting of artesian spring discharges.

The plant site is located approximately 3.8 miles south of the mouth of the Withlacoochee and about the same distance north of the mouth of the Crystal River. The Cross-Florida Barge Canal, which intersects with the Withlacoochee River inland, meets the Gulf about one mile southeast of the mouth of the Withlacoochee River and two miles northwest of the site. The average flow from the Withlacoochee drainage basin, a portion of which enters the Gulf via the Cross-Florida Barge Canal, is approximately 1,820 cubic feet per second (CFS). The average flow of the Crystal River is approximately 600 CFS.

Environmental Setting Supporting Documents

2010 MAPEP.docx
62-520.400 Florida Minimum Criteria for Groundwater.doc
62-520.410 Florida Groundwater Classifications.doc
62-520.430 Florida Standards for Class G-III Groundwater.doc
CR3 2010 Annual Radiological Environmental Operating Report.pdf
CR3 90% draft SPCC Plan 010715.docx
CR3 draft SPCC figures 010715.pdf
CR3 ODCM.pdf
CR3 SPCC 2011.pdf
CR3 SPCC 2012.pdf
Crystal River South - Stormwater Pollution Prevention Plan.pdf
Geology of Citrus County_SEGS_2014.pdf
REMP 2009 Graph.xlsx
REMP 2009_final.docx
REMP 2009_final.pdf
REMP 2010 graph.xlsx
REMP 2010_final.docx
REMP 2010_final.pdf
REMP 2011_final.pdf
REMP 2012_final.pdf
REMP 2013_final.pdf
REMP 2014 graph.xlsx
REMP 2014_final.docx
REMP 2014_final.pdf
SETTLING POND SOIL.pdf
Storm Water Pollution Prevention Plan_Engineering Change.pdf

4.2 Conceptual Site Model

As described in MARSSIM, the Conceptual Site Model (CSM) is essentially a visualization of the site indicating locations of known or suspected contamination, types and concentrations of radionuclides in impacted areas, potentially contaminated media, mechanisms for their transport, locations of potential receptors, and locations of potential reference (background) areas. The model includes the general layout of the site including buildings and property boundaries. The conceptual site model should be upgraded and modified as information becomes available throughout the decommissioning process. [1]

The CSM is used to assess the nature and the extent of contamination and to identify potential contaminant sources, release mechanisms, exposure and migration pathways, and potential human or environmental receptors. Furthermore, the CSM helps identify data gaps, determines media to be sampled, and assists in developing strategies for data collection. [1]

4.2.1 Geology

The CR3 site is adjacent to the Gulf of Mexico in a former marsh area that was reclaimed for plant site development. The entire area is one of very low relief (originally two to five feet above mean sea level) and is located within the Terraced Coastal Lowlands of the Coastal Plain of West Florida. All elevations hereafter mentioned are referenced to the Florida Power Corporation's Plant Datum (mean Gulf low water level equals plant datum 88 feet) [8].

The ground surface over the developed portion of the site is characterized as surface fill. The thickness of this surface fill is approximately three to five feet in the plant area. The natural soil cover beneath the fill consists of recent deposits of thinly laminated, organic sandy silts and clays, interspersed with a Pleistocene marine deposit known as the Pamlico Terrace Formation. These deposits blanket the site and have a variable but average thickness of approximately 4 feet. Beneath these soils is the residual limy soil unit derived from decomposition of the underlying bedrock.

The depth to bedrock at the site is approximately 20 feet beneath the ground surface throughout most of the plant (excluding the Berm Area). The shallow bedrock with significance to the engineering and groundwater geology of CR3 consists of biogenic carbonates of Tertiary Age. Two distinct Eocene formations have been identified at the site. The upper-most member is the Inglis Limestone Member of the Moodys Branch Formation. This unit overlies an unconformity consisting of very dense silt, sands, and organic clays of variable thickness which are the remnants of a formerly exposed erosional surface known as the Jackson-Claiborne Unconformity. The materials comprising this surface are derived, in part, from reworked residual soils, formed from the underlying sequence of carbonates known as the Avon Park Formation, which is the second Eocene formation of interest. The configuration of the unconformity can be represented as an undulatory surface in the area of the plant, ranging from an elevation of -10 feet to an elevation of +20 feet, with a thickness ranging from a few inches to approximately 10 feet in the area of the plant [8].

The Inglis Limestone is the principal foundation material at the site and is identified as a cream colored to occasionally tan, porous, granular, biogenic limestone, and dolomite deposited in a shallow marine environment. The unit is comprised of a matrix of carbonate pellet and skeletal detritus. This member forms the bedrock at the site and varies in thickness from approximately 70 feet to 90 feet, in the area studied. The unit is thinnest at the northern end of this area, and gradually thickens to the south [8].

Fracturing of the rock has occurred in response to the Ocala Uplift and consolidation of the thick sequence of Cretaceous and Tertiary sediments over a stable, competent Paleozoic basement. The sediments of both the Inglis Limestone and the Avon Park Formation are quite porous and have high interstitial permeabilities which have been secondarily augmented by fracturing. Within the Inglis Limestone, along these fractures, and in particular at the intersection of bedding planes and fractures, solution of the relatively soluble limestone has occurred, forming a network of essentially vertical solution channels which have been secondarily infilled with very fine quartz sands, organic silts and clays, and shells [8].

Because these rocks are inherently pervious and are broken by high angle fractures, infiltration of rain water and recharge to the groundwater table is relatively rapid. Atmospheric carbon dioxide within the rain water forms a dilute carbonic acid. The fresh water entering the underground moves rapidly down gradient (toward the Gulf of Mexico) and attacks the limy sediments. The result of this natural process is the destructive alteration of the carbonate rock, leaving a labyrinth of channels throughout the rock mass.

Well-documented subsurface data obtained from exploration and grouting of the foundation for Crystal River Unit 2 show that the solutioning process is most developed in the first 100 feet of section below the existing ground surface. Curtain and consolidation grouting carried out to closure on final order holes spaced on a maximum of 8-foot centers successfully injected 7 percent of grout over the total volume of rock. This figure represents the volume of voids existing in the subsurface, but does not equal the total volume of solution channels because certain solution channels have been infilled by secondary depositional processes.

4.2.2 Groundwater

Throughout west central Florida, groundwater occurs under both water table and artesian conditions. Water table (“unconfined”) conditions occur in shallow aquifers composed of Recent sediments and in pervious Tertiary Age limestones. These aquifers derive their water primarily from rainfall that falls directly onto the exposed formations and infiltrates them. Artesian (“confined”) conditions develop where pervious limestone beds are overlain by effectively impervious layers and are recharged at points of higher elevation where the overlying impervious layers are absent and the limestone beds outcrop at the ground surface.

The Inglis Limestone and the Avon Park Limestone occur at the surface (beneath a thin veneer of Pleistocene and Recent sediments) in the vicinity of the CR3 plant site. These two stratigraphic units comprise a part of the Floridan aquifer which supplies most of the groundwater in the State. Except in Citrus and Levy Counties, these rock units are buried beneath more impervious units, creating artesian conditions [8]. Surface expression of artesian conditions exists at numerous places throughout the region in the form of springs where "windows" exist in the overlying impervious confining layer, allowing groundwater to discharge.

In Citrus and Levy Counties the Inglis and Avon Park Limestones are exposed along the Gulf Coast and there they contain groundwater which occurs under water table conditions. These conditions allow relatively rapid groundwater recharge by infiltration of rainfall. Because an overlying confining layer is absent the risk of groundwater contamination in water table aquifers is greater relative to that in artesian aquifers.

Recharge to the groundwater table occurs as a result of approximately 55 inches of annual rainfall, most of which occurs during the summer months. Long-term meteorological measurements made at the station demonstrate that although wind direction varies, the predominant direction is from the northeast [8]. Groundwater gradients in the area of the plant slope generally to the west southwest (seaward) and groundwater eventually discharges into the Gulf of Mexico. However, the groundwater flow domain is three-dimensional and there is also a vertical component of flow. The vertical component of flow in the area of the station is upward, as would be expected in a coastal zone of groundwater discharge [9]. The deep foundations of the structures in the power block are below the water table, form a barrier to shallow groundwater flow and divert flow locally around and under the foundations.

4.2.3 Potential Contaminant Sources and Transport Mechanisms

Potential sources of soil and groundwater contamination, both radiological and non-radiological, include various tanks and pipelines containing radioactive liquids, tanks and pipelines containing diesel fuel, station transformers containing dielectric oil, radiologically contaminated components and equipment stored in temporary RCAs (SeaLand containers, decontamination tents), building sumps, spills from chemical storage areas, machine shops and paint shops and wastewater settling ponds. Contaminants from these sources potentially could be released directly to the soil where infiltrating rain water would transport them to the groundwater or residual contamination on plant equipment and impermeable surfaces potentially could be mobilized in storm water and infiltrate the groundwater. Minor spills and leaks of diesel fuel, hydraulic oil and engine coolant have occurred from various pieces of mobile equipment during the operating history of the station. Although they were immediately isolated and cleaned up, the cumulative effect of residual contaminants from the spills may impact local groundwater quality.

A network of thirteen groundwater monitoring wells has been constructed around the perimeter of the CR3 PA [10]. These wells are sampled quarterly as part of the station REMP and the samples are analyzed for tritium and gamma-emitting radionuclides. No groundwater samples from the site wells have been analyzed for indicators of non-radiological contaminants. Five of the wells on the west and southwest side of the PA (downgradient in both groundwater flow and predominant wind direction) have periodically contained very low concentrations of tritium, but no gamma-emitting radionuclides. In 2014 the levels of tritium measured ranged from 88 to 427 pCi/L [11]. The drinking water standard for tritium is 20,000 pCi/L [12]. In 2009 the highest tritium level measured in one of the five wells (CR3-5) was 1,967 pCi/L. This concentration has been attributed to infiltration of some of the hydro-demolition water used to cut an opening in the southwest side of the Reactor Building for the Steam Generator Replacement project in 2009.

No historical or current leaks to the environment in plant systems containing radioactive liquids are known and the source of these very low levels of tritium in groundwater has not been determined. Based on experience at other operating nuclear power stations these levels are consistent with those produced by wash out of tritium from routine gaseous plant effluent. Tritium was measured in 2014 in groundwater from two additional monitoring wells located on the north and south sides of the plant Settling Ponds at concentrations of 87 and 144 pCi/L. These detections have been attributed to discharges of the Station Drain Tank (SDT-1) to the Settling Ponds [11].

The available data suggest that significant impacts to groundwater at the station have not occurred. CR3 has not produced power for approximately seven years and has been permanently defueled for approximately three years. The volume of radioactive liquids currently produced and processed is a small fraction of that produced when the plant was producing power. Accordingly, the risk of an incident that would cause significant soil or groundwater contamination occurring now or in the future is substantially reduced. There are no water supply wells on the CR3 site and the direction of horizontal groundwater flow is generally west southwest to the Gulf of Mexico and not toward any off site wells. Therefore, a release of contaminants from sources at the station would likely not pose a risk to off-site receptors.

At the plant site, groundwater occurs under water table conditions with groundwater levels ranging from approximately 5.5 to 9 feet below ground surface, with an average of about 7 feet. The direction of flow is generally to the west southwest [10]. An average tidal range of about three feet has been measured in the plant intake and discharge canals. Fluctuations of the water levels in monitoring wells have been measured with changing tides to observe the effect of the tides on groundwater flow.

A time lag from less than one hour to as long as four hours has been observed between peaks of high tides and peaks of groundwater levels in monitoring wells [9]. In general, the time lag increases and the magnitude of tidally influenced groundwater level fluctuations decreases in wells located more distant from the canals. It can be noted that there are substantially different attenuation times in some monitoring wells that are approximately equidistant from the canals. The significance of this empirical observation is that variation exists in the transmissibility of the limestone. This variation is likely at least partly due to the presence of solution channels. These solution channels could provide preferential flow paths for potential groundwater contaminants.

Intrusion of salt water inland occurs within the Floridan aquifer along the Gulf Coast. At the coast, shallow groundwater is brackish to saline and chloride concentrations increase with depth due to the density difference between seawater and fresh groundwater. Moving inland, the thickness of the lens of fresh groundwater overlying saline groundwater increases. Based on electrical resistivity measurements completed in the area between the Crystal River and the Homosassa River at a depth of 100 feet the 250 mg/L isochlor was encountered 2 miles inland [13]. Groundwater seaward of this isochlor, including that beneath CR3, exceeds the FDEP Primary Drinking Water Standard for chlorides (250 mg/L) [12].

Chemical analyses of groundwater at the site indicate the water contains more than 350 ppm chlorides with a pH range of 7.0 to 7.1 and a conductivity of greater than 2,000 microhms/cm [8]. These analyses confirm that the groundwater beneath CR3 is not potable. No water supply wells exist on the CR3 site or in the down-gradient area between the station and the Gulf of Mexico. Drinking water is supplied to Crystal River Units 1, 2 and 3 from wells in the Floridan aquifer located approximately 6 miles inland, east and immediately west of US Highway 19 and up-gradient from the site. For these reasons, there are no human receptors on or down-gradient from the CR3 site and ingestion of groundwater is not a viable pathway for exposure to contamination.

The well field east of US Highway 19 also supplies water to Units 4 and 5 for operation of their clean air scrubbers. An investigation was completed in 2012 to determine if activities related to construction of these clean air scrubbers or the increased withdrawals from the well field to support their operation significantly affect groundwater flow patterns in the vicinity of CR3. The report concluded that they do not. [9]

Conceptual Site Model Supporting Documents

ANI Inspection Report_Groundwater.TIF
CR3 20090515 ANI Report.pdf
CR3 Groundwater Flow Study Report-EnHydro-Jan2007 (1).pdf
CR3 Groundwater Well Monitoring Program.pdf
CR3 ODCM.pdf
CR3 Rad GW Protection Operating Manual.pdf
Environmental Impacts Ranking Matrix.xls
Gaydos_GW Flow Study Summary Report 12.5.12.pdf
Haz Waste Inspection Report 11-12-2010.pdf
MW Installation Report_MW-11_MW-12_MW-13.pdf

5 Historical Site Assessment Methodology

The HSA is the first step in a process described in MARSSIM. The purpose of MARSSIM is to provide a standardized approach to demonstrating compliance with a dose or risk-based regulation. MARSSIM provides guidance to prepare and implement a statistically valid site investigation and survey plan that will support termination of the NRC operating license for a facility. [1]

5.1 Approach and Rationale

The primary tasks in the site investigation and survey process are listed here:

- Historical Site Assessment
- Scoping Survey
- Characterization Survey
- Remedial Action Support Survey
- Final Status Survey
- Regulatory Agency Confirmation and Verification

A phased approach is used in the site investigation process so that the information developed during each successive task benefits from and builds upon information from previous tasks. If a scoping survey determines that an area impacted by radioactivity or other hazardous materials is smaller or the contaminants are fewer or less concentrated than had been identified by the HSA, fewer resources and less effort can be expended during the characterization survey and later tasks. In this way, investigation can proceed most efficiently. A brief discussion of each of the tasks in the MARSSIM process follows. [1]

5.1.1 Historical Site Assessment

The intent of an HSA is to document a comprehensive investigation that identifies and evaluates historical information pertaining to events that may have resulted in contamination during the operating history of the subject site. Contaminants of interest include both radiological and non-radiological, and may have impacted SSCs of the plant or environmental media within the owner-controlled property. The information developed by the HSA is evaluated to differentiate impacted from non-impacted areas of the site. [1]

As defined in MARSSIM, a non-impacted area is any area "where there is no reasonable possibility (extremely low potential) of residual contamination." An impacted area is defined in MARSSIM as "Any area that is not classified as non-impacted" and "Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels." Areas determined to be impacted are further classified (based on preliminary information) as Class 1, Class 2 or Class 3, depending upon the apparent extent of their impact. [1]

It should be noted, that for the purpose of classifying impacted areas a subjective evaluation based on judgment and previous experience was utilized. The site release criteria will not be developed until later in the decommissioning process.

As defined in NUREG-1575, Class 1 areas are those that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation surveys) at concentrations greater than the site release criteria. Examples of Class 1 areas include:

- site areas previously subjected to remedial actions,
- locations where leaks or spills are known to have occurred,
- former burial or disposal sites,
- waste storage sites, and
- areas with contaminants in discrete solid pieces and with high specific activity.

Class 2 areas are those that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but not at concentrations expected to exceed the site release criteria. To justify changing the classification from Class 1 to Class 2, there should be measurement data that provides a high degree of confidence that no individual measurement would exceed the site release criteria. Examples of areas that might be classified as Class 2 include:

- locations where radioactive materials were present in an unsealed form,
- potentially contaminated transport routes,
- areas downwind from stack release points,
- upper walls and ceilings of buildings or rooms subjected to airborne radioactivity,
- areas handling low concentrations of radioactive materials, and
- areas on the perimeter of former contamination control areas.

Class 3 areas are any impacted areas that are not expected to contain residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the site release criteria, based on site operating history and previous radiation surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but with insufficient information to justify a non-impacted classification. [1]

For purposes of classifying non-radiologically contaminated areas, the same concept has been applied, with the substitution of Florida Groundwater Standards and Soil Cleanup Target Levels, federal Maximum Contaminant Levels (MCLs) or Risk Based Concentrations (RBCs) in lieu of radiological site release criteria. The prefix NR (Non-Radiological) has been applied to these classifications to differentiate them from MARSSIM-based classifications. [1]

NR Class 1 areas have the greatest potential for contamination and, therefore, receive the highest degree of investigative effort using a graded approach, followed by NR Class 2, and then by NR Class 3 areas. Non-impacted areas do not receive any level of investigative effort because they have no potential for residual contamination. [1]

5.1.2 Scoping Survey

Scoping surveys are conducted after the HSA is completed and consist of measurements, sampling and analysis. The number and locations of these measurements, samples and analyses are based on the HSA data and professional judgment. If the results of the HSA indicate that an area is Class 3 and no residual contamination at concentrations greater than a small fraction of the site release criteria is found during the scoping survey, the area may be downgraded to Non-Impacted or confirmed as Class 3 and a Class 3 FSS would be performed. However, if the scoping survey of an area with a preliminary classification of Class 3 identifies residual contamination at concentrations greater than a small fraction of the site release criteria, the area must be reclassified as Class 1 (or Class 2) and a characterization survey performed, followed by a FSS with rigor appropriate for the class. Sufficient information should be collected during a scoping survey to identify situations that require immediate attention. [1]

5.1.3 Characterization Survey

This type of survey is a detailed radiological environmental characterization of an area. The characterization survey is the most comprehensive of all the survey types and generates the most data. This survey includes preparation of a reference grid, systematic (random) as well as judgment (biased) measurements, and surveys of different media (e.g., surface soils, interior and exterior surfaces of buildings). The decision as to which media will be surveyed is a site-specific decision addressed throughout the radiation survey and site investigation process and informed by the results of the HSA. [1]

The data obtained during the site characterization survey will inform all follow-on phases of the site decommissioning. The radiological or hazardous material information will be used to determine the extent of contamination, select methods for any required remediation of structural surfaces or open land areas, and to determine the classification and ultimate disposal method for waste generated during the remediation. Ultimately, the characterization survey will provide sufficient information to successfully design a License Termination Plan that will be approved by federal and state regulatory agencies to terminate the site operating license with the goal of release of the site for unrestricted use. [1]

5.1.4 Remedial Action Support Survey

If an area is adequately characterized and is determined to be contaminated at concentrations greater than the site release criteria, decontamination will be required before the area can be released for unrestricted use. A remedial action support survey is performed while remediation is being conducted, and guides the cleanup in a real-time mode. The remedial action support survey also provides the basis for determining when a site or survey unit is ready for the FSS. [1]

5.1.5 Final Status Survey

The FSS is used to demonstrate compliance with regulations. The primary objectives of the FSS are to select/verify survey unit classification and to demonstrate that the potential dose or risk from residual contamination is less than the release criteria for each survey unit. The FSS process consists of four principal elements:

- Planning
- Design
- Implementation
- Assessment

5.1.5.1 Planning

Final Status Survey planning includes review of the HSA and other pertinent characterization information to establish Data Quality Objectives (DQOs, final survey unit classification, and the radionuclides or other contaminants of concern. The HSA reviews historical use of licensed and hazardous material at the facility and the levels of potential contamination through personnel interviews and review of plant records and presents preliminary area classifications based on this data. After scoping and characterization surveys, a final classification is then assigned to site buildings and areas based upon their potential for contamination. Areas that have no reasonable potential for residual contamination from site operations receive a final classification of non-impacted. [1]

Areas with reasonable potential for residual contamination from site activities are classified as impacted areas. Impacted areas are divided into three final classifications based upon the potential contamination levels and how the contamination is distributed. Areas with the same classification are broken into survey units. Survey units are fundamental elements for which FSSs are designed and executed. The classification of a survey unit determines how large it can be in terms of surface area. [1]

Before the survey process can proceed to the design phase, concentration levels that correspond to the maximum annual radiological dose criterion prescribed by federal regulation 10 CFR 20.1402 (25 mrem yr^{-1}) must be established. These concentrations are established for either surface contamination (measured in Disintegrations Per Minute [DPM] per 100 cm^2) or volumetric contamination (measured in pCi g^{-1}). The concentrations are used in the survey design process to establish the minimum sensitivities required for the available survey instruments and techniques, and in some cases, the spacing of fixed measurements or number of samples to be collected within a survey unit. Surface or volumetric concentrations that correspond to the maximum annual dose criteria are referred to as DCGLs which are site-specific license termination and site release criteria. [1]

5.1.5.2 Design

After the license termination criteria are established, a survey design is developed and documented for each survey unit. The plan is documented as a Survey Package that selects the appropriate survey instruments and techniques to provide adequate coverage of the survey unit through a combination of scans, fixed measurements, sampling and analysis. The Survey Package implements the DQOs for its survey unit and provides instructions for carrying out the survey. The Survey Package documents the assessment of survey results, the statistical basis used to determine if the survey unit contains residual contamination at concentrations greater or less than the DCGL or the non-radiological site release criteria, and the review and approval of the package. [1]

If any of the radionuclides or other contaminants of concern are present in background at levels that impact the DCGL or the non-radiological site release criteria, the planning effort may include establishing appropriate reference areas to determine baseline concentrations for those radionuclides or other contaminants and their variability. A reference coordinate system may be used for documenting locations where measurements were made and to allow replication of survey efforts if necessary. This process ensures that data of sufficient quantity and quality are obtained to make decisions regarding the suitability of the survey design assumptions and whether or not the unit satisfies the release criterion. Approved site procedures will direct this process to ensure consistent implementation and adherence to applicable requirements. [1]

5.1.5.3 Implementation

Survey implementation is the process of carrying out the survey plan (package) for a given survey unit. Implementation consists of scan measurements, fixed measurements, and collection and analysis of samples. Scan measurements will always be made, while fixed measurements and sampling may not be necessary. Data are collected and stored using a data management system. [1]

5.1.5.4 Assessment

Data assessment includes data Verification and Validation (V&V), review of survey design bases, and data analysis. For a given survey unit, the survey data are evaluated to determine if the residual activity levels in the unit are less than the applicable release criteria and if any areas of elevated activity exist. In some cases, data evaluation will simply serve to show that all of the measurements made in a given survey unit are below the applicable license termination criteria. In this case, demonstrating compliance with the release criteria is a simple matter and requires little in the way of analysis. [1]

In other cases, residual radioactivity or other contamination may exist with measurement results both above and below the license termination criteria. In these cases, statistical tests must be performed to make a decision as to whether or not the survey unit satisfies the release criteria. The statistical tests that might be required to make decisions regarding the residual activity levels remaining in a survey unit relative to the applicable license termination criteria must be considered in the survey design to ensure that a sufficient number of measurements are collected. Quality assurance and control measures are employed throughout the FSS process to ensure that all decisions are made on the basis of data of acceptable quality. [1]

5.1.6 Regulatory Agency Confirmation and Verification

The regulatory agency responsible for the site often confirms whether the site is acceptable for release. This confirmation may be accomplished by the agency or an impartial party contracted by the agency. Although some actual measurements may be performed by the agency or its contractor, much of their work for confirmation and verification will involve evaluation and review of documentation and data from completed survey activities. The evaluation may include site visits to observe survey and measurement procedures or split sample analyses by the regulatory agency's laboratory. Therefore, accounting for confirmation and verification activities during the planning stages is important to each type of survey. [1]

5.2 Documents Reviewed

The following list summarizes many of the sources of information used to develop this HSA. This bulleted list is followed by a larger all-inclusive list of hyperlinked files consisting of all the supporting documents reviewed during the generation of this report. These supporting documents are repeated, for ease of access, in their relevant sections.

- ANI inspection reports
- Drawings of the CR3 site and various building drawings
- CR3 10 CFR 50.75(g) File (HPP0230)
- CR3 Off-site Dose Calculation Manual (ODCM)
- CR3 Spill Prevention, Control and Countermeasures Plan
- CR3 Stormwater Pollution Prevention Plan (SWPPP)
- CR3 Consultant's reports of various subsurface investigations including a Groundwater Flow Study (January, 2007), a Groundwater Flow Study Summary Report (November, 2012) and a Monitoring Well Installation Report (May, 2013)
- CR3 Final Safety Analysis Report, Rev. 35
- CR3 historical photographs
- CR3 Annual Radioactive Effluents Release Reports
- CR3 Annual Radiological Environmental Monitoring Program (REMP) Reports
- CR3 Nonconforming Operations Reports (NCOR)
- CR3 Action Requests (ARs)
- CR3 Precursor Cards
- CR3 Plant Event Reports
- CR3 Groundwater Well Monitoring Program
- CR3 Groundwater monitoring data and well installation logs
- CR3 Buried Pipe Drawings
- CR3 Florida Pollutant Discharge Elimination System Permit
- CR3 Inventories of Asbestos Containing Material (ACM) and Lead-Acid Batteries
- CR3 special survey and operational radiological survey records
- CR3 Radioactive Source Program (source inventories and leak check records)
- CR3 operator or HP logs associated with spills of radioactive material
- CR3 effluent sample analyses

- CR3 soil and asphalt sample analyses
- CR3 waste stream analyses
- CR3 survey responses by long-tenured employees
- NUREG 1575 (MARSSIM)
- CR3 Significant Environmental Impacts Scoring Sheet
- Reports on the geology of the CR3 region published by the Florida Geological Survey and the Southeastern Geological Society
- FDEP Storage Tank Database
- FDEP Groundwater Standards
- U.S. Fish and Wildlife Service National Wetlands Inventory

Documents Reviewed Supporting Documents

62-520.400 Florida Minimum Criteria for Groundwater.doc
62-520.410 Florida Groundwater Classifications.doc
62-520.430 Florida Standards for Class G-III Groundwater.doc
CR3 AI0402B Procedure Writing Guide.pdf
CR3 Groundwater Flow Study Report-EnHydro-Jan2007 (1).pdf
CR3 PSDAR.pdf
CR3 RSP-101 Basic Radiological Safety Information and Instructions for Radiation Workers.pdf
FDEP Health Effects of Microbiological Contaminants - Drinking Water Program.pdf
FDEP Inorganic Contaminants - Drinking Water Program.pdf
FDEP Miscellaneous Contaminants - Drinking Water Program.pdf
FDEP Radionuclide Contamination - Drinking Water Program.pdf
FDEP Secondary Drinking Water Standards - Drinking Water Program.pdf
FDEP SoilCleanupTargetLevels.pdf
FDEP Synthetic Organic Contaminants - Drinking Water Program.pdf
FDEP Tank Database.xlsx
FDEP Tank Inventory.pdf
FDEP Tanks with Discharges.xlsx
FDEP Volatile Organic Chemical Contaminants - Drinking Water Program.pdf
Fretwell and Stewart_Resistivity Study of Coastal Karst_1981.PDF
Gaydos_GW Flow Study Summary Report 12.5.12.pdf
Geology of Citrus County_SEGS_2014.pdf
NEI 07-07.pdf
NPDES Permit.doc
NUREG-1575 (MARSSIM).pdf
REMP 2014_final.pdf
Site Picture Wetlands.pdf
2010 MAPEP.docx
62-520.400 Florida Minimum Criteria for Groundwater.doc
62-520.410 Florida Groundwater Classifications.doc
62-520.430 Florida Standards for Class G-III Groundwater.doc
CR3 2010 Annual Radiological Environmental Operating Report.pdf
CR3 90% draft SPCC Plan 010715.docx

CR3 draft SPCC figures 010715.pdf
CR3 ODCM.pdf
CR3 SPCC 2011.pdf
CR3 SPCC 2012.pdf
Crystal River South - Stormwater Pollution Prevention Plan.pdf
Geology of Citrus County_SEGS_2014.pdf
REMP 2009 Graph.xlsx
REMP 2009_final.docx
REMP 2009_final.pdf
REMP 2010 graph.xlsx
REMP 2010_final.docx
REMP 2010_final.pdf
REMP 2011_final.pdf
REMP 2012_final.pdf
REMP 2013_final.pdf
REMP 2014 graph.xlsx
REMP 2014_final.docx
REMP 2014_final.pdf
SETTLING POND SOIL.pdf
Storm Water Pollution Prevention Plan_Engineering Change.pdf
ANI Inspection Report_Groundwater.TIF
CR3 20090515 ANI Report.pdf
CR3 Groundwater Flow Study Report-EnHydro-Jan2007 (1).pdf
CR3 Groundwater Well Monitoring Program.pdf
CR3 ODCM.pdf
CR3 Rad GW Protection Operating Manual.pdf
Environmental Impacts Ranking Matrix.xls
Gaydos_GW Flow Study Summary Report 12.5.12.pdf
Haz Waste Inspection Report 11-12-2010.pdf
MW Installation Report_MW-11_MW-12_MW-13.pdf
ODCM AI-1500 Enclosure 1.docx
ODCM rev 36 Final.docx
ODCM rev 36 Final.pdf
ODCM rev 36 Markup.docx
REMP 2012_final.pdf
SP0736F Release Rev 18.TIF
SP0736F Release Rev 4.TIF
SP0736F to pond 584130.TIF
SP0736I-CDT-1.TIF
SP0736K hydro demolition Rev 2.TIF
SP0736K hydro demoliton Rev 1.TIF
SP0736L, Liquid Discharges to the Discharge Canal via RM-L2 (WDT-1).pdf
SP736F SDT-1 to pond 582798.TIF
SP736G SDT-1 Releases to the Discharge Canal.pdf
SP736I Condensate Release to the Discharge Canal (CDT-1).pdf

SP736M Liquid Releases to the Discharge Canal via RM-l7 (SDT-1).pdf
CR3 FSAR.pdf
10CFR61 Analysis Condensate Resin_2015.docx
10CFR61 Analysis Condensate Resin_2015.pdf
10CFR61 Analysis DAW_2010.docx
10CFR61 Analysis DAW_2010.pdf
10CFR61 Analysis DAW_2014.docx
10CFR61 Analysis DAW_2014.pdf
10CFR61 Analysis NUS Charcoal Resin_2015.docx
10CFR61 Analysis NUS Charcoal Resin_2015.pdf
10CFR61 Analysis Primary Resin_2014.docx
10CFR61 Analysis Primary Resin_2014.pdf
Alpha ratio tracking sheet.xlsx
Canal Radionuclide data.xlsx
HPP-112 ENCLOSURE 1.doc
HPP112_isotopic_mix.xlsx
NRC Screening Values.pdf
ODCM rev 36 draft for review.docx
ODCM Revision Form_Rev 35.pdf
ODCM_rev35 DRAFT.DOCX
PCP.07.docx
R16 Alpha ratios.xlsx
REMP 2014_final.docx
RS2009-10-2195 CTMT SG Opening for R16.pdf
RS2011-12-0137 Concrete Samples.pdf
RS2012-01-0120 Concrete Samples.pdf
RS2016-05-0004 Intake Structure Survey Results.docx
RS2016-05-0004 Intake Structure.pdf
10 CFR 75(g)_HPP0230_1977.PDF
10 CFR 75(g)_HPP0230_1978.PDF
10 CFR 75(g)_HPP0230_1979.PDF
10 CFR 75(g)_HPP0230_1980.PDF
10 CFR 75(g)_HPP0230_1981.PDF
10 CFR 75(g)_HPP0230_1982.PDF
10 CFR 75(g)_HPP0230_1983.PDF
10 CFR 75(g)_HPP0230_1986.PDF
10 CFR 75(g)_HPP0230_1988.PDF
10 CFR 75(g)_HPP0230_1989.PDF
10 CFR 75(g)_HPP0230_1991.PDF
10 CFR 75(g)_HPP0230_1992.PDF
10 CFR 75(g)_HPP0230_1993.PDF
10 CFR 75(g)_HPP0230_1994.PDF
10 CFR 75(g)_HPP0230_1997.PDF
10 CFR 75(g)_HPP0230_1998.PDF
10 CFR 75(g)_HPP0230_1999.PDF

10 CFR 75(g)_HPP0230_2000.PDF
10 CFR 75(g)_HPP0230_2001.PDF
10 CFR 75(g)_HPP0230_2006.PDF
10 CFR 75(g)_HPP0230_2007.PDF
10 CFR 75(g)_HPP0230_2008.PDF
10 CFR 75(g)_HPP0230_2009.PDF
10 CFR 75(g)_HPP0230_2010.PDF
10 CFR 75(g)_HPP0230_2011.PDF
10 CFR 75(g)_HPP0230_2012.PDF
10 CFR 75(g)_HPP0230_2013.PDF
10 CFR 75(g)_HPP0230-1Q2014.PDF
10 CFR 75(g)_HPP0230-1Q2015.pdf
10 CFR 75(g)_HPP0230-2Q2014.PDF
10 CFR 75(g)_HPP0230-3Q2014.pdf
10 CFR 75(g)_HPP0230-4Q2014.pdf
10 CFR 75(g)_HPP0230-Annual Review_1-1-07_6-1-08.pdf
10 CFR 75(g)_HPP0230-CR3 Settling Pond.pdf
Site Picture CR3 Buildings and Structures.pdf
Site Picture For Licensing Discussion.pdf
Site Picture Wetlands.pdf
Discharge Canal - 1.JPG
Discharge Canal - 2.JPG
Discharge Canal.JPG
Intake Canal.JPG
Intake Structure - 1.JPG
Intake Structure - 2.JPG
Intake Structure - 3.JPG
Intake Structure.JPG
Monitoring Well 3.JPG
Monitoring Well 3S.JPG
Monitoring Wells 3 & 3S.JPG
Nitrogen and Hydrogen Storage Area.JPG
Old Chemical Storage Building - 1.JPG
Old Chemical Storage Building - 2.JPG
Old Chemical Storage Building - 3.JPG
Old Chemical Storage Building - 4.JPG
Old Chemical Storage Building.JPG
OTSG Area Drainage.JPG
OTSG South Side.JPG
OTSG Storage Facility - 1.JPG
OTSG Storage Facility.JPG
Outfall into Intake Canal.JPG
Outside OTSG toward RR Tracks.JPG
RMSW 'G' - 10.JPG
RMSW 'G' - 11.JPG

RMSW 'G' - 2.JPG
RMSW 'G' - 3.JPG
RMSW 'G' - 4.JPG
RMSW 'G' - 5.JPG
RMSW 'G' - 6.JPG
RMSW 'G' - 7.JPG
RMSW 'G' - 8.JPG
RMSW 'G' - 9.JPG
RMSW 'G' - East Side.JPG
RMSW 'G' - Floor crack.JPG
RMSW 'G' - Sand Blast Tent Area.JPG
RMSW 'G' - South Side.JPG
RMSW 'G'.JPG
Site Picture Aerial View of CR3 R3wflow3.jpg
Site Picture Aux119.pdf
Site Picture Aux143.pdf
Site Picture Aux75and95.pdf
Site Picture Berms.JPG
Site Picture Buried Piping MapPro output.pdf
Site Picture Control Complex.pdf
Site Picture CR3 Berms.jpg
Site Picture CR3 Buildings and Structures.pdf
Site Picture CR3-G86-D_SitePlotPlan_Buildings.pdf
Site Picture DSC01888.JPG
Site Picture DSC01894.JPG
Site Picture For Licensing Discussion.pdf
Site Picture RB160.pdf
Site Picture RB180.pdf
Site Picture Site Map with labels.JPG
Site Picture TB119.pdf
Site Picture TB145.pdf
Site Picture TB95.pdf
Site Picture TBNorth.pdf
Site Picture Wetlands.pdf
Southeast toward RT Bunker.JPG
Spill Retention Pond - 1.JPG
Spill Retention Pond - 2.JPG
Spill Retention Pond.JPG
Storm Water Retention Pond 'A' - 1.JPG
Storm Water Retention Pond 'A' - 2.JPG
Storm Water Retention Pond 'A'.JPG
Storm Water Retention Pond 'B' - 1.JPG
Storm Water Retention Pond 'B'.JPG
Survey Map AB 119' (IH Survey).pdf
Survey Map AB 119'_(Yellow Rm as a LHRA).pdf

Survey Map AB 119'_(Yellow Rm as an HRA).pdf
Survey Map AB 119'_Block Orifice Rm (BLANK).pdf
Survey Map AB 119'_Block Orifice Rm.pdf
Survey Map AB 119'_EGDG Rm's.pdf
Survey Map AB 119'_Hot Machine Shop (BLANK).pdf
Survey Map AB 119'_Hot Machine Shop (ROUTINE).pdf
Survey Map AB 119'_Hot Machine Shop.pdf
Survey Map AB 119'_MUT Room.pdf
Survey Map AB 119'_Personnel Hatch & Dress Out areas.pdf
Survey Map AB 119'_Personnel Hatch (BLANK).pdf
Survey Map AB 119'_Personnel Hatch.pdf
Survey Map AB 119'_Post Filter Mezzanine.pdf
Survey Map AB 119'_Post Filter Rm. & Valve Alley.pdf
Survey Map AB 119'_Pre Filter Mezzanine.pdf
Survey Map AB 119'_Pre Filter Rm (BLANK).pdf
Survey Map AB 119'_Pre Filter Rm.pdf
Survey Map AB 119'_RCBT 119'.pdf
Survey Map AB 119'_RM-A6 Area (BLANK).pdf
Survey Map AB 119'_RM-A6 Area.pdf
Survey Map AB 119'_Spent Fuel Demin Rm.pdf
Survey Map AB 119'_Spent Fuel Pumps area (alternate view BLANK).pdf
Survey Map AB 119'_Spent Fuel Pumps area (alternate view).pdf
Survey Map AB 119'_Spent Fuel Pumps area (BLANK).pdf
Survey Map AB 119'_Yellow & Green Rm (BLANK).pdf
Survey Map AB 119'_Yellow & Green Rm (HRA).pdf
Survey Map AB 119'_Yellow & Green Rm (LHRA).pdf
Survey Map AB 143' (IH Survey).pdf
Survey Map AB 143'.pdf
Survey Map AB 143'_RB Purge Valve Alley & Vent Rm.pdf
Survey Map AB 143'_Spent Fuel Filter hallway (BLANK).pdf
Survey Map AB 143'_Spent Fuel Filter hallway.pdf
Survey Map AB 143'_Spent Fuel Filter Mezzanine.pdf
Survey Map AB 160' (IH Survey).pdf
Survey Map AB 160'_(SFF) BLANK.pdf
Survey Map AB 160'_(SFF).pdf
Survey Map AB 160'_Spent Fuel Pool Area (Blank).pdf
Survey Map AB 160'_Spent Fuel Pool Area.pdf
Survey Map AB 95' (IH Survey).pdf
Survey Map AB 95'_(BLANK).pdf
Survey Map AB 95'_AB Sump.pdf
Survey Map AB 95'_Complete.pdf
Survey Map AB 95'_Decant Slurry Pump Rm. & Valve Alley (BLANK).pdf
Survey Map AB 95'_Decant Slurry Pump Rm. & Valve Alley(LABELED).pdf
Survey Map AB 95'_Decant Slurry Pump Rm. & Valve Alley(UNLABELED).pdf
Survey Map AB 95'_Decay Heat Vaults.pdf

Survey Map AB 95'_Hallway.pdf
Survey Map AB 95'_HPI Rm (BLANK).pdf
Survey Map AB 95'_HPI Rm.pdf
Survey Map AB 95'_MUP's & Valve Alley (BLANK).pdf
Survey Map AB 95'_MUP's & Valve Alley.pdf
Survey Map AB 95'_Neutralizer Tank - Laundry & Shower Tanks.pdf
Survey Map AB 95'_Nuclear Sample Rm. (BLANK).pdf
Survey Map AB 95'_Nuclear Sample Rm.pdf
Survey Map AB 95'_RC & Misc. Waste Evaporator Rm.pdf
Survey Map AB 95'_RC Waste Xfer Pumps & Valve Alley (BLANK).pdf
Survey Map AB 95'_RC Waste Xfer Pumps & Valve Alley.pdf
Survey Map AB 95'_RCBT 95'.pdf
Survey Map AB 95'_Seawater Rm.pdf
Survey Map AB 95'_Top of Nuclear Sample Rm.pdf
Survey Map AB 95'_Triangle Rm.(BLANK).pdf
Survey Map AB 95'_Triangle Rm.pdf
Survey Map AB 95'_WG Compressor Rm & Sample Area C & D.pdf
Survey Map AB 95'_WG Compressor Rm. & Sample Area C & D (BLANK).pdf
Survey Map Buttress #1 (95 ft).pdf
Survey Map Buttress #2 (95 ft).pdf
Survey Map Buttress #3 (95 ft).pdf
Survey Map Buttress #4 (95 ft).pdf
Survey Map Buttress #5 (119 ft).pdf
Survey Map Buttress #5 (95 ft).pdf
Survey Map Buttress #6 (119 ft).pdf
Survey Map Buttress #6 (95 ft).pdf
Survey Map Buttress Drawing with ID tabs.pdf
Survey Map Buttress Drawing.pdf
Survey Map BWST Rm.pdf
Survey Map Cold Machine Shop.pdf
Survey Map Cold Tool Rm.pdf
Survey Map Components_90 Globe Valve.pdf
Survey Map Components_Angle Globe 1Valve.doc
Survey Map Components_Angle Globe Valve.pdf
Survey Map Components_Building Spray Pump.pdf
Survey Map Components_Check Valve.pdf
Survey Map Components_Diaphram Valve.pdf
Survey Map Components_Gate Valve.pdf
Survey Map Components_Globe Valve.pdf
Survey Map Components_Limitorque.pdf
Survey Map Control Complex_CC 108'.pdf
Survey Map Control Complex_CC 124'.pdf
Survey Map Control Complex_CC 134'.pdf
Survey Map Control Complex_CC 145'.pdf
Survey Map Control Complex_CC 164'.pdf

Survey Map Control Complex_CC 95'.pdf
Survey Map Control Complex_CC Complete.pdf
Survey Map Control Complex_Roof.pdf
Survey Map IB 119' (IH Survey).pdf
Survey Map IB 95' (IH Survey).pdf
Survey Map IB CAV-2 Valve Alley (IH Survey).pdf
Survey Map Intermediate Building_CAV-2 Valve Alley (BLANK).pdf
Survey Map Intermediate Building_CAV-2 Valve Alley.pdf
Survey Map Intermediate Building_IB 119'.pdf
Survey Map Intermediate Building_IB 95'.pdf
Survey Map Intermediate Building_Tendon Gallery.pdf
Survey Map Lunchroom & Cold Tool Rm..pdf
Survey Map Lunchroom.pdf
Survey Map Miscellaneous Survey.pdf
Survey Map MSB (ROUTINE).pdf
Survey Map MSB.pdf
Survey Map RCA Berm (BLANK).pdf
Survey Map RCA Berm (ROUTINE).pdf
Survey Map RCA Berm.pdf
Survey Map Reactor Building_3C Letdown Cooler Rm RB 95'.pdf
Survey Map Reactor Building_A Core Flood Tank Rm.pdf
Survey Map Reactor Building_A D-Ring.pdf
Survey Map Reactor Building_A OTSG Lower.pdf
Survey Map Reactor Building_A OTSG Upper.pdf
Survey Map Reactor Building_B D-Ring.pdf
Survey Map Reactor Building_B OTSG Lower.pdf
Survey Map Reactor Building_B OTSG Upper.pdf
Survey Map Reactor Building_Cavity Refueling Upender.pdf
Survey Map Reactor Building_FHCR-1 Control Panel.pdf
Survey Map Reactor Building_Fuel Bridge Crane.pdf
Survey Map Reactor Building_Incore Pit.pdf
Survey Map Reactor Building_Letdown Cooler Rms RB 95'.pdf
Survey Map Reactor Building_New Letdown Cooler Rm RB 95'.pdf
Survey Map Reactor Building_Polar Crane.pdf
Survey Map Reactor Building_RB 119'.pdf
Survey Map Reactor Building_RB 160'.pdf
Survey Map Reactor Building_RB 180'.pdf
Survey Map Reactor Building_RB 95'.pdf
Survey Map Reactor Building_RCP Seal Cavity Area.pdf
Survey Map Reactor Building_Reactor Coolant Pump & Motor.pdf
Survey Map Reactor Building_Refuel Cavity & Incore Pit.pdf
Survey Map Reactor Building_Rx Cavity Head in Place.pdf
Survey Map Reactor Building_Rx Head & Service Structure.pdf
Survey Map Reactor Building_Top of PZR.pdf
Survey Map Reactor Building_Top of Rx Head.pdf

Survey Map Retired Rx Head Storage Bldg.pdf
Survey Map RMSW-D (Oil Tank).pdf
Survey Map RMSW-D (ROUTINE).pdf
Survey Map RMSW-G (ROUTINE).pdf
Survey Map RMSW-G.pdf
Survey Map ROOF.pdf
Survey Map Satellite Decon Tent (BLANK).pdf
Survey Map Satellite Decon Tent.pdf
Survey Map Scrap Metal & Tool Storage Areas.pdf
Survey Map Shipping_5 Gallon Bucket.pdf
Survey Map Shipping_5 Gallon Drum.pdf
Survey Map Shipping_B-12 Box.pdf
Survey Map Shipping_B-25 Box.pdf
Survey Map Shipping_Bucket Survey (1 sample bottle).pdf
Survey Map Shipping_Bucket Survey (2 sample bottles).pdf
Survey Map Shipping_Bucket Survey (3 sample bottles).pdf
Survey Map Shipping_Bucket Survey (4 sample bottles).pdf
Survey Map Shipping_Bucket Survey (5 sample bottles).pdf
Survey Map Shipping_Bucket Survey (6 sample bottles).pdf
Survey Map Shipping_Cask Truck Survey.pdf
Survey Map Shipping_Cooler Survey (1 sample bottle).pdf
Survey Map Shipping_Cooler Survey (2 sample bottles).pdf
Survey Map Shipping_Cooler Survey (3 sample bottles).pdf
Survey Map Shipping_Cooler Survey (4 sample bottles).pdf
Survey Map Shipping_Cooler Survey (5 sample bottles).pdf
Survey Map Shipping_Cooler Survey (6 sample bottles).pdf
Survey Map Shipping_Cooler Survey (7 sample bottles).pdf
Survey Map Shipping_Cooler Survey (8 sample bottles).pdf
Survey Map Shipping_Cooler Survey (9 sample bottles).pdf
Survey Map Shipping_Custom Critical Van.pdf
Survey Map Shipping_Drum.pdf
Survey Map Shipping_Flatbed Truck Survey.pdf
Survey Map Shipping_Hardigg Box.pdf
Survey Map Shipping_HIC.pdf
Survey Map Shipping_IP-2 Box.pdf
Survey Map Shipping_Sealand.pdf
Survey Map Shipping_Shipping Container Box.pdf
Survey Map Shipping_Truck Van Survey.pdf
Survey Map TB 119' (IH Survey).pdf
Survey Map TB 145' (IH Survey).pdf
Survey Map TB 164' (IH Survey).pdf
Survey Map TB 95' (IH Survey).pdf
Survey Map TB Complete (IH Survey).pdf
Survey Map Top of NSR.pdf
Survey Map Troxler density gauge.pdf

Survey Map Turbine Building_TB 119'.pdf
Survey Map Turbine Building_TB 145'.pdf
Survey Map Turbine Building_TB 164'.pdf
Survey Map Turbine Building_TB 95'.pdf
Survey Map Turbine Building_TB Complete.pdf
BST Rm Blank Map.pdf
Copy of Source Inventory Database.xlsx
RS 1978 Survey resin spill HP log.pdf
RS Reactor-Aux-Intermediate Bldg.docx
RS_CR3-M-20140412-1 RMSW G - Survey for Release.pdf
RS_CR3-M-20140426-3 Decon Tent Release.pdf
RS_CR3-M-20140520-1 Triangle Room-LPI.pdf
RS_CR3-M-20140617-1 Reactor Bldg Routine.pdf
RS_CR3-M-20140624-2 Post-filter Valve Alley.pdf
RS_CR3-M-20140808-3 RMSW D - Survey for Release.pdf
RS_CR3-M-20140812-3 RMSW D - Survey for Release.pdf
RS_CR3-M-20140812-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140813-6 RMSW D - Survey for Release.pdf
RS_CR3-M-20140814-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140815-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140816-3 HPI Valve Alley (Alpha Ratio).pdf
RS_CR3-M-20140819-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140820-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140829-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140903-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140905-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140910-2 RMSW D - Survey for Release.pdf
RS_CR3-M-20141023-3 AB 119' Seal Return Cooler Room.pdf
RS_CR3-M-20150204-1 - Swamp.pdf
RS_CR3-M-20150217-2 - Swamp.pdf
RS_CR3-M-20150223-3 - Swamp.pdf
RS_CR3-M-20150226-4 - Swamp.pdf
RS_CR3-M-20150303-5.pdf
RS_CR3-M-20150413-3.pdf
RS_CR3-M-20150416-2 RMSW G Yard - Survey for Release.pdf
RS_CR3-M-20150511-3 RB Upper Cavity.pdf
RS_CR3-M-20150601-5 RMSW G Yard - Survey for Release.pdf
RS_CR3-M-20150602-4 RMSW G Yard - Survey for Release.pdf
RS_CR3-M-20160119-3 Yellow Room over Half Wall.pdf
RS_CR3-M-20160120-3 Yellow Room.pdf
RS_CR3-M-20160123-5 95' Aux Bldg.pdf
RS_CR3-M-20160128-5 160' Aux Bldg Spent Fuel Floor.pdf
RS_CR3-M-20160129-5 Hot Shop.pdf
RS_CR3-M-20160130-2 MSB.pdf
RS_CR3-M-20160131-2 Berm.pdf

RS_CR3-M-20160131-2 South Berm.pdf
RS_CR3-M-20160201-9 143' Aux Bldg.pdf
RS_CR3-M-20160203-2 Decay Heat Vaults.pdf
RS_CR3-M-20160203-5 119' Aux Bldg.pdf
RS_CR3-M-20160203-6 95' Control Complex.pdf
RS_FR-12-110 SDT-1 Solid Material Isotopic (West Berm).pdf
RS1978 Survey-1978.pdf
RS1978-05-12 S. Berm Asphalt Following Resin Spill.pdf
RS1983-04-301 scrap metal pile note.pdf
RS1983-04-307.pdf
RS1983-LOG-4-5-1983.pdf
RS1997-09-0335 Turbine Parts-Kelly Bldg.pdf
RS1998-02-0144 Tb Parts Survey Results.pdf
RS1998-10-0099 Post Turbine Parts.pdf
RS1999-02-0104 RMSW G - Survey for Release.pdf
RS1999-02-0121 RMSW G - Survey for Release.pdf
RS1999-02-0147 RMSW G - Survey for Release.pdf
RS1999-02-0161 RMSW G - Survey for Release.pdf
RS1999-02-0171 RMSW G - Survey for Release.pdf
RS1999-02-0185 RMSW G - Survey for Release.pdf
RS1999-02-0195 RMSW G - Survey for Release.pdf
RS1999-02-0252 Turbine Parts Area-Sand Blast.pdf
RS1999-02-195 RMSW G - A Level Release.pdf
RS1999-03-0128 Turbine Parts.pdf
RS1999-03-0197 Turbine Parts.pdf
RS1999-03-317 Turbine Parts.pdf
RS1999-04-0004 Turbine Parts.pdf
RS1999-04-0076 Turbine Parts.pdf
RS1999-04-0117 Turbine Parts.pdf
RS1999-04-0228 Turbine Parts.pdf
RS1999-04-144 Turbine Parts.pdf
RS2000-10-0024 Soil Samples from Swamp.pdf
RS2001-10-0576 FTI Boxes for Shipment (South Berm).pdf
RS2001-10-0612 DRP MSB Berm.TIF
RS2001-10-0612 DRP outside of Eq Hatch (South Berm).pdf
RS2002-01-0018 IB TB 119'.pdf
RS2002-01-0018 Intermediate Bldg 119'.pdf
RS2003-10-0916 RVCH Transport Leak.pdf
RS2008-07-0012 B Diesel Gen Survey.pdf
RS2008-10-0026 - Excavation of Light Pole.TIF
RS2009-02-0099 Tendon Gallery Sump Sample.pdf
RS2009-02-0109 Site Soil Survey Data Swamp.pdf
RS2009-02-0224 Tendon Gallery Survey.pdf
RS2009-03-0185 119' S Berm Slab B Soils.pdf
RS2009-03-0185 S Berm Slab B Soil Samples.pdf

RS2009-05-0244 Sealand Container Storage Yard.pdf
RS2009-06-0266 R16 Storage Yard - Baseline Survey.pdf
RS2009-10-0057 145' Turbine Bldg HDV-507-508.pdf
RS2009-10-0058 145' Turbine Bldg MSR-3A Crossover.pdf
RS2009-10-0064 145' Turbine Bldg Crossover Pipe.pdf
RS2009-10-0073 N2 Line 119' Turbine Bldg.pdf
RS2009-10-0082 Cold Machine Shop MSV-24.pdf
RS2009-10-0544 Alpha Ratio 600-1 (Aux Bldg).pdf
RS2009-10-2195 CTMT SG Opening for R16.pdf
RS2009-10-8015 RT Bunker.pdf
RS2009-10-8068 RT Bunker.pdf
RS2009-10-8137 Decon Tent Area.pdf
RS2009-10-8137 Decon Tent.pdf
RS2009-12-8053 RT Bunker.pdf
RS2009-12-8068 Decon Tent.pdf
RS2009-12-8192 Decon Tent.pdf
RS2010-03-0092 AB 119' Make Up Demins.pdf
RS2010-05-0050 South Berm Fixed Contam.pdf
RS2010-05-0050_001 south berm fixed contam.pdf
RS2010-05-0357 - Tendon Gallery.pdf
RS2010-05-0371 - South Berm - RCA Downsize.pdf
RS2010-07-0090 South Laydown Yard.pdf
RS2010-07-0232 Soil Samples Issue Warehouse.pdf
RS2010-07-0236 Nitrogen Line Excavation (East Berm).pdf
RS2010-07-0244 N2 Line Cut Outside Tb Bldg (East Berm).pdf
RS2010-11-0221 Composite Sand Pile Ease of SAB.pdf
RS2010-11-0221_001 Site Soil Survey Data Pond B.pdf
RS2010-11-0226 Pond B Retention Area.pdf
RS2010-11-0226_001 Site Soil Survey Data Pond B.pdf
RS2010-11-0236 Pond B Outside Townsend Work Area.pdf
RS2010-11-0236_001 Site Soil Survey Data Pond B.pdf
RS2010-11-0322 MTF Extension and Pond B.pdf
RS2010-11-0322_001 Site Soil Survey Data Pond B.pdf
RS2010-12-0101 Pond B Outlet Structure.pdf
RS2010-12-0101 Site Soil Survey Data Pond B.pdf
RS2010-12-0118 Pond A.pdf
RS2010-12-0118 Site Soil Survey Data Pond A.pdf
RS2010-12-0134 Pond A.pdf
RS2010-12-0134 Site Soil Survey Data Pond A.pdf
RS2010-12-0224 Retention Pond.pdf
RS2010-12-0224 Site Soil Survey Data Spill Retention Basin.pdf
RS2010-12-0245 Pond B.pdf
RS2010-12-0245 Site Soil Survey Data Pond B.pdf
RS2010-12-0312 Pond A.pdf
RS2010-12-0312 Site Soil Survey Data Pond A.pdf

RS2010-12-0327 Pond B Outlet Spillway.pdf
RS2010-12-0327 Site Soil Survey Data Spill Retention Basin.pdf
RS2011-03-0357 Site Soil Survey Data Spill Retention Basin.pdf
RS2011-03-0357 Spillway.pdf
RS2011-05-0020 Site Soil Survey Data Pond A.pdf
RS2011-05-0179 ISFSI Jack&Bore and Railroad Tracks.pdf
RS2011-05-0179 Site Soil Survey Data Spill Retention Basin.pdf
RS2011-06-0007 AB 95' Concentrate Waste Tank Room.pdf
RS2011-06-0205 Site Soil Survey Data Pond A.pdf
RS2011-08-0021 AB 119' Deborating Demin Tank Room.pdf
RS2011-12-0137 Concrete Samples.pdf
RS2012-01-0120 Concrete Samples.pdf
RS2012-07-0001 CC 95' Nuclear Sample Room.pdf
RS2012-07-0001 Nuclear Sample Room.pdf
RS2012-07-0029 Tendon Gallery.pdf
RS2012-07-0056 Block Orifice Room.pdf
RS2012-07-0090 AB 119' RCBT.pdf
RS2012-08-0129 Building Spray Tank Room.pdf
RS2012-08-0133 SDT-1 Leak (West Berm).tiff
RS2012-08-0133 SDT-1 leak.pdf
RS2012-08-0133 SDT-1 leak.tiff
RS2012-09-0097 Crane Dunnage (South Berm).pdf
RS2012-09-0101 Crane Dunnage (South Berm).pdf
RS2012-10-0108 RC Evap Rm.pdf
RS2012-11-0057 Letdown Cooler Room.pdf
RS2012-12-0030 Letdown Cooler Room.pdf
RS2012-12-0090 Pre-filter Room.pdf
RS2012-12-0184 AB 119' Spent Fuel Demin.pdf
RS2013-03-0037 Decon Tent.pdf
RS2013-03-0151 Letdown Line outside D-rings.pdf
RS2013-04-0210 south berm storm drain.pdf
RS2013-07-0100 AB 95' RCBT Room.pdf
RS2013-07-0224 Decon Tent - Down Post.pdf
RS2013-07-0224 Decon Tent Down Post.pdf
RS2013-07-0233 RMSW G outside.pdf
RS2013-07-0285 R16 Shipping Yard - Down Post.pdf
RS2013-07-0285 R16 Shipping Yard.pdf
RS2013-12-0132 CAV 2-6 valve alley.pdf
RS2013-12-0225 Letdown Line outside d-rings.pdf
RS2014-01-0007 IB AB MUT-RMA-6 area-119' map.pdf
RS2014-01-0031 AB IB HPI-rainforest.pdf
RS2014-01-0057 AB 95' Decant Slurry Pump Room.pdf
RS2014-04-0151 Decon Tent Area Soil Samples.pdf
RS2014-05-0040 Turbine Sump Sludge.pdf
RS2015-01-0006 source leak check.pdf

RS2016-02-0005 Routine_z03.pdf
RS2016-05-0004 Intake Structure Survey Results.docx
RS2016-05-0004 Intake Structure.pdf
s-berm storm drain isotopic.pdf
Site Survey Data.xlsx
South Laydown Yard.pdf
Survey Log 2003 November.pdf
Survey Log 2003 October.pdf
Survey Log 2009 Survey Sediment Pond Soils.pdf
AR00043635 Settling Pond Discharge Line Damaged.TIF
AR00061143 Morpholine Spill on East Berm.TIF
AR00067665 Hydrazine Spill on Berm.TIF
AR00069477 Contamination Found Inside Raw Water Piping.pdf
AR00070409 Diesel Fuel Leak While MTDG-1 in Operation.TIF
AR00072099 SDT-1 Drainline to Settling Pond Break.TIF
AR00075086 Sewage Flowing Outside of the MTF.TIF
AR00080166 00004655 Minor Diesel Spill.TIF
AR00085637 Paint Shop Deficiencies.TIF
AR00086804 Tank at the Old Chemical Storage Area Overflowed (1).TIF
AR00088523 Ethylene Glycol Spill on SE Berm.TIF
AR00089282 Oil Found on Floor of Chemical Storage Building.TIF
AR00093167 Storage Tanks did not meet PT-356 Requirements.TIF
AR00106444 SDT-1 Discharge Line Leak.pdf
AR00107680 Contaminated Sewage Sludge.pdf
AR00108043 Old RVCH Containment Bag Leaked Water at Storage Building.pdf
AR00111233 Oil Water Separator Tank SDS-1 Leaking.TIF
AR00133478 Mercury in Outlet Receptacle in Primary Sample Lab.TIF
AR00144217 Possible Asbestos in Unit 4160 Room.TIF
AR00145490 Forklift Coolant Spill.TIF
AR00145505 Coating Spill While Transporting into Protected Area.TIF
AR00154113 Petroleum Fluids Leaked from Garbage Truck.TIF
AR00217211 Oil Leak in 500 KV Yard.TIF
AR00217570 IAP-4 Fuel Tank Overflow due to tanks not equalized.TIF
AR00217692 High Particulate in FO Storage Tanks DFT-1B and FST-2B.TIF
AR00229985 Underground Water Pipe Leak (2).TIF
AR00230927 Questionable Site Wide Grit Blasting Operation.TIF
AR00232613 Safety Hazards at Paint Shop.TIF
AR00234946 Chemical Spill on Berm While Spraying Weeds.TIF
AR00244767 Air Compressor Leaking Oil near Paint Shack.TIF
AR00246475 Lead Based Paint testing needs improvement.TIF
AR00253129 Water and Oil in DFT-1A Sandpipe Area.TIF
AR00259995 Treated Sewage from Unit 1 and 2 Low Level Contamination.pdf
AR00265015 Small Oil Leak on MTTR-3A.TIF
AR00274815 Oil Leak from B Step up Transformer.TIF
AR00277615 MTTR-3B Oil Leakage Increased.TIF

AR00278462 Transformer Oil Leak 5-7-08.TIF
AR00285638 Contamination in B Diesel Generator Room.pdf
AR00287789 Hydraulic Fluid Leak on Fork Lift.TIF
AR00289150 Hydraulic Oil Spill During Forklift Operation.TIF
AR00292693 Oil spill at Helper Cooler Tower.TIF
AR00294825 Heavy Fuel Oil Residue Found in Soil at Fossil's Round WH.TIF
AR00306686 TSC Diesel Fuel Oil Spill.TIF
AR00309140 PCB Ballast Collection Exceeded 30 Days.TIF
AR00312383 Fluid Found Under Forklift 7154.TIF
AR00315135 MTTR-2 Startup Transformer Low Oil Level and Leakage.TIF
AR00316434 Oil Leak on Auxiliary Transformer.TIF
AR00316860 Discrete Radioactive Particle Found at OSB Demobilization Area.pdf
AR00319845 Fixed Contamination Found in MSB Support Girder.pdf
AR00320618 Trace Levels of Licensed Material Inside PA (Swamp).pdf
AR00320618 Trace Levels of Licensed Material Inside PA (Swamp).TIF
AR00320787 Sewer Line Ruptured During Core Boring.TIF
AR00322908 Hydraulic Line Ruptured on Manlift in Swamp.TIF
AR00329712 Trace Levels of Radionuclides Detected in Aux Bldg Exhaust SXs.pdf
AR00332430 Fill Dumped near Rail Spur Spare Transformer.TIF
AR00336603 RB Hydro Demo Release to Settling Ponds.TIF
AR00336763 Temporary Rad Controlled Areas in Controlled Area.pdf
AR00336767 ANI Inspection 09-03 - Settling Pond.pdf
AR00338693 Underground Pipe Leak OS Protected Area.pdf
AR00348439 Sewage Spill at Units 1,2,3 Sewage Treatment Plant.TIF
AR00351509 MSB - Contamination Found in a Clean Area.pdf
AR00356886 AREVA Shipment Arrived Onsite with a Small Leak.pdf
AR00358312 NRC RP Team Identified Deficiency in Radwaste Storage.pdf
AR00358882 2016-01-2810-31-27.pdf
AR00362812 Radioactive Material Outside of the Primary RCA.pdf
AR00366105 Minor Hydraulic Oil Spill on South Berm.TIF
AR00368569 Leakage from Drum of Turbine Building Sump Material.pdf
AR00370075 Minor Domestic Wastewater Release from CR1 2 and 3 WWTP.TIF
AR00372431 Waste Water Line Leak at CR 1 and 2.pdf
AR00377007 Damaged Radioactive Source.pdf
AR00388158 A Decay Heat Vault Wall Leakage.TIF
AR00389468 Oil Sheen on Berm near Spare Transformer.TIF
AR00396119 Fuel Spill Outside PA from CSX Train.TIF
AR00399804 B Decay Heat Vault Increased Inleakage.TIF
AR00401623 Fixed Contamination on Concrete in RCA Back Berm.pdf
AR00401785 Contaminated Water inadvertently Pumped to the A DH Vault.pdf
AR00405005 Section of Buried Piping Leaking.pdf
AR00407940 Unexplained leakage from WDT-1.pdf
AR00410140 MTTR-3B Oil Leak from Cooler No 1.TIF
AR00411245 Contamination Outside RCA.pdf
AR00435178 Transformer Oil Pumped to Storm Drain 11-24-10.TIF

AR00443392 Elevated Tritium on A-Decay Heat Vault Water Intrusion.pdf
AR00452489 Leakage Existed from SDT-1 to the Settling Pond.pdf
AR00455636 Some Leakage Identified from SFP Liner Tell Tale Drain.pdf
AR00464998 Rad Material Storage Practices.pdf
AR00515017 Hydraulic Oil Leak at S Vehicle Gate 2-6-12.pdf
AR00515732 Suspected Waste Water Leaking from Below Grade.pdf
AR00515996 Diesel Spill Under Mobile Crane 2-9-12.pdf
AR00543135 Hydraulic Oil Leak at Car Wash Area 6-14-12.pdf
AR00554989 Crane Leaking Coolant on S Berm 8-14-12.pdf
AR00555078 Trace Rad Contamination Found in Excavated West Berm Trench.pdf
AR00558601 Potential DW Leakage into Condensate System.pdf
AR00560532 Trace Levels of Contamination Found Outside the RCA Inside PA.pdf
AR00562443 Unmarked Drums in RR Loop 9-20-2012.pdf
AR00563859 Radioactive material Found in Warehouse Package Pickup Area.pdf
AR00568080 Surface Water Pooling From Underground Source 10-18-12.pdf
AR00579415 CP0161, Rev 7, REMP.pdf
AR00596294 Rental Vehicle Coolant Leak 3-19-13.pdf
AR00601863 'A' OTSG Secondary Leakage has Increased.pdf
AR00603660 Storm Drain Contaminaton.pdf
AR00645833 SF Pool Tell Tale Drain Leaking at SFV-157.pdf
AR00645836 SF Pool Tell Tale Drain Leaking at SFV-151.PDF
AR00682781 JLG Man Lift Oil Leak 4-21-14.pdf
AR00692913 Hydraulic Oil Leak from Dump Trailer 6-12-14.pdf
AR00694175 Hydraulic Oil Leak from Truck at RB Equipment Hatch 6-19-14.pdf
AR00707774 Hydraulic Oil Spill from Fork Truck 9-11-14.pdf
AR00714933 Truck Power Steering Fluid Leak 10-23-14.pdf
AR00723232 Hydraulic Oil Leak from Truck at Sally Port 12-12-14.pdf
AR00724987 Hydraulic Fluid on W Berm 12-29-14.pdf
AR00728315 Hydraulic Oil Spill at Main Transformer 3A 1-20-15.pdf
AR00752539 Trace Levels of Contamination Identified at the G RMSW.pdf
Historical Text Search for Contamination_Radioactive_etc Report AR type NCR.pdf
HPP0230_1981 (cut out 2 NCORs).PDF
NCOR779-0258, Radioactive Spill outside the RCA (Core Flood_N2 Line Event).pdf
NCOR79-0258, Core Flood - N2 Event (discusses Piping inside Tb Bldg).pdf
NCOR80-0124 Radioactive Waste Outside RCA.pdf
NCOR81-0186 SDT-1 Spill on Berm.pdf
NCOR81-0186, SDT-1 Spill on Berm.pdf
NCOR81-0213 SDT-1 Spill on Berm.pdf
NCOR81-0213, SDT-1 Spill on Berm.pdf
NCOR82-0067, Secondary Resin Spill outside the RCA.pdf
NCOR82-0329 Uncontrolled Contaminated Material Outside RCA.pdf
NCOR83-0089 Contaminated Pipe Found Outside RCA.pdf
NCOR88-0139, Leakage of SDT-1 Contents to the Berm and Storm Drain.pdf
NCOR89-164.PDF
NCRs 2001.csv

NCRs 2002 First Half.csv
NCRs 2002 Fourth Qtr.csv.idfvault
NCRs 2002 Third Qtr.csv.idfvault
NCRs 2003 First Qtr.csv.idfvault
NCRs 2003 Fourth Qtr.csv
NCRs 2003 Second Qtr.csv
NCRs 2003 Third Qtr.csv.idfvault
NCRs 2004 First Qtr.csv.idfvault
NCRs 2004 Fourth Qtr.csv.idfvault
NCRs 2004 Second Qtr.csv
NCRs 2004 Third Qtr.csv.idfvault
NCRs 2005 First Qtr.csv
NCRs 2005 Fourth Qtr.csv
NCRs 2005 Second Qtr.csv
NCRs 2005 Third Qtr.csv.idfvault
NCRs 2006 First Qtr.csv.idfvault
NCRs 2006 Fourth Qtr.csv
NCRs 2006 Second Qtr.csv
NCRs 2006 Third Qtr.csv.idfvault
NCRs 2007 December.csv
NCRs 2007 First Qtr.csv.idfvault
NCRs 2007 November.csv
NCRs 2007 October.csv.idfvault
NCRs 2007 Second Qtr.csv.idfvault
NCRs 2007 Third Qtr.csv
NCRs 2008 April.csv
NCRs 2008 First Qtr.csv
NCRs 2008 Fourth Qtr.csv.idfvault
NCRs 2008 June.csv
NCRs 2008 May.csv.idfvault
NCRs 2008 Third Qtr.csv
NCRs 2009 August.csv.idfvault
NCRs 2009 December.csv
NCRs 2009 First Qtr.csv.idfvault
NCRs 2009 July.csv.idfvault
NCRs 2009 November.csv.idfvault
NCRs 2009 October.csv
NCRs 2009 Second Qtr.csv
NCRs 2009 September.csv
NCRs 2010 First Qtr.csv
NCRs 2010 Second Half.csv
NCRs 2010 Second Qtr.csv.idfvault
NCRs 2011 February.csv.idfvault
NCRs 2011 January.csv
NCRs 2011 March.csv

NCRs 2011 Second Half.csv
NCRs 2011 Second Qtr.csv.idfvault
NCRs 2012 First Half.csv.idfvault
NCRs 2012 Fourth Qtr.csv.idfvault
NCRs 2012 Third Qtr.csv
NCRs 2013 First Qtr.csv.idfvault
NCRs 2013 second half.csv
NCRs 2013 Second Qtr.csv
NCRs 2014 first half.csv.idfvault
NCRs 2014 Second half.csv
NCRs 2015.csv
PC001239 Low Levels of Contamination in Storm Drain.pdf
PC9802106 Leak in Discharge Piping from SDT-1 to Settling Ponds along West Berm.pdf
PC982106.pdf
PC98903279 Unplanned Release of Condensate Water at CR1 & 2 from the Settling Pond Release Flow Path Pipe.pdf
PC9904219 Sludge from Unit 1 &2 Sewage Treatment Plant is Contaminated with Cobalt-58.pdf
PC9904557 Detectable Radioactivity Found in the Sewage Treatment Plant.pdf
PR94-0347 Amerzine Spill in Chemical Warehouse 12-14-94.pdf
ST3241 AT Text Search all AR types.pdf
UOER 4-80, Radioactivity through N2 Supply Header to Tank Farm.PDF
HSA Interview Questionnaire.docx
Organization Chart - SAFSTOR 1.docx
Primary to Secondary LR 2005 - 2007.xls
Primary to Secondary LR.xls
Hot Spot 2013 June Hot Sot Index.doc
Hot Spot 2014 Jan HOT SPOT INDEX.doc
Diesel Spill From Coal Train 4-27-2010.pdf
IWW Release to secondary contain. 4-2-2013.pdf
IWW Release to Secondary Containment 4-2-2003.pdf
NALCO.pdf
Spill of Industrial Waste Water to Intake Canal 12-17-2009.pdf
Wastewater Treatment Facility Inspection Report 10-22-12.pdf

5.3 Property Inspections

Site tours were conducted December 8, 9, and 10, 2015; January 18 through 29 and February 22 through 26, 2016. These tours included observing SSCs on each elevation of the Reactor Building, Auxiliary Building, Intermediate Building and Turbine Building. Tours of the following buildings and areas also were conducted:

- Alternate AC Diesel Generator Building
- B.5.b Diesel Water Pump Building
- Construction Debris Dump
- Discharge Structure
- Emergency Diesel Generator Building
- Emergency Feedwater Pump 3 Building
- Fire Service Pump House
- Firing Range
- Hazardous Material Storage Buildings
- Intake Structure
- Issue Warehouse
- Maintenance Support Building (MSB)
- Nuclear Administration Building (NAB)
- Nuclear Security Operations Center (NSOC)
- Paint Shack
- Plant Administration Building-Technical Support Center (PAB/TSC)
- RMSW D
- RMSW G
- Sandblast Booth
- Settling Ponds
- Sewage Treatment Plant
- Site Administration Building (SAB)

In addition, the OTSG Storage Facility, the RT Bunker, the former SeaLand Container Storage Area, the Swamp Area, the former Nitrogen and Hydrogen Storage Area, the R16 Shipping Yard, the Switch Yard and the Storm Water Retention Ponds were observed during multiple walking and vehicle tours.

5.4 Personnel Interviews

During the period of time between 2013 and 2015, inclusive, Duke Energy issued questionnaires to departing employees in an effort to understand whether there was any knowledge of events (spills, leaks, etc.) involving radiological or hazardous material in addition to the events that had already been documented. A total of approximately 90 questionnaires were reviewed, none of which identified any additional events.

Several station employees were consulted during the preparation of this HSA regarding information related to their work responsibilities and their recollection of historical contamination events that may have significance during plant decommissioning. A brief summary of those consulted and the nature of the information discussed is contained in Table 1.

Table 1: CR3 Employee Discussion Subjects

Employee	Discussion Subjects
M. Culver	Former site facilities (tents, trailers, etc.), storm water retention ponds
M. Siapno	Contamination events, primary to secondary side leakage, settling ponds, radioactive waste issues, failed fuel
I. Wilson	Operational events, general plant knowledge
R. Pinner	Environmental information (groundwater & effluents)
C. McKeown	Operational events
G. McCallum	Site walkdown discussing status of SSCs
B. Akins	Radiation protection program
J. Lane	Underground pipes, plant configuration
C. Burtoff	Operating history
P. Rose	Plant licensing
J. Endsley	Electrical transformers and circuit breakers
T. Hobbs	HSA scope, plant licensing issues
M. VanSicklen	Operational status of selected SSCs
A. Riley	Document Control

Based on the responses to the employee questionnaire, there do not appear to be any undocumented incidents of contamination at the station that would be significant for its decommissioning.

Personnel Interviews Supporting Documents

HSA Interview Questionnaire.docx
Organization Chart - SAFSTOR 1.docx

6 Assessment Findings

One hundred and twenty-three (123) areas of interest on the CR3 site have been evaluated for the potential of impact by either radiological or non-radiological contaminants. The areas of interest are subdivided into the following categories: Building or Structure (35), Chemical and Drum Storage Area (6), Exterior Area (23), Oil-Filled Mechanical Equipment (10), Site-Wide Impacts (4), Storage Tanks (28) and Transformers (17).

Forty-nine (49) of these areas have been determined to be Non-Impacted with non-radiological contamination. Areas that have been classified preliminarily as Impacted with non-radiological contaminants include fifty-two (52) Class 3 areas, thirteen (13) Class 2 areas and nine (9) Class 1 areas.

Eighty-one (81) of the one hundred and twenty-three (123) areas of interest have been determined to be either Non-Impacted or Not Applicable with respect to radiological contamination. Areas that have been classified preliminarily as Impacted with radiological contamination include twenty-four (23) Class 3 areas, eleven (11) Class 2 areas and seven (7) Class 1 areas.

Appendix A summarizes the non-radiological findings, including preliminary area classifications. Appendix B summarizes the radiological findings, including preliminary area MARSSIM classifications. None of the impacted areas are considered to be an imminent threat to human health or the environment that would warrant immediate corrective action, or appear to present a significant challenge to the decommissioning process. The map locations listed in Appendix A and Appendix B refer to the areas shown in the figures.

6.1 Site-Wide Impacts

6.1.1 Asbestos Containing Material

Description and Historical Use

ACM was used widely during the construction of CR3 as a component of building materials (i.e. insulation, caulk, flooring, roofing, paint). During site decommissioning this material will require removal by licensed personnel using appropriate personal protective equipment and control of the removed asbestos.

Known and Potential Contaminants

The non-radiological contaminant is Asbestos. If handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Materials
- Pipe Insulation
- Roofing Materials

Preliminary Classification

Because of their known presence throughout many buildings and components of the station and the need to properly remove and dispose of ACM, areas where they exist are assigned a preliminary classification of NR Class 1.

Data Gaps

- A preliminary inventory of building materials and SSCs containing ACM.

Supporting Documents

AR00144217 Possible Asbestos in Unit 4160 Room.TIF
Asbestos Inventory 2007.pdf

6.1.2 Lead and Lead-Based Paint

Description and Historical Use

Use of lead-based paint was not controlled prior to 1978 and it was widely used during the construction of CR3. Lead blankets and blocks are currently used for shielding in parts of the RCA. In addition to lead, the potential presence of other RCRA metals (including cadmium, chromium and mercury) on building surfaces and components should be evaluated to determine their appropriate disposition during future station decommissioning activities.

Known and Potential Contaminants

The non-radiological contaminant is Lead. If handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Surfaces
- Component Surfaces

Preliminary Classification

Because of its known presence throughout many buildings and components of the station and the need to properly remove and dispose of lead-based paint, areas where it exists are assigned a preliminary classification of NR Class 1.

Data Gaps

- A preliminary inventory of lead batteries and components, and building and component surfaces where lead and other RCRA metals are present.

Supporting Documents

AR00246475 Lead Based Paint testing needs improvement.TIF
Lead-Acid Battery Inventory.pdf

6.1.3 Mercury-Containing Components

Description and Historical Use

Components containing elemental mercury, including switches, gauges and fluorescent bulbs, are distributed throughout the station. These materials will require special handling and disposal as universal waste.

Known and Potential Contaminants

The non-radiological contaminant is Mercury. If handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Gauges
- Electrical Switches
- Thermometers

Preliminary Classification

Because of their known presence throughout many buildings and components of the station and the need to properly remove and dispose of mercury-containing components, areas where they exist are assigned a preliminary classification of NR Class 1.

Data Gaps

- A preliminary inventory of mercury-containing components.

Supporting Documents

AR00133478 Mercury in Outlet Receptacle in Primary Sample Lab.TIF

6.1.4 Storm Drain System

Description and Historical Use

The storm drain system at CR3 consists of twenty-eight (28) catch basins and interconnected pipes that convey storm water from the PA to system outfalls (Figure 6). Five (5) interconnected catch basins in the southern part of the PA outfall into the Intake Canal near its eastern end. Twenty-one (21) interconnected catch basins in the northern part of the PA outfall into the Discharge Canal at two locations near its eastern end. Two (2) catch basins on the eastern berm of the PA discharge to the Swamp Area, where the ISFSI is currently under construction. A bermed containment area in the northwest corner of the Swamp Area collects oil and storm water from the transformer bays on the north berm.

Several minor spills of primarily diesel fuel and hydraulic oil have occurred at various locations in the PA over the operating history of the station. These spills were immediately remediated but their cumulative effect may have resulted in residual concentrations of contaminants entering the storm drain system.

Non-Radiological Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents, RCRA Metals, and Dielectric Oil.

Non-Radiological Potentially Contaminated Media

- Storm Drain Sediment
- Discharge Canal Sediment
- Intake Canal Sediment
- Drain Pipes

Radiological Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Radiological Potentially Contaminated Media

- Concrete
- Piping
- Storm Drain Sediment

Preliminary Classification

Because the Storm Drain System receives drainage from all parts of the PA it has the potential to contain a wide variety of contaminants. Some contaminants may have accumulated at significant concentrations in sediment traps within the system Therefore, the Storm Drain System is assigned a preliminary classification of NR Class 2. Note that the Storm Drain system is assigned a preliminary classification of MARSSIM Class 3 in regard to radiological contaminants.

Data Gaps

- Chemical analysis for the list of potential contaminants in samples of sediment in storm drain pipes and near system outfalls, and in samples of soil and groundwater near areas determined to be impacted.

Supporting Documents

2014 Q1 NPDES Inspection w-comments.pdf
AR00435178 Transformer Oil Pumped to Storm Drain 11-24-10.TIF
AR00603660 Storm Drain Contaminaton.pdf
Concrete Curing Water to Storm Drain 10-7-2010.pdf
Crystal River South - Stormwater Pollution Prevention Plan.pdf
Hydro-Demolition Water to Storm Drain 10-2-2009.pdf
NPDES Permit.doc
Oil Spill to Storm Drain 1-26-93.pdf
Oily Sheen Around Storm Drain 9-2-2009.pdf
OW Mixture Pumped to Storm Drain 11-24-2010.pdf
PC001239 Low Levels of Contamination in Storm Drain.pdf
RS2013-04-0210 south berm storm drain.pdf
Storm Water Pollution Prevention Plan_Engineering Change.pdf

6.2 Non-Radiological Impacts

6.2.1 Non-Impacted Areas

Based on identified historical use there is a very low probability that non-radiological contaminants have impacted the environment in the area of the following list of site features. Therefore, these features have been assigned a preliminary classification of NR Non-Impacted. Refer to the summary descriptions in Appendix A for details regarding the features.

- 12,500 KVA Temporary Cooling Tower Transformers
- 750 KVA Temporary Cooling Tower Transformers
- ACP Diesel Generator Fuel Tank
- Auxiliary Boiler Power Transformer
- Borated Water Storage Tank (BWST)
- Chemical and Flammable Material Storage Cabinets
- Chemical Warehouse
- Circulating Water Pump Pits
- Circulation Water Pump Motors
- Compressed Gas Storage Area
- Condensate Storage Tank (CDT-1)
- Conference and Cafeteria Building (CCB)
- Control Complex
- Decon Tent Area
- Discharge Structure
- Emergency Feedwater Tank Building
- Fire Service Tank 2A (FST-2A)
- Fire Service Tank 2A (FST-2B)
- Hazardous Waste Satellite Accumulation Areas
- Intake Structure
- Intermediate Building
- Maintenance Training Facility
- Meteorological Towers
- MNT Scaffold Yard
- NAB
- Nitrogen and Hydrogen Storage Area
- NSOC
- Old Chemical Storage Building
- Old Chemical Storage Building Transformer
- OTSG Storage Facility
- Paint Shack
- Parking Areas
- Plant Administration Building (PAB)
- Protected Area Ground Surfaces

- R16 Shipping Yard
- Reactor Building
- Reactor Building Polar Crane
- Reactor Building Spray Tank Room
- RMSW G
- Rusty Building
- RVCH Storage Facility
- SAB
- SAB Diesel Generator Fuel Tank
- Sandblast Booth
- SeaLand Container Storage Area
- Security CAS Building
- Tendon Grease Storage Tanker A
- Tendon Grease Storage Tanker B
- Units 1 and 2 (CR1/2)

6.2.2 Impacted Areas

Based on identified historical use, there is presumed to be some potential for non-radiological contamination in the environment in each area listed in Subsections 6.2.3 through 6.2.8 and summarized in Appendix A. Non-radiologically impacted areas are classified here as NR Class 1, NR Class 2 or NR Class 3, similar to the classification approach used for radiologically impacted areas described in MARSSIM, where Class 1 areas have the highest potential for impacts that may be significant to decommissioning. The same concept as that applied for radiologically impacted areas has been applied for non-radiologically impacted areas, with the substitution of FDEP Groundwater Standards [2] (GWSs), Soil Cleanup Target Levels (SCTLs), federal maximum contaminant levels (MCLs) or risk-based concentrations (RBCs) as the site release criteria rather than DCGLs. The prefix “NR” is added to the classification of each area potentially impacted by non-radiological contaminants to clearly distinguish it from areas with radiological impacts.

Appendix A is a summary of all areas on site where the potential for the existence of non-radiological contamination was evaluated and lists the preliminary classifications of each area. NR Class 1 areas have been judged to have a relatively high potential to be impacted by non-radiological contamination at concentrations greater than the site release criteria. Because they are all presumed to have some potential to have been impacted, NR Class 1, NR Class 2, and NR Class 3 areas will each require an appropriate level of characterization before they can be released for unrestricted use. NR Class 1 areas will require more comprehensive characterization during decommissioning and NR Class 3 areas will require the least rigorous level of characterization.

6.2.3 Building or Structure

6.2.3.1 Alternate AC Diesel Generator Building

Description and Historical Use
The Alternate AC Diesel Generator Building is located off the South Berm, south of the Auxiliary Building (Figure 3 and Figure 8). The building was constructed in approximately 2005 and houses the Alternate AC Diesel Generator. The generator has been removed from service permanently.

Known and Potential Contaminants
The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Building Surfaces
- Concrete

Preliminary Classification
No record of a release of hazardous material from this building to the environment has been identified. Should a spill of diesel fuel occur in the Alternate AC Diesel Generator Building it probably would be fully contained within the building. However, based on its past use, and the volume of fuel used in the building, this area is assigned a preliminary classification of NR Class 2.

Data Gaps
None

Supporting Documents
AR00070409 Diesel Fuel Leak While MTDG-1 in Operation.TIF

6.2.3.2 Auxiliary Building

Description and Historical Use
The Auxiliary Building is a concrete and steel multistory structure that interfaces with the Reactor Building (Figure 3 and Figure 8). The Auxiliary Building houses the essential auxiliaries, spent fuel storage facilities, and the RW handling and treatment facilities.

Known and Potential Contaminants
The non-radiological contaminants are Asbestos, Lead, Mercury, and Petroleum Products. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Building Materials
- Component Surfaces
- Mercury-Containing Components
- Pipe Insulation
- Sumps
- Penetration Sealants

Preliminary Classification
No record of a release of hazardous material from this building to the environment has been identified. Minor spills of non-radiological contaminants, including hydraulic oil, lubricating oil, etc., have been contained within the Auxiliary Building and have not been released to the environment. These contaminants are not likely to have impacted soil or groundwater quality at the station. For this reason a preliminary classification of NR Class 3 is assigned to this building.

Data Gaps
None

Supporting Documents
AR00388158 A Decay Heat Vault Wall Leakage.TIF
AR00399804 B Decay Heat Vault Increased Inleakage.TIF
NAOH and Sulfuric Acid Spill in Aux Building 6-23-94.pdf

6.2.3.3 Cable Trays and Duct Banks

Description and Historical Use
Underground cable trays and duct banks contain cables and pipes running to various areas of the station. Stormwater and groundwater that may have mobilized site contaminants infiltrates these conduits. This water is pumped periodically to portable polyethylene tanks where it is sampled before releasing it to local storm drains.

Known and Potential Contaminants
The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media
- Groundwater
- Storm Water

Preliminary Classification
Because of the potential for low-level contamination to be detected in water that accumulates in underground cable trays and duct banks these structures are assigned a preliminary classification of NR Class 3.

Data Gaps
Analysis of groundwater sampled from nearby monitoring wells for the potential contaminants.

Supporting Documents
None

6.2.3.4 Dry Cleaning Facility

Description and Historical Use

A dry cleaning facility was formerly operated on both the South and East Berms (though not at the same time) for cleaning protective clothing (Figure 3 and Figure 8). The facility has been removed. The facility used Freon as a cleaning solvent. Spent solvent and filters were shipped from the site as hazardous waste.

Known and Potential Contaminants

The non-radiological contaminant is Solvents.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

No record of a release of hazardous material from this facility to the environment has been identified. Based on its past use, and the unknown nature of potential impacts to nearby soil and groundwater, this area is assigned a preliminary classification of NR Class 2.

Data Gaps

- Chemical analyses of soil and groundwater samples for the potential contaminants.

Supporting Documents

None

6.2.3.5 Emergency Diesel Generator Building

Description and Historical Use
The Emergency Diesel Generator Building is located at the southeast corner of the Auxiliary Building (Figure 3 and Figure 8). The generators provide electrical power to operate all safety-related SSCs in the event of the loss of off-site electrical power. The building contains two large diesel generators and their associated day tanks. Fuel has been drained from day tank A and day tank B is in service.

Known and Potential Contaminants
The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Building Surfaces
- Concrete

Preliminary Classification
No record of a release of hazardous material from this building to the environment has been identified. Should a spill of diesel fuel occur in the Emergency Diesel Generator Building it probably would be fully contained within the building. However, based on the age of the day tanks and the volume of diesel fuel used by the generators, the building surfaces and concrete could be significantly contaminated with diesel fuel and the building is assigned a preliminary classification of NR Class 2.

Data Gaps
None

Supporting Documents
None

6.2.3.6 Emergency Feedwater Pump 3 Building

Description and Historical Use

The Emergency Feedwater Pump 3 Building is located on the South Berm near the Emergency Feedwater Tank Building (Figure 3 and Figure 8). The enclosure was constructed in approximately 1998 and contains DFT-4, a 13,750-gallon single-walled above ground storage tank containing fuel for the pump.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Surfaces
- Concrete

Preliminary Classification

No record of a release of hazardous material from this building to the environment has been identified. Should a spill of diesel fuel occur in the pump enclosure it probably would be fully contained within the building. However, based on the age of the tank, the volume of diesel fuel that it contains and the potential for overfilling, the pump enclosure could be contaminated with diesel fuel and it is assigned a preliminary classification of NR Class 3.

Data Gaps

None

Supporting Documents

None

6.2.3.7 Fire Service Pump House

Description and Historical Use
The Fire Service Pump House is located in the West Berm area, immediately south of the Fire Service Water Tanks and the Intermediate Building (Figure 3 and Figure 8). The Pump House contains two pumps for charging the Fire Service hydrants and standpipes and two above ground tanks storing diesel fuel for the pumps.

Known and Potential Contaminants
The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Building Surfaces
- Concrete

Preliminary Classification
No record of a release of hazardous material from this building to the environment has been identified. Should a spill of diesel fuel occur in the Fire Service Pump House it probably would be fully contained within the building. The building is assigned a preliminary classification of NR Class 3.

Data Gaps
None

Supporting Documents
None

6.2.3.8 Maintenance Support Building

Description and Historical Use

The MSB is inside the RCA, southwest of the Reactor Building (Figure 3 and Figure 8). Reactor Coolant Pump (RCP) seals were rebuilt in this building. The RCP motors were shipped off site for repair. Other maintenance completed in this building includes cleaning of the Reactor Head studs and non-destructive examination of the Reactor Head lifting tripod.

Known and Potential Contaminants

The non-radiological contaminants are RCRA Metals, Hydraulic Oil, Oil-Soaked Rags, Petroleum Constituents, Lubricating Oil, and Spent Solvents. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Materials (Floor)
- Concrete

Preliminary Classification

No record of a release of hazardous material from this building to the environment has been identified. Should a spill of lubricating oil, hydraulic oil or other hazardous fluid occur in the MSB it would be fully contained within the building. However, based on the type of activities undertaken in the building, building surfaces and concrete could be significantly contaminated with lubricating oil, hydraulic oil and other hazardous fluids and the building is assigned a preliminary classification of NR Class 2.

Data Gaps

None

Supporting Documents

AR00093167 Storage Tanks did not meet PT-356 Requirements.TIF

6.2.3.9 Receiving Warehouse

Description and Historical Use

The Receiving Warehouse is located outside of the PA, south of the CCB (Figure 3 and Figure 8). Materials and equipment shipped from off-site vendors were delivered to this warehouse and were then distributed where needed in the plant. Chemicals formerly used in the plant were received here, but the building is no longer used and all materials have been removed.

Known and Potential Contaminants

The non-radiological contaminants are Acids-Bases, Petroleum Products, Sodium Hypochlorite, Laboratory Chemicals, and Solvents. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Surfaces
- Concrete

Preliminary Classification

No record of a release of hazardous material from this building to the environment has been identified. Based on its previous use, it is unlikely that hazardous materials that may have been released in the warehouse would be detectable in the environment at concentrations greater than a small fraction of the site release criteria. For this reason, the building is assigned a preliminary classification of NR Class 3.

Data Gaps

None

Supporting Documents

None

6.2.3.10 RMSW D

Description and Historical Use
RMSW D is a large oil tank located west of CR1/2 (Figure 2 and Figure 7) that was used to store boiler fuel for the previously oil-fired units. After CR1/2 were converted to coal-fired boilers the tank was converted into a warehouse where CR3 stored both radiological material and potentially more than 1,000 55-gallon drums of lubricating oil and other petroleum products. All radiological material and drums of lubricating oil have been removed and the structure has been returned to the control of CR1/2.

Known and Potential Contaminants
The non-radiological contaminants are Lubricating Oil and Petroleum Products.

Potentially Contaminated Media
- Building Surfaces
- Concrete

Preliminary Classification
No record of a release of hazardous material from this building to the environment has been identified. Based on its previous use, it is unlikely that hazardous materials that may have been released in the warehouse would be detectable in the environment at concentrations greater than a small fraction of the site release criteria. For this reason, the building is assigned a preliminary classification of NR Class 3.

Data Gaps
None

Supporting Documents
AR00294825 Heavy Fuel Oil Residue Found in Soil at Fossil's Round WH.TIF

6.2.3.11 RT Bunker

Description and Historical Use

The RT Bunker is a small corrugated metal-sided building surrounded by a high earthen berm located inside the railroad loop east of the Paint Shack (Figure 3 and Figure 8). The building is where radiography technicians inspected weld coupons and welds on small components using industrial radiographic sources including Cobalt 60. The interior walls of the RT Bunker are painted with lead-based paint and likely also contain lead shielding to help shield the gamma rays produced during radiographic inspections.

Known and Potential Contaminants

The non-radiological contaminants are Lead and Asbestos.

Potentially Contaminated Media

- Building Surfaces

Preliminary Classification

No record of a release of hazardous material from the RT Bunker to the environment has been identified. However, because of the presence of lead-based paint and likely presence of lead shielding, the area of the RT Bunker is assigned a preliminary classification of NR Class 1.

Data Gaps

- Survey of the interior walls of the RT Bunker for the presence of lead-based paint and lead shielding.

Supporting Documents

None

6.2.3.12 Sewage Treatment Plant

Description and Historical Use

The Sewage Treatment Plant is located outside of the southwest corner of the PA, north of the Intake Canal (Figure 2, Figure 3 and Figure 8). The plant processes domestic wastewater from CR Units 1, 2 and 3 in accordance with a permit issued by the FDEP. A sand filter formerly used to filter treated effluent before it is discharged to the Settling Ponds has been removed. Sludge from the system is disposed periodically in an off-site landfill.

Known and Potential Contaminants

The non-radiological contaminant is RCRA Metals.

Potentially Contaminated Media

- Concrete
- Piping

Preliminary Classification

No record of a release of hazardous material from the Sewage Treatment Plant to the environment has been identified. Discharge Monitoring Reports indicate that the water quality of the treated effluent complies with the permit criteria. Based on its current and previous use, it is unlikely that hazardous materials that may have been released from the Sewage Treatment Plant would be detectable in the nearby environment at concentrations greater than a small fraction of the site release criteria. For this reason, the plant is assigned a preliminary classification of NR Class 3.

Data Gaps

None

Supporting Documents

AR00075086 Sewage Flowing Outside of the MTF.TIF
AR00320787 Sewer Line Ruptured During Core Boring.TIF
AR00348439 Sewage Spill at Units 1,2,3 Sewage Treatment Plant.TIF
AR00370075 Minor Domestic Wastewater Release from CR1 2 and 3 WWTP.TIF
Buried Sanitary Sewer Leak to Roadway 6-3-2009.pdf
Domestic Waste Water Spill From Manhole 12-9-2009.pdf
IWW Release to secondary contain. 4-2-2013.pdf
IWW Release to Secondary Containment 4-2-2003.pdf
Sanitary Sewer Lift Station Overflow 10-25-13.docx
Sanitary Sewer Lift Station Spill 4-30-2009.pdf
Spill of Industrial Waste Water to Intake Canal 12-17-2009.pdf
Wastewater Treatment Facility Inspection Report 10-22-12.pdf

6.2.3.13 Turbine Building

Description and Historical Use

The Turbine Building is located north of the Reactor Building and Intermediate Building (Figure 3 and Figure 8). The Turbine Building houses the Turbine Generator and associated auxiliaries, including the Condensers, Feedwater System, and Condensate Water Treatment System.

Known and Potential Contaminants

The non-radiological contaminants are Asbestos, Lead, Mercury, and Petroleum Products. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Materials
- Component Surfaces
- Mercury-Containing Components
- Pipe Insulation
- Sumps

Preliminary Classification

Equipment and floor drains in the Turbine Building are directed to the Turbine Building Sump. From there wastewater passes through an oil-water separator that discharges to the SDT-1 on the West Berm, outside of the building. Small volumes of oil that have been released from the separator were completely contained within the building and immediately cleaned up. It is unlikely that hazardous materials that may have been released in the Turbine Building would be detectable in the environment at concentrations greater than a small fraction of the site release criteria. For this reason, the Turbine Building is assigned a preliminary classification of NR Class 3.

Data Gaps

None

Supporting Documents

NaOH Spill Battery Rm 11-18-1993.pdf

6.2.4 Chemical and Drum Storage Areas

Chemical and Drum Storage Areas Supporting Documents

2011 Chemicals Used Inventory.xls
AR00086804 Tank at the Old Chemical Storage Area Overflowed (1).TIF
AR00089282 Oil Found on Floor of Chemical Storage Building.TIF
AR00309140 PCB Ballast Collection Exceeded 30 Days.TIF
EPCRA Chemical Inventory Report to FLDEP.pdf
Haz Waste Inspection Report 11-12-2010.pdf
NaOH Spill 6-22-1994.pdf
PR94-0347 Amerzine Spill in Chemical Warehouse 12-14-94.pdf
TCA in Soil in Haz Waste Storage Area 1-19-88.pdf

6.2.4.1 CRP Grease Tanker and Drum Storage Area

Description and Historical Use

The CRP Grease Tanker and Drum Storage Area was located inside the railroad loop, east of the Paint Shack (Figure 3 and Figure 8). There were two grease tankers that provided grease for control of corrosion of the steel tendons in the Reactor Building. The grease tankers and drums have been removed.

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents, RCRA Metals, and Volatile Organic Compounds.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from this area to the environment has been identified. Grease in the tankers is a semisolid material with a melting point of 135 degrees F. However, the storage area is unpaved, it is estimated that more than fifty drums were stored there and the contents of the drums are unknown. Based on the volume of hazardous material potentially stored in the CRP Grease Tanker and Drum Storage Area, this area is assigned a preliminary classification of NR Class 3.

Data Gaps

- Chemical analyses of soil and groundwater samples for petroleum constituents, heavy metals and volatile organic compounds.

6.2.4.2 Hazardous Material Storage Buildings

Description and Historical Use
There are three hazardous material storage buildings in the southeast corner of the South Berm (Figure 3 and Figure 8). These buildings have steel siding and roofs and are each about the size of a SeaLand container. The buildings store small containers and a few drums of spent solvents, oily rags, waste oil, universal wastes and other hazardous wastes. The surface in the area of the buildings is paved with asphalt. The buildings are locked and contain spill pans in the floors to provide secondary containment.

Known and Potential Contaminants
The non-radiological contaminants are Acids-Bases, Waste Oil Constituents, Laboratory Chemicals, Oil-Soaked Rags, Universal Wastes, and Spent Solvents. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Building Materials
- Asphalt
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from these buildings to the environment has been identified. The buildings are RCRA waste storage areas and will require final closure in accordance with RCRA regulations. Based on the types of materials stored there is the potential that contaminants could be detected at concentrations likely less than but potentially approaching those of the site release criteria. For this reason, a preliminary classification of NR Class 2 is assigned to the area of these buildings.

Data Gaps
- Chemical analysis of soil and groundwater samples for the potential contaminants.

6.2.4.3 Issue Warehouse

Description and Historical Use

The Issue Warehouse is located east of the PAB/TSC and north of the Maintenance Training Facility (Figure 3 and Figure 8). Chemicals and petroleum products that were formerly stored in the now removed Chemical Warehouse are stored in this building.

Approximately twenty drums of virgin oils currently are stored in racks equipped with spill pans. Several steel cabinets contain small containers of acids, oxidizers or flammable materials. Containers of paint, cleaners, solvents and laboratory chemicals no more than five gallons in capacity are stored on pallets with spill pans.

Known and Potential Contaminants

The non-radiological contaminants are Acids-Bases, Petroleum Products, Sodium Hypochlorite, Laboratory Chemicals, and Solvents. If handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Building Surfaces
- Concrete

Preliminary Classification

No record of a release of hazardous material from this building to the environment has been identified. It is unlikely that hazardous materials that may have been released in the Issue Warehouse would be detectable in the environment at concentrations greater than a small fraction of the site release criteria. For this reason, the Issue Warehouse is assigned a preliminary classification of NR Class 3.

Data Gaps

None

6.2.5 Exterior Areas

6.2.5.1 Area Surrounding RMSW G

Description and Historical Use
RMSW G is located outside of the PA, south of the Maintenance Training Facility (Figure 3 and Figure 8). The area around the building was formerly fenced and is where contaminated turbine components were processed. These activities included use of a Sandblast Booth. No activities are ongoing in the formerly fenced area.

Known and Potential Contaminants
The non-radiological contaminant is RCRA Metals.

Potentially Contaminated Media
- Sandblast Grit
- Soil
- Groundwater
- Asphalt

Preliminary Classification
No record of a significant spill from this area to the environment has been identified. Based on the past use of a Sandblast Booth in the area there is the potential that residual contaminants could be detected in environmental samples, but probably at levels not exceeding a small fraction of the site release criteria. For this reason, a preliminary classification of NR Class 3 is assigned to the area surrounding RMSW G.

Data Gaps
- Chemical analysis of soil and groundwater samples for RCRA metals.

Supporting Documents
None

6.2.5.2 Construction Debris Dump

Description and Historical Use

The Construction Debris Dump is located inside the Railroad Loop, south of the coal conveyor (Figure 3 and Figure 8). Soil excavated during various construction projects at the station has been staged there. Debris was removed from the area during the 1990s and radiological surveys were completed but no soil or groundwater samples were analyzed for potential non-radiological contaminants.

Material currently in this area includes two large stockpiles; one of 1.5-inch crushed stone (gneiss) and one of limy soil and limestone. Other material in the area includes approximately 100 dump truck load-sized piles of crushed limestone, various piles of large concrete pieces, timber cribbing, large diameter steel and concrete pipe, asphalt and scrap metal. There is no indication of the presence of hazardous materials.

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents, RCRA Metals, and Asbestos.

Potentially Contaminated Media

- Soil
- Asphalt
- Building Materials
- Concrete
- Groundwater

Preliminary Classification

No record of a significant spill from this area to the environment has been identified. Based on the types of material placed in the Construction Debris Dump and the uncontrolled method of storage, a preliminary classification of NR Class 3 has been assigned to this area.

Data Gaps

- Chemical analysis of soil and groundwater samples for the potential contaminates.

Supporting Documents

None

6.2.5.3 East Berm

Description and Historical Use

The entire power block area is constructed on a berm whose elevation is approximately twenty-one (21) feet higher than the surrounding facilities. The berm provides protection against the originally estimated maximum storm surge and wave height that would result from the maximum probable storm.

The East Berm (Figure 4) encompasses the area east of the Security CAS Building, the Control Complex, the Maintenance Shops and the Auxiliary Building. Small spills or leaks of diesel fuel and hydraulic oil have occurred in this area during the operating history of the station. These spills and leaks were immediately isolated and cleaned up. A dry cleaning facility for cleaning protective clothing was operated in this area (Subsection 6.2.3.4).

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents, RCRA Metals, and Solvents.

Potentially Contaminated Media

- Soil
- Groundwater
- Sediment

Preliminary Classification

Because the East Berm is subject to weathering there is some potential that residual contaminants from past spills could be mobilized by wind and rain and be detectable in soil, sediment or groundwater. These contaminants probably would be detectable at levels not exceeding a small fraction of the site release criteria. For this reason, a preliminary classification of NR Class 3 is assigned to the area of the East Berm.

Data Gaps

- Chemical analysis of soil, sediment, and groundwater samples for the potential contaminants.

Supporting Documents

AR00061143 Morpholine Spill on East Berm.TIF
AR00234946 Chemical Spill on Berm While Spraying Weeds.TIF
AR00312383 Fluid Found Under Forklift 7154.TIF
AR00682781 JLG Man Lift Oil Leak 4-21-14.pdf

6.2.5.4 Firing Range

Description and Historical Use

The Firing Range is located west of the coal ash storage area for CR1/2, near the north bank of the Intake Canal (Figure 2 and Figure 7). The Firing Range is an active facility used for weapons training by the station security force. Lead bullets fired during training accumulate within a soil berm at the western end of the facility. This berm was remediated in 2012. The Environmental Stewardship Plan for this facility specifies that to minimize the potential for groundwater contamination lead abatement activities should be completed on a five-year cycle or as determined by a contractor [14]. The CR3 Environmental Coordinator has reported that, going forward, lead abatement activities will be completed on a 10-year cycle.

Known and Potential Contaminants

The non-radiological contaminant is Lead.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from this area to the environment has been identified. Because of the known presence of lead in the soil of the Firing Range berm and the potential for associated groundwater contamination, a preliminary classification of NR Class 1 is assigned to this facility.

Data Gaps

- Chemical analysis of soil and groundwater samples for lead.

Supporting Documents

2011 Firing Range Lead Analysis Results.pdf
2012 Firing Range TCLP Results.pdf
Shooting Range Environmental Stewardship Plan.docx
Shooting Range Location.pdf

6.2.5.5 North Berm

Description and Historical Use
The entire power block area is constructed on a berm whose elevation is approximately twenty-one (21) feet higher than the surrounding facilities. The berm provides protection against the originally estimated maximum storm surge and wave height that would result from the maximum probable storm.

The North Berm (Figure 4) encompasses the area north of the Turbine Building and the Rusty Building, and includes the Transformer Bays. Small spills or leaks of diesel fuel and hydraulic oil have occurred in this area during the operating history of the station. These spills and leaks were immediately isolated and cleaned up.

Known and Potential Contaminants
The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media
- Soil
- Groundwater

Preliminary Classification
Because the North Berm is subject to weathering there is some potential that residual contaminants from past spills could be mobilized by wind and rain and be detectable in soil, sediment or groundwater. These contaminants probably would be detectable at levels not exceeding a small fraction of the site release criteria. For this reason, a preliminary classification of NR Class 3 is assigned to the area of the North Berm.

Data Gaps
- Chemical analysis of soil, sediment, and groundwater samples for the potential contaminants.

Supporting Documents
AR00234946 Chemical Spill on Berm While Spraying Weeds.TIF
AR00389468 Oil Sheen on Berm near Spare Transformer.TIF
Portable Diesel Air Compressor Fuel Spill 4-2-80.pdf
Portable Diesel Air Compressor Fuel Spill 6-13-80.pdf

6.2.5.6 Settling Ponds

Description and Historical Use

The East and West Settling Ponds are located west of the PA, near the south bank of the Discharge Canal and west of the large circular tanks that formerly stored oil for CR1/2 (Figure 2 and Figure 7). Effluent from the Sewage Treatment Plant that serves Units 1, 2 and 3 is discharged to these ponds. Effluent from SDT-1Tank has also been discharged to the ponds on a few occasions when the effluent quality did not comply with the station's NPDES permit criteria. The Settling Ponds were flooded in 1993 during the "No Name" storm.

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents, RCRA Metals, Hydrazine and Nalco, a water-treatment chemical.

Potentially Contaminated Media

- Sediment
- Groundwater

Preliminary Classification

No record of a significant spill from this area to the environment has been identified. Based on the types of wastewater discharged to the Settling Ponds, a preliminary classification of NR Class 2 has been assigned to this area.

Data Gaps

- Chemical analysis of sediment and groundwater for the potential contaminants.

Supporting Documents

AR00043635 Settling Pond Discharge Line Damaged.TIF
AR00336603 RB Hydro Demo Release to Settling Ponds.TIF
Leaks in Drain Line to Settling Pond.doc
NALCO.pdf
SD Line Plan.doc
SD Line Repair Logic.xls
SD Line to settling ponds.doc
SD System Buried Piping information.docx

6.2.5.7 South Berm

Description and Historical Use

The entire power block area is constructed on a berm whose elevation is approximately twenty-one (21) feet higher than the surrounding facilities. The berm provides protection against the originally estimated maximum storm surge and wave height that would result from the maximum probable storm.

The South Berm (Figure 4) encompasses the area south of the Reactor Building and the Auxiliary Building. Small spills or leaks of diesel fuel and hydraulic oil have occurred in this area during the operating history of the station. These spills and leaks were immediately isolated and cleaned up. A dry cleaning facility for cleaning protective clothing was operated in this area (Subsection 6.2.3.4).

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents, RCRA Metals, and Solvents.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

Because the South Berm is open to the weather there is some potential that residual contaminants from past spills could be mobilized by wind and rain and be detectable in soil, sediment or groundwater. These contaminants probably would be detectable at levels not exceeding a small fraction of the site release criteria. For this reason, a preliminary classification of NR Class 3 is assigned to the area of the South Berm.

Data Gaps

- Chemical analysis of soil, sediment, and groundwater samples for the potential contaminants.

Supporting Documents

AR00067665 Hydrazine Spill on Berm.TIF
AR00088523 Ethylene Glycol Spill on SE Berm.TIF
AR00234946 Chemical Spill on Berm While Spraying Weeds.TIF
AR00366105 Minor Hydraulic Oil Spill on South Berm.TIF
AR00554989 Crane Leaking Coolant on S Berm 8-14-12.pdf
AR00694175 Hydraulic Oil Leak from Truck at RB Equipment Hatch 6-19-14.pdf
AR00714933 Truck Power Steering Fluid Leak 10-23-14.pdf
Hydraulic Oil Spill 10-5-2010.pdf

6.2.5.8 Station Drain Tank Effluent Pipe Leak Area

Description and Historical Use

The Station Drain Tank Effluent Pipe Leak Area is located on the side of the roadway between CR1/2, south of the Discharge Canal (Figure 2 and Figure 7). The contents of the tank normally was routed to the Discharge Canal, except when sampling of the tank indicated that its contents did not meet the discharge criteria in the CR3 NPDES permit. Under those circumstances the tank contents would be discharged to the Settling Ponds west of CR1/2 by way of an eight-inch diameter fiberglass pipeline that runs along the roadway. The pipe runs underground from CR3 to the point where it joins the effluent pipe from the Sewage Treatment Plant for Units 1, 2 and 3.

In June 2001 the underground portion of the pipeline on the side of the roadway between CR1/2 was damaged while excavating in the area. Discharge through the pipe was not occurring at the time of the pipe break but stagnant water drained from the broken pipe into the excavation. A vacuum truck removed the standing water in the excavation and transported it to the Settling Ponds. After review of the discharge permit for the last discharge through the pipeline it was determined that the spill did not create a radiological or non-radiological environmental impact.

A previous leak in the piping from SDT-1 was discovered in April 1998 on the West Berm. The leak was underground and occurred at a pipe elbow that had been improperly glued and fitted at the time of installation. Although the pipe joint apparently had been leaking since the time of plant startup both CR3 and the FDEP determined that no significant environmental impact resulted.

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

The area of the pipe leak is subject to weathering and there is some potential that residual contaminants from the spill could be mobilized by wind and rain and be detectable in nearby soil, sediment or groundwater. The area of the spill has been remediated but there is the potential that residual contamination at levels no greater than a small fraction of the site release criteria may remain in the local soil or groundwater. For this reason, a preliminary classification of NR Class 3 has been assigned to the area of the pipe leak.

Data Gaps

- Chemical analysis of soil and groundwater for petroleum constituents and RCRA metals.

Supporting Documents

AR00043635 Settling Pond Discharge Line Damaged.TIF
AR00072099 SDT-1 Drainline to Settling Pond Break.TIF
Leaks in Drain Line to Settling Pond.doc
PC9802106 Leak in Discharge Piping from SDT-1 to Settling Ponds along West Berm.pdf
SD Line Plan.doc
SD Line Repair Logic.xls
SD Line to settling ponds.doc
SD System Action Plan 1.doc
SD System Buried Piping information.docx

6.2.5.9 Storm Water Retention Ponds

Description and Historical Use
There are two storm water retention ponds: Storm Water Retention Pond A, north of the railroad tracks and west of RMSW G, and Storm Water Retention Pond B, south of the railroad tracks and southeast of Storm Water Retention Pond A (Figure 3 and Figure 8). Retention Pond A collects storm water from the Swamp Area.

A third structure, the Spill Retention Basin, is located south of the railroad tracks and directly south of Storm Water Retention Pond A (Figure 3 and Figure 8). The Spill Retention Basin receives drainage from Storm Water Retention Pond A. A control structure in the Spill Retention Basin allows overflow to Storm Water Retention Pond B.

Known and Potential Contaminants
The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media
- Sediment
- Groundwater

Preliminary Classification
No record of a significant spill from the Storm Water Retention Ponds or the Spill Retention Basin to the environment has been identified. Because there is the potential that low levels of residual contaminants from vehicle leaks in the eastern part of the PA or small spills in other areas of the station may have been mobilized by storm water, the areas of the ponds and basin are assigned a preliminary classification of NR Class 3.

Data Gaps
- Chemical analysis of soil, sediment, and groundwater samples for the potential contaminants.

Supporting Documents
None

6.2.5.10 Swamp Area

<u>Description and Historical Use</u>
The Swamp Area is in the eastern portion of the PA, south of the PAB/TSC and east of the East Berm (Figure 3 and Figure 8). The ISFSI currently is under construction in the Swamp Area. This area of the station is approximately twenty-one (21) feet lower in elevation than the buildings of the power block, which are on the Berm. Storm water from the East Berm is collected in two catch basins and discharged to the Swamp Area.

An unlined, bermed catchment area in the northwest corner of the Swamp Area receives drainage from the Transformer Bays on the North Berm. Storm water and leaks of dielectric oil from the transformers were collected in this catchment area.

In September 1989 approximately 200 gallons of diesel fuel were spilled to the Swamp Area from a 500-gallon Aboveground Storage Tank (AST) for a diesel-driven air compressor. The spill was remediated by excavating and shipping approximately seventy five cubic yards of contaminated soil to an approved off-site facility. Low levels of diesel fuel constituents were detected in a groundwater sample from a monitoring well installed next to the remediated area. The FDEP closed the spill in 1990.

<u>Known and Potential Contaminants</u>
The non-radiological contaminants are Dielectric Oil, Petroleum Constituents, and RCRA Metals.

<u>Potentially Contaminated Media</u>
- Soil
- Groundwater

<u>Preliminary Classification</u>
There is the potential that residual contaminants mobilized by storm water from the East Berm may have been discharged to the Swamp Area. Impacts to soil or groundwater quality also may have occurred in the area of the bermed catchment in the northeast corner of the Swamp Area due to leaks of dielectric oil from the station transformers. The spill of approximately 200 gallons of diesel fuel was cleaned up in 1989 and the incident has been closed by the FDEP.

Soil samples were collected from the Swamp Area circa 2010 prior to placing fill for construction of the ISFSI. Analysis of these samples did not identify non-radiological contaminants at levels above presumed action levels. However, no groundwater samples were analyzed. For these reasons, a preliminary classification of NR Class 2 is assigned to this area.

<u>Data Gaps</u>
- Chemical analysis of soil and groundwater samples for the potential contaminants.

Supporting Documents

100276-0100 PE Crystal River SoilResults.pdf
AR00287789 Hydraulic Fluid Leak on Fork Lift.TIF
AR00322908 Hydraulic Line Ruptured on Manlift in Swamp.TIF
AR00692913 Hydraulic Oil Leak from Dump Trailer 6-12-14.pdf
Diesel Fuel Spill into AST Secondary Containment 2-7-90.pdf
Diesel Spills 12-20-89 and 9-27-89.pdf

6.2.5.11 Switch Yard

Description and Historical Use
The Switch Yard is located north of the Discharge Canal and west of the Main CR3 Parking Lot (Figure 2, Figure 3, Figure 7 and Figure 8). The Switch Yard is where the electrical power produced by Units 1, 2, 3, 4 and 5 is distributed to the power transmission grid. A layer of crushed limestone forms the floor of the Switch Yard. Five oil-cooled circuit breakers, each with capacities of 1,720 gallons of mineral oil and staged within concrete containments, are in use in the Switch Yard but none are related to activities at CR3.

An Off Site Power Transformer to provide power to CR3 is located in the Switch Yard. This transformer contains 9,430 gallons of mineral oil and is located within a concrete containment. Two gas-cooled circuit breakers are connected to the Off Site Power Transformer.

Known and Potential Contaminants
The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from the Switch Yard to the environment has been identified. However, there is the potential that dielectric oil could have been released from the Off Site Power Transformer or oil-cooled circuit breakers in the Switch Yard. For this reason a preliminary classification of NR Class 3 has been assigned to this area.

Data Gaps
- Chemical analysis of soil and groundwater samples for the potential contaminants.

Supporting Documents
AR00217211 Oil Leak in 500 KV Yard.TIF

6.2.5.12 Unit 4 and 5 Coal Ash Storage Area

Description and Historical Use
Unit 4 and 5 Coal Ash Storage Area is a large coal ash storage area east of Units 4 and 5 (Figure 2 and Figure 7). Sediment dredged from the Settling Ponds was deposited in a portion of this area.

Known and Potential Contaminants
The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media
- Sediment
- Groundwater

Preliminary Classification
No record of a significant spill from this area to the environment has been identified. Because the dredge spoils deposited in this location may contain non-radiological contaminants there is a potential that these contaminants could be detectable in the nearby soil or groundwater. However, the volume of dredge spoils placed there is a small fraction of the coal ash stored in this location and it is reasonable to assume that any residual contaminants in the dredge spoil would be detectable at only a small fraction of the site release criteria. For this reason, a preliminary classification of NR Class 3 is assigned to Unit 4 and 5 Coal Ash Storage Area.

Data Gaps
- Chemical analysis of soil and groundwater samples for the potential contaminants.

Supporting Documents
None

6.2.5.13 West Berm

Description and Historical Use

The entire power block area is constructed on a berm whose elevation is approximately twenty-one (21) feet higher than the surrounding facilities. The berm provides protection against the originally estimated maximum storm surge and wave height that would result from the maximum probable storm.

The West Berm (Figure 4) encompasses the area west of the Turbine Building, Reactor Building and the Fire Service Pump House. Small spills or leaks of diesel fuel and hydraulic oil have occurred in this area during the operating history of the station. These spills and leaks were immediately isolated and cleaned up.

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

Because the West Berm is open to the weather there is some potential that residual contaminants from past spills could be mobilized by wind and rain and be detectable in soil, sediment or groundwater. These contaminants probably would be detectable at levels not exceeding a small fraction of the site release criteria. For this reason, a preliminary classification of NR Class 3 is assigned to the area of the West Berm.

Data Gaps

- Chemical analysis of soil, sediment, and groundwater samples for the potential contaminants.

Supporting Documents

AR00234946 Chemical Spill on Berm While Spraying Weeds.TIF
AR00724987 Hydraulic Fluid on W Berm 12-29-14.pdf

6.2.6 Oil-Filled Mechanical Equipment

Oil-Filled Mechanical Equipment Supporting Documents

AR00515017 Hydraulic Oil Leak at S Vehicle Gate 2-6-12.pdf
AR00515996 Diesel Spill Under Mobile Crane 2-9-12.pdf
Diesel Spill From Coal Train 4-27-2010.pdf
Diesel Spill From Mobile Light Plant 9-19-2010.pdf
Hydraulic Oil Spill 10-5-2010.pdf
NaOH Spill 6-22-1994.pdf
NaOH Spill Battery Rm 11-18-1993.pdf

6.2.6.1 Auxiliary Building Elevator

Description and Historical Use

A hydraulically operated elevator has been in service in the Auxiliary Building (Figure 3 and Figure 8) during the operating history of the station. This equipment includes a reservoir containing hydraulic oil.

Known and Potential Contaminants

The non-radiological contaminant is Hydraulic Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from the Auxiliary Building Elevator to the environment has been identified. Any spill that might occur would likely be fully contained within the building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the Auxiliary Building Elevator.

Data Gaps

- Visual inspection of the elevator mechanical equipment to identify indications of leaking hydraulic oil.

6.2.6.2 Conference and Cafeteria Building Elevator

Description and Historical Use

A hydraulically operated elevator has been in service in the CCB (Figure 3 and Figure 8) during the operating history of the building. This equipment includes a reservoir containing hydraulic oil.

Known and Potential Contaminants

The non-radiological contaminant is Hydraulic Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from the CCB Elevator to the environment has been identified. Any spill that might occur would likely be fully contained within the building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the Conference and Cafeteria Building Elevator.

Data Gaps

- Visual inspection of the elevator mechanical equipment to identify indications of leaking hydraulic oil.

6.2.6.3 Control Complex Elevator

Description and Historical Use
A hydraulically operated elevator has been in service in the Control Complex Building (Figure 3 and Figure 8) during the operating history of the station. This equipment includes a reservoir containing hydraulic oil.

Known and Potential Contaminants
The non-radiological contaminant is Hydraulic Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Concrete
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from the Control Complex Building Elevator to the environment has been identified. Any spill that might occur would likely be fully contained within the building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the Control Complex Building Elevator.

Data Gaps
- Visual inspection of the elevator mechanical equipment to identify indications of leaking hydraulic oil.

6.2.6.4 Feedwater Pump Motors

Description and Historical Use

Feedwater Pumps and their motors containing lubricating oil are located in the Turbine Building and the Intermediate Building (Figure 3 and Figure 8). The pumps have been retired permanently and the motor oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Lubricating Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete

Preliminary Classification

No record of a significant spill from the Feedwater Pump Motors to the environment has been identified. Any spill that might occur would likely be fully contained within the Turbine Building or Intermediate Building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the area of the Feedwater Pump Motors.

Data Gaps

- Visual inspection of the area of the pump motors to identify indications of leaking lubricating oil.

6.2.6.5 Nuclear Administration Building Elevator

Description and Historical Use

A hydraulically operated elevator has been in service in the NAB (Figure 3 and Figure 8) during the operating history of the station. This equipment includes a reservoir containing hydraulic oil.

Known and Potential Contaminants

The non-radiological contaminant is Hydraulic Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from the Nuclear Administration Building Elevator to the environment has been identified. Any spill that might occur would likely be fully contained within the building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the Nuclear Administration Building Elevator.

Data Gaps

- Visual inspection of the elevator mechanical equipment to identify indications of leaking hydraulic oil.

6.2.6.6 Plant Administration Building-Technical Support Center Elevator

Description and Historical Use
A hydraulically operated elevator has been in service in the PAB/TSC (Figure 3 and Figure 8) during the operating history of the station. This equipment includes a reservoir containing hydraulic oil.

Known and Potential Contaminants
The non-radiological contaminant is Hydraulic Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Concrete
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from the PAB/TSC Elevator to the environment has been identified. Any spill that might occur would likely be fully contained within the building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the PAB/TSC Elevator.

Data Gaps
- Visual inspection of the elevator mechanical equipment to identify indications of leaking hydraulic oil.

6.2.6.7 Reactor Building Elevator

Description and Historical Use

A hydraulically operated elevator has been in service in the Reactor Building (Figure 3 and Figure 8) during the operating history of the station. This equipment includes a reservoir containing hydraulic oil.

Known and Potential Contaminants

The non-radiological contaminant is Hydraulic Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from the Reactor Building Elevator to the environment has been identified. Any spill that might occur would likely be fully contained within the building and not cause substantial impact to local soil or groundwater. For these reasons a preliminary classification of NR Class 3 has been assigned to the Reactor Building Elevator.

Data Gaps

- Visual inspection of the elevator mechanical equipment to identify indications of leaking hydraulic oil.

6.2.6.8 Reactor Coolant Pump Motors

Description and Historical Use

Reactor Coolant Pumps and Motors are located in the Reactor Building (Figure 3 and Figure 8). The Reactor Coolant Pump Motors each contained 190 gallons of lubricating oil. The pumps have been retired permanently and the motor oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Lubricating Oil. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete

Preliminary Classification

No record of a significant spill from the Reactor Coolant Pump Motors to the environment has been identified. Any spill that might occur would likely be fully contained within the Reactor Building and not cause substantial impact to local soil or groundwater. For these reasons, a preliminary classification of NR Class 3 has been assigned to the area of the Reactor Coolant Pump Motors.

Data Gaps

- Visual inspection of the area of the pump motors to identify indications of leaking lubricating oil.

6.2.7 Storage Tanks

Storage Tanks Supporting Documents

AR00093167 Storage Tanks did not meet PT-356 Requirements.TIF
AR00111233 Oil Water Separator Tank SDS-1 Leaking.TIF
AR00217570 IAP-4 Fuel Tank Overflow due to tanks not equalized.TIF
AR00217692 High Particulate in FO Storage Tanks DFT-1B and FST-2B.TIF
AR00253129 Water and Oil in DFT-1A Sandpipe Area.TIF
AR00306686 TSC Diesel Fuel Oil Spill.TIF
DFT-4 & DFT-5 Fuel Oil Removal.docx
Diesel Fuel Spill into AST Secondary Containment 2-7-90.pdf
Diesel Fuel Spill onto Pervious Surface 7-18-91.pdf
Diesel Spills 12-20-89 and 9-27-89.pdf
FDEP Tank Database.xlsx
FDEP Tank Inventory.pdf
FDEP Tanks with Discharges.xlsx
Lube Oil Under Storage Tank in TB 11-23-82.pdf
Lube Oil Under Storage Tank in TB 2-28-81.pdf
NOTC Diesel AST.pdf
OP-407N SDT-1 release 223729.TIF
OP-407-N, Liquid Releases from the Secondary Plant.pdf
Portable Diesel Air Compressor Fuel Spill 4-2-80.pdf
Portable Diesel Air Compressor Fuel Spill 6-13-80.pdf
SD System Action Plan 1.doc

6.2.7.1 ACP Diesel Generator Fuel Tank

Description and Historical Use

The Access Control Point (ACP) Diesel Generator Fuel Tank is an approximately 275-gallon steel above ground tank providing diesel fuel for the stand-by generator at the security control point on the plant access road. The generator and fuel tank were visually inspected and determined to be leak free when they and the remainder of the ACP were turned over to the control of Duke Corporate Security in 2014.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from the ACP Diesel Generator Fuel Tank to the environment has been identified. Because the tank is an above ground tank and a visual inspection of the tank and its vicinity showed it to be leak free, and because the tank is no longer associated with CR3 and its use and control has been turned over to Duke Corporate Security, a preliminary classification of NR Non-Impacted has been assigned to the area of the tank.

Data Gaps

None

6.2.7.2 B.5.b Diesel Water Pump Fuel Tank

Description and Historical Use

The B.5.b Diesel Water Pump Fuel Tank is a 240-gallon trailer-mounted, double-walled AST inside a concrete containment near the Intake Structure (Figure 5 and Figure 9). The pump and tank are in service. The portable pump and tank were required by the NRC following the September 2001 terror attacks in New York and Washington, D.C. Their purpose is to provide additional capability to supply water for cooling the reactor core and spent fuel pool in the event of a "beyond design basis accident" such as loss of large areas of the plant due to explosions or fire.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from the B.5.b Diesel Water Pump Fuel Tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.3 DFT-1A

Description and Historical Use
DFT-1A is a 30,000-gallon underground tank storing diesel fuel for Emergency Diesel Generator A. The tank is located on the East Berm, outside of the Diesel Generator Building at the southeast corner of the Auxiliary Building (Figure 5 and Figure 9). Emergency Diesel Generator A is no longer in service and its tank has been drained.

The tank is cathodically protected and is surrounded by crushed limestone within a concrete containment. During its operating history the contents of the tank were sampled periodically and analyzed for water and sediment to provide an indication of a leak.

Known and Potential Contaminants
The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media
- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification
No record of a significant spill from DFT-1A to the environment has been identified. Because DFT-1A is an underground tank that previously stored a large volume of fuel with the potential for spills and overfills, a preliminary classification of NR Class 1 has been assigned to the area of the tank.

Data Gaps
- Chemical analysis of soil and groundwater samples for the potential contaminants in the area of the tank.

6.2.7.4 DFT-1B

Description and Historical Use

DFT-1B is a 30,000-gallon underground tank storing diesel fuel for Emergency Diesel Generator B. The tank is located on the East Berm, next to DFT-1A, outside of the Diesel Generator Building at the southeast corner of the Auxiliary Building (Figure 5 and Figure 9). The tank is in service.

The tank is cathodically protected and is surrounded by crushed limestone within a concrete containment. During its operating history the contents of the tank were sampled periodically and analyzed for water and sediment to provide an indication of a leak.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from DFT-1B to the environment has been identified. Because DFT-1B is an underground tank storing a large volume of fuel with the potential for spills and overfills, a preliminary classification of NR Class 1 has been assigned to the area of the tank.

Data Gaps

- Chemical analysis of soil and groundwater samples for the potential contaminants in the area of the tank.

6.2.7.5 DFT-4

Description and Historical Use

DFT-4 is a single-walled 13,750-gallon above ground diesel fuel tank for the Emergency Feedwater Pump 3. The tank and pump are located in the Emergency Feedwater Pump 3 Building in the southwest corner of the South Berm, southwest of the Reactor Building (Figure 5 and Figure 9). The pump is no longer in service and the tank has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from DFT-4 to the environment has been identified. Minor spills and overfills of the tank that may have occurred would have been entirely contained within the Emergency Feedwater Pump 3 Building. However, because of the volume of fuel formerly stored in the tank and the potential for residual contamination, a preliminary classification of NR Class 2 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.6 DFT-5

Description and Historical Use

DFT-5 is a double-walled 10,000-gallon above ground diesel fuel tank for the Alternate AC Diesel Generator. The tank is located within a concrete secondary containment structure immediately east of the Alternate AC Diesel Generator Building, which is off the South Berm (Figure 5 and Figure 9). The tank was installed in 2005 and is now permanently retired and drained.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from the Alternate AC Diesel Generator Fuel Tank to the environment has been identified. Based on the volume of diesel fuel stored and the potential for overfills, a preliminary classification of NR Class 2 is assigned to this tank.

Data Gaps

None

6.2.7.7 Diesel Generator A Fuel Day Tank

Description and Historical Use

Diesel Generator A Fuel Day Tank is an AST located in the Diesel Generator Building at the southeast corner of the Auxiliary Building (Figure 5 and Figure 9). The purpose of the day tank is to provide sufficient fuel for operation of the diesel generator for a few hours while limiting the volume of fuel that could spill or cause a fire near the generator. Diesel Generator A is no longer in service and its day tank has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from the Diesel Generator A Fuel Day Tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.8 Diesel Generator B Fuel Day Tank

Description and Historical Use

Diesel Generator B Fuel Day Tank is an AST located in the Diesel Generator Building at the southeast corner of the Auxiliary Building (Figure 5 and Figure 9). The purpose of the day tank is to provide sufficient fuel for operation of the diesel generator for a few hours while limiting the volume of fuel that could spill or cause a fire near the generator. Diesel Generator B and its day tank are in service.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from the Diesel Generator B Fuel Day Tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.9 EHC Fluid Tank

Description and Historical Use
The EHC Fluid Tank is an AST located in the northwest corner of the Turbine Deck. The tank contains high pressure, fire-resistant electrohydraulic control fluid (Fyrquel®) used to control high-pressure steam valves on the Turbine.

Known and Potential Contaminants
The non-radiological contaminant is Electrohydraulic Control Fluid. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification
The EHC Fluid Tank is located within the Turbine Building and no record of a significant spill from the tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps
None

6.2.7.10 Fire Service Pump A Fuel Tank

Description and Historical Use

The Fire Service Pump A Fuel Tank is an approximately 275-gallon above ground storage tank located on the West Berm in the Fire Service Pump House (Figure 3, Figure 5, Figure 8 and Figure 9). The pump and tank are in service and contained within concrete containments.

Known and Potential Contaminants

The non-radiological contaminants are Diesel Fuel and Petroleum Constituents. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from the tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.11 Fire Service Pump B Fuel Tank

Description and Historical Use

The Fire Service Pump B Fuel Tank is an approximately 550-gallon above ground storage tank located on the West Berm in the Fire Service Pump House (Figure 3, Figure 5, Figure 8 and Figure 9). The pump and tank are in service and contained within concrete containments.

Known and Potential Contaminants

The non-radiological contaminants are Diesel Fuel and Petroleum Constituents. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from the tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.12 Hydrazine Feed Tank

Description and Historical Use
The Hydrazine Feed Tank is an above ground storage tank in the Auxiliary Building (Figure 3 and Figure 8). Hydrazine was injected into the reactor coolant to scavenge oxygen and inhibit corrosion.

Known and Potential Contaminants
The non-radiological contaminant is Hydrazine. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media
- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification
The Hydrazine Feed Tank is located within the Auxiliary Building and no record of a significant spill from the tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps
None

6.2.7.13 IAP-4

Description and Historical Use

IAP-4 was a 500-gallon AST containing fuel for a diesel-driven air compressor. The tank was double-walled and located within a concrete containment on the North Berm, near the easternmost of the transformer bays (Figure 5 and Figure 9). The air compressor and tank have been removed from the station.

In September 1989 approximately 200 gallons of fuel spilled from the tank when its Tygon sight tube became disconnected. The spilled fuel drained to the bermed catchment area in the northwest corner of the Swamp Area. Remediation of the spill was completed when approximately 75 cubic yards of contaminated soil was excavated and transported to an approved off-site facility for disposal. The FDEP has closed the spill.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

Because it is likely that any remaining residual contamination from IAP-4 would be detectable at concentrations no greater than a small fraction of the site release criteria, a preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.14 LOT-1

Description and Historical Use
LOT-1 is a 25,100-gallon Underground Storage Tank (UST) that stored lubricating oil for the Turbine. The tank was installed in 1971, replaced in 2009, and is now drained and permanently out of service. LOT-1 was normally empty except when oil was being transferred from the Turbine Lubricating Oil Reservoir (LOT-2) during outages. LOT-1 is located within a below-grade vault on the West Berm outside of the Turbine Building (Figure 5 and Figure 9). The tank has overflowed in the past but it has been reported that oil never escaped the vault.

Known and Potential Contaminants
The non-radiological contaminant is Lubricating Oil Constituents.

Potentially Contaminated Media
- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification
Based on the volume of oil stored in LOT-1, the potential for overfills and its operating history, a preliminary classification of NR Class 1 has been assigned to the area of the tank.

Data Gaps
- Chemical analysis of soil and groundwater samples for the potential contaminants.

6.2.7.15 LOT-2

Description and Historical Use

LOT-2 is a 25,000-gallon reservoir for turbine lubricating oil. The reservoir is located within a concrete containment on the floor of the Turbine Building basement (Figure 5 and Figure 9). LOT-2 is permanently out of service and has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Lubricating Oil Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification

No record of a significant spill from LOT-2 to the environment has been identified. Spills from LOT-2 most likely would have been fully contained within the Turbine Building and collected within the Turbine Building Sump. Because of its size a preliminary classification of NR Class 2, has been assigned to LOT-2

Data Gaps

None

6.2.7.16 MET-1

Description and Historical Use

MET-1 is a 1,500-gallon UST storing diesel fuel for the PAB/TSC Generator. The tank is in service and is located inside the PA, east of the PAB/TSC (Figure 5 and Figure 9).

MET-1 is cathodically protected and is surrounded by crushed limestone within a concrete containment. During its operating history the contents of the tank were sampled periodically and analyzed for water and sediment to provide an indication of a leak.

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MET-1 to the environment has been identified. Because MET-1 is an underground tank storing a large volume of fuel with the potential for spills and overfills, a preliminary classification of NR Class 1 has been assigned to the area of the tank.

Data Gaps

- Chemical analysis of soil and groundwater samples for the potential contaminants in the area of the tank.

6.2.7.17 MET-2

Description and Historical Use

MET-2 is the diesel fuel day tank for the PAB/TSC Diesel Generator. The tank is in service. The tank is within a concrete containment in the lower level of the PAB/TSC (Figure 5 and Figure 9).

Known and Potential Contaminants

The non-radiological contaminant is Diesel Fuel Constituents. Because of its location within a building, if handled properly, this material is not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MET-2 to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps

None

6.2.7.18 NSOC Diesel Generator Fuel Tank

Description and Historical Use
The Nuclear Security Operations Center Diesel Generator Fuel Tank is a 350-gallon AST located outside the southern wall of the NSOC (Figure 5 and Figure 9), the checkpoint for personnel gaining access to the PA. The tank is within a concrete containment structure and is in service.

Known and Potential Contaminants
The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media

- Concrete
- Soil
- Groundwater
- Tank Interior
- Piping

Preliminary Classification
No record of a significant spill from the NSOC Diesel Generator Fuel Tank to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the area of the tank.

Data Gaps
None

6.2.7.19 Poly Tanks

Description and Historical Use
Portable polyethylene tanks with capacities ranging from approximately 200 to 500 gallons are staged at various locations on the Berms. Storm water and groundwater that accumulates in underground cable trays and duct banks is pumped to these tanks periodically. The contents of the tanks are sampled, analyzed, and released to local storm drains if the water quality complies with the criteria in the station NPDES Permit.

Known and Potential Contaminants
The non-radiological contaminants are Petroleum Constituents and RCRA Metals.

Potentially Contaminated Media

- Groundwater

Preliminary Classification
No record of a significant spill from the Poly Tanks to the environment has been identified. A preliminary classification of NR Class 3 has been assigned to the areas of the tanks.

Data Gaps
None

6.2.7.20 SAB Diesel Generator Fuel Tank

Description and Historical Use
The Site Administration Building (SAB) Diesel Generator Fuel Tank is an approximately 275-gallon steel above ground tank providing diesel fuel for the stand-by generator at the SAB on the plant access road. The generator and fuel tank were visually inspected and determined to be leak free when they and the remainder of the SAB were turned over to the control of the Duke fossil plants in 2014.

Known and Potential Contaminants
The non-radiological contaminant is Diesel Fuel Constituents.

Potentially Contaminated Media
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from the SAB Diesel Generator Fuel Tank to the environment has been identified. Because the tank is an above ground tank and a visual inspection of the tank and its vicinity showed it to be leak free; and because the tank is no longer associated with CR3 and its use and control have been transferred to the Duke fossil plants, a preliminary classification of NR Non-Impacted has been assigned to the area of the tank.

Data Gaps
None

6.2.7.21 SDT-1

Description and Historical Use

SDT-1 is the Station Drain Tank. The tank is in service. This tank is a 100,000-gallon AST located on the West Berm outside of the Turbine Building (Figure 5 and Figure 9). The Turbine Building Sump discharges through an oil-water separator to SDT-1. The contents of this tank normally is batch released to the Discharge Canal, except when the station NPDES permit limits are not achieved and discharge is to the Settling Ponds (Subsection 6.2.5.6). A hole in the tank bottom discovered during an internal tank inspection was repaired.

Known and Potential Contaminants

The non-radiological contaminants are RCRA Metals, Petroleum Constituents, and Hydrazine.

Potentially Contaminated Media

- Sludge
- Tank Interior
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from SDT-1 to the environment has been identified. Based on its past and current use, the area of SDT-1 is assigned a preliminary classification of NR Class 2.

Data Gaps

- Chemical analysis of sludge, soil and groundwater samples for the potential contaminants.

6.2.7.22 Turbine Building Sump Oil and Water Separator

Description and Historical Use

The Turbine Building Sump Oil and Water Separator is in the basement of the Turbine Building (Figure 3 and Figure 8). The separator receives wastewater collected in the Turbine Building Sump and removes immiscible non-aqueous liquids such as lubricating oil, fuel oil and other petroleum products.

These immiscible liquids are pumped to a 55-gallon drum and transported off site for disposal. The separated wastewater is pumped to SDT-1. Samples from SDT-1 are analyzed and its contents are discharged to the Discharge Canal if the water quality complies with the station's NPDES Permit criteria; otherwise the wastewater is pumped to the Settling Ponds.

Known and Potential Contaminants

The non-radiological contaminants are Petroleum Constituents and RCRA Metals. Because of its location within a building, if handled properly, these materials are not expected to pose a risk of contamination to environmental media such as soil or groundwater.

Potentially Contaminated Media

- Concrete
- Sludge
- Tank Interior
- Piping

Preliminary Classification

Overflow of the 55-gallon drum to which immiscible liquids from the Oil and Water Separator are pumped has occurred in the past. These spills have been isolated and immediately cleaned up, with little potential for impact to soil or groundwater. A preliminary classification of NR Class 3 has been assigned to the area of the Turbine Building Sump Oil and Water Separator.

Data Gaps

None

6.2.8 Transformers

<u>Transformers Supporting Documents</u>

AR00265015 Small Oil Leak on MTTR-3A.TIF
AR00274815 Oil Leak from B Step up Transformer.TIF
AR00277615 MTTR-3B Oil Leakage Increased.TIF
AR00278462 Transformer Oil Leak 5-7-08.TIF
AR00315135 MTTR-2 Startup Transformer Low Oil Level and Leakage.TIF
AR00316434 Oil Leak on Auxiliary Transformer.TIF
AR00410140 MTTR-3B Oil Leak from Cooler No 1.TIF
AR00435178 Transformer Oil Pumped to Storm Drain 11-24-10.TIF
AR00728315 Hydraulic Oil Spill at Main Transformer 3A 1-20-15.pdf

6.2.8.1 Concrete Batch Plant Transformers

Description and Historical Use
Four (4) 750 KVA transformers, each containing 313 gallons of mineral oil, were located within a gravel trench containment in the CR3 parking lot (Figure 2 and Figure 7). The transformers powered a concrete batch plant formerly located in the CR3 parking lot. The transformers have been removed from the site.

Known and Potential Contaminants
The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from the Concrete Batch Plant Transformers to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. Because these transformers contained a relatively small volume of dielectric oil and they have been removed from the site a preliminary classification of NR Class 3 has been assigned to the area of the transformers.

Data Gaps
None

6.2.8.2 Maintenance Training Facility Transformer

Description and Historical Use
The Maintenance Training Facility Transformer is a 500 KVA transformer containing 268 gallons of mineral oil. The transformer is located within a concrete containment at the southeast corner of the Maintenance Training Facility (Figure 5 and Figure 9). The transformer is in service.

Known and Potential Contaminants
The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from the Maintenance Training Facility Transformer to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. Because this transformer contained a relatively small volume of dielectric oil a preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps
None

6.2.8.3 MTSH-3HA

Description and Historical Use

MTSH-3HA is a 500 KVA transformer located near the Intake Structure (Figure 5 and Figure 9) and provided power to the traveling screens and other intake equipment. The transformer is staged within a concrete containment structure. MTSH-3HA was replaced in 2005 and is now out of service.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTSH-3HA to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. Because this transformer contained a relatively small volume of dielectric oil a preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

None

6.2.8.4 MTSH-3HB

Description and Historical Use

MTSH-3HA is a 500 KVA transformer located near the Intake Structure (Figure 5 and Figure 9) and provided power to the traveling screens and other intake equipment. The transformer is staged within a concrete containment structure. MTSH-3HA was replaced in 2005 and is now out of service.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTSH-3HB to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. Because this transformer contained a relatively small volume of dielectric oil a preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

None

6.2.8.5 MTTR-1

Description and Historical Use

MTTR-1 is the station Auxiliary Transformer that transforms off-site power for operating on-site equipment and can also be configured to run on-site equipment with power produced by the station. The transformer is located on the North Berm in a concrete containment bay with a two-foot base of crushed limestone (Figure 5 and Figure 9). Drainage from the containment flows to a bermed catchment in the northwest corner of the Swamp Area. MTTR-1 has a capacity of 6,620 gallons of dielectric oil. The transformer was installed in approximately 1978. MTTR-1 is permanently out of service and has been drained of dielectric oil.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-1 to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the crushed limestone base in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.6 MTTR-2

Description and Historical Use

MTTR-2 is the station Start-Up Transformer. The transformer is located on the North Berm in a concrete containment bay with a two-foot base of crushed limestone (Figure 5 and Figure 9). Drainage from the containment flows to a bermed catchment in the northwest corner of the Swamp Area. MTTR-2 has a capacity of 3,380 gallons of dielectric oil. The transformer was installed in approximately 1978. MTTR-2 is out of service and its oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-2 to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the crushed limestone base in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.7 MTTR-3A

Description and Historical Use

MTTR-3A is the station Generator Step-Up Transformer A. The transformer is located on the North Berm in a concrete containment bay with a two-foot base of crushed limestone (Figure 5 and Figure 9). Drainage from the containment flows to a bermed catchment in the northwest corner of the Swamp Area. MTTR-3A has a capacity of 19,318 gallons of dielectric oil. The transformer was replaced in 2007, is now out of service and its oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-3A to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the crushed limestone base in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.8 MTTR-3B

Description and Historical Use

MTTR-3B is the station Generator Step-Up Transformer B. The transformer is located on the North Berm in a concrete containment bay with a two-foot base of crushed limestone (Figure 5 and Figure 9). Drainage from the containment flows to a bermed catchment in the northwest corner of the Swamp Area. MTTR-3B has a capacity of 19,318 gallons of dielectric oil. The transformer was replaced in 2007, is now out of service and its oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-3B to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the crushed limestone base in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.9 MTTR-3C

Description and Historical Use
MTTR-3C is the station Generator Step-Up Transformer C. The transformer is located on the North Berm in a concrete containment bay with a two-foot base of crushed limestone (Figure 5 and Figure 9). Drainage from the containment flows to a bermed catchment in the northwest corner of the Swamp Area. MTTR-3C has a capacity of 19,318 gallons of dielectric oil. The transformer was replaced in 2007, is now out of service and its oil has been drained.

Known and Potential Contaminants
The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media
- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification
No record of a significant spill from MTTR-3C to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps
- Chemical analysis of samples of the crushed limestone base in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.10 MTTR-3D

Description and Historical Use

MTTR-3D is the station Generator Step-Up Transformer D. This transformer was a back-up Generator Step-Up Transformer. MTTR-3D is located on the North Berm in a concrete diked area (Figure 5 and Figure 9). Any accumulated dielectric oil inside the dike would have been pumped to the secondary containment of adjacent transformer MTTR-3C, where it would have drained to the bermed catchment in the northwest corner of the Swamp Area. MTTR-3D has a capacity of 19,318 gallons of dielectric oil. The transformer was replaced in 2007, is now out of service and its oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-3D to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the concrete in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.11 MTTR-6

Description and Historical Use

MTTR-6 is the station Backup Engineering Safeguards Transformer (BEST). The transformer is located on the North Berm in a concrete containment bay with a two-foot base of crushed limestone (Figure 5 and Figure 9). Drainage from the containment flows to a bermed catchment in the northwest corner of the Swamp Area. MTTR-6 has a capacity of 8,280 gallons of dielectric oil. The transformer was replaced in 1985, is now out of service and its oil has been drained.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-6 to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 3 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the crushed limestone base in the transformer bay and in the bermed catchment in the Swamp Area to which it drains for the potential contaminants.

6.2.8.12 MTTR-7

Description and Historical Use

MTTR-7 is the Alternate AC Diesel Generator Transformer. The transformer is located off the South Berm, near DFT-5, in a concrete containment bay (Figure 5 and Figure 9). The transformer was installed in 2005 and is in service.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Drain Pipes
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from MTTR-7 to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 2 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the concrete in the transformer bay for the potential contaminants.

6.2.8.13 Off Site Power Transformer

Description and Historical Use

The Off Site Power Transformer is located in the Switch Yard (Figure 2 and Figure 7) and was installed in 1985 in a concrete containment. The transformer provides off site power to the station and has a capacity of 9,430 gallons of mineral oil.

Known and Potential Contaminants

The non-radiological contaminant is Dielectric Oil.

Potentially Contaminated Media

- Gravel
- Soil
- Groundwater

Preliminary Classification

No record of a significant spill from the Off Site Power Transformer to the environment has been identified. However, it is common for transformer bushings and gaskets to develop small leaks with age due to thermal fatigue as the temperature of the dielectric oil varies between periods of operation and periods of outage. A preliminary classification of NR Class 2 has been assigned to the area of the transformer.

Data Gaps

- Chemical analysis of samples of the concrete in the transformer bay for the potential contaminants.

6.3 Radiological Impacts

The approach for sorting historical radiological information collected at CR3 was to divide the data into two review areas, those being:

1. Buildings or Structures
2. Exterior Areas (outside of buildings and structures)

Historical information was collected and reviewed to first classify all areas as either Impacted or Non-Impacted. Impacted areas, buildings, and structures have been given a preliminary MARSSIM classification based on available radiological characterization data, knowledge of historical site operations, and results of personnel interviews. The classification of an area or subsection of an area may be revised when new radiological sample data become available. Appropriate documentation would be provided to justify the revised classification. This subsection and Appendix B contain a summary of all potentially impacted areas, buildings and structures on site at the time this HSA was developed and their preliminary classifications. Figure 2 and Figure 3 show the location and preliminary classification of each exterior area, building, and structure.

Each condition of interest summarized in Appendix B has been assigned a preliminary classification, as described in MARSSIM. Site-specific DCGLs for CR3, which are the basis for classification of radiologically contaminated areas, have not yet been determined. The preliminary classifications listed here and in Appendix B are only estimates of the relative magnitude of radiological contamination that may now exist in an area of interest. In some areas, for example the NSOC, the classification is based solely on knowledge of plant operations and processes, rather than radiological sampling and analysis. In other areas, for example the area outside of the Containment Equipment Hatch, the classification is based on past radiological surveys.

The major structures inside the PA are the Reactor Building, the Turbine Building, the Auxiliary Building, the Intermediate Building, the Maintenance Support Building, the Emergency Diesel Generator Building, The Emergency Feedwater Pump Building, and the Control Complex. Additionally, several office-type buildings exist within the PA, such as the NSOC, PAB, NAB, Security CAS, and the Rusty Building. All buildings and SSCs directly associated with the CR3 nuclear power reactor or associated with handling of related radioactive material are Class 1 areas as they are defined in MARSSIM [1].

Areas designated as Class 1 are very likely to contain radioactive contamination at concentrations greater than the license termination criteria. Remediation of this contamination will require removal and disposal of Radioactive Waste (RW) at a licensed disposal facility if the CR3 site is to be released for unrestricted use and its operating license issued by the U.S. NRC is to be terminated.

6.3.1 Non-Impacted Areas

There are many buildings, structures, and areas which are located within the licensed footprint of the site, namely a 4,400 foot minimum exclusion radius centered on the Reactor Building (Figure 15), but outside of the CR3 Protected Area that are likely to not have been impacted by site operations. However gaseous and particulate emissions from CR3 may have resulted in the presence of low levels of contamination.

A meeting was conducted on February 25, 2016 between the assessment team and station management to discuss an approach to dispositioning those buildings, structures, and areas outside of the Protected Area, that are not specifically identified in this HSA. The meeting minutes are linked below. Furthermore, Section 8 - Recommendations contains a discussion on how to disposition these areas.

<u>Non-Impacted Areas Supporting Documents</u>
HSA Licensed Footprint Meeting Minutes (25Feb2016).pdf

6.3.2 Radionuclides of Concern

The following waste characterization analyses (which were performed to demonstrate compliance with 10 CFR Part 61) were reviewed to determine the primary Radionuclides of Concern (ROCs):

- 2010 Dry Active Waste
- 2014 Dry Active Waste
- 2014 Primary (WDT) Resin
- 2015 Condensate Resin
- 2015 NUS Charcoal Resin

Any radioisotope identified as "positive" by CR3's evaluation of the 10 CFR 61 analyses was included in the master list of ROCs contained in Table 2. In the table, if the fraction remaining is less than 1.0E-06, which roughly corresponds to twenty half-lives, the fraction is reported as zero (0.0E+00).

Table 2: Part 61 Composite List of Positively Identified Radionuclides

		Fraction Remaining After			
Element	**Half-Life (yrs)**	**2 yrs**	**5 yrs**	**10 yrs**	**50 yrs**
Hydrogen-3	1.2E+01	8.9E-01	7.5E-01	5.7E-01	6.0E-02
Carbon-14	5.7E+03	1.0E+00	1.0E+00	1.0E+00	9.9E-01
Manganese-54	8.5E-01	2.0E-01	1.7E-02	3.0E-04	0.0E+00
Iron-55	2.7E+00	6.0E-01	2.8E-01	8.0E-02	3.3E-06
Cobalt-57	7.4E-01	1.6E-01	9.5E-03	9.0E-05	0.0E+00
Cobalt-58	1.9E-01	7.9E-04	0.0E+00	0.0E+00	0.0E+00
Nickel-59	7.6E+04	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Cobalt-60	5.3E+00	7.7E-01	5.2E-01	2.7E-01	1.4E-03
Nickel-63	1.0E+02	9.9E-01	9.7E-01	9.3E-01	7.1E-01
Zinc-65	6.7E-01	1.3E-01	5.6E-03	3.1E-05	0.0E+00
Strontium-90	2.9E+01	9.5E-01	8.9E-01	7.9E-01	3.0E-01
Niobium-94	2.0E+04	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Niobium-95	9.6E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zirconium-95	1.8E-01	3.7E-04	0.0E+00	0.0E+00	0.0E+00
Silver-110m	6.8E-01	1.3E-01	6.3E-03	4.0E-05	0.0E+00
Antimony-125	2.8E+00	6.0E-01	2.8E-01	8.1E-02	3.5E-06
Iodine-129	1.6E+07	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Cesium-134	2.1E+00	5.1E-01	1.9E-01	3.5E-02	0.0E+00
Cesium-137	3.0E+01	9.5E-01	8.9E-01	7.9E-01	3.2E-01
Cerium-141	8.9E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cerium-144	7.8E-01	1.7E-01	1.2E-02	1.4E-04	0.0E+00
Plutonium-238	8.8E+01	9.8E-01	9.6E-01	9.2E-01	6.7E-01
Plutonium-239	2.4E+04	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Plutonium-240	6.6E+03	1.0E+00	1.0E+00	1.0E+00	9.9E-01
Americium-241	4.3E+02	1.0E+00	9.9E-01	9.8E-01	9.2E-01

		Fraction Remaining After			
Element	**Half-Life (yrs)**	**2 yrs**	**5 yrs**	**10 yrs**	**50 yrs**
Plutonium-241	1.4E+01	9.1E-01	7.8E-01	6.2E-01	8.8E-02
Curium-243	2.9E+01	9.5E-01	8.9E-01	7.9E-01	3.0E-01
Curium-244	1.8E+01	9.3E-01	8.3E-01	6.8E-01	1.5E-01

This composite list was subsequently shortened (via process knowledge and a realistic analysis of each ROC's respective half-life) and the ROCs were categorized into four distinct groups. These groups are the gamma emitters (Gammas), the Hard to Detect (HTD) beta emitters (HTD&Betas), tritium, and Transuranics (TRUs). The results are listed in Table 3 for radionuclides with a half-life greater than 0.5 years.

Table 3: Categorized Radioisotopes of Concern

Element	**Category**	**Half-Life (yrs)**
Manganese-54	Gammas	8.5E-01
Cobalt-57	Gammas	7.4E-01
Nickel-59	Gammas	7.6E+04
Cobalt-60	Gammas	5.3E+00
Zinc-65	Gammas	6.7E-01
Silver-110m	Gammas	6.8E-01
Antimony-125	Gammas	2.8E+00
Cesium-137	Gammas	3.0E+01
Cerium-144	Gammas	7.8E-01
Europium-152[b]	Gammas	1.3E+01
Europium-154[b]	Gammas	1.6E+01
Europium-155[b]	Gammas	1.8E+00
Carbon-14	HTD&Betas	5.7E+03
Iron-55	HTD&Betas	2.7E+00
Nickel-63	HTD&Betas	1.0E+02
Strontium-90	HTD&Betas	2.9E+01
Technetium-99[a]	HTD&Betas	2.1E+05
Iodine-129	HTD&Betas	1.6E+07
Hydrogen-3	Tritium	1.2E+01
Plutonium-238	TRUs	8.8E+01
Plutonium-239	TRUs	2.4E+04
Plutonium-240	TRUs	6.6E+03
Americium-241	TRUs	4.3E+02
Plutonium-241	TRUs	1.4E+01
Curium-243	TRUs	2.9E+01
Curium-244	TRUs	1.8E+01
[a] = Tc-99 was not identified in site samples but is a required 10CFR20 App. G waste stream analyte		
[b] = EU-152,154 & 155 were not identified in site samples but are typically identified in activated concrete		

The potential presence of any of these ROCs will be denoted by their respective assigned category for the remainder of the HSA.

Radionuclides of Concern Supporting Documents

10CFR61 Analysis Condensate Resin_2015.docx
10CFR61 Analysis Condensate Resin_2015.pdf
10CFR61 Analysis DAW_2010.docx
10CFR61 Analysis DAW_2010.pdf
10CFR61 Analysis DAW_2014.docx
10CFR61 Analysis DAW_2014.pdf
10CFR61 Analysis NUS Charcoal Resin_2015.docx
10CFR61 Analysis NUS Charcoal Resin_2015.pdf
10CFR61 Analysis Primary Resin_2014.docx
10CFR61 Analysis Primary Resin_2014.pdf
Alpha ratio tracking sheet.xlsx
Canal Radionuclide data.xlsx
HPP-112 ENCLOSURE 1.doc
HPP112_isotopic_mix.xlsx
NRC Screening Values.pdf
ODCM rev 36 draft for review.docx
ODCM Revision Form_Rev 35.pdf
ODCM_rev35 DRAFT.DOCX
PCP.07.docx
R16 Alpha ratios.xlsx
REMP 2014_final.docx
RS2009-10-2195 CTMT SG Opening for R16.pdf
RS2011-12-0137 Concrete Samples.pdf
RS2012-01-0120 Concrete Samples.pdf
RS2016-05-0004 Intake Structure Survey Results.docx
RS2016-05-0004 Intake Structure.pdf

6.3.3 Building or Structure

6.3.3.1 Alternate AC Diesel Generator Building

Description and Historical Use

The Alternate AC Diesel Generator Building is located off the South Berm, south of the Auxiliary Building (Figure 3 and Figure 12). The building was constructed in approximately 2005 and houses the Alternate AC Diesel Generator. The generator has been removed from service permanently.

Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The Alternate AC Diesel Generator Building and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.3.2 Auxiliary Building

Description and Historical Use

The Auxiliary Building is a concrete and steel multistory structure that interfaces with the Reactor Building (Figure 3 and Figure 12). The Auxiliary Building houses the essential auxiliaries, spent fuel storage facilities, and the RW handling and treatment facilities.

A review of radiological surveys conducted over the past couple of years shows a reasonable estimate of current conditions inside the Auxiliary Building. The Auxiliary Building is currently posted as an RCA and Radiation Area, with smaller areas within posted as Locked High Radiation Area (LHRA), High Radiation Area (HRA), and Contaminated Area (CA). Survey information for the Auxiliary Building is contained in Table 4.

Table 4: Auxiliary Building Survey Information

Area or Component	Dose Rate (mR/hr)
75' 'A' Decay Heat Vault	<1-7
75 'B' Decay Heat Vault	<1-1.5
75' Tendon Gallery	<1
95' G/A	<1-*12/1
95' Sea Water Rm	<1
95' Triangle Room (LPI)	1-*30/10
95' Rainforest (HPI)	<1-*6/1
95' RC Evap. Rm	<1-4
95' Condensate Waste Tank Rm	5-*26/10
95' Nuclear Sample Rm	<1-3
95' RCBT (bleed tank)	5-20
95' Decant Slurry Pump Rm	<1-6
119' N G/A	<1-*5/1
119' S G/A	<1-1
119' EGDG 1A-1B	<1
119' Green Rm	<1
119' Block Orifice Rm	*20/12, <1-3
119' RCBT	5-7
119' RMA-6 Area	<1
119' Deborating Demin Rm	2-*30/15
119' Post Filter Valve Alley	<1-*1.5/1
119' Pre Filter Rm	1.2-*1200/300
119' Make Up Tank	1.5
119' Seal Return Cooler Room	<1
119' BST Rm	<1-*4
119' Yellow Rm	<1-50
119' Yellow Rm ½ Wall	1-5
119' Yellow Rm ½ Wall Access Cage	15-*4500/700
119' Spent Fuel Demin Rm	50-*5000/600

Area or Component	Dose Rate (mR/hr)
119’ Berm	<0.5-*3/<1
119’ MSB	<1
119’ Hot Machine Shop	<1
143’ G/A	<1-1.5
162” G/A	*1-<1
** = denotes contact reading, otherwise general area*	

Known and Potential Contaminants
The ROCs are those categorized as Gammas, HTD&Betas, Tritium, and TRUs. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Building Materials
- Concrete
- Filters
- Resins
- SSCs
- Steel

Preliminary Classification
The Auxiliary Building and all SSCs within it, are preliminarily classified as a MARSSIM Class 1 structure due to the fact that the building has been an RCA throughout the station operating years, and has a high potential for containing residual radioactive material, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents
AR00358312 NRC RP Team Identified Deficiency in Radwaste Storage.pdf
RS_CR3-M-20140520-1 Triangle Room-LPI.pdf
RS_CR3-M-20140624-2 Post-filter Valve Alley.pdf
RS_CR3-M-20140816-3 HPI Valve Alley (Alpha Ratio).pdf
RS_CR3-M-20141023-3 AB 119' Seal Return Cooler Room.pdf
RS_CR3-M-20160119-3 Yellow Room over Half Wall.pdf
RS_CR3-M-20160120-3 Yellow Room.pdf
RS_CR3-M-20160123-5 95' Aux Bldg.pdf
RS_CR3-M-20160128-5 160' Aux Bldg Spent Fuel Floor.pdf

RS_CR3-M-20160129-5 Hot Shop.pdf
RS_CR3-M-20160201-9 143' Aux Bldg.pdf
RS_CR3-M-20160203-2 Decay Heat Vaults.pdf
RS_CR3-M-20160203-5 119' Aux Bldg.pdf
RS2009-10-0544 Alpha Ratio 600-1 (Aux Bldg).pdf
RS2010-03-0092 AB 119' Make Up Demins.pdf
RS2011-06-0007 AB 95' Concentrate Waste Tank Room.pdf
RS2011-08-0021 AB 119' Deborating Demin Tank Room.pdf
RS2012-07-0056 Block Orifice Room.pdf
RS2012-07-0090 AB 119' RCBT.pdf
RS2012-10-0108 RC Evap Rm.pdf
RS2012-11-0057 Letdown Cooler Room.pdf
RS2012-12-0030 Letdown Cooler Room.pdf
RS2012-12-0090 Pre-filter Room.pdf
RS2012-12-0184 AB 119' Spent Fuel Demin.pdf
RS2013-07-0100 AB 95' RCBT Room.pdf
RS2014-01-0007 IB AB MUT-RMA-6 area-119 ft map.pdf
RS2014-01-0031 AB IB HPI-rainforest.pdf
RS2014-01-0057 AB 95' Decant Slurry Pump Room.pdf

6.3.3.3 Control Complex

Description and Historical Use

The Control Complex is a multistory structure comprised of six elevations, namely 95', 108', 124', 134', 145' and 164' (Figure 3 and Figure 12). The 95' elevation is primarily comprised of the HP office complex and the primary chemistry lab. A portion of this elevation is within the RCA, as it serves as the primary RCA entrance and exit. The 95' elevation has been reconfigured over the years. Early on, the HP calibration facility was located in the HP office complex. The 145' elevation contains the Control Room.

With the exception of the 95' elevation, radioactive material was not used or stored in this building, but because of its proximity to the RCA there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The majority of the Control Complex and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria. The 95' elevation is preliminarily classified as a MARSSIM Class 1 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

RS_CR3-M-20160203-6 95' Control Complex.pdf
RS2012-07-0001 Nuclear Sample Room.pdf

6.3.3.4 Discharge Structure

Description and Historical Use

The Discharge Structure is an on-shore reinforced concrete structure that discharges plant effluents into the discharge canal for transport to the Gulf of Mexico (Figure 3 and Figure 12). The Discharge Structure is the point of termination for the circulating water discharge pipe. That pipe enters the Discharge Structure below the water level of the discharge canal. The structure provides a transition from the pipe to the discharge canal, and is the outlet to the Gulf. The Discharge Structure also receives drainage and Service Water returns from the Auxiliary Building and Turbine Building standpipes.

Plant radioactive liquid effluent discharges are sent through the Circulating Water System discharge to provide dilution. There is a potential that residual radioactive material may have accumulated in the structure from years of radioactive liquid effluent discharges. However, radioactive material was not used or stored in the Discharge Structure.

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and Tritium. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Concrete
- Piping
- Steel

Preliminary Classification

The Discharge Structure is preliminarily classified as a MARSSIM Class 2 structure based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the Discharge Structure concrete
- Direct measurements of the discharge piping
- Radiological analysis of additional sediment samples from the discharge pipe

Supporting Documents

OP-407-N, Liquid Releases from the Secondary Plant.pdf
SP0736I-CDT-1.TIF
SP0736L, Liquid Discharges to the Discharge Canal via RM-L2 (WDT-1).pdf
SP736G SDT-1 Releases to the Discharge Canal.pdf
SP736I Condensate Release to the Discharge Canal (CDT-1).pdf
SP736M Liquid Releases to the Discharge Canal via RM-l7 (SDT-1).pdf

6.3.3.5 Emergency Diesel Generator Building

Description and Historical Use

The Emergency Diesel Generator Building is at the southeast corner of the Auxiliary Building (Figure 3 and Figure 12). The generators provide electrical power to operate all safety-related SSCs in the event of the loss of off-site electrical power. The building contains two large diesel generators and their associated day tanks.

In July of 2008, AR00285638 was written when contaminated scaffolding was found in the "B" Diesel Generator Fan Room. Surveys identified that the contamination was limited to the scaffold pic boards, and once the scaffolding material was relocated to the MSB, the Fan Room was surveyed (RS08-07-0012) and found to be clean. Aside from this room and this instance, radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The Emergency Diesel Generator Building and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

AR00285638 Contamination in B Diesel Generator Room.pdf
RS2008-07-0012 B Diesel Gen Survey.pdf

6.3.3.6 Emergency Feedwater Pump 3 Building

Description and Historical Use

The Emergency Feedwater Pump 3 Building is located within the PA on the southwest berm near the Emergency Feedwater Tank Building (Figure 3 and Figure 12). The building contains DFT-4, a 13,750-gallon single-walled above ground storage tank containing fuel for the pump.

Radioactive material was not used or stored in this building, but because of its proximity to the power block, there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The Emergency Feedwater Diesel Pump 3 Building and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.3.7 Emergency Feedwater Tank Building

Description and Historical Use

The Emergency Feedwater Tank Building is located on the South Berm south of the MSB (Figure 3 and Figure 12). The building houses a large above ground tank storing makeup feedwater to be used during a loss of coolant emergency.

Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The Emergency Feedwater Tank Building and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.3.8 Fire Service Pump House

Description and Historical Use

The Fire Service Pump House is located in the PA in the West Berm area, immediately south of the Fire Service Water Tanks and the Intermediate Building (Figure 3 and Figure 12). The Pump House contains two pumps for charging the Fire Service hydrants and standpipes, and two above ground tanks storing diesel fuel for the pumps.

Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The Fire Service Pump House and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.3.9 Intake Structure

Description and Historical Use
The Intake Structure is located at the eastern end of the Intake Canal (Figure 3 and Figure 12) and is where circulating water and raw seawater was withdrawn from the Intake Canal.

Based on the fact that plant derived material has been identified in the storm water drains, several of which discharge to the Intake Canal through an outfall, there is a possibility, albeit small because of dilution, that contamination has accumulated in the Intake Structure.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification
The Intake Structure is preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the Intake Structure concrete
- Direct measurements of the intake piping
- Radiological analysis of additional sediment samples from the intake pipe

Supporting Documents
RS2016-05-0004 Intake Structure Survey Results.docx
RS2016-05-0004 Intake Structure.pdf

6.3.3.10 Intermediate Building

Description and Historical Use

The Intermediate Buildings (Figure 3 and Figure 12) are Seismic Class I structures designed for abnormal incidents such as tornado loads and missiles. The buildings' inner walls fully (75′) or partially (95′ & 119′) surround the Reactor Building and allow access to many of the Reactor Building tendons. There are three distinct areas that define the Intermediate Building.

a. The 75′ area is known as the Tendon Gallery. Access to this area is through the 95′ intermediate building. An alternate access is located on the southwest berm but the hatch is locked by Security. The Tendon Gallery allows access to the lower containment building tendons. A sump along with two sumps pumps are located in the area.
b. The 95′ Intermediate Building is accessed through the Seawater Room or the area just outside the Pass Room / Nuclear Sample Room of the Auxiliary Building (AB). This building allows access to Reactor Building tendons located on the 95′ elevation. The CAV-2/6 valve alley is located in the northeast section of the building.
c. The 119′ Intermediate Building is accessed from the 119′ Turbine Building. This building allows access to containment building tendons located on the 119′ elevation. The building allows access to the Personnel Hatch, which is the primary ingress and egress area to the Reactor Building. The Personnel Hatch was accessed through the 119′ Auxiliary Building but has since been barricaded. Main Steam Safety Valves and the four main steam lines exiting the reactor building are located in this structure. Delamination of the Reactor Building in 2011 resulted in concrete spalling off and falling inside the Intermediate Building.

Relatively recent survey data provide a reasonable estimate of current conditions inside the Intermediate Building. Survey information for the Intermediate Building is contained in Table 5.

Table 5: Intermediate Building Survey Information

Area or Component	Dose Rate (mR/hr)
95′ Intermediate Bldg.	<1
119′ Intermediate Bldg.	<1
** = denotes contact reading, otherwise general area*	

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and Tritium. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete

- SSCs
- Steel

Preliminary Classification

The Intermediate Building and all SSCs within it are preliminarily classified as a MARSSIM Class 1 structure because the 95' elevation of the building has been an RCA throughout the station operating years and the 119' elevation contains turbine system components (MSIVs, MSRVs, etc.) that have become contaminated due to primary to secondary side leakage. Therefore, there is a high potential for containing residual radioactive material, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

RS Reactor-Aux-Intermediate Bldg.docx
RS2002-01-0018 IB TB 119'.pdf
RS2009-02-0099 Tendon Gallery Sump Sample.pdf
RS2009-02-0224 Tendon Gallery Survey.pdf
RS2010-05-0357 - Tendon Gallery.pdf
RS2012-07-0029 Tendon Gallery.pdf
RS2013-12-0132 CAV 2-6 valve alley.pdf
RS2014-01-0007 IB AB MUT-RMA-6 area-119 ft map.pdf
RS2014-01-0031 AB IB HPI-rainforest.pdf

6.3.3.11 Maintenance Support Building

Description and Historical Use

The MSB is inside the RCA, southwest of the Reactor Building (Figure 3 and Figure 12). Activities that occurred in this facility included work on Reactor Coolant Pump motors, Rx Head Stud cleaning, RCP seal rebuild, and non destructive examination (NDE) on RVCH Tripod. Additionally, contamination was identified (RS08-07-0012) on the floor attributable to contaminated scaffolding that was being stored in the building. In February of 2009, AR00319845 was written to document the fact that fixed contamination was found on a support girder. The MSB includes an HP office and a former HP calibration lab.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

The MSB and all the SSCs contained within are preliminarily classified as a MARSSIM Class 1 structure based on the discussion above and the fact that the building has been an RCA throughout the station operating years. Therefore, the building has a high potential for containing residual radioactive material, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

AR00319845 Fixed Contamination Found in MSB Support Girder.pdf
AR00351509 MSB - Contamination Found in a Clean Area.pdf
RS_CR3-M-20160130-2 MSB.pdf

6.3.3.12 Nuclear Administration Building

Description and Historical Use
The NAB is a two-story office structure located within the PA, but outside of the RCA. The NAB is located north of the PAB/TSC and is depicted on Figure 3 and Figure 12.

Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Building Materials
- Concrete
- Steel

Preliminary Classification
The NAB and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents
RS2016-02-0005 Routine_z03.pdf

6.3.3.13 Nuclear Security Operations Center

Description and Historical Use

The NSOC is the point of access for personnel into the PA. The building is located on the south side of West Powerline Street, northeast of the NAB (Figure 3 and Figure 12).

The only radioactive material that was utilized in the building were sealed sources used to perform calibrations/checks of the exit portal monitors and Ni-63 sources in the Security explosive detector monitors. Additionally, there have been alarms of the portal monitors due to individuals that had been administered radiopharmaceuticals. Follow up and routine surveys have not identified contamination in the facility. However, because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

The NSOC and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

RS2016-02-0005 Routine_z03.pdf

6.3.3.14 OTSG Storage Facility

Description and Historical Use

The OTSGs and portions of the hot leg piping were replaced in Refuel Outage 16. The original OTSGs and portions of the hot leg piping are considered as solid waste only and are stored in a separate containment building designed and built (reference Engineering Change 63043) to specifically house the original OTSGs and portions of the hot leg piping until plant decommissioning. This facility is located outside the CR3 PA (Figure 3 and Figure 12). The building was designed as a Seismic Class III structure, with reinforced walls, roof and floor, to meet the radiation dose criteria to operating personnel and the general public, as outlined in 10CFR20.1301.

The OTSGs are wrapped for contamination control, and surveys associated with the OTSGs have not shown contamination on the outside of the package or within the facility. Planning is currently underway to prepare the OTSGs for shipment, and the forthcoming work will involve cutting the radioactive piping, which will result in a potential for the spread of contamination. Additionally, once the OTSGs have been shipped offsite, the Reactor Vessel Closure Head, currently stored in the RVCH Storage Facility, will be brought into the OTSG Storage Facility for processing (segmentation) prior to shipment. This activity will also have a high potential for contaminating the OTSG Storage Facility.

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and TRUs. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

The OTSG Storage Facility is preliminarily classified as a MARSSIM Class 1 structure due to the discussion above, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.3.15 Plant Administration Building-Technical Support Center

Description and Historical Use
The PAB was built in the 1989 – 1991 timeframe to provide additional office space within the PA. The PAB encompassed the existing TSC (Figure 3 and Figure 12).

Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification
The PAB and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents
RS2016-02-0005 Routine_z03.pdf

6.3.3.16 Reactor Building

Description and Historical Use

The Reactor Building is a cylindrical reinforced concrete structure bearing on a sound foundation (Figure 3 and Figure 12). The foundation slab is reinforced with conventional steel reinforcing. The cylindrical walls are pre-stressed with a post-tensioning tendon system in the vertical and horizontal directions. The dome roof is pre-stressed utilizing a three-way, post-tensioning tendon system. The inside surface of the Reactor Building is lined with a carbon steel liner to ensure a high degree of leak-tightness for containment.

Several samples of Reactor Building concrete taken during hydro-demolition and attempted delamination repair efforts were radiologically analyzed. Several of the samples showed low levels of Tritium (13.4 - 47.6 pCi/gm).

The Reactor Building houses the Reactor Pressure Vessel, Steam Generators, Reactor Coolant Pumps, the Reactor Coolant Pressurizer, the Refueling Cavity, the Transfer Canal, the Reactor Building Sump and other ancillary components.

A quarterly routing survey, conducted in June 2014 shows a reasonable estimate of current conditions inside the Reactor Building. The Reactor Building is currently posted as an RCA and Radiation Area, with smaller areas within posted as LHRA, HRA, and CA. Survey information for the Reactor Building is contained in Table 6.

Table 6: Reactor Building Survey Information

Area or Component	Dose Rate (mR/hr)
95' general area (G/A)	<1-8
Letdown Line Outside D-Rings	*800/250
RB Sump	12-80
SFV-83 (sump area)	*140/30
119' G/A	<1
160' G/A	<1-2
180' G/A	<1-1.5
'A' D-Ring G/A 95'	1-*8/5
'A' D-Ring 95' to 180' Ladders & Platforms	0.5-20
RCV-25	*250/60
RCV-35	*200/100
RCV-21	*4/1
'B' D-Ring G/A 95'	3-6
Letdown Line Inside D-rings	*170/80
'B' D-Ring 95' to 180' Ladders & Platforms	<1 -5
RCV-41	*40/10
Top of Pressurizer	*100/50
Bottom of pressurizer	*150/60
Pressurizer Spray Line	*100/50

Area or Component	Dose Rate (mR/hr)
Pressurizer Surge Line	*200/70
'Old' Letdown Cooler Room (LDCR)	10-300
'New" LDCR	2-6
Reactor Coolant Drain Tank	<1-2
'A' Core Flood Rm	<1
'B' Core Flood Rm	<1
Reactor Cavity – Shallow End	2-20
Reactor Cavity Deep End	80-*3000/800
* denotes contact reading, otherwise general area	

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, Tritium, and TRUs. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification

The Reactor Building and all SSCs within it are preliminarily classified as a MARSSIM Class 1 structure due to the fact that the building has been an RCA throughout the station operating years, has a high potential for containing residual radioactive material, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples of building sumps

Supporting Documents

Containment Wall Concrete Samples.xlsx
RS Reactor-Aux-Intermediate Bldg.docx
RS_CR3-M-20140617-1 Reactor Bldg Routine.pdf
RS_CR3-M-20150511-3 RB Upper Cavity.pdf
RS2009-10-2195 CTMT SG Opening for R16.pdf
RS2011-12-0137 Concrete Samples.pdf
RS2012-01-0120 Concrete Samples.pdf
RS2012-11-0057 Letdown Cooler Room.pdf
RS2012-12-0030 Letdown Cooler Room.pdf

RS2013-03-0151 Letdown Line outside D-rings.pdf
RS2013-12-0225 Letdown Line outside d-rings.pdf

6.3.3.17 Reactor Building Spray Tank Room

Description and Historical Use
The Reactor Building Spray Tank Room is a structure located adjacent to and north of the BWST (Figure 3 and Figure 12). The building was part of the original plant construction and houses 2 Building Spray Tanks and associated components.

Historically, this room has been located within the RCA on the South Berm. From time to time the area immediately outside the door to this room would be radiologically released from the RCA to support work on tendons.

Known and Potential Contaminants
The ROCs are those categorized as Gammas, HTD&Betas, and Tritium. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Building Materials
- Concrete
- SSCs
- Steel

Preliminary Classification
The Reactor Building Spray Tank Room and all SSCs within it are preliminarily classified as a MARSSIM Class 1 structure based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration could exceed the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents
RS2012-08-0129 Building Spray Tank Room.pdf

6.3.3.18 RMSW D

Description and Historical Use

The RMSW D is a converted oil tank located outside of the PA and west of Units 1 & 2 (Figure 2 and Figure 11). Approximately one half of the warehouse was utilized to store radioactive material contained within SeaLand containers, LSA boxes and 55-gallon drums. An area constructed of concrete block walls was utilized to store higher dose rate items. Surveys of the facility never detected contamination (loose or fixed) on the warehouse floors and walls. This warehouse underwent a free release survey in Aug-Sept of 2009, prior to turning the warehouse over to the fossil organization. Survey CR3-M-20140903-5 identified one spot with fixed contamination (14K DPM/Area Under Probe (AUP)), which was subsequently mechanically removed. Resurveys of the area verified that no contamination remained.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Concrete
- Steel

Preliminary Classification

RMSW D is preliminarily classified as a MARSSIM Class 2 structure because it formerly stored radioactive material, and the presumption that if residual radioactivity is present, it will not be at concentrations expected to exceed the site release criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof

Supporting Documents

RS_CR3-M-20140808-3 RMSW D - Survey for Release.pdf
RS_CR3-M-20140812-3 RMSW D - Survey for Release.pdf
RS_CR3-M-20140812-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140813-6 RMSW D - Survey for Release.pdf
RS_CR3-M-20140814-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140815-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140819-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140820-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140829-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140903-5 RMSW D - Survey for Release.pdf
RS_CR3-M-20140905-4 RMSW D - Survey for Release.pdf
RS_CR3-M-20140910-2 RMSW D - Survey for Release.pdf

6.3.3.19 RMSW G

Description and Historical Use

RMSW G is located outside of the PA, south of the Maintenance Training Facility (Figure 3 and Figure 12). The area around the building was formerly fenced and is where contaminated turbine components were processed. These activities included use of a Sandblast Booth. No activities are ongoing in the formerly fenced area.

A series of free release surveys were performed in the February 2009 timeframe. One survey (RS99-02-0121) identified fixed contamination of 3K DPM/AUP. Two additional surveys (RS99-02-185 and RS99-02-0195) referred to areas as "previously contaminated".

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

RMSW "G" is preliminarily classified as a MARSSIM Class 2 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof

Supporting Documents

AR00752539 Trace Levels of Contamination Identified at the G RMSW.pdf
RS_CR3-M-20140412-1 RMSW G - Survey for Release.pdf
RS1999-02-0104 RMSW G - Survey for Release.pdf
RS1999-02-0121 RMSW G - Survey for Release.pdf
RS1999-02-0147 RMSW G - Survey for Release.pdf
RS1999-02-0161 RMSW G - Survey for Release.pdf
RS1999-02-0171 RMSW G - Survey for Release.pdf
RS1999-02-0185 RMSW G - Survey for Release.pdf
RS1999-02-0195 RMSW G - Survey for Release.pdf
RS1999-02-195 RMSW G - A Level Release.pdf

6.3.3.20 Rusty Building

Description and Historical Use

The Rusty Building is part of the original plant construction and served as the original Administration Building (Figure 3 and Figure 12). With construction of the NAB and PAB, the Rusty Building became an "overflow" office complex for project personnel during plant operations.

Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

The Rusty Building and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof

Supporting Documents

RS2016-02-0005 Routine_z03.pdf

6.3.3.21 RVCH Storage Facility

Description and Historical Use

The Reactor Vessel Closure Head (RVCH) and attached Control Rod Drive Mechanism (CRDM) Service Structure (CRDMSS) were replaced in Refuel Outage 13. The original RVCH is considered solid waste only, and is stored in a separate containment building designed and built (reference Engineering Change 50223) to specifically house the RVCH/CRDMSS until plant decommissioning. This facility is located outside the CR3 PA (Figure 3 and Figure 12). The building is designed as a Seismic Class III structure, with reinforced concrete walls, to meet the radiation dose criteria to operating personnel and the general public, as outlined in 10CFR20 Section 11.3.1.

The RVCH is wrapped for contamination control, and surveys associated with the RVCH have not shown contamination on the outside of the package or within the facility.

Planning is currently underway to transfer the RVCH to the OTSG Storage Facility for processing in support of shipping the components offsite for burial. Contamination control measures will be employed to prevent the spread of contamination during the transfer, however, should the measures prove ineffective and contamination is released from the RVCH package, the contamination will likely change the preliminary classification of the facility.

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and TRUs. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

The RVCH Storage Facility is preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

AR00108043 Old RVCH Containment Bag Leaked Water at Storage Building.pdf
RS2003-10-0916 RVCH Transport Leak.pdf

6.3.3.22 Security CAS Building

Description and Historical Use

The Security Central Alarm Station is a red, steel-sided, two-story office structure completed circa 2010. The building is located within the PA, but outside of the RCA north of the former Ready Warehouse and southwest of the PAB/TSC. The building is shown on Figure 3 and Figure 12.

The Security CAS Building is the location where closed circuit camera feeds and other security sensors are monitored and alarms initiated for a security breach. Radioactive material was not used or stored in this building, but because of its proximity to the power block there is the potential that trace levels of contamination may have accumulated in this building, primarily from airborne deposition on the roof and from the routine movement of personnel and equipment between buildings.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Steel

Preliminary Classification

The Security CAS Building and all SSCs within it are preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.3.23 Sewage Treatment Plant

Description and Historical Use

The Sewage Treatment Plant is located outside of the southwest corner of the PA, north of the Intake Canal (Figure 3 and Figure 12). The plant processes domestic wastewater from CR Units 1, 2 and 3 in accordance with a permit issued by the FDEP. A sand filter formerly used to filter treated effluent before it was discharged to the Settling Ponds has been removed. Sludge from the system is disposed periodically in an off-site landfill.

There have been several condition reports (AR00107680, AR00259995, PC9904219, and PC9904557) documenting instances where plant derived radioactive material was identified in the sewage, albeit at very low levels. The presence of radioactive material was attributed to low levels (i.e. below detection limits) of contamination on outage workers who subsequently showered prior to leaving site. The drains from the showers are routed to the sewage treatment plant. The low levels of radioactive material would accumulate in the sludge which was surveyed prior to release from the site.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Concrete
- Steel

Preliminary Classification

The Sewage Treatment Plant is preliminarily classified as a MARSSIM Class 3 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the structure interior surfaces
- Radiological analysis of concrete samples to assess volumetric contamination
- Radiological analysis of sediment samples

Supporting Documents

AR00107680 Contaminated Sewage Sludge.pdf
AR00259995 Treated Sewage from Unit 1 and 2 Low Level Contamination.pdf
PC9904219 Sludge from Unit 1 &2 Sewage Treatment Plant is Contaminated with Cobalt-58.pdf
PC9904557 Detectable Radioactivity Found in the Sewage Treatment Plant.pdf

6.3.3.24 Turbine Building

Description and Historical Use

The Turbine Building is located north of the Reactor Building and Intermediate Building (Figure 3 and Figure 12). The Turbine Building houses the Turbine Generator and associated auxiliaries, including the Condensers, Feedwater System, and Condensate Water Treatment System.

CR3 operated with primary to secondary leaks through the steam generator tubes and as a result, contamination was transported to various systems within the Turbine Building. These systems were identified in procedure RSP-101 (Enclosure 3) and controlled as Administratively Established RCAs. The systems identified in RSP-101 are:

- All Steam Systems
  - Main and Reheat Steam [MS & RH]
  - Extraction Steam [EX]
  - Auxiliary Steam [AS]
  - Feedwater System [FW]
  - Feedwater Heater Drains [HD]
  - Feedwater Heater Reliefs, Vents, and Drains [HV]
  - Miscellaneous Turbine Room Steam Drains [MS & SD]
  - Turbine Gland Steam and Drains [GS]
  - Steam Generator Blowdown/Sample Lines
- Secondary side laundry drains
- Condensate [CD] System up to and including the Condensate Demineralizers [CX] and Regeneration [SD]
- Turbine Building Sump
- Nitrogen [NG] System
- Hydrogen [HY] System
- Service Water [SW] System
- Secondary Services Cooling [SC] System
- Industrial Cooling [CI] System
- Air Removal System [AR]
- Raw Water System upstream of RM-L2

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and Tritium. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Materials
- Concrete
- Filters
- Resins
- SSCs
- Steel

Preliminary Classification

Except as noted below, the Turbine Building and all SSCs within it are preliminarily classified as a MARSSIM Class 2 structure based on the discussion above, and the presumption that if residual radioactivity is present, its concentration could exceed the acceptance criteria.

The Turbine Building Sump, the Steam Generator Blowdown System, the Service Water System, the leading edge of the Main Turbine Blades, the Main Steam System valve packing and tank drains, and sludge from the Main Condenser are preliminarily classified as MARSSIM Class 1 SSCs due to a high potential for localized areas of residual radioactivity that could exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building interior
- Direct measurements and contamination surveys of the building roof
- Direct measurements and contamination surveys of the Turbine Building Sump, Main (high and low pressure) Turbine Blades, and Steam Generator Blowdown System
- Radiological analysis of roofing material samples to determine volumetric contamination
- Radiological analysis of sediment samples from the Turbine Building Sump
- Radiological analysis of sediment samples from the Main Condenser

Supporting Documents

AR00069477 Contamination Found Inside Raw Water Piping.pdf
AR00601863 'A' OTSG Secondary Leakage has Increased.pdf
RS2009-10-0057 145' Turbine Bldg HDV-507-508.pdf
RS2009-10-0058 145' Turbine Bldg MSR-3A Crossover.pdf
RS2009-10-0064 145' Turbine Bldg Crossover Pipe.pdf
RS2009-10-0073 N2 Line 119' Turbine Bldg.pdf
RS2009-10-0082 Cold Machine Shop MSV-24.pdf
RS2014-05-0040 Turbine Sump Sludge.pdf

6.3.3.25 Units 1 and 2

Description and Historical Use

CR1/2, designed and built as coal-fired stations, began commercial operation in 1966 and 1969, respectively, prior to and during construction of CR3. The locations of CR1/2 are shown on Figure 3 and Figure 12.

CR1/2 and CR3 share some of the onsite commodities. All three units withdraw cooling water from the intake canal, and discharge to both the discharge canal and the Settling Ponds. CR3 gets its start-up steam from CR1/2 and as such does not have an Auxiliary Boiler. Finally, CR1/2 and CR3 all share the Sewage Treatment Plant.

Known and Potential Contaminants

The ROCs are those categorized as Gammas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Building Surfaces
- Roofing Materials
- Asphalt
- Concrete
- Filters

Preliminary Classification

The exterior surfaces (walls and roof) of CR1/2 are preliminarily classified as a MARSSIM Class 3 structure based on the fact that the units are in the predominant downwind direction of CR3. As such, deposition of plant derived radioactivity may be present on these surfaces. If residual radioactivity is present, it is presumed that its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the building exterior
- Direct measurements and contamination surveys of the building roof
- Direct measurements and contamination surveys of concrete and asphalt surfaces around the facility
- Direct measurements and contamination surveys of the ventilation intake components
- Radiological analysis of roofing material samples to determine volumetric contamination

Supporting Documents

None

6.3.4 Exterior Area

6.3.4.1 Area Surrounding RMSW G

Description and Historical Use

RMSW G is located outside of the PA, south of the Maintenance Training Facility (Figure 3 and Figure 12). The area around the building was formerly fenced and is where contaminated turbine components were processed. These activities included use of a Sandblast Booth. No activities are ongoing in the formerly fenced area.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Asphalt
- Soil

Preliminary Classification

The area surrounding the RMSW G is preliminarily classified as a MARSSIM Class 2 area, based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the ground surfaces
- Radiological analysis of asphalt and soil samples to determine volumetric contamination

Supporting Documents

AR00368569 Leakage from Drum of Turbine Building Sump Material.pdf
RS_CR3-M-20150416-2 RMSW G Yard - Survey for Release.pdf
RS_CR3-M-20150601-5 RMSW G Yard - Survey for Release.pdf
RS_CR3-M-20150602-4 RMSW G Yard - Survey for Release.pdf
RS1997-09-0335 Turbine Parts-Kelly Bldg.pdf
RS1998-02-0144 Tb Parts Survey Results.pdf
RS1999-02-0252 Turbine Parts Area-Sand Blast.pdf
RS1999-03-0128 Turbine Parts.pdf
RS1999-03-0197 Turbine Parts.pdf
RS1999-03-317 Turbine Parts.pdf
RS1999-04-0004 Turbine Parts.pdf
RS1999-04-0076 Turbine Parts.pdf
RS1999-04-0117 Turbine Parts.pdf
RS1999-04-0228 Turbine Parts.pdf
RS1999-04-144 Turbine Parts.pdf
RS2013-07-0233 RMSW G Outside.pdf

6.3.4.2 Decon Tent Area

Description and Historical Use

The Decon Tent Area is north of the OTSG Storage Building where a decontamination tent had been erected for use during the 2009 Steam Generator Replacement Outage (Figure 3 and Figure 12). The tent was allowed to remain after the outage, but has since been removed. The Decon Tent was a posted RCA, and contained posted Contamination Areas. The floor of the Decon Tent was constructed of stainless steel plate.

In 2013 and 2014, surveys were performed on land areas outside and below (following tent removal) the Decon Tent. Smears, direct frisk, and soil samples demonstrated that there was no contamination outside or below the tent.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Asphalt
- Soil

Preliminary Classification

The Decon Tent Area is preliminarily classified as a MARSSIM Class 2 area, based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the ground surfaces
- Radiological analysis of asphalt and soil samples to determine volumetric contamination

Supporting Documents

RS2009-10-8137 Decon Tent Area.pdf
RS2009-10-8137 Decon Tent.pdf
RS2009-12-8068 Decon Tent.pdf
RS2009-12-8192 Decon Tent.pdf
RS2013-03-0037 Decon Tent.pdf
RS2013-07-0224 Decon Tent Down Post.pdf
RS2014-04-0151 Decon Tent Area Soil Samples.pdf

6.3.4.3 East Berm

Description and Historical Use
The East Berm encompasses the area east of the Maintenance Shops and the Auxiliary Building (Figure 4 and Figure 13).

The East Berm was utilized during outages for placement of a laundry cleaning facility and served as a travel path for material being brought out of and into the hot machine shop.

In the 1979 and 1980 timeframe there were two events where core flood water was cross-tied to the Nitrogen system resulting in contamination going to the Nitrogen and Hydrogen Storage Area. The Nitrogen system piping that became contaminated during these events was abandoned in place, however, it was never removed from this area. An event in July, 2010 (AR00411245) was written to document the release of radioactive water outside of the RCA, when a piece of the nitrogen piping was cut outside of the Turbine Building Roll Up Door. Soil samples taken in the area showed low levels of Co-60 and Cs-137. The contaminated soils were remediated and resurveyed until radioactivity was no longer above detectable levels.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Asphalt
- Soil
- Piping

Preliminary Classification
The East Berm is preliminarily classified as a MARSSIM Class 2 area, based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the ground surfaces
- Radiological analysis of asphalt and soil samples to determine volumetric contamination

Supporting Documents
AR00411245 Contamination Outside RCA.pdf
RS2010-07-0236 Nitrogen Line Excavation (East Berm).pdf
RS2010-07-0244 N2 Line Cut Outside Tb Bldg (East Berm).pdf

6.3.4.4 Nitrogen and Hydrogen Storage Area

Description and Historical Use

The Nitrogen and Hydrogen Storage Area is inside the railroad loop, west of the Paint Shack (Figure 3 and Figure 12). The area was contaminated on two occasions by leaks that developed when the nitrogen pipeline was mistakenly cross-tied with a line associated with the core flood system. The nitrogen and hydrogen storage tanks have been removed, however the concrete pads and system piping remain.

The two occurrences are detailed in NCOR79-0258 and Unusual Operating Event Report (UOER) 4-80. The second event resulted much higher levels of activity being discovered in the area. The report indicates that a soil sample was measured with 1.2E-02 uCi/g. The area was remediated and resurveyed until radioactivity was no longer above detectable levels.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Concrete
- Soil

Preliminary Classification

The Nitrogen and Hydrogen Storage Area is preliminarily classified as a MARSSIM Class 2 area, based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

- Direct measurements and contamination surveys of the ground surfaces
- Radiological analysis of concrete and soil samples to determine volumetric contamination

Supporting Documents

NCOR779-0258, Radioactive Spill outside the RCA (Core Flood_N2 Line Event).pdf
NCOR79-0258, Core Flood - N2 Event (discusses Piping inside Tb Bldg).pdf
UOER 4-80, Radioactivity through N2 Supply Header to Tank Farm.PDF

6.3.4.5 North Berm

Description and Historical Use
The North Berm is within the PA and encompasses the area north of the Transformer Bays and the Rusty Building (Figure 4 and Figure 13). This area was never used to store RAM, and there is no history of events involving leaks or spills of radioactive liquids.

This area, however, was subject to the routine movement of personnel and equipment.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Asphalt
- Soil
- Piping

Preliminary Classification
The North Berm is preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the ground surfaces
- Radiological analysis of concrete, asphalt, and soil samples to determine volumetric contamination

Supporting Documents
None

6.3.4.6 Protected Area Ground Surfaces

Description and Historical Use
This section is a catch-all for ground surfaces within the PA that are not contained within any of the four identified berm areas. The areas include the asphalt-paved area / roadway extending from the NSOC up to the East Berm, the Security Sally Ports, concrete walkways around and between the NAB and the PAB, as well as the landscaped areas.

The areas encompassed within this category were not used to store radioactive material. However, these areas are within the PA and subject to the routine movement of personnel and equipment between buildings. The Sally Ports were used to inspect vehicles transporting RAM into and out of the PA.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Asphalt
- Soil

Preliminary Classification
The Protected Area Ground Surfaces, with the exception of the two Security Sally Ports, are preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria. The two Security Sally Ports are classified as MARSSIM Class 2 areas based on the discussion above, and the presumption that if residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps
- Direct measurements and contamination surveys of the ground surfaces
- Radiological analysis of concrete, asphalt, and soil samples to determine volumetric contamination.

Supporting Documents
None

6.3.4.7 R16 Shipping Yard

Description and Historical Use

The R16 Shipping Yard, also referred to as the North Shipping Yard, is located north of CR3, north of the Switch Yard and outside the PA (Figure 2 and Figure 11). This area was used as a RAM shipment staging area during Refuel Outage #16. A release survey (RS13-07-0285) was performed in July, 2013, which consisted of a gamma walkover survey and five (5) soil samples. The soil samples were isotopically analyzed to environmental LLDs and did not identify any plant derived activity. The values were consistent with the values obtained during a baseline survey (RS09-06-0266) conducted in June of 2009, prior to use of the area.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Soil

Preliminary Classification

The R16 Shipping Yard is preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Gamma walkover survey to identify any areas with elevated activity
- Radiological Analysis of soil samples taken in areas with elevated activity, if any

Supporting Documents

RS2009-06-0266 R16 Storage Yard - Baseline Survey.pdf
RS2013-07-0285 R16 Shipping Yard - Down Post.pdf
RS2013-07-0285 R16 Shipping Yard.pdf

6.3.4.8 SeaLand Container Storage Area

Description and Historical Use

The SeaLand Container Storage Area is located outside of the PA and inside of the railroad loop (Figure 3 and Figure 12). Radioactive material was stored in the containers but they have all been removed from the area.

This area was used as a sealand container storage area during Refuel Outage #16. A release survey (RS10-07-0090) was performed in July, 2010, which consisted of a gamma walkover survey and five (5) soil samples. The soil samples were isotopically analyzed to environmental LLDs and did not identify any plant derived activity. The dose rates in the area were higher, but consistent with background levels, than the values obtained during a baseline survey (RS09-05-0244), conducted in May of 2009, prior to use of the area. Soil samples taken as part of the release survey following use of the area, failed to identify plant derived material when counted to environmental LLDs.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Soil

Preliminary Classification

The SeaLand Container Storage Area is preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Gamma walkover survey to identify any areas with elevated activity
- Radiological Analysis of soil samples taken in areas with elevated activity, if any

Supporting Documents

RS2009-05-0244 Sealand Container Storage Yard.pdf
RS2010-07-0090 South Laydown Yard.pdf
South Laydown Yard.pdf

6.3.4.9 Settling Ponds

Description and Historical Use

The East and West Settling Ponds are located west of the PA, near the south bank of the Discharge Canal and west of the large circular tanks that formerly stored oil for CR1/2 (Figure 2 and Figure 11). Effluent from the Sewage Treatment Plant that serves Units 1, 2 and 3 is discharged to these ponds. Effluent from SDT-1 has also been discharged to the ponds on a few occasions when the effluent quality did not comply with the station's NPDES permit criteria.

In an ANI Inspection Report dated 15 May 2009, a recommendation was made to collect soil and vegetation samples from the banks of the ponds and analyze the samples for gamma emitting radionuclides. In response to this recommendation, samples have been obtained with the results reported as supplemental data in the annual REMP Reports. The data indicate a steadily decreasing concentration and are summarized in Table 7.

Table 7: Analytical Results for Soil and Vegetation Samples From the Settling Ponds

Year	Sample results (pCi/gm)
2009	0.190 – 0.299 (Cs137); 0.027 (Co-60)
2010	0.020 – 0.137 (Cs-137)
2011	0.076 – 0.097 (Cs-137)
2012	0.010 – 0.016 (Cs-137)
2013	0.006 – 0.008 (Cs-137)
2014	0.007 (Cs-137)

While DCGLs have yet to be determined, the NRC screening levels (NUREG-1757, Vol. 2), list values of 11 pCi/gm and 3.8 pCi/gm for Cs-137 and Co-60, respectively. These screening levels are significantly higher than the levels historically seen in Settling Pond soils/sediments.

Tritium was measured in 2014 in groundwater from two monitoring wells located on the north and south sides of the plant Settling Ponds at concentrations of 87 and 144 pCi/L. These detections have been attributed to discharges of the Station Drain Tank (SDT-1) to the Settling Ponds [11].

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and Tritium. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Soil

Preliminary Classification

The Settling Ponds are preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Radiological analysis of sediment and soil samples from within and around the ponds

Supporting Documents

AR00452489 Leakage Existed from SDT-1 to the Settling Pond.pdf
AR00579415 CP0161, Rev 7, REMP.pdf
OP-407N SDT-1 release 223729.TIF
PC98903279 Unplanned Release of Condensate Water at CR1 & 2 from the Settling Pond Release Flow Path Pipe.pdf
Setting Pond Survey Results.pdf
settling pond data.msg
SETTLING POND SOIL.pdf
SP0736F Release Rev 18.TIF
SP0736F Release Rev 4.TIF
SP0736F to pond 584130.TIF
SP0736K hydro demolition Rev 2.TIF
SP0736K hydro demoliton Rev 1.TIF
SP736F SDT-1 to pond 582798.TIF

6.3.4.10 South Berm

Description and Historical Use
The South Berm encompasses the area inside the PA and south of the Fire Service Pump House, Reactor Building, Auxiliary Building and the Emergency Diesel Generator Building (Figure 4 and Figure 13). During the life of the plant a large portion of the South Berm has been included in the Radiation Controlled Area due to the storage of RW, removal of the Equipment Hatch, and contamination events. A portion of the South Berm has never been included in the RCA.

There have been several events and related surveys that identified contamination in the RCA portion of the South Berm. The most notable event occurred in May 1978 which resulted when a line that was transferring primary resin from a storage tank inside the plant to a HIC on a transport vehicle outside of the plant ruptured and released spent resin to the ground. This event is captured in NCOR78-119 and LER No. 78-015/04T-1.

Known and Potential Contaminants
The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media
- Asphalt
- Soil
- Piping

Preliminary Classification
The South Berm area that has been included in the RCA is preliminarily classified as a MARSSIM Class 1 area based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration may exceed the acceptance criteria. That portion of the berm that has not been included in the RCA is preliminarily classified as a MARSSIM Class 2 area, because it borders the Class 1 area, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps
- Direct measurements of soil, asphalt, and concrete
- Radiological analysis of concrete and asphalt samples to determine volumetric contamination
- Radiological analysis of soil samples to determine volumetric contamination

Supporting Documents
AR00316860 Discrete Radioactive Particle Found at OSB Demobilization Area.pdf
AR00362812 Radioactive Material Outside of the Primary RCA.pdf
AR00401623 Fixed Contamination on Concrete in RCA Back Berm.pdf
AR00560532 Trace Levels of Contamination Found Outside the RCA Inside PA.pdf
RS_CR3-M-20160131-2 Berm.pdf

RS_CR3-M-20160131-2 South Berm.pdf
RS1978-05-12 S. Berm Asphalt Following Resin Spill.pdf
RS2000-01-10B8 - Excavation of Light Pole.TIF
RS2001-10-0576 FTI Boxes for Shipment (South Berm).pdf
RS2001-10-0612 DRP MSB Berm.TIF
RS2008-10-0026 - Excavation of Light Pole.TIF
RS2009-03-0185 S Berm Slab B Soil Samples.pdf
RS2010-05-0050 South Berm Fixed Contam.pdf
RS2010-05-0050_001 south berm fixed contam.pdf
RS2010-05-0371 - South Berm - RCA Downsize.pdf
RS2012-09-0097 Crane Dunnage (South Berm).pdf
RS2012-09-0101 Crane Dunnage (South Berm).pdf
RS2013-04-0210 South Berm Storm Drain.pdf
s-berm storm drain isotopic.pdf

6.3.4.11 Station Drain Tank Effluent Pipe Leak Area

Description and Historical Use

The Station Drain Tank Effluent Pipe Leak was located on the side of the roadway between CR1/2, south of the Discharge Canal (Figure 2 and Figure 11). The contents of the tank normally was routed to the Discharge Canal, except when sampling of the tank indicated that its contents did not meet the discharge criteria in the CR3 NPDES permit. Under those circumstances the tank contents would be discharged to the Settling Ponds west of CR1/2 by way of an eight-inch diameter fiberglass pipeline that runs along the roadway. The pipe runs underground from CR3 to the point where it joins the effluent pipe from the Sewage Treatment Plant for Units 1, 2 and 3.

In June 2001, the underground portion of the pipeline on the side of the roadway between CR1/2 was damaged while excavating in the area. Discharge through the pipe was not occurring at the time of the pipe break but stagnant water drained from the broken pipe into the excavation. A vacuum truck removed the standing water in the excavation and transported it to the Settling Ponds. After review of the discharge permit for the last discharge through the pipeline it was determined that the spill did not create a radiological or non-radiological environmental impact.

A previous leak in the piping from SDT-1 was discovered in April 1998 on the West Berm. The leak was underground and occurred at a pipe elbow that had been improperly glued and fitted at the time of installation. Although the pipe joint apparently had been leaking since the time of plant startup both CR3 and the FDEP determined that no significant environmental impact resulted.

Known and Potential Contaminants

The ROCs are those categorized as Gammas, HTD&Betas, and Tritium. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Soil
- Drain Pipes

Preliminary Classification

The Station Drain Tank Effluent Pipe Leak Area is preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

- Gamma walkover survey to identify any areas with elevated activity
- Radiological Analysis of soil samples taken in areas with elevated activity

Supporting Documents

10 CFR 75(g)_HPP0230_1999.PDF

6.3.4.12 Storm Water Retention Ponds

Description and Historical Use

There are two storm water retention ponds: Storm Water Retention Pond A, north of the railroad tracks and west of RMSW G, and Storm Water Retention Pond B, south of the railroad tracks and southeast of Storm Water Retention Pond A (Figure 3 and Figure 12). Retention Pond A collects storm water from the Swamp Area.

A third pond, the Spill Retention Basin, is located south of the railroad tracks and directly south of Storm Water Retention Pond A (Figure 3). The Spill Retention Basin receives drainage from Storm Water Retention Pond A. A control structure in the Spill Retention Basin allows overflow to Storm Water Retention Pond B.

In 2010 Spill Retention Pond A was being modified for increased runoff from the planned construction of the ISFSI. Low levels of Cs-137 above background (maximum of 5.65 E-7 μCi/g) were found. About 200 cubic yards was shipped offsite as radwaste.

Storm Water Retention Pond B and the Spill Retention Basin were also modified and excavated in 2010 and 2011. Over 100 samples of the excavated soil were taken and counted to environmental MDAs. No licensed material was identified.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Beta. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Sediment
- Soil

Preliminary Classification

Storm Water Retention Pond A is preliminarily classified as a MARSSIM Class 2 area based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria. Storm Water Retention Pond B and the Spill Retention Basin are preliminarily classified as MARSSIM Class 3 based on the fact that they communicate with Pond A, and sampling has not identified the presence of plant derived material.

Data Gaps

- Gamma walkover survey to identify any areas with elevated activity
- Radiological Analysis of soil samples taken in areas with elevated activity

Supporting Documents

RS1998-02-0144 Tb Parts Survey Results.pdf
RS2010-11-0221 Composite Sand Pile Ease of SAB.pdf
RS2010-11-0226 Pond B Retention Area.pdf
RS2010-11-0236 Pond B Outside Townsend Work Area.pdf

RS2010-11-0322 MTF Extension and Pond B.pdf
RS2010-12-0101 Pond B Outlet Structure.pdf
RS2010-12-0118 Pond A.pdf
RS2010-12-0134 Pond A.pdf
RS2010-12-0224 Retention Pond.pdf
RS2010-12-0245 Pond B.pdf
RS2010-12-0312 Pond A.pdf
RS2010-12-0327 Pond B Outlet Spillway.pdf
RS2011-03-0357 Spillway.pdf
RS2011-05-0179 ISFSI Jack&Bore and Railroad Tracks.pdf

6.3.4.13 Swamp Area

Description and Historical Use

The Swamp Area is in the eastern portion of the PA, south of the PAB/TSC and east of the East Berm (Figure 3 and Figure 12). The ISFSI currently is under construction in the Swamp Area. This area of the station is approximately 21 feet lower in elevation than the buildings of the power block, which are on the Berm. Stormwater from the East Berm is collected in two catch basins and discharged to the Swamp Area.

Radioactivity attributable to runoff from the east berm has been identified in soil samples in the western portion of the Swamp Area. Although soil has been removed from this area and shipped offsite as RW, the scope of the cleanup activities was not meant to remove all impacted soils from the area.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Sediment
- Soil

Preliminary Classification

The Swamp Area is preliminarily classified as a MARSSIM Class 2 area based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

Supporting Documents

AR00320618 Trace Levels of Licensed Material Inside PA (Swamp).TIF
RS_CR3-M-20150204-1 - Swamp.pdf
RS_CR3-M-20150217-2 - Swamp.pdf
RS_CR3-M-20150223-3 - Swamp.pdf
RS_CR3-M-20150226-4 - Swamp.pdf
RS2000-10-0024 Soil Samples from Swamp.pdf

6.3.4.14 Unit 4 and 5 Coal Ash Storage Area

Description and Historical Use

Unit 4 and 5 Coal Ash Storage Area is a large coal ash storage area east of Units 4 and 5 (Figure 2 and Figure 11). Sediment dredged from the Settling Ponds was deposited in a portion of this area. While licensed material has been identified in Settling Pond sediment, the concentrations have been very low relative to anticipated dose based DCGLs based on a reasonable pathway model.

Known and Potential Contaminants

The ROCs are those categorized as Gammas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Soil

Preliminary Classification

The Unit 4 and 5 Coal Ash Storage Area is preliminarily classified as a MARSSIM Class 3 area based on the discussion above, and the presumption that if residual radioactivity is present, its concentration will not exceed a small fraction of the acceptance criteria.

Data Gaps

Radiological analysis of soil samples, from below the ash pile in the specific area where Settling Pond sediments were placed, to determine volumetric contamination.

Supporting Documents

None

6.3.4.15 West Berm

Description and Historical Use

The West Berm encompasses the area inside the PA and west of the Turbine Building and Intermediate Building (Figure 4 and Figure 13). The west berm contains SDT-1, CDT-1, and the two Fire Service Water Tanks.

During the period of the station operation, there have been several events involving SDT-1 which resulted in contamination on the west berm. Additionally, this area is the location where water slap and sludge lancing trailers were placed during outages.

Known and Potential Contaminants

The ROCs are those categorized as Gammas and HTD&Betas. The ROCs may be revised based upon more definitive data collected during site characterization activities.

Potentially Contaminated Media

- Asphalt
- Soil
- Piping

Preliminary Classification

The West Berm area is preliminarily classified as a MARSSIM Class 2 area based on the discussion above, and the presumption that if localized residual radioactivity is present, its concentration is not likely to exceed the acceptance criteria.

Data Gaps

- Direct measurements of soil, asphalt, and concrete; especially around SDT-1.
- Radiological analysis of concrete and asphalt samples to determine volumetric contamination
- Radiological analysis of soil samples to determine volumetric contamination

Supporting Documents

AR00106444 SDT-1 Discharge Line Leak.pdf
AR00555078 Trace Rad Contamination Found in Excavated West Berm Trench.pdf
NCOR81-0186, SDT-1 Spill on Berm.pdf
NCOR81-0213, SDT-1 Spill on Berm.pdf
NCOR82-0067, Secondary Resin Spill outside the RCA.pdf
NCOR88-0139, Leakage of SDT-1 Contents to the Berm and Storm Drain.pdf
PC9802106 Leak in Discharge Piping from SDT-1 to Settling Ponds along West Berm.pdf
RS2012-08-0133 SDT-1 leak.pdf
RS2012-08-0133 SDT-1 leak.tiff
SDT-1 free release of solid material isotopic.pdf
SDT-1 Pipe.TIF

7 Conclusions

This HSA has been completed in accordance with guidance provided in NUREG-1575 (MARSSIM). As expected, operational activities at CR3 from initial power generation in March 1977 to the present have resulted in areas that have been impacted with radiological and/or non-radiological contaminants. A general conclusion that can be drawn from the record reviews, personnel interviews, and site walk-downs that were part of HSA development is that CR3 had an excellent operating history that has resulted in very low radiological and non-radiological impacts to the environment beyond the PA. No identified areas of contamination are a current or expected threat to human health or the environment that would warrant immediate corrective action, or appear to present a significant challenge for decommissioning.

In most cases, contamination was remediated immediately at the time of its discovery. Some incidents of contamination were not completely remediated at the time of discovery for one or more of the following reasons:

- the source of contamination was removed and residual contaminant concentrations were very low,
- screening data indicated that the measured contaminant levels did not present a risk to human health or the environment,
- the contamination was contained and managed within a structure,
- the contamination was inaccessible,
- the contaminants were not mobile in soil.

It should be noted that the HSA reflects the current radiological and non-radiological status of the site. Because the chosen decommissioning strategy is SAFSTOR, the information contained in the HSA will need to be evaluated with respect to the period of time that has elapsed when the next stages of decommissioning are initiated. As an example, the initial MARSSIM classification of SSCs and the environs will need to be reevaluated if characterization and FSS planning activities are initiated 40 years from now. The following conclusions are presented for consideration and to clearly state important observations.

- Known incidents of contamination were remediated immediately to reduce the risk to human health and the environment.
- As part of decommissioning planning, each area identified as potentially impacted will require further characterization as it becomes more accessible during decommissioning to determine the extent to which it may have been impacted, if at all.
- In order to reduce the size of the licensed footprint of the site, FSS quality surveys should be performed of the buildings/areas in accordance with MARSSIM guidance and regulatory awareness.
- No new impacted areas that were not previously known have been identified by this HSA.
- Where lead-based paint, ACM, or components containing mercury are present the areas are located within buildings, are not exposed to the environment and are being managed in accordance with site procedures. The current management

practices for these areas are sufficient to ensure the safety of site workers until the materials of concern are permanently removed from the station.

- Most of the large transformers located in transformer bays on the North Berm outside the Turbine Building have been drained of their dielectric oil and do not pose a continuing risk of non-radiological contamination.
- CR3 has implemented the guidance prescribed by NEI 07-07 (the Industry Groundwater Protection Initiative) and has established an on-going groundwater monitoring program.
- A hydrogeological investigation was undertaken in 2006 to install groundwater monitoring wells, determine groundwater gradients and probable flow paths, and characterize near-surface groundwater quality. These initiatives further strengthen the groundwater monitoring program.
- The horizontal component of groundwater flow in both unconsolidated sediments and bedrock beneath the site is generally to the southwest toward the Gulf of Mexico. Knowledge of groundwater flow patterns supports future decommissioning planning in terms of both managing groundwater intrusion to deep excavations and in evaluating the potential migration of plant-related radionuclides.
- Tritium, at very low levels, is the only plant-related radionuclide that has been identified in groundwater at CR3. Although this conclusion will be verified during future soil characterization activities, the absence of other plant-related radionuclides in groundwater indicates there will not be significant migration of plant-related radionuclides in on-site soils.

8 Recommendations

With completion of this HSA, the next task in the process prescribed in MARSSIM is to collect samples in the areas identified as potentially impacted and analyze the samples for the contaminants that past activities may have released. The characterization data will support design of the final status surveys for each building, structure, and land area that has been classified as impacted. Planning for this characterization phase should include consideration of the data gaps identified in Section 6.

Given that the decommissioning strategy is the SAFSTOR option, the next phases of the MARSSIM process described in Section 5.1 may not be initiated for approximately 40 years. It is recommended that an evaluation be performed to determine which characterization activities should be performed over the next several years to support decommissioning planning. The intent of these near-term characterization activities will be to identify the extent of contamination in SSCs and the environs and to then incorporate this information in planning and estimating costs for decommissioning activities planned in the future. An example of the benefits of strategic characterization activities in the near term is a more accurate estimate of contaminated soil and concrete volumes that will require disposal as either radiological or non-radiological waste.

As decommissioning of the station advances and areas become accessible, all areas of the site identified as potentially impacted should be evaluated to document current conditions and select appropriate remedial responses, if they are required. Characterization should include not only environmental media (soils, sediment and groundwater), but also building materials to determine whether or not radioactive or other hazardous materials are present and may potentially pose a risk to human health and safety or the environment during site-related activities. However, the extent of building characterization should depend on the anticipated end-state of the site at the time of license termination and site release. For example, if the buildings will be removed as waste prior to license termination, then the extent of their characterization need only be sufficient for waste disposal purposes rather than for the design of their final status survey(s).

To facilitate planning for decommissioning, CR3 should consider advancing core borings approximately 24 inches into selected concrete surfaces in the Auxiliary Building, Reactor Building and Intermediate Building. The total length of each concrete core should be divided into equal sections each approximately four inches long. A sample from each of the sections should be analyzed to determine its content of tritium and Carbon-14 and the depth to which these radionuclides have penetrated the concrete. This information will be useful in preparing an estimate of the volume of concrete that is contaminated at a concentration greater than the DCGLs for tritium and Carbon-14 and in estimating costs for waste disposal.

Subsurface soil and groundwater sampling should be conducted at Class 1 and NR Class 1 areas not contained within buildings. Several soil and groundwater samples from each area should be analyzed for the contaminants of concern and the results compared to appropriate DCGLs (in the case of radiological contaminants) or regulatory criteria (in the case of non-radiological contaminants) to determine the need for remediation. Screening of Class 2, NR Class 2, Class 3 and NR Class 3 areas to determine whether or not environmental contaminants are present should follow the same process as that used in Class 1 and NR Class 1 areas but may be less rigorous and require fewer sample analyses. In some areas characterization may be limited to sampling of containment surfaces, surface soil or groundwater from nearby existing monitoring wells.

While the existing array of CR3 groundwater monitoring wells is routinely sampled and analyzed for radiological constituents in support of the station REMP, no analyses have been completed to characterize the groundwater quality pertaining to non-radiological contaminants. At least one round of groundwater samples from the CR3 monitoring wells should be analyzed for non-radiological contaminants including petroleum constituents, solvents, PCBs and RCRA metals.

Material accumulated within the sediment traps at the bottom of storm drains should be sampled and analyzed for plant-related radionuclides and non-radiological contaminants such as petroleum constituents and RCRA metals. CR3 should consider additional sampling and analysis of sediment in the Discharge Canal near the station circulating water and Stormwater outfalls, in the Intake Canal near the Stormwater outfall (for non-radiological constituents) and at the Settling Ponds to determine whether or not radiological or non-radiological contamination of the sediments in these locations has occurred. This sampling and analysis would support planning for decommissioning of the station and license termination.

Monitoring of groundwater from CR3 monitoring wells has detected only tritium at very low levels above the lower limits of detection in these wells. CR3 has not produced power for approximately seven years and has been permanently defueled for approximately three years. The volume of radioactive liquids currently produced and processed is a small fraction of that produced when the plant was producing power. Accordingly, the risk of an incident that would cause significant soil or groundwater contamination occurring now or in the future is substantially reduced.

Monitoring of groundwater from plant monitoring wells currently required by the CR3 Radiological Environmental Monitoring Program should continue at its current frequency at least until all fuel is removed from the Spent Fuel Pool and the pool and associated systems are drained. At that time CR3 can consider a reduction in the frequency of groundwater monitoring during SAFSTOR and active decommissioning of the station.

An approach to reducing the size of the licensed footprint for those buildings and areas <u>not</u> classified as impacted would be to identify the area within the footprint with the maximum effluent particulate deposition (D/Q) in the predominant downwind direction. Once identified, a survey protocol can be developed in an attempt to demonstrate a negligible impact from site releases. The results could then be presented to the regulators as a partial site release package, in accordance with 10CFR50.83, as the basis for releasing other non-impacted areas.

9 Cited References

[1] U.S. Nuclear Regulatory Commission, U.S. Environmental Protection Agency, U.S. Department of Energy, and U.S. Department of Defense, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Rev 1," 2000.

NUREG-1575 (MARSSIM).pdf

[2] Florida Department of Environmental Protection, "62-520.400 Minimum Criteria for Ground Water".

62-520.400 Florida Minimum Criteria for Groundwater.doc
62-520.410 Florida Groundwater Classifications.doc
62-520.430 Florida Standards for Class G-III Groundwater.doc

[3] U.S. Nuclear Regulatory Commission, "10 CFR 50.75(g) Reporting and Recordkeeping for Decommissioning Planning," 2015.

10 CFR 75(g)_HPP0230-1Q2015.pdf
10 CFR 75(g)_HPP0230-2Q2014.PDF
10 CFR 75(g)_HPP0230-3Q2014.pdf
10 CFR 75(g)_HPP0230-4Q2014.pdf
10 CFR 75(g)_HPP0230-Annual Review_1-1-07_6-1-08.pdf
10 CFR 75(g)_HPP0230-CR3 Settling Pond.pdf
10 CFR 75(g)_HPP0230_1977.PDF
10 CFR 75(g)_HPP0230_1978.PDF
10 CFR 75(g)_HPP0230_1979.PDF
10 CFR 75(g)_HPP0230_1980.PDF
10 CFR 75(g)_HPP0230_1981.PDF
10 CFR 75(g)_HPP0230_1982.PDF
10 CFR 75(g)_HPP0230_1983.PDF
10 CFR 75(g)_HPP0230_1986.PDF
10 CFR 75(g)_HPP0230_1988.PDF
10 CFR 75(g)_HPP0230_1989.PDF
10 CFR 75(g)_HPP0230_1991.PDF
10 CFR 75(g)_HPP0230_1992.PDF
10 CFR 75(g)_HPP0230_1993.PDF
10 CFR 75(g)_HPP0230_1994.PDF
10 CFR 75(g)_HPP0230_1997.PDF
10 CFR 75(g)_HPP0230_1998.PDF
10 CFR 75(g)_HPP0230_1999.PDF
10 CFR 75(g)_HPP0230_2000.PDF
10 CFR 75(g)_HPP0230_2001.PDF
10 CFR 75(g)_HPP0230_2006.PDF

10 CFR 75(g)_HPP0230_2007.PDF
10 CFR 75(g)_HPP0230_2008.PDF
10 CFR 75(g)_HPP0230_2009.PDF
10 CFR 75(g)_HPP0230_2010.PDF
10 CFR 75(g)_HPP0230_2011.PDF
10 CFR 75(g)_HPP0230_2012.PDF
10 CFR 75(g)_HPP0230_2013.PDF

[4] Nuclear Energy Institute, "NEI 07-07 Industry Groundwater Protection Initiative," NEI, 2007.

NEI 07-07.pdf

[5] U.S. Nuclear Regulatory Commission, "10 CFR 50 DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES," 2015.

NRC Acknowledgement Letter of Permanent Cessation of CR3 Power Ops.pdf

[6] U.S. Fish and Wildlife Service, "National Wetlands Inventory".

USFWS National Wetlands Inventory.pdf

[7] Southeastern Geological Society, "Geology of Citrus County, Florida," 2014.

Geology of Citrus County_SEGS_2014.pdf

[8] Duke Energy Florida, "Final Safety Analysis Report, Crystal River Unit 3, Rev 35".

CR3 FSAR.pdf

[9] Gaydos Hydro Services LLC, "CR3 Groundwater Flow Study Summary Report," November 2012.

Gaydos_GW Flow Study Summary Report 12.5.12.pdf

[10] EnHydro LLC, "Groundwater Flow Study Report, Crystal River Unit 3," 2007.

CR3 Groundwater Flow Study Report-EnHydro-Jan2007 (1).pdf

[11] Duke Energy Florida, "Annual Radiological Environmental Operating Report, Crystal River Unit 3," 2014.

CR3 2010 Annual Radiological Environmental Operating Report.pdf

[12] Florida Department of Environmental Protection, "Drinking Water Standards".

FDEP Health Effects of Microbiological Contaminants - Drinking Water Program.pdf
FDEP Inorganic Contaminants - Drinking Water Program.pdf
FDEP Miscellaneous Contaminants - Drinking Water Program.pdf
FDEP Radionuclide Contamination - Drinking Water Program.pdf
FDEP Secondary Drinking Water Standards - Drinking Water Program.pdf
FDEP SoilCleanupTargetLevels.pdf
FDEP Synthetic Organic Contaminants - Drinking Water Program.pdf
FDEP Tank Database.xlsx
FDEP Tank Inventory.pdf
FDEP Tanks with Discharges.xlsx
FDEP Volatile Organic Chemical Contaminants - Drinking Water Program.pdf

[13] J. D. a. S. M. T. Fretwell, "Resistivity Study of a Coastal Karst Terrain, Florida," *Ground Water,* vol. Vol 19, no. No 2, March-April 1981.

Fretwell and Stewart_Resistivity Study of Coastal Karst_1981.PDF

[14] Crystal River Nuclear Power Station, "Crystal River Security Training Facility Shooting Range Environmental Stewardship Plan, Rev 00," March 2012.

Shooting Range Environmental Stewardship Plan.docx

[15] Duke Energy Florida, "Offsite Dose Calculation Manual (ODCM), Crystal River Unit 3, Rev 36".

CR3 ODCM.pdf

[16] Duke Energy Florida, "Annual Radiological Effluent Release Report, Crystal River Unit 3," 2014.

REMP 2014_final.pdf

[17] American Nuclear Insurers, "Nuclear Liability Insurance Inspection Report".

CR3 20090515 ANI Report.pdf

[18] Duke Energy Florida, "Spill Prevention, Control and Countermeasures Plant, Crystal River Unit 3".

CR3 SPCC 2012.pdf

10Appendices

A. Summary Table of Non-Radiological Areas

Table 8: Summary Table of Non-Radiological Areas

Potentially Impacted Area	Figure Number	Potential Contaminants	Preliminary Classification
Building or Structure			
Alternate AC Diesel Generator Building	3 & 8	Diesel Fuel Constituents	NR Class 2
Auxiliary Building	3 & 8	Asbestos, Lead, Mercury, and Petroleum Products	NR Class 3
Cable Trays and Duct Banks	Not Shown	Petroleum Constituents and RCRA Metals	NR Class 3
Dry Cleaning Facility	3 & 8	Solvents	NR Class 2
Emergency Diesel Generator Building	3 & 8	Diesel Fuel Constituents	NR Class 2
Emergency Feedwater Pump 3 Building	3 & 8	Diesel Fuel Constituents	NR Class 3
Fire Service Pump House	3 & 8	Diesel Fuel Constituents	NR Class 3
Maintenance Support Building	3 & 8	RCRA Metals, Hydraulic Oil, Oil-Soaked Rags, Petroleum Constituents, Lubricating Oil, and Spent Solvents	NR Class 2
Receiving Warehouse	3 & 8	Acids-Bases, Petroleum Products, Sodium Hypochlorite, Laboratory Chemicals, and Solvents	NR Class 3
RMSW D	2 & 7	Lubricating Oil and Petroleum Products	NR Class 3
RT Bunker	3 & 8	Lead and Asbestos	NR Class 1
Sewage Treatment Plant	(2;3) & 8	RCRA Metals	NR Class 3
Turbine Building	3 & 8	Asbestos, Lead, Mercury, and Petroleum Products	NR Class 3
Chemical and Drum Storage Areas			
CRP Grease Tanker and Drum Storage Area	3 & 8	Petroleum Constituents, RCRA Metals, and Volatile Organic Compounds	NR Class 3
Hazardous Material Storage Buildings	3 & 8	Acids-Bases, Waste Oil Constituents, Laboratory Chemicals, Oil-Soaked Rags, Universal Wastes, and Spent Solvents	NR Class 2
Issue Warehouse	3 & 8	Acids-Bases, Petroleum Products, Sodium Hypochlorite, Laboratory Chemicals, and Solvents	NR Class 3

Potentially Impacted Area	Figure Number	Potential Contaminants	Preliminary Classification
Exterior Area			
Area Surrounding RMSW G	3 & 8	RCRA Metals	NR Class 3
Construction Debris Dump	3 & 8	Petroleum Constituents, RCRA Metals, and Asbestos	NR Class 3
East Berm	4	Petroleum Constituents, RCRA Metals, and Solvents	NR Class 3
Firing Range	2 & 7	Lead	NR Class 1
North Berm	4	Petroleum Constituents and RCRA Metals	NR Class 3
Settling Ponds	2 & 7	Petroleum Constituents, RCRA Metals, Hydrazine, and Nalco	NR Class 2
South Berm	4	Petroleum Constituents, RCRA Metals, and Solvents	NR Class 3
Station Drain Tank Effluent Pipe Leak Area	2 & 7	Petroleum Constituents and RCRA Metals	NR Class 3
Storm Water Retention Ponds	3 & 8	Petroleum Constituents and RCRA Metals	NR Class 3
Swamp Area	3 & 8	Dielectric Oil, Petroleum Constituents, and RCRA Metals	NR Class 2
Switch Yard	(2;3) & (7;8)	Dielectric Oil	NR Class 3
Unit 4 and 5 Coal Ash Storage Area	2 & 7	Petroleum Constituents and RCRA Metals	NR Class 3
West Berm	4	Petroleum Constituents and RCRA Metals	NR Class 3
Oil-Filled Mechanical Equipment			
Auxiliary Building Elevator	Not Shown	Hydraulic Oil	NR Class 3
Conference and Cafeteria Building Elevator	Not Shown	Hydraulic Oil	NR Class 3
Control Complex Elevator	Not Shown	Hydraulic Oil	NR Class 3
Feedwater Pump Motors	Not Shown	Lubricating Oil	NR Class 3
Nuclear Administration Building Elevator	Not Shown	Hydraulic Oil	NR Class 3
Plant Administration Building-Technical Support Center Elevator	Not Shown	Hydraulic Oil	NR Class 3
Reactor Building Elevator	Not Shown	Hydraulic Oil	NR Class 3
Reactor Coolant Pump Motors	Not Shown	Lubricating Oil	NR Class 3
Site Wide Impacts			
Asbestos Containing Material	Not Shown	Asbestos	NR Class 1
Lead and Lead-Based Paint	Not Shown	Lead	NR Class 1
Mercury-Containing Components	Not Shown	Mercury	NR Class 1
Storm Drain System	6 & 10	Petroleum Constituents, RCRA Metals, and Dielectric Oil	NR Class 2
Storage Tanks			
B.5.b Diesel Water Pump Fuel Tank	5 & 9	Diesel Fuel Constituents	NR Class 3

Potentially Impacted Area	Figure Number	Potential Contaminants	Preliminary Classification
DFT-1A	5 & 9	Diesel Fuel Constituents	NR Class 1
DFT-1B	5 & 9	Diesel Fuel Constituents	NR Class 1
DFT-4	5 & 9	Diesel Fuel Constituents	NR Class 3
DFT-5	5 & 9	Diesel Fuel Constituents	NR Class 2
Diesel Generator A Fuel Day Tank	5 & 9	Diesel Fuel Constituents	NR Class 3
Diesel Generator B Fuel Day Tank	5 & 9	Diesel Fuel Constituents	NR Class 3
EHC Fluid Tank	Not Shown	Electrohydraulic Control Fluid	NR Class 3
Fire Service Pump A Fuel Tank	(3;5) & (8;9)	Diesel Fuel and Petroleum Constituents	NR Class 3
Fire Service Pump B Fuel Tank	(3;5) & (8;9)	Diesel Fuel and Petroleum Constituents	NR Class 3
Hydrazine Feed Tank	Not Shown	Hydrazine	NR Class 3
IAP-4	5 & 9	Diesel Fuel Constituents	NR Class 3
LOT-1	5 & 9	Lubricating Oil Constituents	NR Class 1
LOT-2	5 & 9	Lubricating Oil Constituents	NR Class 2
MET-1	5 & 9	Diesel Fuel Constituents	NR Class 1
MET-2	5 & 9	Diesel Fuel Constituents	NR Class 3
NSOC Diesel Generator Fuel Tank	5 & 9	Diesel Fuel Constituents	NR Class 3
Poly Tanks	Not Shown	Petroleum Constituents and RCRA Metals	NR Class 3
SDT-1	5 & 9	RCRA Metals, Petroleum Constituents, and Hydrazine	NR Class 2
Turbine Building Sump Oil and Water Separator	Not Shown	Petroleum Constituents and RCRA Metals	NR Class 3
Transformers			
Concrete Batch Plant Transformers	2 & 7	Dielectric Oil	NR Class 3
Maintenance Training Facility Transformer	5 & 9	Dielectric Oil	NR Class 3
MTSH-3HA	5 & 9	Dielectric Oil	NR Class 3
MTSH-3HB	5 & 9	Dielectric Oil	NR Class 3
MTTR-1	5 & 9	Dielectric Oil	NR Class 3
MTTR-2	5 & 9	Dielectric Oil	NR Class 3
MTTR-3A	5 & 9	Dielectric Oil	NR Class 3
MTTR-3B	5 & 9	Dielectric Oil	NR Class 3
MTTR-3C	5 & 9	Dielectric Oil	NR Class 3
MTTR-3D	5 & 9	Dielectric Oil	NR Class 3
MTTR-6	5 & 9	Dielectric Oil	NR Class 3
MTTR-7	5 & 9	Dielectric Oil	NR Class 2
Off Site Power Transformer	2 & 7	Dielectric Oil	NR Class 2

B. Summary Table of Radiological Areas

Table 9: Summary Table of Radiological Areas

Potentially Impacted Area	Figure Number	Potential Contaminants	Preliminary Classification
Building or Structure			
Alternate AC Diesel Generator Building	3 & 12	Gammas and HTD&Betas	Class 3
Auxiliary Building	3 & 12	Gammas, HTD&Betas, Tritium, and TRUs	Class 1
Control Complex	3 & 12	Gammas and HTD&Betas	Class 3
Discharge Structure	3 & 12	Gammas, HTD&Betas, and Tritium	Class 2
Emergency Diesel Generator Building	3 & 12	Gammas and HTD&Betas	Class 3
Emergency Feedwater Pump 3 Building	3 & 12	Gammas and HTD&Betas	Class 3
Emergency Feedwater Tank Building	3 & 12	Gammas and HTD&Betas	Class 3
Fire Service Pump House	3 & 12	Gammas and HTD&Betas	Class 3
Intake Structure	3 & 12	Gammas and HTD&Betas	Class 3
Intermediate Building	3 & 12	Gammas, HTD&Betas, and Tritium	Class 1
Maintenance Support Building	3 & 12	Gammas and HTD&Betas	Class 1
Nuclear Administration Building	3 & 12	Gammas and HTD&Betas	Class 3
Nuclear Security Operations Center	3 & 12	Gammas and HTD&Betas	Class 3
OTSG Storage Facility	3 & 12	Gammas, HTD&Betas, and TRUs	Class 1
Plant Administration Building-Technical Support Center	3 & 12	Gammas and HTD&Betas	Class 3
Reactor Building	3 & 12	Gammas, HTD&Betas, Tritium, and TRUs	Class 1
Reactor Building Spray Tank Room	3 & 12	Gammas, HTD&Betas, and Tritium	Class 1
RMSW D	2 & 11	Gammas and HTD&Betas	Class 2
RMSW G	3 & 12	Gammas and HTD&Betas	Class 2
Rusty Building	3 & 12	Gammas and HTD&Betas	Class 3
RVCH Storage Facility	3 & 12	Gammas, HTD&Betas, and TRUs	Class 2
Security CAS Building	3 & 12	Gammas and HTD&Betas	Class 3
Sewage Treatment Plant	3 & 12	Gammas and HTD&Betas	Class 3
Turbine Building	3 & 12	Gammas, HTD&Betas, and Tritium	Class 2
Units 1 and 2	3 & 12	Gammas	Class 3
Exterior Area			
Area Surrounding RMSW G	3 & 12	Gammas and HTD&Betas	Class 2
Decon Tent Area	3 & 12	Gammas and HTD&Betas	Class 2
East Berm	4 & 13	Gammas and HTD&Betas	Class 2
Nitrogen and Hydrogen Storage Area	3 & 12	Gammas and HTD&Betas	Class 2
North Berm	4 & 13	Gammas and HTD&Betas	Class 3
Protected Area Ground Surfaces	Not Shown	Gammas and HTD&Betas	Class 3
R16 Shipping Yard	2 & 11	Gammas and HTD&Betas	Class 3
SeaLand Container Storage Area	3 & 12	Gammas and HTD&Betas	Class 3

Potentially Impacted Area	Figure Number	Potential Contaminants	Preliminary Classification
Settling Ponds	2 & 11	Gammas, HTD&Betas, and Tritium	Class 3
South Berm	4 & 13	Gammas and HTD&Betas	Class 1
Station Drain Tank Effluent Pipe Leak Area	2 & 11	Gammas, HTD&Betas, and Tritium	Class 3
Storm Water Retention Ponds	3 & 12	Gammas and HTD&Betas	Class 2
Swamp Area	3 & 12	Gammas and HTD&Betas	Class 2
Unit 4 and 5 Coal Ash Storage Area	2 & 11	Gammas	Class 3
West Berm	4 & 13	Gammas and HTD&Betas	Class 3
Site Wide Impacts			
Storm Drain System	6 & 14	Gammas and HTD&Betas	Class 3

C. Document Figures

Figure 1: Location of Crystal River Energy Center

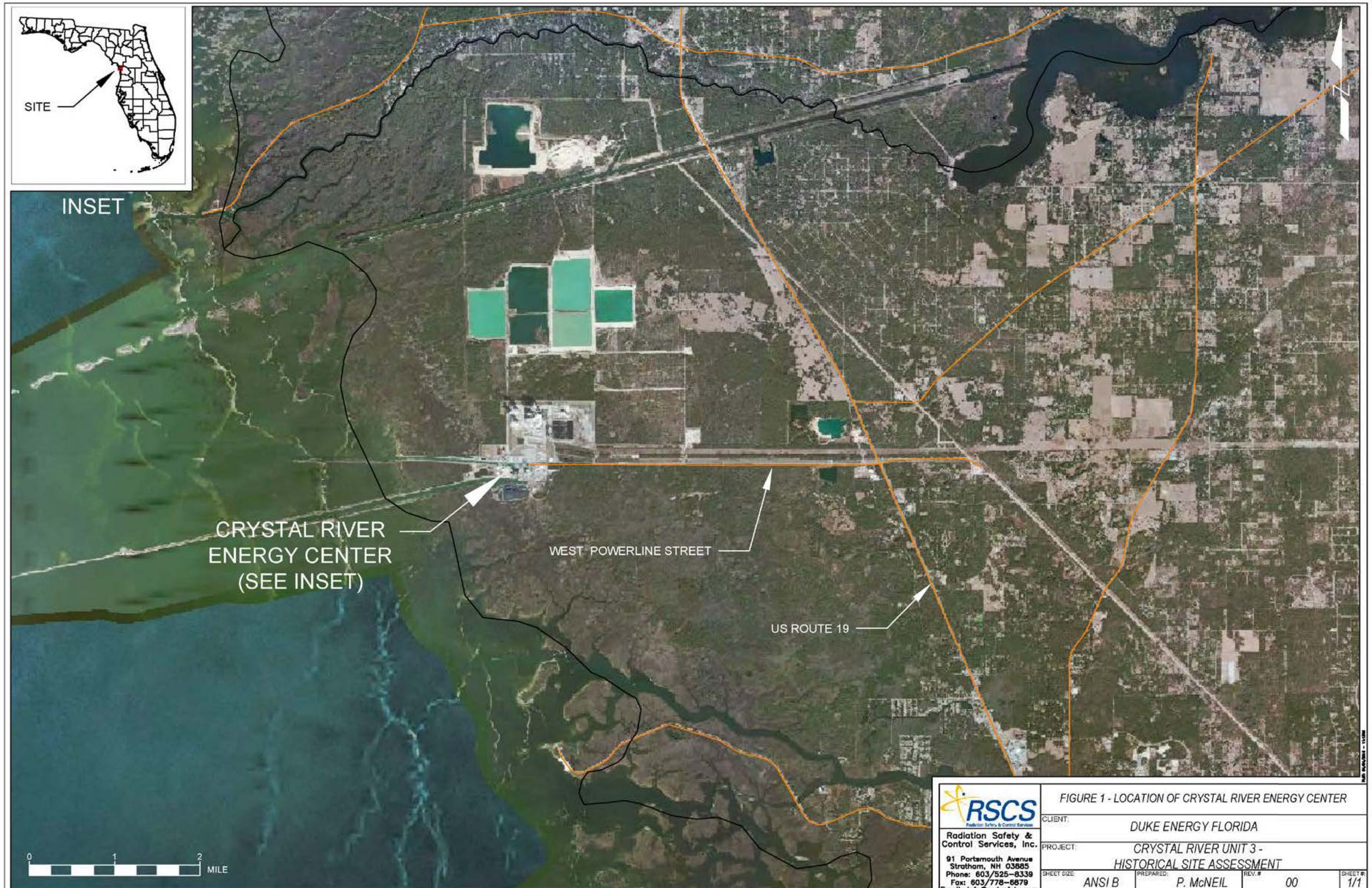


Figure 2: Crystal River Energy Center Facilities

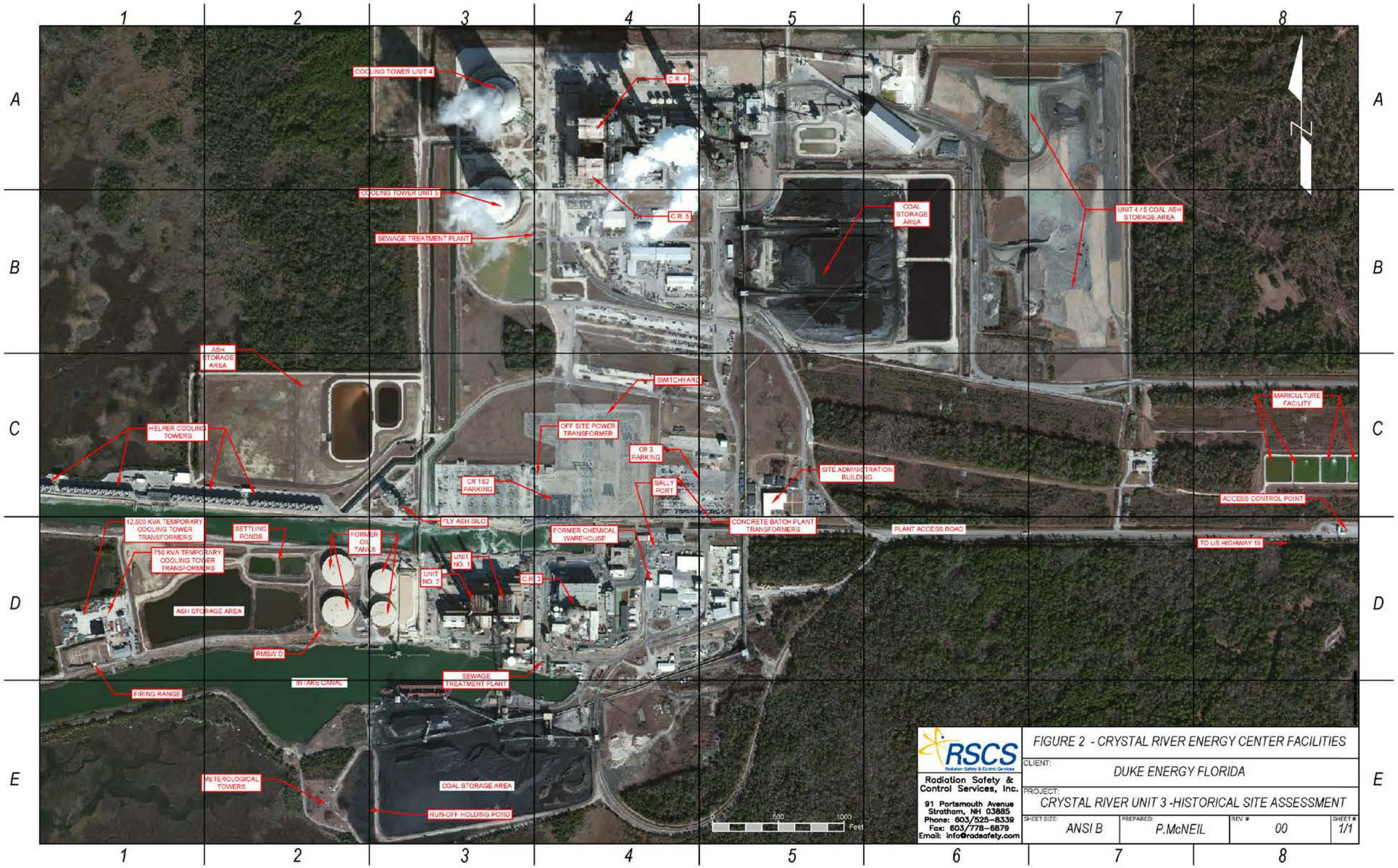


Figure 3: Crystal River Unit 3 Facilities

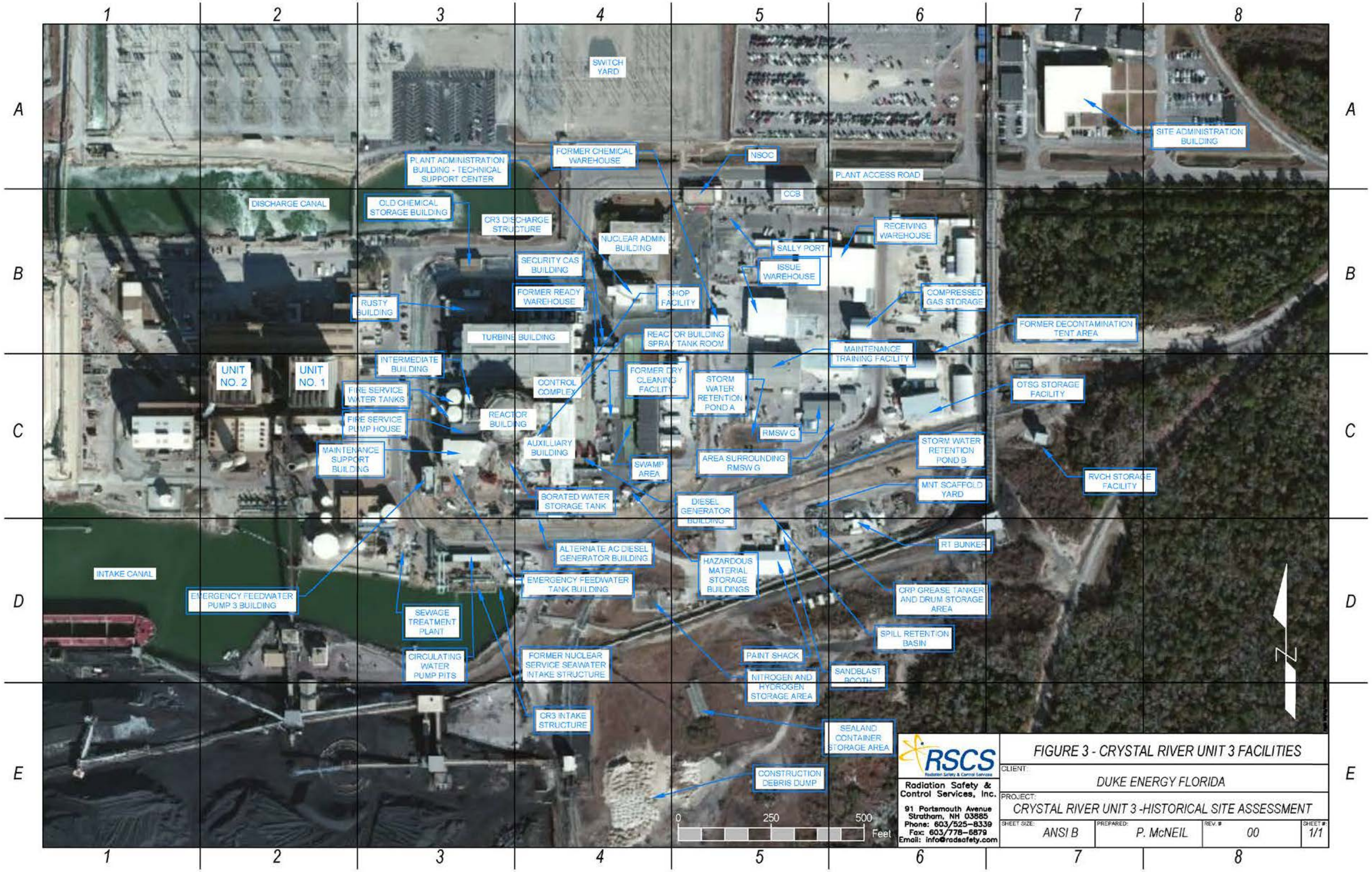


Figure 4: Crystal River Unit 3 Berm Areas

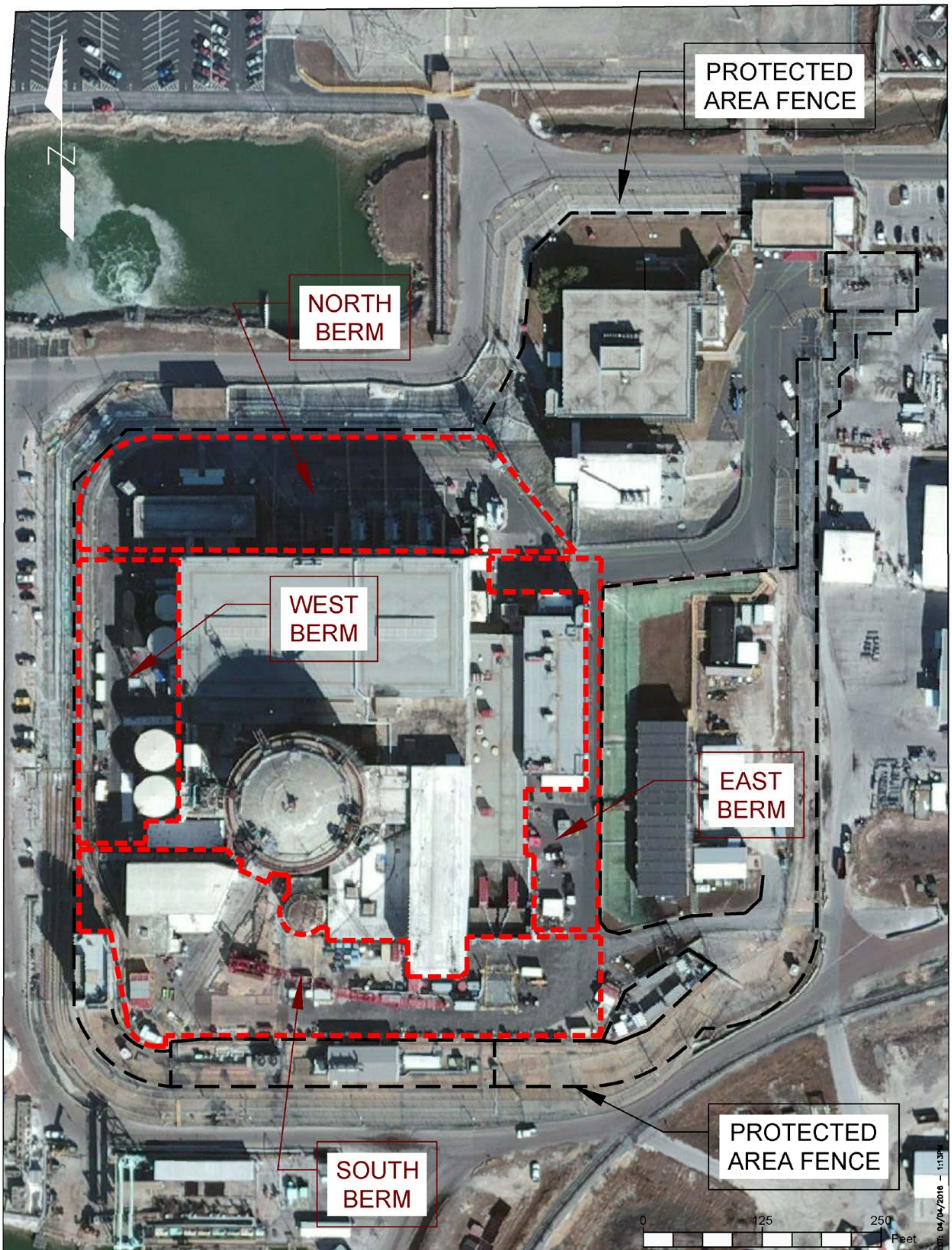


FIGURE 4 - CRYSTAL RIVER UNIT 3 BERM AREAS			
CLIENT: DUKE ENERGY FLORIDA			
PROJECT: CRYSTAL RIVER 3 - HISTORICAL SITE ASSESSMENT			
SHEET SIZE: ANSI B	PREPARED: G. PAIVA	REV. #: 00	SHEET #: 1/1

RSCS
Radiation Safety & Control Services
Radiation Safety & Control Services, Inc.
91 Portsmouth Avenue
Stratham, NH 03885
Phone: 603/525-8339
Fax: 603/778-6879
Email: info@radsafety.com

Figure 5: Crystal River Unit 3 Petroleum Storage and Transformer Locations

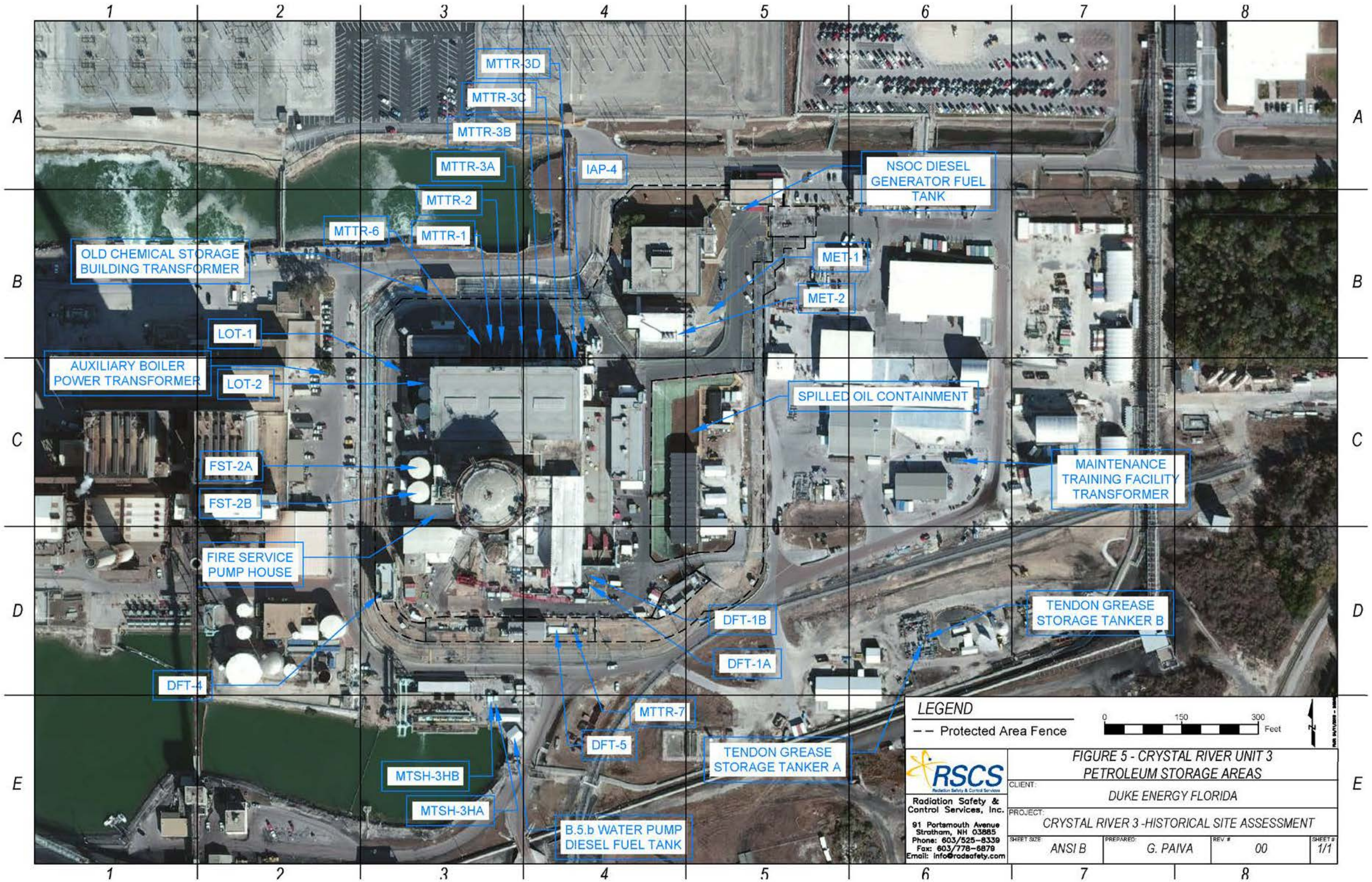


Figure 6: Crystal River Unit 3 Storm Drain Locations Within the Protected Area

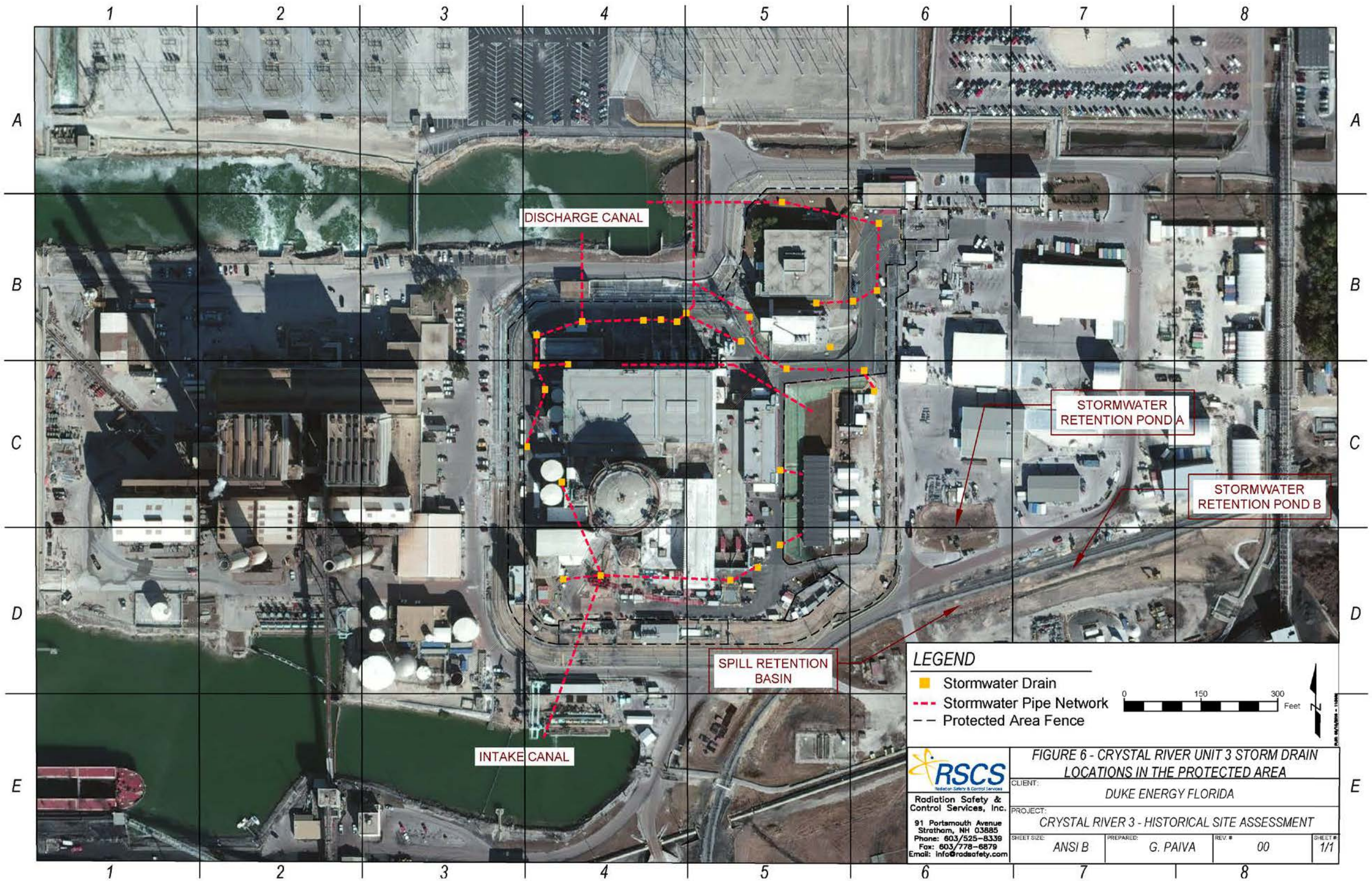


Figure 7: Crystal River Unit 3 Preliminary Classifications of Non-Radiological Impacts in Outlying Areas of the Station

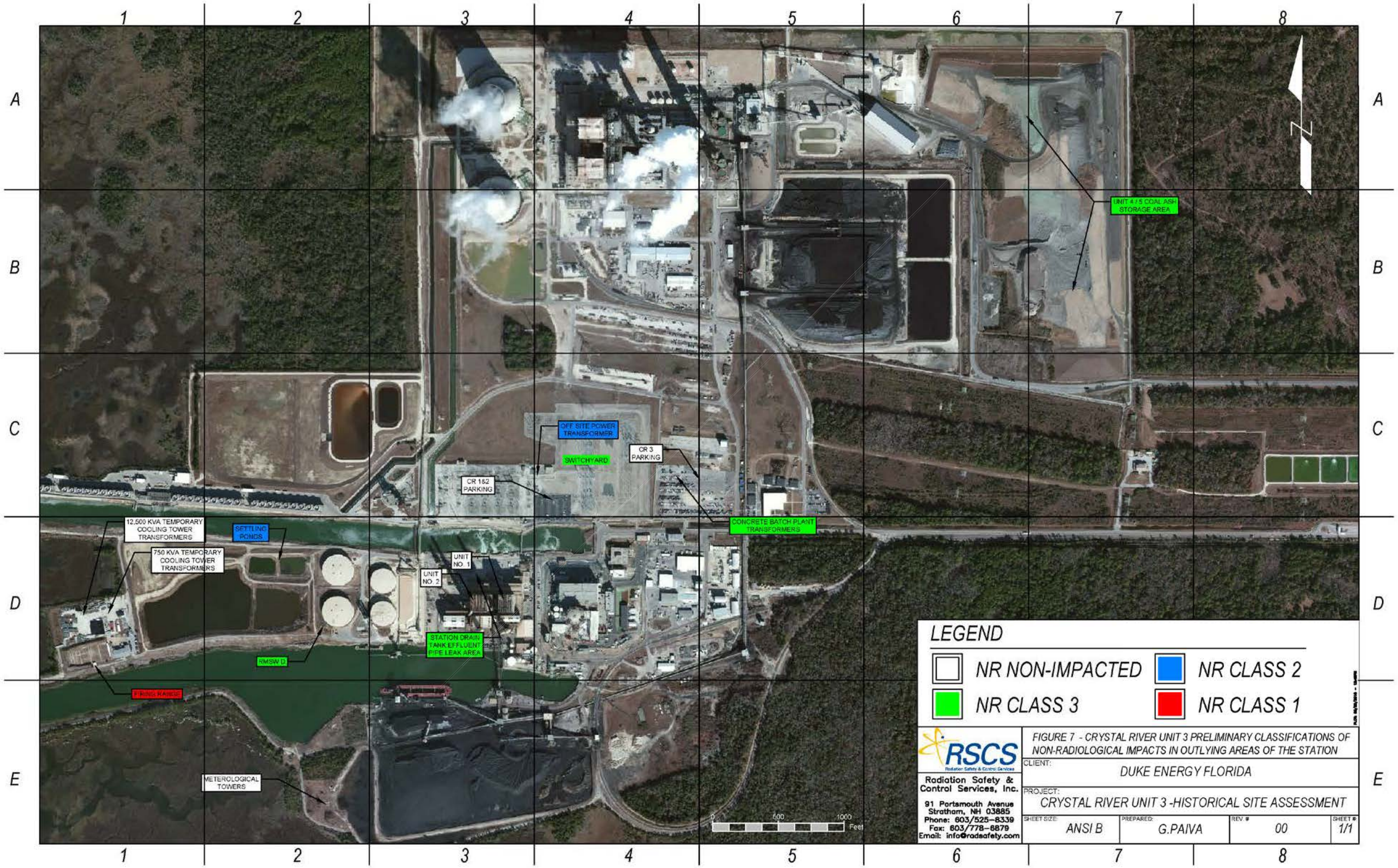


Figure 8: Crystal River Unit 3 Preliminary Classifications of Non-Radiological Impacts in the Vicinity of the Protected Area

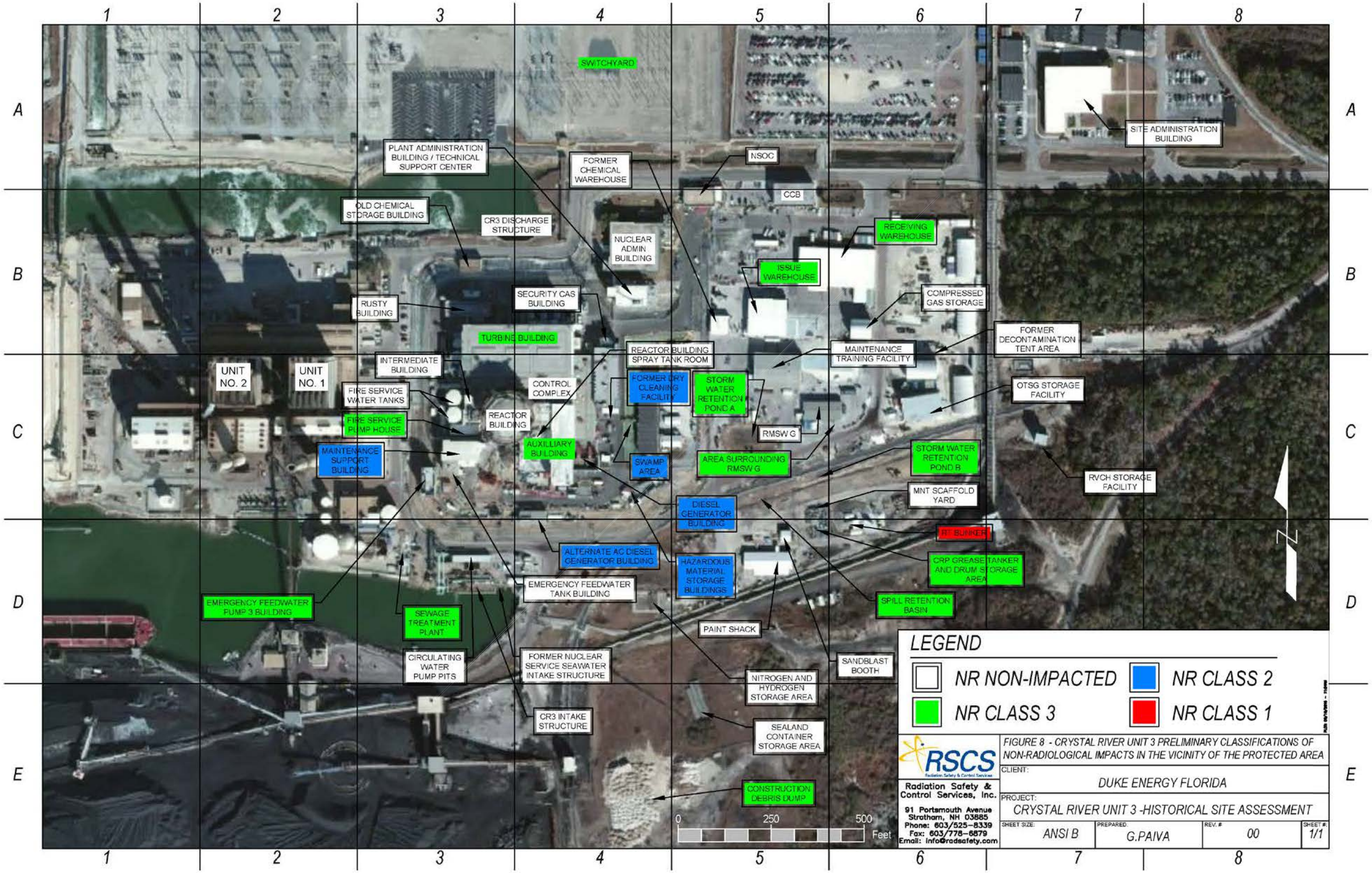


Figure 9: Crystal River Unit 3 Preliminary Classifications of Non-Radiological Impacts in the Vicinity of Storage Tanks and Transformers

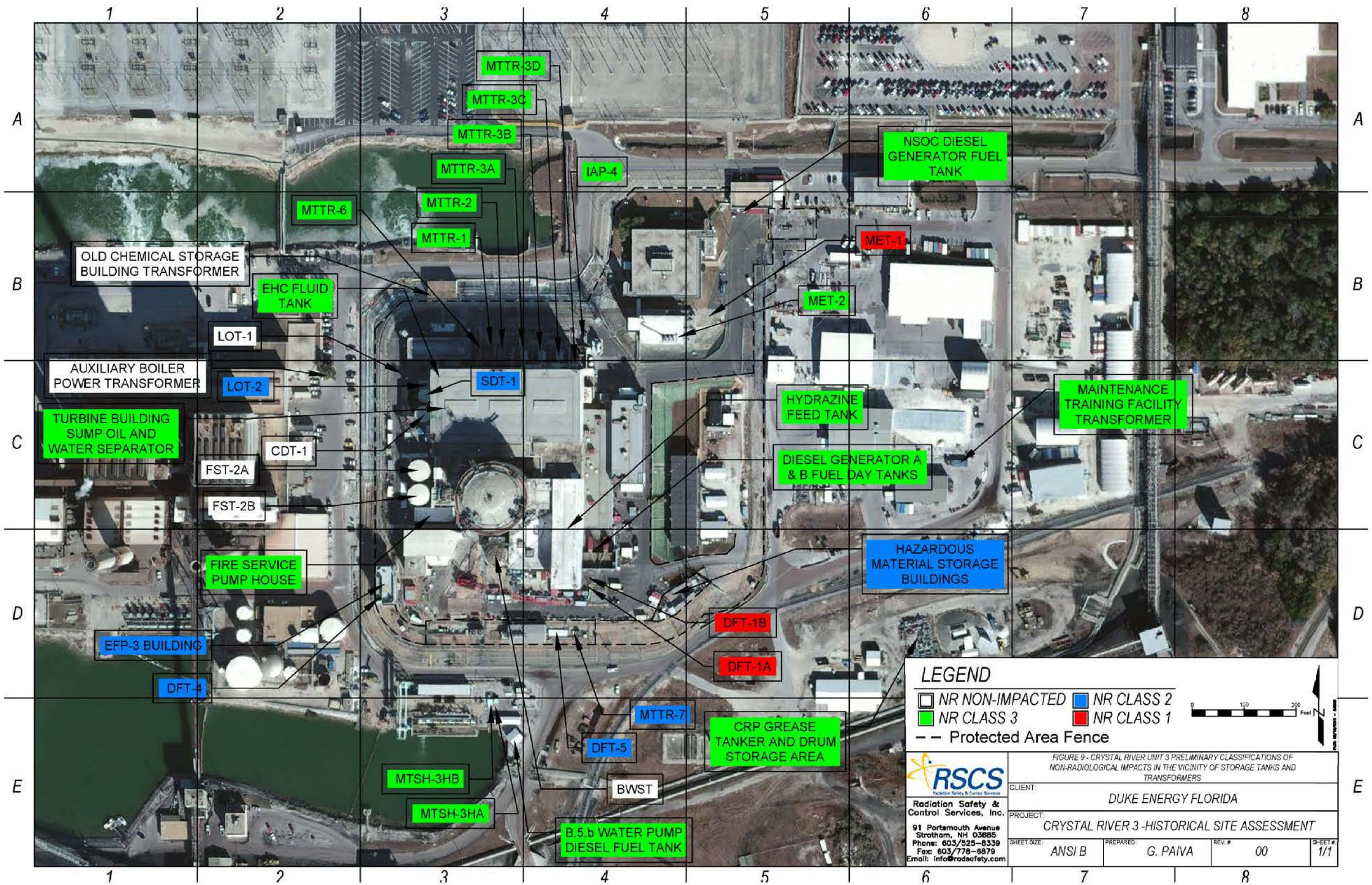


Figure 10: Crystal River Unit 3 Preliminary Classifications of Non-Radiological Impacts in the Storm Drain System

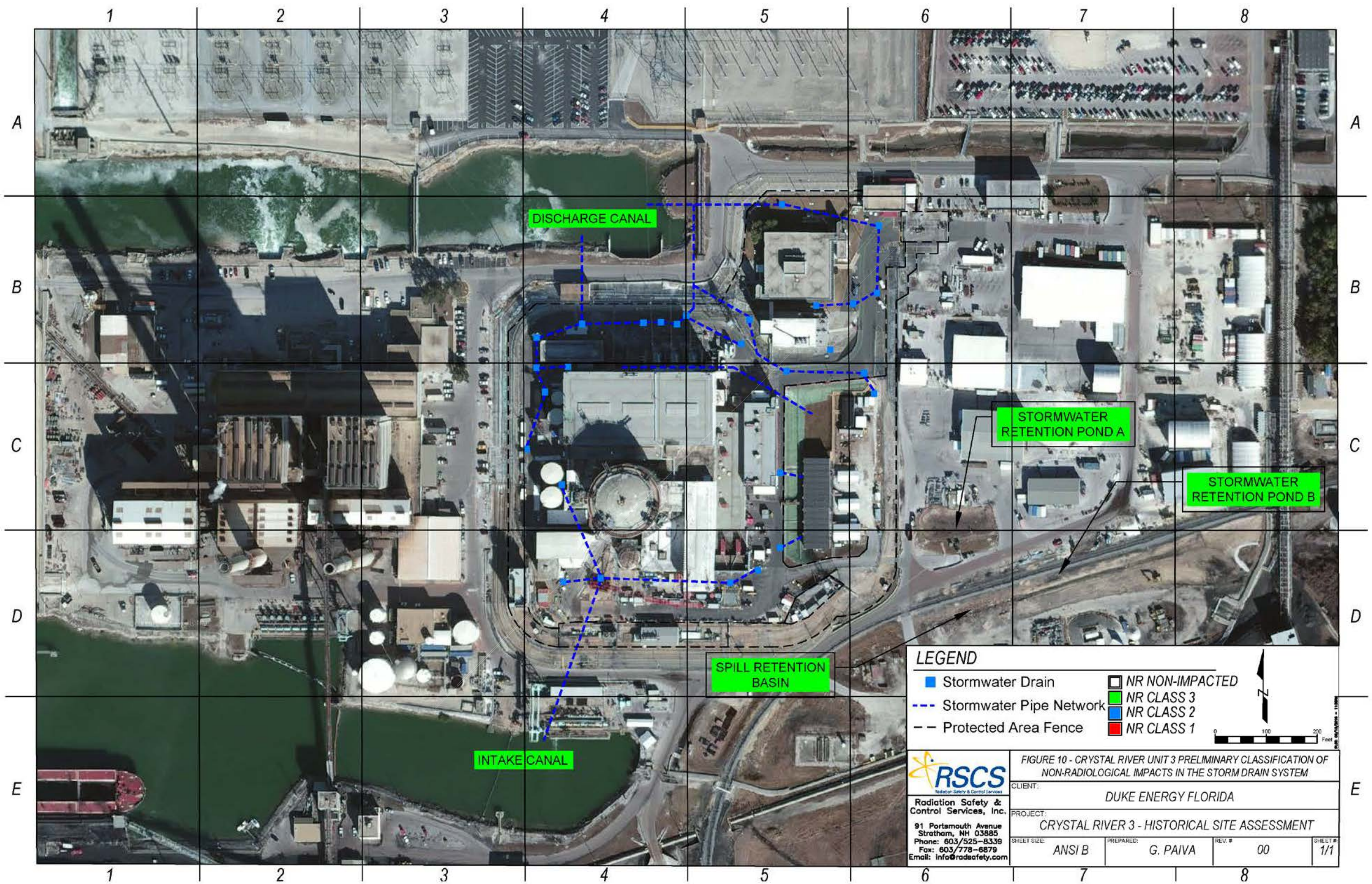


Figure 11: Crystal River Unit 3 Preliminary Classifications of Radiological Impacts in Outlying Areas of the Station

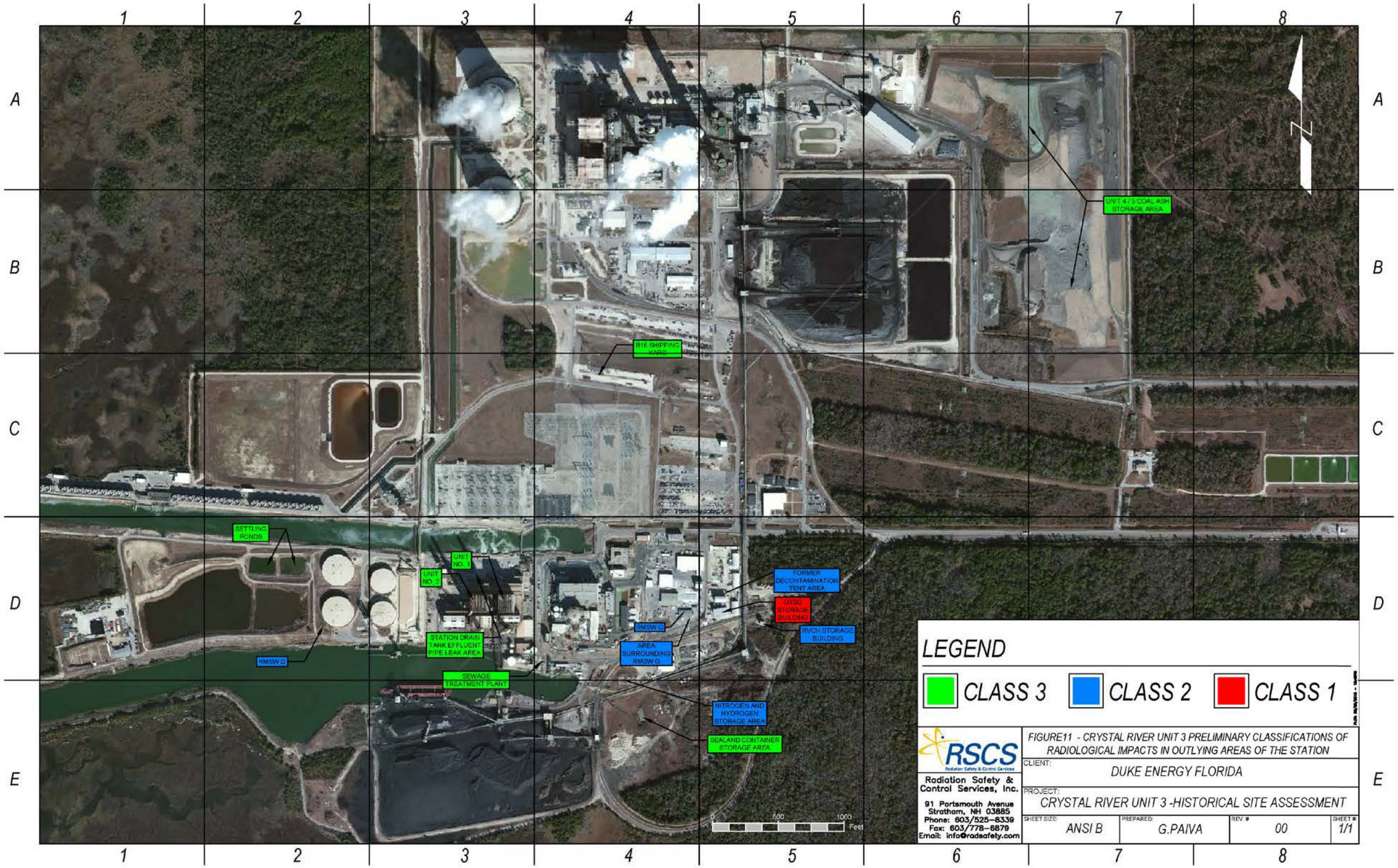


Figure 12: Crystal River Unit 3 Preliminary Classifications of Radiological Impacts in the Vicinity of the Protected Area

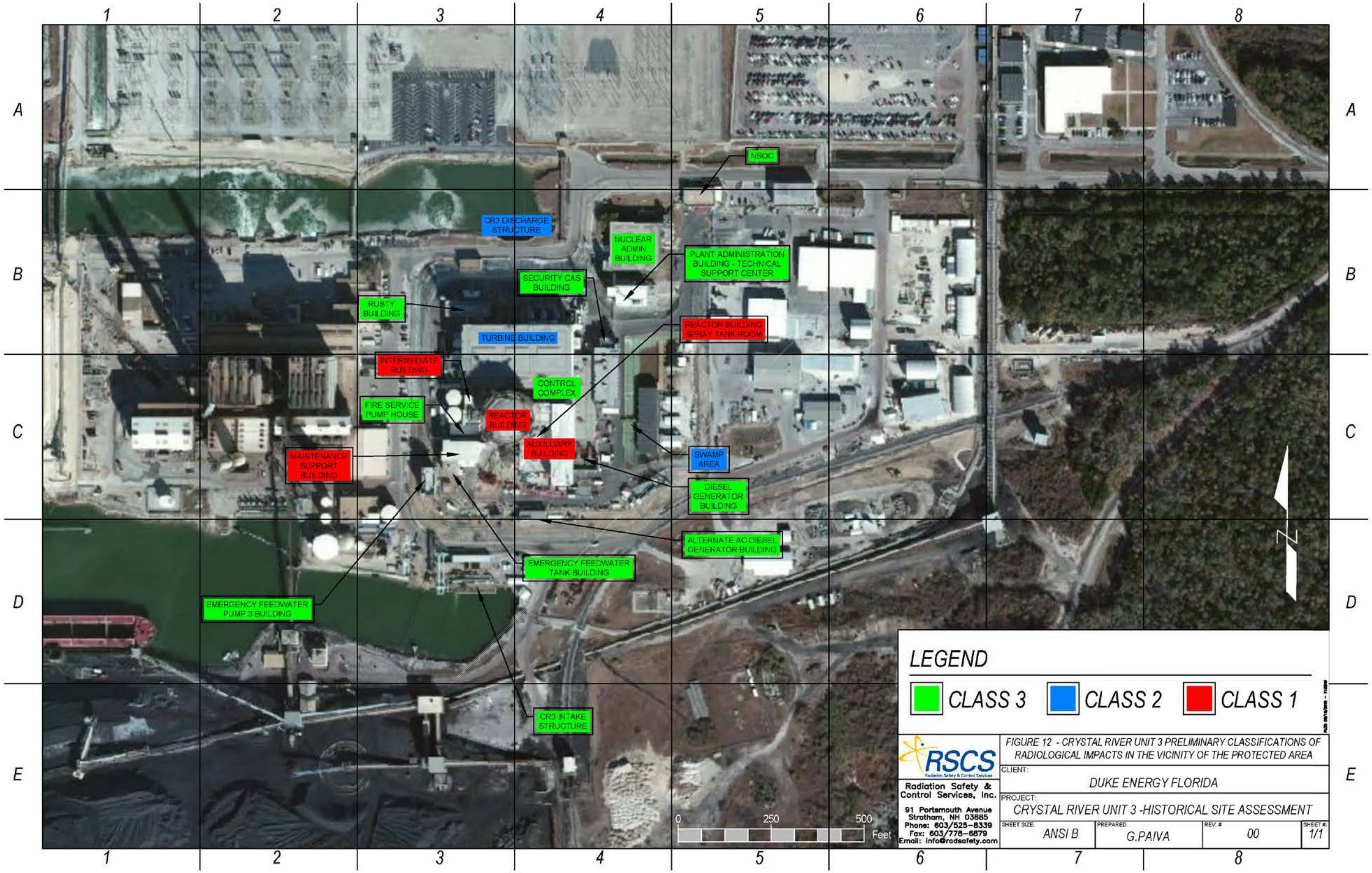
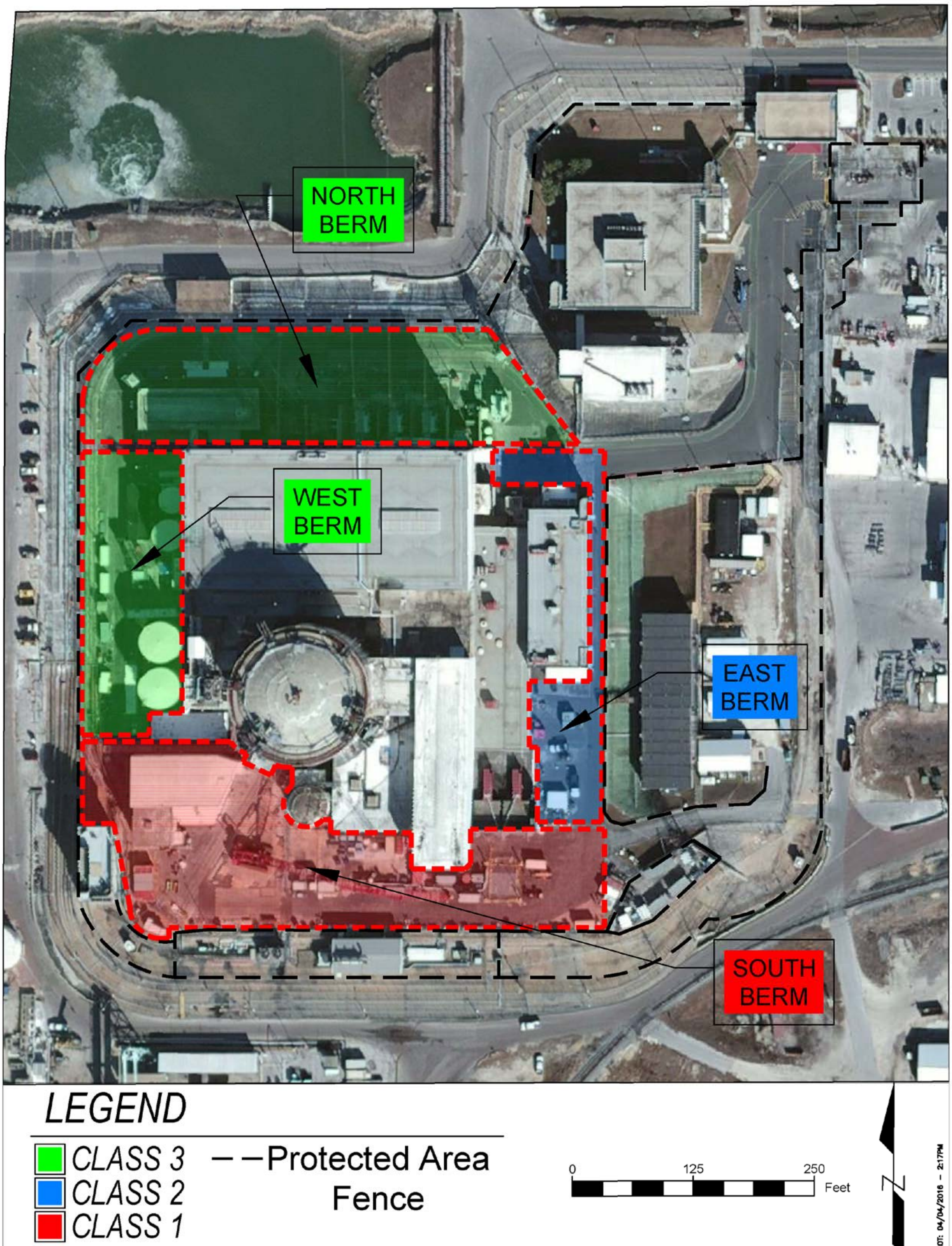


Figure 13: Crystal River Unit 3 Preliminary Classifications of Radiological Impacts in the Berm Areas



RSCS Radiation Safety & Control Services	FIGURE 13 - CRYSTAL RIVER UNIT 3 PRELIMINARY CLASSIFICATION OF RADIOLOGICAL IMPACTS IN THE BERM AREAS		
Radiation Safety & Control Services, Inc.	CLIENT: DUKE ENERGY FLORIDA		
91 Portsmouth Avenue Stratham, NH 03885 Phone: 603/525-8339 Fax: 603/778-6879 Email: info@radsafety.com	PROJECT: CRYSTAL RIVER 3 - HISTORICAL SITE ASSESSMENT		
	SHEET SIZE: ANSI B	PREPARED: G. PAIVA	REV. #: 00 / SHEET #: 1/1

Figure 14: Crystal River Unit 3 Preliminary Classifications of Radiological Impacts in the Storm Drain System

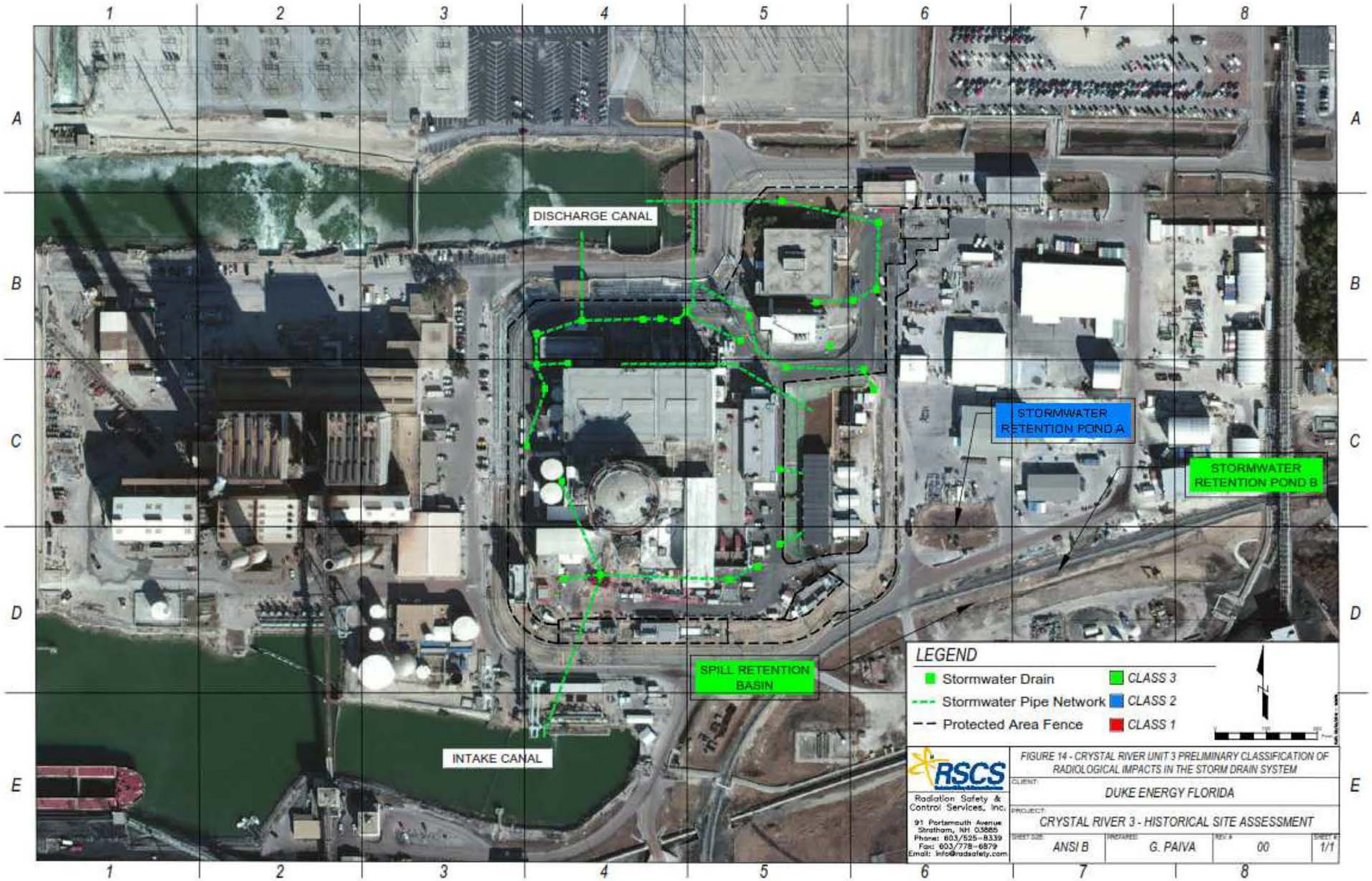
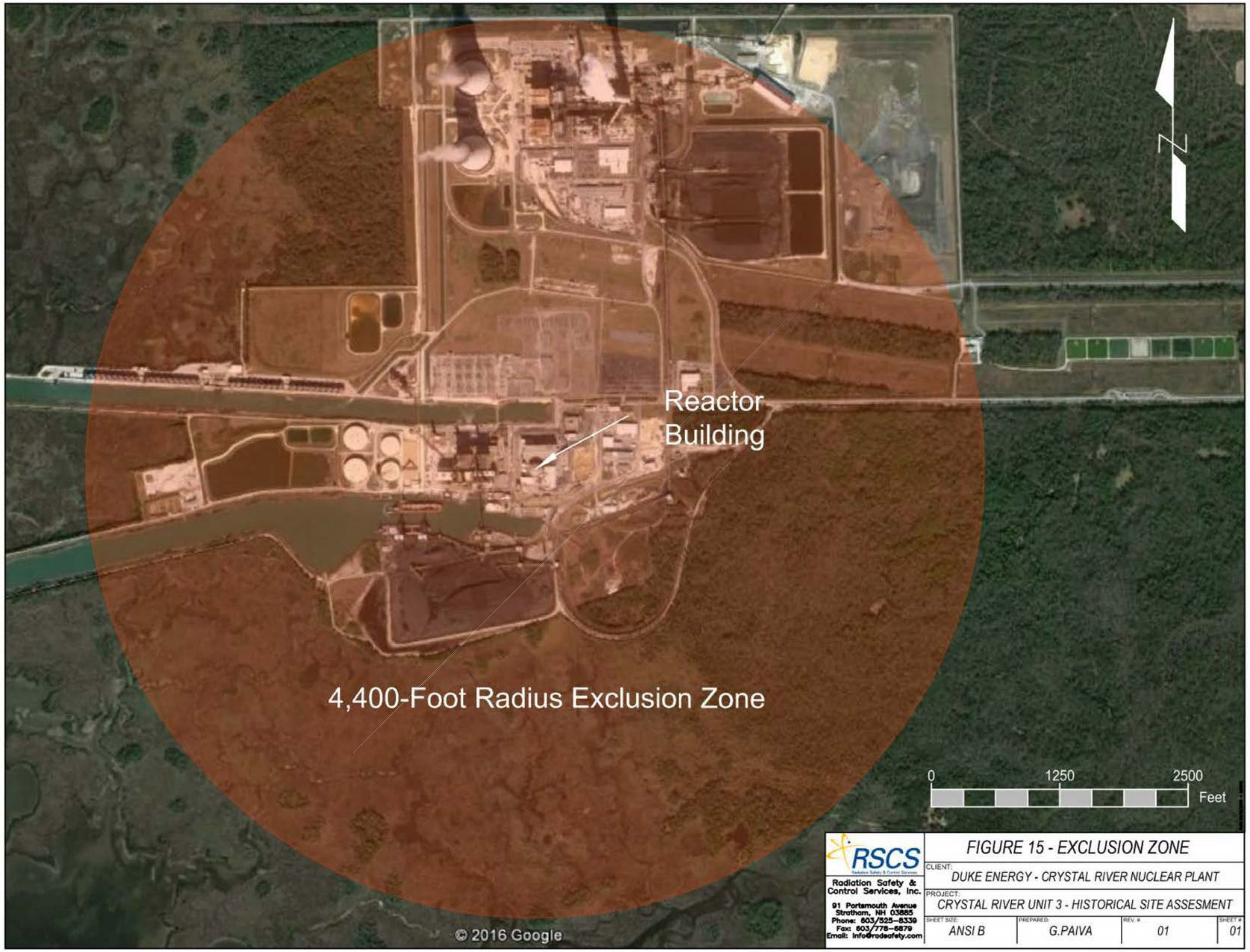


Figure 15: Exclusion Zone



Enclosure 5

"Crystal River Nuclear Power Station

Radiological Nuclide Selection for DCGL Development"

June 21, 2021

BEGINS ON NEXT PAGE

Crystal River 3 Nuclear Power Plant
Radiological Nuclide Selection
For DCGL Development

Martin Erickson

June 21, 2021

Reviewed by: Marshall H Blake *Marshall Blake*

Approved by: Gordon Madison *Gordon Madison*
Gordon Madison (Nov 2, 2022 14:18 EDT)

Contents

Tables

EXECUTIVE SUMMARY

An integral part in the development of the site-specific Derived Concentration Guideline Levels (DCGLs) for Crystal River 3 Nuclear Power Plant (CR3) is the identification of potential radionuclides present, at the time of Final Status Survey (FSS), which will contribute to the dose-based assessment of the radiological status of the site. Radionuclide selection is a systematic approach to the identification of the potential nuclides and a deselecting of those nuclides which would not be present or would be present in insignificant concentrations.

The initial step in this process is to develop a theoretical suite of radionuclides that would be present in a reactor at shutdown. Comparisons of the materials present in CR3 were compared to those in a typical Pressurized Water Reactor (PWR) so as to identify possible anomalies in the activation analysis. Additional nuclides were added to the list based on previous analyses and documentation (NUREG-4289 and CR3 HSA). Radionuclides with half-lives of two years or less were omitted from the list since these nuclides would have decayed at least six half-lives since shutdown.

The next step was to determine which individual nuclides on the list would contribute 0.1 percent or less to the total activity present, providing the total activity from all discounted nuclides did not exceed one percent of the total activity. The total activity of all discounted nuclides equaled approximately 0.005 percent. Several nuclides met the criteria of contributing less than 0.1 percent to the total activity but could not be discounted because they have other methods of production in addition to activation of reactor components and/or have been observed in 10 CFR Part 61 waste stream analyses or site characterization samples.

In order to evaluate compliance with the dose criteria for discounted radionuclides, doses for both residential and occupancy scenarios for those nuclides supported by the DandD code were generated. The calculated total dose from discounted NUREG/CR3474 radionuclides represents only 0.0449 percent of the total calculated dose for the residential scenario. The calculated total dose from discounted NUREG/CR-3474 radionuclides represent only 0.0016 percent for the occupancy scenario. The activity represented by the radionuclides not supported by the DandD code resulted in a calculated total dose contribution of 5.12E-03 mrem for inhalation exposure-to-dose conversion factors (DCFs) and 2.89E-03 mrem for ingestion DCFs.

As a result of the analysis, a CR3 suite of nuclides was developed from the theoretical set of nuclides and the deletion of the remaining nuclides was justified.

1.0 INTRODUCTION

CR3 is a single unit pressurized light-water reactor (PWR) supplied by Babcock & Wilcox. CR3 was initially licensed to operate at a maximum of 2,452 megawatt-thermal (MWt). In 1981, 2002, and 2007, the NRC approved three Duke Energy Florida LLC (DEF) requests to increase the licensed core power level to a maximum power level of 2,609 MWt. The Crystal River reactor went offline in September 2009 for refueling, OTSG replacement (once through steam generator), and 20% power up-rate outage. During the preparation for the OTSG replacement it was discovered that delamination had occurred in the containment walls. The reactor containment structure is a steel-lined, reinforced-concrete structure in the shape of a cylinder and capped with a shallow dome. After further investigation, Duke Energy senior executives announced in February 2013 that the Crystal River Nuclear Plant would be permanently shut down.

As a part of the source-term abstraction process at CR3, a site-specific suite of radionuclides potentially present in the site environs, or present as contamination on structural surfaces, at the time of FSS, must be identified. The purpose of this Technical Based Document is to provide the identification of those radionuclides and methodology behind the selection process.

2.0 TECHNICAL POSITION

The theoretical suite of radionuclides that could potentially still be present at CR3 (based upon the guidance contained in NUREG/CR-3474) is provided in Table 4-1 along with their half-lives and mode of decay. All gamma spectrometry analyses that are performed onsite for characterization or FSS surveys should include the detectable gamma emitters listed in Table 6-1 in the gamma spectrometry libraries for analysis. FSS samples sent to an offsite laboratory for analysis shall be analyzed for the suite of radionuclides listed in Table 6-1.

3.0 LIMITATIONS

The suite of radionuclides listed in Table 4-1 is a theoretical list based on NUREG/CR-3474 and should not be used as a site-specific suite for developing DCGLs. The suite of radionuclides listed in Table 6-1 is a CR3 site-specific suite of radionuclides for developing site-specific DCGLs.

4.0 TECHNICAL BASES

NRC regulations established in 10CFR20, Subpart E, *Radiological Criteria for License Termination*, requires that the dose to an average member of the critical group resulting from residual plant-related radioactivity that is distinguishable from background radiation does not exceed 25 mrem (0.25 mSv) per year. In order to demonstrate compliance to regulatory radiological criteria, a licensee must understand, identify, and assess the potential constituents in radioactive contamination. Identification of potential plant-related radionuclides present in site environs and on structures with a firm justified basis allows a licensee to confidently demonstrate compliance with site release criteria. The approach applied in this effort follows NRC guidance for identifying site-specific radionuclides found in Volume 2 of NUREG 1757, *Consolidated Decommissioning Guidance*.

4.1 THEORETICAL SUITE of NUCLIDES

Development of the suite of radionuclides listed in Table 6-1 began with NUREG/CR-3474. This NUREG assessed the problems posed to reactor decommissioning by long-lived activation products in reactor construction materials. Samples of stainless steel, vessel steel, concrete and concrete ingredients were analyzed for up to 52 elements in order to develop a database of activated major, minor and trace elements. The list of radionuclides was developed by combining those radionuclides listed in Table 5.13, "*Activity Inventory of PWR Internals at Shutdown (Total Ci)*," and Table 5.15, "*Inventories of PWR and BWR Vessel Walls at Shutdown (Total Ci)*". Only radionuclides with half-lives of two or more years were included on the list. Radionuclides with half-lives less than two years would not be expected to be observed since two years or less represents six half-lives, or greater, from final shutdown of the CR3 reactor to license termination.

Table 4-1 NUREG/CR-3474 Identified Activation Product Radionuclides

Radionuclide	Half-life (years)	Decay Mode	Radionuclide	Half-life (years)	Decay Mode
Ag-108m	1.30E+02	IT	Kr-81	2.10E+05	y
Ar-39	2.70E+02	β^-	Kr-85	1.10E+01	β^-, y
Ba-133	1.00E+01	y	Mn-53	3.70E+06	y
C-14	5.70E+03	β^-	Mo-93	3.50E+00	y
Ca-41	1.00E+05	β^+, y	Nb-94	2.00E+04	β^-, y
Cl-36	3.00E+05	β^-	Ni-59	8.00E+04	β^+, y
Co-60	5.30E+00	β^-, y	Ni-63	1.00E+02	β^-
Cs-134	2.10E+00	β^-, y	Pb-205	1.40E+07	y
Cs-135	2.30E+06	β^-	Pm-145	1.80E+01	y
Cs-137	3.00E+01	β^-	Pu-239	2.40E+04	α, y
Eu-152	1.30E+01	β^-, y	Se-79	6.50E+04	β^-
Eu-154	8.60E+00	β^-, y	Sm-146	1.00E+08	α
Eu-155	4.80E+00	β^-, y	Sm-151	9.30E+01	β^-, y
Fe-55	2.70E+00	y	Sn-121m	5.00E+00	β^-
H-3	1.20E+01	β^-	Sr-90	2.90E+01	β^-
Hf-178m	3.00E+01	IT	Tb-158	1.50E+02	β^-
Ho-166m	1.20E+03	β^-, y	Tc-99	2.10E+05	β^-, y
I-129	1.60E+07	β^-, y	U-233	1.60E+05	α, y
Zr-93	9.50E+05	β^-			

α - Alpha decay
β^- Beta decay
β^+ - Positron decay
y- Gamma decay
IT - Isomeric transition

4.2 DISCOUNTING INSIGNIFICANT RADIONUCLIDES

4.2.1 ACTIVATION PRODUCT CONSIDERATIONS

Since Table 4-1 includes trace-elements that would not likely be found at CR3 due to their low abundance, an evaluation of radionuclides that may be discounted as being of potential importance was performed. The total inventory for each radionuclide was determined from activity inventories provided in Table 5.14 and Table 5.15 of NUREG/CR-3474. From this information, the percentage of total inventory for each radionuclide (decayed to 12/31/2026) was calculated. The results of this evaluation are provided in Table 4-2.

Table 4-2 Evaluation of NUREG/CR-3474 Activity Fractions

Radionuclide	T1/2 (Years)	Shroud (A_o)	Shroud(A)	Vessel Cladding (A	Vessel Cladding (A)	Core Barrel (Ao)	Core Barrel (A)	Thermal Pads (Ac	Thermal Pads (A	Total Activity	Total Fractior	Less than 0.1%
Ag-108m	1.30E+02	9.30E-01	8.72E-01	2.90E-04	2.72E-04	1.50E-01	1.41E-01	8.90E-03	6.42E-07	1.01E+00	1.55E-06	Yes
Ar-39	2.70E+02	1.40E+00	1.36E+00	3.43E-04	3.33E-04	1.40E-01	1.36E-01	3.00E-03	6.54E-06	1.49E+00	2.29E-06	Yes
Ba-133	1.00E+01	2.70E+01	1.18E+01	9.40E-04	4.09E-04	1.50E-01	6.53E-02	3.60E-01	1.77E-01	1.20E+01	1.84E-05	Yes
C-14*	5.70E+03	2.32E+02	2.32E+02	8.70E-02	8.69E-02	5.10E+01	5.09E+01	3.70E+00	3.57E+00	2.86E+02	4.38E-04	Yes
Ca-41	1.00E+05	4.30E-02	4.30E-02	1.60E-05	1.60E-05	9.55E-03	9.55E-03	6.97E-04	6.42E-88	5.26E-02	8.05E-08	Yes
Cl-36	3.00E+05	4.70E+00	4.70E+00	1.25E-03	1.25E-03	1.10E+00	1.10E+00	8.10E-02	1.38E-02	5.81E+00	8.90E-06	Yes
Co-60	5.30E+00	1.21E+06	2.52E+05	4.36E+02	9.07E+01	2.39E+05	4.97E+04	1.62E+04	1.62E+04	3.18E+05	4.86E-01	No
Cs-134	2.10E+00	6.50E+01	1.24E+00	3.00E-02	5.71E-04	1.70E+01	3.23E-01	1.37E+00	1.64E-03	1.56E+00	2.39E-06	Yes
Cs-135	2.30E+06	4.00E-04	4.00E-04	1.03E-08	1.03E-08	1.50E-05	1.50E-05	4.10E-07	0.00E+00	4.15E-04	6.35E-10	Yes
Cs-137 *	3.00E+01	1.90E+01	1.44E+01	5.55E-04	4.21E-04	8.50E-01	6.44E-01	2.20E-02	1.23E-02	1.51E+01	2.30E-05	Yes
Eu-152 *	1.30E+01	1.00E-03	5.27E-04	1.00E-01	5.27E-02	1.55E-02	8.17E-03	1.38E+00	0.00E+00	6.14E-02	9.40E-08	Yes
Eu-154*	8.60E+00	5.20E+00	1.98E+00	1.60E-02	6.08E-03	1.02E+01	3.88E+00	5.00E-01	7.43E-03	5.87E+00	8.98E-06	Yes
Eu-155	4.80E+00	3.80E+00	6.71E-01	6.90E-04	1.22E-04	2.39E+00	4.22E-01	4.05E-02	1.68E-07	1.09E+00	1.67E-06	Yes
Fe-55	2.70E+00	1.95E+06	8.95E+04	7.13E+02	3.27E+01	4.09E+05	1.88E+04	3.00E+04	3.00E+04	1.38E+05	2.12E-01	No
H-3*	1.20E+01	9.30E+01	4.65E+01	4.40E-01	2.20E-01	1.54E+02	7.70E+01	1.79E+01	1.50E+01	1.39E+02	2.12E-04	Yes
Hf-178m	3.00E+01	4.00E-01	3.03E-01	1.60E-03	1.21E-03	4.77E-01	3.61E-01	2.50E-02	3.01E-14	6.66E-01	1.02E-06	Yes
Ho-166m	1.20E+03	1.50E+00	1.49E+00	4.00E-04	3.97E-04	2.21E-01	2.19E-01	8.90E-03	3.34E-05	1.71E+00	2.62E-06	Yes
I-129	1.60E+07	6.00E-06	6.00E-06	1.45E-10	1.45E-10	2.39E-07	2.39E-07	6.49E-09	0.00E+00	6.24E-06	9.55E-12	Yes
Kr-81	2.10E+05	7.10E-03	7.10E-03	2.77E-09	2.77E-09	5.80E-05	5.80E-05	2.84E-07	0.00E+00	7.16E-03	1.10E-08	Yes
Kr-85	1.10E+01	7.90E+00	3.71E+00	1.72E-04	8.07E-05	3.24E-01	1.52E-01	7.70E-03	8.17E-04	3.86E+00	5.91E-06	Yes
Mn-53	3.70E+06	3.00E-02	3.00E-02	9.00E-06	9.00E-06	3.60E-03	3.60E-03	8.10E-05	2.93E-125	3.36E-02	5.14E-08	Yes
Mo-93	3.50E+00	8.70E+00	8.08E-01	1.50E-03	1.39E-04	6.65E-01	6.17E-02	1.70E-02	5.70E-07	8.69E-01	1.33E-06	Yes
Nb-94*	2.00E+04	3.70E+00	3.70E+00	9.90E-04	9.90E-04	4.95E-01	4.95E-01	2.40E-02	2.53E-03	4.20E+00	6.42E-06	Yes
Ni-59	8.00E+04	1.02E+03	1.02E+03	5.70E-01	5.70E-01	3.24E+02	3.24E+02	2.43E+01	2.41E+01	1.37E+03	2.09E-03	No
Ni-63	1.00E+02	1.68E+05	1.55E+05	7.13E+01	6.56E+01	4.09E+04	3.76E+04	3.08E+03	3.08E+03	1.95E+05	2.99E-01	No
Pb-205	1.40E+07	1.70E-05	1.70E-05	4.50E-09	4.50E-09	2.00E-06	2.00E-06	1.05E-07	0.00E+00	1.90E-05	2.91E-11	Yes
Pm-145	1.80E+01	8.00E-03	5.04E-03	4.00E-06	2.52E-06	2.39E-03	1.51E-03	1.78E-04	0.00E+00	6.55E-03	1.00E-08	Yes
Pu-239 *	2.40E+04	6.50E-02	6.50E-02	1.27E-04	1.27E-04	3.92E-02	3.92E-02	1.00E-03	2.47E-59	1.04E-01	1.60E-07	Yes
Se-79	6.50E+04	5.70E-03	5.70E-03	2.00E-06	2.00E-06	7.85E-04	7.85E-04	3.80E-05	0.00E+00	6.49E-03	9.93E-09	Yes
Sm-146	1.00E+08	9.30E-10	9.30E-10	5.70E-13	5.70E-13	2.21E-10	2.21E-10	5.50E-12	0.00E+00	1.15E-09	1.76E-15	Yes
Sm-151	9.30E+01	4.30E-02	3.93E-02	7.80E-04	7.13E-04	7.70E-02	7.04E-02	2.30E-02	2.95E-94	1.10E-01	1.69E-07	Yes
Sn-121m	5.00E+00	4.40E-02	8.33E-03	1.50E-05	2.84E-06	5.80E-03	1.10E-03	1.38E-04	0.00E+00	9.43E-03	1.44E-08	Yes
Sr-90*	2.90E+01	1.86E+01	1.40E+01	4.76E-04	3.57E-04	8.50E-02	6.38E-02	2.10E-02	1.16E-02	1.40E+01	2.15E-05	Yes
Tb-158	1.50E+02	1.80E-02	1.70E-02	7.00E-06	6.62E-06	2.90E-03	2.74E-03	6.90E-04	4.52E-216	1.98E-02	3.03E-08	Yes
Tc-99 *	2.10E+05	1.20E+00	1.20E+00	3.17E-04	3.17E-04	1.40E-01	1.40E-01	3.40E-03	3.31E-06	1.34E+00	2.05E-06	Yes
U-233	1.60E+05	3.30E-03	3.30E-03	4.00E-06	4.00E-06	1.70E-03	1.70E-03	8.90E-05	0.00E+00	5.00E-03	7.66E-09	Yes
Zr-93	9.50E+05	1.00E-03	1.00E-03	1.13E-07	1.13E-07	6.70E-05	6.70E-05	2.00E-06	0.00E+00	1.07E-03	1.63E-09	Yes
Total			4.97E+05		1.90E+02		1.07E+05		4.93E+04	6.53E+05		
Total percent of activity discounted							Total of discounted			3.03E+01	0.46%	

* Radionuclides meet the criteria of contributing less than 0.1 percent of the total activity but cannot be discounted because they have other methods of production in addition to activation of reactor components and/or have been observed in 10 CFR Part 61 waste stream analyses or site characterization samples.

Based on the above evaluation, it was determined that individual radionuclides which contributed less than 0.1 percent of the total activity could be discounted providing that dose contributed by the sum of those radionuclides does not exceed one percent of the total calculated dose. The total percentage of activity attributed to radionuclides that meet these criteria amounts to 0.46 percent.

With the exception of Co-60, radionuclides with half-lives less than 5.4 years identified in NUREG/CR-4289 were discounted and not included in the list provided in Table 4-3. Based on the time period from final shutdown of CR3 to the anticipated completion of the license termination in 2026, it is highly unlikely that any activity from radionuclides with half-lives less than 5.4 years would remain significant. Although Co-60 has a half-life of 5.27 years, it is appropriate to retain Co-60 in the list of potential radionuclides.

Radionuclides identified in NUREG/CR-4289 along with their half-lives in years and their decay modes, are provided in Table 4-3.

Table 4-3 Radionuclides Identified in NUREG/CR- 4289

Radionuclide	Half-life (years)	Decay mode
Am-241	4.32E+02	α, y
C-14	5.73E+03	β^-
Cm-244	1.81E+01	α, y
Co-60	5.27E+00	β^-, y
Cs-137	3.02E+01	β^-
Eu-152	1.36E+01	β^-, y
Eu-154	8.80E+00	β^-, y
H-3	1.23E+01	β^-
Nb-94	2.03E+04	β^-, y
Ni-59	7.50E+04	y
Ni-63	1.00E+02	β^-
Pu-238	8.78E+01	α, y
Pu-239	2.41 E+04	α, y
Pu-240	6.60E+03	α, y
Sr-90	2. 86E+01	β^-
Tc-99	2.13E+05	β^-, y

α - Alpha decay
β- Beta decay
y- Gamma decay

4.2.2 POTENTIAL DISCOUNTED DOSE CONSIDERATIONS

Based on the above evaluation, it was determined that individual radionuclides which contributed less than 0.1 percent of the total activity in Table 4-2 could be discounted from the list of Table 4-1 identified radionuclides providing that potential dose contributed by the sum of the radionuclides discounted does not exceed one percent of the total calculated dose. The radionuclides that meet the criteria of contributing less than 0.1 percent-of the total activity include:

Eu-155	Hf-178m	Ho-166m	Kr-81	Kr-85	Mn-53	Mo-93
Pb-205	Pm-145	Se-79	Sm-146	Sm-151	Sn-121m	Tb-158
Zr-93	U-233	Ar-39	Ba-133	Ca-41	Cl-36	Cs-134
Cs-135	Ag-108m	I-129				

Although originally included in the list of theoretical radionuclides, the naturally occurring radionuclides K-40, U-234, U-235, U-236 and U-238 have not been detected in characterization/waste stream samples at concentrations distinguishable from naturally occurring concentrations. Therefore, these radionuclides have been discounted from any further consideration.

In order to evaluate compliance with the dose criteria for discounted radionuclides, the NRC developed computer code DandD, Version 2.1.0 was used to calculate doses for both residential and occupancy scenarios for those nuclides supported by the DandD code. The DandD code was used with the NRC determined default parameters to represent a conservative screening tool. Input concentrations for each radionuclide used in the residential scenario were their percent of total activity input as concentration in pCi/g. Input concentrations-for each radionuclide used in the occupancy scenario were 1,000 times their percent of total activity input as surface contamination in dpm/100 cm^2. Calculated doses for the following nuclides were developed using the DandD code:

Cl-36	Cs-134	Ca-41	Cs-135	Sm-151	Eu-155
Se-79	Ho-166m	Zr-93	U-233	Mo-93	Sn-121m
I-129					

The calculated total dose from discounted NUREG radionuclides represents only 0.0449 percent of the total calculated dose for the residential scenario. The calculated total dose from discounted NUREG radionuclides represents only 0.0016 percent for the occupancy scenario. Therefore, it is appropriate to discount these radionuclides. Summary reports for the DandD calculations are included in Attachment A. Summary Results are depicted in Tables 4-4 and 4-5.

Table 4-4 DandD Building Occupancy

Building Occupancy			
Nuclide	**All Nuclides All Pathways Dose (mrem)**	**Nuclide**	**Discounted All Pathways Dose (mrem)**
C-14	3.61E-06	Cl-36	7.93E-07
Ca-41	5.90E-10	Ca-41	5.90E-10
Cl-36	7.93E-07	Cs-134	1.31E-06
Co-60	1.45E+00	Cs-135	1.90E-11
Cs-134	1.31E-06	Sm-151	1.82E-08
Cs-135	1.90E-11	Eu-155	2.10E-07
Cs-137	4.25E-06	Se-79	5.23E-10
Eu-152	2.27E-07	Ho-166m	1.73E-05
Eu-154	2.08E-05	Zr-93	1.96E-09
Eu-155	2.10E-07	U-233	3.87E-06
Fe-55	8.76E-04	Mo-93	5.66E-08
H-3	5.51E-08	Sn-121m	3.90E-10
Ho-166m	1.73E-05	I-129	1.15E-11
I-129	1.15E-11		
Mo-93	5.66E-08		
Sn-121m	3.90E-10		
Nb-94	3.17E-05		
Ni-59	2.20E-06		
Ni-63	7.06E-03		
Pu-239	5.56E-04		
Se-79	5.23E-10		

Building Occupancy			
Nuclide	All Nuclides All Pathways Dose (mrem)	Nuclide	Discounted All Pathways Dose (mrem)
Sm-151	1.82E-08		
Sr-90	9.55E-05		
Tc-99	6.96E-08		
U-233	3.87E-06		
Zr-93	1.96E-09		
Total	1.46E+00	Total	2.28E-05
		Total %	1.56E-03

Table 4-5 DandD Residential

Residential			
Nuclide	Not Discounted All Pathways Dose (mrem)	Nuclide	Discounted All Pathways Dose (mrem)
C-14	4.56E-04	Cl-36	1.18E-03
Ca-41	5.78E-08	Ca-41	5.78E-08
Cl-36	1.18E-03	Cs-134	2.95E-06
Co-60	2.67E+00	Cs-135	1.20E-10
Cs-134	2.95E-06	Sm-151	3.57E-10
Cs-135	1.20E-10	Eu-155	1.08E-07
Cs-137	2.82E-05	Se-79	2.01E-09
Eu-152	3.23E-07	Ho-166m	1.84E-05
Eu-154	2.87E-05	Zr-93	2.83E-11
Eu-155	1.08E-07	U-233	1.50E-08
Fe-55	3.37E-04	Mo-93	9.28E-08
H-3	7.15E-05	Sn-121m	1.52E-10
Ho-166m	1.84E-05	I-129	1.68E-10
I-129	1.68E-10		
Mo-93	9.28E-08		
Sn-121m	1.52E-10		
Nb-94	4.36E-05		
Ni-59	7.94E-06		
Ni-63	2.99E-03		
Pu-239	1.64E-07		
Se-79	2.01E-09		
Sm-151	3.57E-10		
Sr-90	5.95E-04		
Tc-99	5.43E-06		
U-233	1.50E-08		
Zr-93	2.83E-11		
Total	2.68E+00	Total	1.20E-03
		Total %	4.49E-02

DandD does not support the following radionuclides and could not calculate their dose:

Ar-39	Pm-145	Mn-53	Sm-146	Tb-158
Ba-133	Ag-108m	Hf-178m	Pb-205	

The activity represented by the radionuclides not supported by the DandD code is calculated to be only 0.005 percent of the total activity presented in NUREG/CR-3474. Of these radionuclides, Ar-39, Kr-81 and Kr-85 are noble gases and it is highly unlikely that they would still be present in soil and on structural surfaces. Therefore, it is appropriate to discount Ar-39, Kr-81 and Kr-85. Potential dose contribution from the remaining radionuclides not supported by the DandD code was evaluated by comparison of the inhalation and ingestion dose conversion factors (DCFs) contained in Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion. Weighted DCFs were calculated for each discounted radionuclide and summed for both inhalation and ingestion DCFs. These totals were then compared to the sum of the weighted ingestion DCFs and the DCFs for the most abundant radionuclide, Co-60. The calculations to demonstrate these results are provided in Table 4-6. This resulted in a total of 3.55E-03 mrem for inhalation DCFs and 2.18E-03 mrem for ingestion DCFs. The calculations to demonstrate these results are provided in Table 4-6.

Table 4-6 DCF Comparisons

		Inhalition				Ingestion			
Radionuclide	**Total Fraction**	**DCF**	**Weighted DCF**	**% Total Wt. DCF**	**Dose contribution**	**DCF**	**Weighted DCF**	**Dose contribution**	**% Total Wt. DCF**
Mn-53	5.14E-08	1.35E-10	6.94E-18	2.42E-08	7.20E-08	2.92E-11	1.50E-18	1.26E-07	4.24E-08
Ba-133	1.84E-05	2.11E-09	3.88E-14	1.35E-04	4.03E-04	9.19E-10	1.69E-14	1.42E-03	4.78E-04
Pm-145	1.00E-08	6.85E-09	6.85E-17	2.38E-07	7.11E-07	1.28E-10	1.28E-18	1.08E-07	3.62E-08
Sm-146	1.76E-15	2.23E-05	3.92E-20	1.37E-10	4.07E-10	5.51E-08	9.70E-23	8.17E-12	2.74E-12
Tb-158	3.03E-08	6.91E-08	2.09E-15	7.29E-06	2.17E-05	1.19E-09	3.61E-17	3.04E-06	1.02E-06
Hf-178m	1.02E-06	1.79E-07	1.83E-13	6.36E-04	1.89E-03	5.68E-09	5.79E-15	4.88E-04	1.64E-04
Pb-205	2.91E-11	1.06E-09	3.08E-20	1.07E-10	3.20E-10	4.41E-10	1.28E-20	1.08E-09	3.63E-10
Ag-108m	1.55E-06	7.66E-08	1.19E-13	4.13E-04	1.23E-03	2.06E-09	3.19E-15	2.69E-04	9.02E-05
				Total	**3.55E-03**		**Total**	**2.18E-03**	
Co-60	4.86E-01	5.91E-08	2.87E-08			7.28E-09	3.54E-09		
					Discounted dose	**Total**	**5.74E-03**	**mrem**	

Additionally, the potential external dose contribution from the remaining radionuclides not supported by the DandD code was evaluated by comparing the summed weighted Exposure to Contaminated Ground Surface DCFs contained in Federal Guidance Report No. 12, External Exposure to Radionuclides in Air, Water, and Soil for the comparison of the external dose component to the most abundant gamma producing radionuclide, Co-60. No external dose component contributed greater than 3.62E-05 mrem as shown in Table 4-7.

Table 4-7 Weighted DCF Comparisons

nuclide	fraction	Gonad DCF	Wt DCF	BreastDCF	Wt DCF	Lung DCF	Wt DCF	R Marrow DCF	Wt DCF	B Surface DCF	Wt DCF	Thyroid D(	Wt DCF	Remainder DCF	Wt DCF	Effective DCF	Wt DCF	Skin DCF	Wt DCF		Sum total Wt DCF
Mn-53	5.14E-08	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00		0.00E+00
Ba-133	1.84E-05	4.28E-16	7.88E-21	4.21E-16	7.75E-21	3.63E-16	6.68E-21	3.55E-16	6.53E-21	7.50E-16	1.38E-20	3.84E-16	7.07E-21	3.57E-16	6.57E-21	3.97E-16	7.30E-21	5.13E-16	9.44E-21		7.30E-20
Pm-145	1.00E-08	3.96E-17	3.96E-25	4.13E-17	4.13E-25	2.38E-17	2.38E-25	1.70E-17	1.70E-25	1.17E-16	1.17E-24	2.92E-17	2.92E-25	2.41E-17	2.41E-25	3.26E-17	3.26E-25	5.49E-17	5.49E-25		3.80E-24
Sm-146	1.76E-15	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00		0.00E+00
Tb-158	3.03E-08	8.11E-16	2.46E-23	7.77E-16	2.35E-23	7.33E-16	2.22E-23	7.40E-16	2.24E-23	1.18E-15	3.58E-23	7.57E-16	2.29E-23	7.25E-16	2.20E-23	7.72E-16	2.34E-23	1.17E-15	3.55E-23		2.32E-22
Hf-178m	1.02E-06	2.42E-15	2.47E-21	2.34E-15	2.39E-21	2.20E-15	2.24E-21	2.20E-15	2.24E-21	3.85E-15	3.93E-21	2.28E-15	2.33E-21	2.15E-15	2.19E-21	2.31E-15	2.36E-21	2.88E-15	2.94E-21		2.31E-20
Pb-205	2.91E-11	2.12E-19	6.17E-30	4.59E-19	1.34E-29	1.03E-21	3.00E-32	1.88E-20	5.47E-31	1.13E-19	3.29E-30	3.06E-20	8.90E-31	7.15E-20	2.08E-30	1.50E-19	4.37E-30	1.22E-17	3.55E-28		3.86E-28
Ag-108m	1.55E-06	1.68E-15	2.60E-21	1.62E-15	2.51E-21	1.52E-15	2.36E-21	1.54E-15	2.39E-21	2.30E-15	3.57E-21	1.59E-15	2.46E-21	1.49E-15	2.31E-21	1.60E-15	2.48E-21	2.00E-15	3.10E-21		2.38E-20
																				Sum total	**1.20E-19**
																				Dose (mrem)	**3.62E-05**
Co-60	4.47E-01	2.45E-15	1.10E-15	2.34E-15	1.05E-15	2.27E-15	1.01E-15	2.33E-15	1.04E-15	3.11E-15	1.39E-15	2.25E-15	1.01E-15	2.26E-15	1.01E-15	2.35E-15	1.05E-15	2.76E-15	1.23E-15	**Sum total**	**9.89E-15**

Therefore, it is appropriate to discount all of the radionuclides not supported by the DandD code.

5.0 HISTORICAL SITE ASSESSMENT

Historical 10 CFR Part 61 analyses have also identified Cm-243, Am-241, Pu-238 and Pu-241 to be present in the waste streams analyzed. Therefore, these radionuclides should be added to the list of radionuclides potentially present.

6.0 CONCLUSION

Table 6-1 represents a list of radionuclides potentially present at CR3 based on applying the described screening criteria to the combined list of potential radionuclides from regulatory guidance contained in NUREG/CR-3474 and NUREG/CR-4289 and historical 10 CFR Part 61 analyses.

Table 6-1 CR3 Site-Specific Suite of Radionuclides

Radionuclide	Half-Life (years)
*Cm-243/244	1.81E+01
Am-241	4.32E+02
C-14	5.73E+03
Co-60	5.27E+00
Cs-137	3.02E+01
Eu-152	1.36E+01
Eu-154	8.80E+00
H-3	1.23E+01
Nb-94	2.03E+04
Ni-59	7.50E+04
Pu-238	8.77E+01
Ni-63	1.00E+02
*Pu-239/240	6.50E+03
Pu-241	1.44E+01
Sr-90	2. 86E+01
Tc-99	2.13E+05
Fe-55	2.70E+00

*Listed half-life is the shortest half-life for the radionuclides in the pair

7.0 REFERENCES

EPA-520/1-88-020, (1988), "*Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No.11*"

EPA-402-R-93-081, (1993), "*External Exposure to Radionuclides in Air, Water, and Soil for the comparison of the external dose component, Federal Guidance Report No. 12"*

Pacific Northwest National Laboratory, (1984), "*Long-lived Activation Products in Reactor Materials,"* NUREG/CR-3474, 1984

Sandia National Laboratories, (2001), "*Residual Radioactive Contamination from Decommissioning,*"

NUREG/CR- 5512, Vol. 2 Revision 1, 2006

"Historical Site Assessment for Crystal River 3," RSCS, June 28, 2016

"*Residual Radionuclide Contamination Within and Around Commercial Nuclear Power Plants*", NUREG/CR-4289, 1986

"Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria – Final Report (Revision 2)," NUREG-1757 Volume 2, Revision 2, July 2022

Hacker, C., *Radiation Decay, Version 4*, September 2005.

2021 Dry Active Waste 10CFR61 Analysis for RB and AB

Attachment A

DandD Results

BEGINS ON NEXT PAGE

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 6/22/2021 1:51:30 PM
Site Name: CR3
Description: Discounted Occupancy
FileName:C:\Users\mceri\Documents\CR3 Discounted Occupancy.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
36Cl	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Site		Value	1.40E-02
93Zr	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Site		Value	2.56E-06
79Se	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Site		Value	1.56E-05
93Mo	UNLIMITED	CONSTANT(dpm/100 cm**2)	

Justification for concentration: Site		Value 7.38E-04
41Ca	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 1.26E-04
134Cs	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 6.62E-04
135Cs	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 9.97E-07
121mSn	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 1.09E-05
129I	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 1.50E-08
151Sm	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 2.55E-04
166mHo	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 4.09E-03
233U	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 1.20E-05
155Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 1.23E-03

Chain Data:

Number of chains: **13**

Chain No. 1: **36Cl**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
36Cl	1	1.10E+08					8.18E-10	5.93E-09	5.81E-14	1.06E-15

Chain No. 2: **41Ca**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
41Ca	1	5.11E+07					3.44E-10	3.64E-10	0.00E+00	0.00E+00

Chain No. 3: **79Se**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
79Se	1	2.37E+07					2.35E-09	2.66E-09	1.79E-15	8.60E-18

Chain No. 4: **93Zr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Zr	1	5.59E+08					4.48E-10	8.67E-08	0.00E+00	0.00E+00
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 5: **93Mo**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))

93Mo	1	1.28E+06					3.64E-10	7.68E-09	4.61E-13	2.73E-16
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 6: **121mSn**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
121mSn	1	2.01E+04					4.19E-10	3.11E-09	4.22E-13	9.11E-16
121Sn	2	1.13E+00	1	0.776	0	0	2.44E-10	1.38E-10	9.07E-15	9.02E-17

Chain No. 7: **129I**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
129I	1	5.73E+09					7.46E-08	4.69E-08	2.23E-12	5.98E-15

Chain No. 8: **134Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
134Cs	1	7.53E+02					1.98E-08	1.25E-08	1.31E-10	3.86E-12

Chain No. 9: **135Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE	Inhalation CEDE	Surface Dose Rate	15 cm Dose Rate

							Factor (Sv/Bq)	Factor (Sv/Bq)	Factor ((Sv/d)/(Bq/m^2))	Factor ((Sv/d)/(Bq/m^3))
135Cs	1	8.40E+08					1.91E-09	1.23E-09	2.87E-15	1.77E-17

Chain No. 10: **151Sm**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
151Sm	1	3.29E+04					1.05E-10	8.10E-09	4.34E-16	4.55E-19

Chain No. 11: **155Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
155Eu	1	1.81E+03					4.13E-10	1.12E-08	5.10E-12	8.42E-14

Chain No. 12: **166mHo**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
166mHo	1	4.38E+05					2.18E-09	2.09E-07	1.47E-10	4.23E-12

Chain No. 13: **233U**
Nuclides in chain: **10**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE	Inhalation CEDE	Surface Dose Rate	15 cm Dose Rate

							Factor (Sv/Bq)	Factor (Sv/Bq)	Factor ((Sv/d)/(Bq/m^2))	Factor ((Sv/d)/(Bq/m^3))
233U	1	5.79E+07					7.81E-08	3.66E-05	6.18E-14	6.25E-16
229Th	2	2.68E+06	1	1	0	0	9.54E-07	5.80E-04	7.38E-12	1.47E-13
225Ra	3	1.48E+01	2	1	0	0	1.04E-07	2.10E-06	1.15E-12	5.09E-15
225Ac	4	1.00E+01	3	1	0	0	3.00E-08	2.92E-06	1.37E-12	2.89E-14
221Fr	Implicit		4	1			0.00E+00	0.00E+00	2.57E-12	6.82E-14
217At	Implicit		4	1			0.00E+00	0.00E+00	2.61E-14	7.43E-16
213Bi	Implicit		4	1			1.95E-10	4.63E-09	1.14E-11	3.24E-13
213Po	Implicit		4	0.9784			0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	Implicit		4	0.0216			0.00E+00	0.00E+00	1.64E-10	4.99E-12
209Pb	Implicit		4	1			5.75E-11	2.56E-11	2.60E-14	3.52E-16

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Nuclide	Surface Concentration (dpm/100 cm**2)
36Cl	1.40E-02
93Zr	2.56E-06
93mNb	0.00E+00
79Se	1.56E-05
93Mo	7.38E-04
41Ca	1.26E-04
134Cs	6.62E-04
135Cs	9.97E-07
121mSn	1.09E-05
121Sn	0.00E+00
129I	1.50E-08
151Sm	2.55E-04
166mHo	4.09E-03

233U	1.20E-05
229Th	0.00E+00
225Ra	0.00E+00
225Ac	0.00E+00
221Fr	0.00E+00
217At	0.00E+00
213Bi	0.00E+00
213Po	0.00E+00
209Tl	0.00E+00
209Pb	0.00E+00
155Eu	1.23E-03

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
To:Time In Building	The time in the building during the occupancy period	CONSTANT(hr/week)
Default value used		Value 4.50E+01
Tto:Occupancy Period	The duration of the occupancy exposure period	CONSTANT(days)
Default value used		Value 3.65E+02
Vo:Breathing Rate	The average volumetric breathing rate during building occupancy for an 8-hour work day	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	DERIVED(1/m)
Default value used		
GO*:Ingestion Rate	Effective secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy = GO * Fl	DERIVED(m**2/hr)
Default value used		
Tstart:Start Time	The start time of the scenario in days	CONSTANT(days)

Default value used		Value 0.00E+00
Tend:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+02
dt:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
Pstep:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
AOExt:External Exposure Area	Minimum surface area to which occupant is exposed via external radiation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOInh:Inhalation Exposure Area	Minimum surface area to which occupant is exposed via inhalation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOIng:Secondary Ingestion Exposure Area	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AO:Exposure Area	Minimum surface area to which occupant is exposed during the occupancy period	DERIVED(m**2)
Default value used		
Fl:Loose Fraction	Fraction of surface contamination available for resuspension and ingestion	CONSTANT(none)
Default value used		Value 1.00E-01
Rfo:Loose Resuspension Factor	Resuspension factor for loose contamination	CONTINUOUS LOGARITHMIC(1/m)
Default value used		Value / Probability 9.12E-06 / 0.00E+00 1.10E-04 / 7.67E-01 1.46E-04 / 9.09E-01 1.62E-04 / 9.50E-01 1.85E-04 / 9.90E-01 1.90E-04 / 1.00E+00
GO:Loose Ingestion Rate	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	CONSTANT(m**2/hr)
Default value used		Value 1.10E-04

Correction Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are <** 2.21E-05 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 2.09E-05 **to** 2.36E-05 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Surface Concentration (dpm/100 cm**2)
36Cl	1.40E-02
93Zr	2.56E-06
93mNb	1.85E-05
79Se	1.56E-05
93Mo	7.38E-04
41Ca	1.26E-04
134Cs	5.62E-04
135Cs	9.97E-07
121mSn	1.08E-05
121Sn	8.37E-06
129I	1.50E-08
151Sm	2.54E-04
166mHo	4.09E-03
233U	1.20E-05
229Th	5.67E-10
225Ra	5.04E-10
225Ac	4.64E-10

221Fr	4.64E-10
217At	4.64E-10
213Bi	4.64E-10
213Po	4.54E-10
209Tl	1.00E-11
209Pb	4.64E-10
155Eu	1.15E-03

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	External	Inhalation	Secondary Ingestion
2.36E-05	1.11E-05	1.24E-05	1.43E-07

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
36Cl	7.93E-07
93Zr	1.96E-09
93mNb	1.33E-09
79Se	5.23E-10
93Mo	5.66E-08
41Ca	5.90E-10
134Cs	1.31E-06
135Cs	1.90E-11
121mSn	3.90E-10
121Sn	2.02E-11
129I	1.15E-11
151Sm	1.82E-08
166mHo	1.73E-05
233U	3.87E-06

229Th	2.90E-09
225Ra	9.56E-12
225Ac	1.20E-11
221Fr	1.94E-14
217At	1.97E-16
213Bi	1.05E-13
213Po	0.00E+00
209Tl	2.67E-14
209Pb	4.15E-16
155Eu	2.10E-07
All Nuclides	2.36E-05

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	External	Inhalation	Secondary Ingestion
36Cl	1.32E-08	7.31E-07	4.91E-08
93Zr	0.00E+00	1.95E-09	4.92E-12
93mNb	2.44E-11	1.29E-09	1.12E-11
79Se	4.54E-13	3.65E-10	1.57E-10
93Mo	5.53E-09	4.99E-08	1.15E-09
41Ca	0.00E+00	4.04E-10	1.86E-10
134Cs	1.20E-06	6.19E-08	4.78E-08
135Cs	4.65E-14	1.08E-11	8.17E-12
121mSn	7.43E-11	2.96E-10	1.95E-11
121Sn	1.23E-12	1.02E-11	8.76E-12
129I	5.44E-13	6.19E-12	4.80E-12
151Sm	1.79E-12	1.81E-08	1.14E-10
166mHo	9.77E-06	7.52E-06	3.82E-08
233U	1.21E-11	3.87E-06	4.02E-09
229Th	6.80E-14	2.89E-09	2.32E-12

225Ra	9.43E-15	9.32E-12	2.25E-13
225Ac	1.03E-14	1.19E-11	5.97E-14
221Fr	1.94E-14	0.00E+00	0.00E+00
217At	1.97E-16	0.00E+00	0.00E+00
213Bi	8.60E-14	1.89E-14	3.88E-16
213Po	0.00E+00	0.00E+00	0.00E+00
209Tl	2.67E-14	0.00E+00	0.00E+00
209Pb	1.96E-16	1.05E-16	1.14E-16
155Eu	9.51E-08	1.13E-07	2.03E-09

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 6/22/2021 10:18:03 AM
Site Name: CR3
Description: Occupancy Not Discounted
FileName:C:\Users\mceri\Documents\CR3 Discounted Residential.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 182
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
36Cl	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 1.40E-05
93Zr	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 2.56E-09
41Ca	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 1.26E-07
93Mo	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 7.38E-07
79Se	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 1.56E-08
134Cs	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 6.62E-07
135Cs	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 9.97E-10
121mSn	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 1.09E-08
129I	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 1.50E-11
151Sm	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Site		Value 2.55E-07
155Eu	UNLIMITED	CONSTANT(pCi/g)

Justification for concentration: Site		Value	1.23E-06
166mHo	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	4.09E-06
233U	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.20E-08

Chain Data:

Number of chains: **13**

Chain No. 1: **36Cl**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
36Cl	1	1.10E+08					8.18E-10	5.93E-09	5.81E-14	1.06E-15

Chain No. 2: **41Ca**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
41Ca	1	5.11E+07					3.44E-10	3.64E-10	0.00E+00	0.00E+00

Chain No. 3: **79Se**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
79Se	1	2.37E+07					2.35E-09	2.66E-09	1.79E-15	8.60E-18

Chain No. 4: **93Zr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Zr	1	5.59E+08					4.48E-10	8.67E-08	0.00E+00	0.00E+00
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 5: **93Mo**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))

93Mo	1	1.28E+06					3.64E-10	7.68E-09	4.61E-13	2.73E-16
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 6: **121mSn**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
121mSn	1	2.01E+04					4.19E-10	3.11E-09	4.22E-13	9.11E-16
121Sn	2	1.13E+00	1	0.776	0	0	2.44E-10	1.38E-10	9.07E-15	9.02E-17

Chain No. 7: **129I**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
129I	1	5.73E+09					7.46E-08	4.69E-08	2.23E-12	5.98E-15

Chain No. 8: **134Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
134Cs	1	7.53E+02					1.98E-08	1.25E-08	1.31E-10	3.86E-12

Chain No. 9: **135Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
135Cs	1	8.40E+08					1.91E-09	1.23E-09	2.87E-15	1.77E-17

Chain No. 10: **151Sm**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
151Sm	1	3.29E+04					1.05E-10	8.10E-09	4.34E-16	4.55E-19

Chain No. 11: **155Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE	Inhalation CEDE	Surface Dose Rate	15 cm Dose Rate

							Factor (Sv/Bq)	**Factor (Sv/Bq)**	**Factor ((Sv/d)/(Bq/m^2))**	**Factor ((Sv/d)/(Bq/m^3))**
155Eu	1	1.81E+03					4.13E-10	1.12E-08	5.10E-12	8.42E-14

Chain No. 12: **166mHo**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
166mHo	1	4.38E+05					2.18E-09	2.09E-07	1.47E-10	4.23E-12

Chain No. 13: **233U**
Nuclides in chain: **10**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
233U	1	5.79E+07					7.81E-08	3.66E-05	6.18E-14	6.25E-16
229Th	2	2.68E+06	1	1	0	0	9.54E-07	5.80E-04	7.38E-12	1.47E-13
225Ra	3	1.48E+01	2	1	0	0	1.04E-07	2.10E-06	1.15E-12	5.09E-15
225Ac	4	1.00E+01	3	1	0	0	3.00E-08	2.92E-06	1.37E-12	2.89E-14
221Fr	Implicit		4	1			0.00E+00	0.00E+00	2.57E-12	6.82E-14
217At	Implicit		4	1			0.00E+00	0.00E+00	2.61E-14	7.43E-16
213Bi	Implicit		4	1			1.95E-10	4.63E-09	1.14E-11	3.24E-13
213Po	Implicit		4	0.9784			0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	Implicit		4	0.0216			0.00E+00	0.00E+00	1.64E-10	4.99E-12
209Pb	Implicit		4	1			5.75E-11	2.56E-11	2.60E-14	3.52E-16

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Nuclide	Soil Concentration (pCi/g)
36Cl	1.40E-05
93Zr	2.56E-09
93mNb	0.00E+00
41Ca	1.26E-07
93Mo	7.38E-07
79Se	1.56E-08
134Cs	6.62E-07
135Cs	9.97E-10
121mSn	1.09E-08
121Sn	0.00E+00
129I	1.50E-11
151Sm	2.55E-07
155Eu	1.23E-06
166mHo	4.09E-06

233U	1.20E-08
229Th	0.00E+00
225Ra	0.00E+00
225Ac	0.00E+00
221Fr	0.00E+00
217At	0.00E+00
213Bi	0.00E+00
213Po	0.00E+00
209Tl	0.00E+00
209Pb	0.00E+00

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv(1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv(2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(4):Translocation:Layer Hen Forage	Translocation factor for forage consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
Th(1):Translocation:Beef	Translocation factor for stored hay	CONSTANT(none)

Hay	consumed by beef cattle	
Default value used		Value 1.00E+00
Th(2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Th(3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Th(4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT(none)
Default value used		Value 3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT(none)
Default value used		Value 1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT(none)
Default value used		Value 6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT(none)
Default value used		Value 1.60E-01
fcf(1):Beef Forage Carbon Fraction	Mass fraction of wet forage consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(4):Layer Hen Forage Carbon Fraction	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02

fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay Carbon Fraction	Mass fraction of wet stored hay consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage Contaminated Fraction	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)

Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01
Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)
Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)

Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)
Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)
Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)
Default value used		
PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)

Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing Rate	Breathing rate while gardening	CONSTANT(m**3/hr)
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)
Default value used		

Value	Probability
3.05E-01	0.00E+00
6.68E-01	4.76E-03
8.11E-01	9.52E-03
9.21E-01	1.43E-02
9.94E-01	1.91E-02
1.03E+00	2.38E-02
1.07E+00	2.86E-02
1.14E+00	3.33E-02
1.21E+00	3.81E-02
1.30E+00	4.29E-02
1.31E+00	4.76E-02
1.32E+00	5.24E-02
1.56E+00	5.71E-02
1.58E+00	6.19E-02
1.61E+00	6.67E-02
1.69E+00	7.62E-02
1.78E+00	8.57E-02
1.80E+00	9.05E-02
1.81E+00	9.52E-02
1.84E+00	1.00E-01
1.87E+00	1.05E-01
1.92E+00	1.10E-01
2.04E+00	1.14E-01
2.10E+00	1.19E-01
2.11E+00	1.24E-01
2.32E+00	1.29E-01
2.36E+00	1.33E-01
2.37E+00	1.38E-01
2.39E+00	1.43E-01
2.44E+00	1.48E-01
2.44E+00	1.52E-01
2.45E+00	1.57E-01
2.59E+00	1.62E-01
2.63E+00	1.67E-01
2.69E+00	1.71E-01
2.79E+00	1.76E-01
2.81E+00	1.81E-01
2.90E+00	1.86E-01
2.95E+00	1.91E-01
3.07E+00	1.95E-01
3.18E+00	2.00E-01
3.22E+00	2.05E-01
3.30E+00	2.10E-01
3.34E+00	2.14E-01

3.37E+00	2.19E-01
3.44E+00	2.24E-01
3.58E+00	2.29E-01
3.62E+00	2.33E-01
3.66E+00	2.38E-01
3.74E+00	2.43E-01
3.86E+00	2.48E-01
3.88E+00	2.52E-01
4.17E+00	2.57E-01
4.26E+00	2.62E-01
4.44E+00	2.71E-01
4.63E+00	2.76E-01
4.87E+00	2.81E-01
5.13E+00	2.86E-01
5.18E+00	2.91E-01
5.54E+00	2.95E-01
5.83E+00	3.00E-01
5.86E+00	3.05E-01
5.86E+00	3.10E-01
5.90E+00	3.14E-01
6.06E+00	3.19E-01
6.13E+00	3.24E-01
6.17E+00	3.29E-01
6.22E+00	3.33E-01
6.31E+00	3.38E-01
6.36E+00	3.43E-01
6.40E+00	3.48E-01
6.46E+00	3.52E-01
6.51E+00	3.57E-01
6.55E+00	3.62E-01
6.60E+00	3.67E-01
6.86E+00	3.71E-01
6.93E+00	3.76E-01
6.95E+00	3.86E-01
6.97E+00	3.91E-01
7.09E+00	3.95E-01
7.18E+00	4.00E-01
7.35E+00	4.05E-01
7.36E+00	4.10E-01
7.40E+00	4.14E-01
7.43E+00	4.19E-01
7.46E+00	4.24E-01
7.59E+00	4.29E-01
7.60E+00	4.33E-01
7.64E+00	4.38E-01
7.87E+00	4.43E-01
8.10E+00	4.48E-01
8.28E+00	4.52E-01
8.35E+00	4.57E-01
8.71E+00	4.62E-01
8.71E+00	4.67E-01
8.73E+00	4.71E-01
8.79E+00	4.76E-01
8.80E+00	4.81E-01
8.82E+00	4.86E-01
8.85E+00	4.91E-01
8.89E+00	4.95E-01
8.90E+00	5.00E-01
8.99E+00	5.05E-01
9.00E+00	5.10E-01
9.13E+00	5.14E-01
9.14E+00	5.19E-01
9.21E+00	5.24E-01
9.31E+00	5.29E-01
9.55E+00	5.33E-01
9.60E+00	5.38E-01

9.63E+00	5.43E-01
9.86E+00	5.48E-01
1.05E+01	5.52E-01
1.07E+01	5.57E-01
1.13E+01	5.62E-01
1.15E+01	5.67E-01
1.17E+01	5.71E-01
1.20E+01	5.76E-01
1.26E+01	5.81E-01
1.26E+01	5.86E-01
1.28E+01	5.91E-01
1.32E+01	5.95E-01
1.32E+01	6.00E-01
1.34E+01	6.05E-01
1.34E+01	6.10E-01
1.36E+01	6.14E-01
1.37E+01	6.19E-01
1.38E+01	6.24E-01
1.41E+01	6.29E-01
1.45E+01	6.33E-01
1.51E+01	6.38E-01
1.52E+01	6.43E-01
1.61E+01	6.48E-01
1.62E+01	6.52E-01
1.65E+01	6.57E-01
1.66E+01	6.62E-01
1.69E+01	6.67E-01
1.74E+01	6.71E-01
1.82E+01	6.76E-01
1.84E+01	6.81E-01
1.84E+01	6.86E-01
1.87E+01	6.91E-01
1.95E+01	6.95E-01
2.01E+01	7.00E-01
2.07E+01	7.05E-01
2.08E+01	7.10E-01
2.17E+01	7.14E-01
2.24E+01	7.19E-01
2.27E+01	7.24E-01
2.29E+01	7.29E-01
2.29E+01	7.33E-01
2.40E+01	7.38E-01
2.47E+01	7.43E-01
2.60E+01	7.48E-01
2.65E+01	7.52E-01
2.72E+01	7.57E-01
2.73E+01	7.62E-01
2.76E+01	7.67E-01
2.77E+01	7.71E-01
2.78E+01	7.76E-01
2.80E+01	7.81E-01
2.86E+01	7.86E-01
2.94E+01	7.91E-01
3.01E+01	7.95E-01
3.03E+01	8.00E-01
3.06E+01	8.10E-01
3.08E+01	8.14E-01
3.11E+01	8.19E-01
3.17E+01	8.24E-01
3.17E+01	8.29E-01
3.17E+01	8.33E-01
3.22E+01	8.38E-01
3.39E+01	8.43E-01
3.48E+01	8.48E-01
3.54E+01	8.52E-01
3.60E+01	8.57E-01

3.68E+01	8.62E-01
4.03E+01	8.67E-01
4.07E+01	8.71E-01
4.24E+01	8.76E-01
4.29E+01	8.81E-01
4.42E+01	8.86E-01
4.72E+01	8.91E-01
4.97E+01	8.95E-01
5.12E+01	9.00E-01
6.13E+01	9.05E-01
6.19E+01	9.10E-01
6.23E+01	9.14E-01
6.32E+01	9.19E-01
6.59E+01	9.24E-01
6.73E+01	9.29E-01
7.47E+01	9.33E-01
7.92E+01	9.38E-01
8.12E+01	9.43E-01
8.28E+01	9.48E-01
8.47E+01	9.52E-01
8.96E+01	9.57E-01
9.47E+01	9.62E-01
1.08E+02	9.67E-01
1.13E+02	9.71E-01
1.15E+02	9.76E-01
1.42E+02	9.81E-01
1.77E+02	9.86E-01
1.78E+02	9.91E-01
1.80E+02	9.95E-01
3.16E+02	1.00E+00

N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)
Default value used		
N2:Unsaturated Zone Porosity	Porosity of the unsaturated zone	DERIVED(none)
Default value used		
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)
Default value used		
F2:Unsaturated Zone Saturation	Saturation ratio of the unsaturated zone	DERIVED(none)
Default value used		
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)
Default value used		
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)
Default value used		

Value	Probability
1.00E+00	1.00E-04
2.00E+00	1.34E-03
3.00E+00	1.06E-02
4.00E+00	2.51E-02
5.00E+00	6.17E-02
6.00E+00	1.09E-01
7.00E+00	1.62E-01
8.00E+00	2.12E-01
9.00E+00	2.85E-01
1.00E+01	5.10E-01
1.10E+01	7.58E-01
1.20E+01	1.00E+00

NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
KSDEV:Permeability	Relative permeability value within the	UNIFORM(none)

Probability	distribution for this soil type	
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		Value / Probability: 6.07E-01 0.00E+00 6.10E-01 4.62E-01 6.35E-01 4.76E-01 7.62E-01 5.40E-01 8.89E-01 6.29E-01 1.02E+00 7.05E-01 1.14E+00 8.04E-01 1.27E+00 8.79E-01 1.40E+00 9.41E-01 1.52E+00 9.82E-01 1.65E+00 9.98E-01 1.78E+00 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)
Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05
VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)
Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02
THV(1):Holdup Period : Leafy	Holdup period for leafy vegetables	CONSTANT(days)
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period :	Holdup period for fruits	CONSTANT(days)

Fruits		
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)
Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)
Default value used		Value 3.00E+01
TGF(2):Growing Period : Poultry Forage	Minimum growing period for forage consumed by poultry	DERIVED(days)
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01
TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		

TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		
TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction : Leafy	Interception fraction for leafy vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction : Poultry forage	Interception fraction for poultry forage	DERIVED(none)
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		
RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		

RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)
Default value used		
YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		

Value	Probability
2.70E+00	0.00E+00
2.71E+00	1.60E-03
2.74E+00	6.00E-03
2.76E+00	1.76E-02
2.78E+00	4.36E-02
2.80E+00	8.48E-02
2.82E+00	1.56E-01
2.85E+00	2.57E-01
2.87E+00	3.64E-01
2.89E+00	5.00E-01
2.91E+00	6.39E-01
2.93E+00	7.46E-01
2.96E+00	8.42E-01
2.98E+00	9.09E-01
3.00E+00	9.60E-01
3.02E+00	9.84E-01
3.04E+00	9.94E-01
3.07E+00	9.97E-01
3.09E+00	9.99E-01
3.11E+00	1.00E+00
3.13E+00	1.00E+00
3.15E+00	1.00E+00

YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		

Value	Probability
2.26E+00	0.00E+00
2.29E+00	8.00E-04
2.30E+00	1.20E-03
2.31E+00	6.40E-03
2.33E+00	1.52E-02
2.34E+00	3.28E-02
2.35E+00	7.44E-02
2.36E+00	1.40E-01
2.38E+00	2.49E-01
2.39E+00	3.80E-01
2.40E+00	5.30E-01
2.42E+00	6.61E-01
2.43E+00	7.88E-01
2.44E+00	8.86E-01
2.45E+00	9.42E-01
2.47E+00	9.75E-01
2.48E+00	9.88E-01
2.49E+00	9.96E-01
2.51E+00	9.97E-01
2.52E+00	9.99E-01
2.53E+00	1.00E+00
2.54E+00	1.00E+00

YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used		Value / Probability 2.17E+00 0.00E+00 2.20E+00 1.20E-03 2.21E+00 2.40E-03 2.23E+00 6.80E-03 2.25E+00 1.80E-02 2.27E+00 4.36E-02 2.29E+00 7.64E-02 2.31E+00 1.38E-01 2.32E+00 2.14E-01 2.34E+00 3.27E-01 2.36E+00 4.50E-01 2.38E+00 5.76E-01 2.40E+00 6.87E-01 2.42E+00 7.88E-01 2.43E+00 8.68E-01 2.45E+00 9.25E-01 2.47E+00 9.60E-01 2.49E+00 9.81E-01 2.51E+00 9.92E-01 2.53E+00 9.98E-01 2.54E+00 1.00E+00 2.56E+00 1.00E+00
YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value / Probability 2.85E-01 0.00E+00 2.90E-01 6.00E-04 3.02E-01 2.80E-03 3.14E-01 9.40E-03 3.26E-01 2.14E-02 3.38E-01 5.42E-02 3.50E-01 1.08E-01 3.62E-01 2.02E-01 3.74E-01 3.15E-01 3.86E-01 4.50E-01 3.98E-01 5.92E-01 4.10E-01 7.20E-01 4.23E-01 8.26E-01 4.35E-01 9.03E-01 4.47E-01 9.51E-01 4.59E-01 9.77E-01 4.71E-01 9.91E-01 4.83E-01 9.96E-01 4.95E-01 9.99E-01 5.07E-01 1.00E+00 5.19E-01 1.00E+00 5.31E-01 1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)
Default value used		Lower Limit 3.70E-01 Upper Limit 5.24E-01 p 2.36E+00 q 1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)
Default value used		

YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)
Default value used		Mean 5.78E-01 Standard Deviation 7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YH(1):Crop Yield : Beef Cow Hay	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)
Default value used		
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)
Default value used		

Value	Probability
3.32E-02	0.00E+00
4.89E-02	3.45E-02
5.47E-02	6.91E-02
5.96E-02	1.04E-01
6.36E-02	1.38E-01
6.70E-02	1.73E-01
7.05E-02	2.07E-01
7.38E-02	2.42E-01
7.48E-02	2.50E-01
7.72E-02	2.76E-01
8.03E-02	3.11E-01
8.34E-02	3.45E-01
8.66E-02	3.80E-01
9.00E-02	4.15E-01
9.36E-02	4.49E-01
9.73E-02	4.84E-01
9.91E-02	4.99E-01
1.01E-01	5.18E-01
1.05E-01	5.53E-01
1.09E-01	5.87E-01
1.13E-01	6.22E-01
1.18E-01	6.56E-01
1.23E-01	6.91E-01
1.29E-01	7.25E-01
1.33E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.50E-01	8.29E-01
1.59E-01	8.64E-01
1.70E-01	8.98E-01
1.85E-01	9.33E-01

2.10E-01	9.67E-01
2.56E-01	9.91E-01
3.24E-01	1.00E+00

WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables	CONTINUOUS LINEAR(none)

Default value used

Value	Probability
3.58E-02	0.00E+00
4.87E-02	3.45E-02
5.46E-02	6.91E-02
5.90E-02	1.04E-01
6.29E-02	1.38E-01
6.69E-02	1.73E-01
7.02E-02	2.07E-01
7.34E-02	2.42E-01
7.41E-02	2.50E-01
7.65E-02	2.76E-01
7.99E-02	3.11E-01
8.32E-02	3.45E-01
8.66E-02	3.80E-01
9.05E-02	4.15E-01
9.41E-02	4.49E-01
9.82E-02	4.84E-01
9.98E-02	4.99E-01
1.02E-01	5.18E-01
1.06E-01	5.53E-01
1.09E-01	5.87E-01
1.14E-01	6.22E-01
1.19E-01	6.56E-01
1.24E-01	6.91E-01
1.29E-01	7.25E-01
1.33E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.50E-01	8.29E-01
1.59E-01	8.64E-01
1.70E-01	8.98E-01
1.87E-01	9.33E-01
2.12E-01	9.67E-01
2.62E-01	9.91E-01
3.13E-01	1.00E+00

WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)

Default value used

Value	Probability
3.66E-02	0.00E+00
4.87E-02	3.45E-02
5.45E-02	6.91E-02
5.93E-02	1.04E-01
6.31E-02	1.38E-01
6.72E-02	1.73E-01
7.10E-02	2.07E-01
7.44E-02	2.42E-01
7.52E-02	2.50E-01
7.78E-02	2.76E-01
8.13E-02	3.11E-01
8.45E-02	3.45E-01
8.78E-02	3.80E-01
9.11E-02	4.15E-01
9.46E-02	4.49E-01
9.82E-02	4.84E-01
9.97E-02	4.99E-01
1.02E-01	5.18E-01
1.06E-01	5.53E-01
1.10E-01	5.87E-01
1.14E-01	6.22E-01
1.19E-01	6.56E-01

		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.34E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.49E-01	8.29E-01
		1.58E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01
		2.14E-01	9.67E-01
		2.58E-01	9.91E-01
		3.25E-01	1.00E+00
WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)	
Default value used		Value	8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)	
Default value used		Lower Limit	1.83E-01
		Upper Limit	3.23E-01
		p	1.15E+00
		q	1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)	
Default value used			
WF(3):Wet/dry : Milk Cow Forage	Wet/dry conversion factor for milk cow forage	DERIVED(none)	
Default value used			
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)	
Default value used			
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)	
Default value used		Value	8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)	
Default value used			
WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)	
Default value used			
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)	
Default value used			
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)	
Default value used			
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)	
Default value used			
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)	
Default value used			
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)	
Default value used			
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)	

Default value used	Lower Limit	1.69E+00
	Upper Limit	2.29E+00
	p	1.99E+00
	q	9.11E-01

QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)

Default value used	Lower Limit	3.48E-03
	Upper Limit	2.82E-02
	p	1.51E+00
	q	1.41E+00

QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)

Default value used	Value	Probability
	6.35E+00	0.00E+00
	6.77E+00	3.45E-02
	6.96E+00	6.91E-02
	7.10E+00	1.04E-01
	7.24E+00	1.38E-01
	7.35E+00	1.73E-01
	7.47E+00	2.07E-01
	7.57E+00	2.42E-01
	7.60E+00	2.50E-01
	7.67E+00	2.76E-01
	7.77E+00	3.11E-01
	7.87E+00	3.45E-01
	7.98E+00	3.80E-01
	8.08E+00	4.15E-01
	8.18E+00	4.49E-01
	8.31E+00	4.84E-01
	8.37E+00	4.99E-01
	8.42E+00	5.18E-01
	8.54E+00	5.53E-01
	8.67E+00	5.87E-01
	8.81E+00	6.22E-01
	8.95E+00	6.56E-01
	9.10E+00	6.91E-01
	9.26E+00	7.25E-01
	9.38E+00	7.50E-01
	9.45E+00	7.60E-01
	9.68E+00	7.94E-01
	9.93E+00	8.29E-01
	1.02E+01	8.64E-01
	1.06E+01	8.98E-01
	1.11E+01	9.33E-01
	1.20E+01	9.67E-01
	1.33E+01	9.91E-01
	1.53E+01	1.00E+00

QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)

Default value used	Lower Limit	1.19E-02
	Upper Limit	2.22E-02
	p	1.45E+00
	q	7.92E-01

QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)

Default value used	Lower Limit	1.69E+00
	Upper Limit	2.29E+00
	p	1.99E+00
	q	9.11E-01

QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)

Default value used	Lower Limit	1.04E-02

		Upper Limit	8.45E-02
		p	1.51E+00
		q	1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)	
Default value used		Mean	1.71E+00
		Standard Deviation	2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)	
Default value used		Lower Limit	3.58E-02
		Upper Limit	6.67E-02
		p	1.43E+00
		q	7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)	
Default value used		Lower Limit	3.38E+00
		Upper Limit	4.58E+00
		p	1.99E+00
		q	9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)	
Default value used		Value	0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)	
Default value used		Value	Probability
		5.12E+00	0.00E+00
		5.43E+00	3.45E-02
		5.57E+00	6.91E-02
		5.68E+00	1.04E-01
		5.79E+00	1.38E-01
		5.89E+00	1.73E-01
		5.98E+00	2.07E-01
		6.06E+00	2.42E-01
		6.08E+00	2.50E-01
		6.14E+00	2.76E-01
		6.22E+00	3.11E-01
		6.30E+00	3.45E-01
		6.38E+00	3.80E-01
		6.46E+00	4.15E-01
		6.54E+00	4.49E-01
		6.63E+00	4.84E-01
		6.67E+00	4.99E-01
		6.72E+00	5.18E-01
		6.81E+00	5.53E-01
		6.92E+00	5.87E-01
		7.03E+00	6.22E-01
		7.13E+00	6.56E-01
		7.26E+00	6.91E-01
		7.39E+00	7.25E-01
		7.49E+00	7.50E-01
		7.56E+00	7.60E-01
		7.70E+00	7.94E-01
		7.89E+00	8.29E-01
		8.11E+00	8.64E-01
		8.39E+00	8.98E-01
		8.75E+00	9.33E-01
		9.44E+00	9.67E-01
		1.05E+01	9.91E-01
		1.27E+01	1.00E+00
QH(4):Ingestion Rate : Layer Hen Hay	Ingestion rate for layer hen hay	CONSTANT(kg dry wt hay/d)	

Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT(L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT(L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT(L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT(L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef Cattle	Soil intake fraction for beef cattle	CONSTANT(none)
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT(none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)
Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(1):Mass-Loading :	Mass-loading factor for beef cattle grain	CONSTANT(none)

Beef Cattle Grain		
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT(days)
Default value used		Value 3.65E+02

TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT(days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT(none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT(none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT(none)
Default value used		Value 6.80E-02
fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction :	Hydrogen fraction for layer hen forage	CONSTANT(none)

Layer Hen Forage		
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)
Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00
sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product Yield : Poultry	Annual yield of chicken per individual animal	CONSTANT(kg/y)
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
ARExt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)

Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater Exposure Area	Minimum surface area to which resident is exposed via groundwater during residential period	DERIVED(m**2)
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution	
Cl:Coefficient	Partition coefficient for Cl	NORMAL(Log10(mL/g))	
Default value used		Mean	7.00E-01
		Standard Deviation	1.40E+00
Ca:Coefficient	Partition coefficient for Ca	NORMAL(Log10(mL/g))	
Default value used		Mean	3.17E+00
		Standard Deviation	1.40E+00
Se:Coefficient	Partition coefficient for Se	NORMAL(Log10(mL/g))	
Default value used		Mean	2.06E+00
		Standard Deviation	2.50E-01
Zr:Coefficient	Partition coefficient for Zr	NORMAL(Log10(mL/g))	
Default value used		Mean	3.38E+00
		Standard Deviation	1.40E+00
Nb:Coefficient	Partition coefficient for Nb	NORMAL(Log10(mL/g))	
Default value used		Mean	2.80E+00
		Standard Deviation	1.40E+00
Mo:Coefficient	Partition coefficient for Mo	NORMAL(Log10(mL/g))	
Default value used		Mean	1.42E+00
		Standard Deviation	7.50E-01
Sn:Coefficient	Partition coefficient for Sn	NORMAL(Log10(mL/g))	
Default value used		Mean	2.70E+00
		Standard Deviation	1.40E+00
I:Coefficient	Partition coefficient for I	NORMAL(Log10(mL/g))	
Default value used		Mean	6.60E-01
		Standard Deviation	9.50E-01
Cs:Coefficient	Partition coefficient for Cs	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.01E+00
Sm:Coefficient	Partition coefficient for Sm	NORMAL(Log10(mL/g))	

Default value used		Mean	2.97E+00
		Standard Deviation	1.40E+00
Eu:Coefficient	Partition coefficient for Eu	NORMAL(Log10(mL/g))	
Default value used		Mean	2.98E+00
		Standard Deviation	1.74E+00
Ho:Coefficient	Partition coefficient for Ho	NORMAL(Log10(mL/g))	
Default value used		Mean	2.97E+00
		Standard Deviation	1.40E+00
Tl:Coefficient	Partition coefficient for Tl	NORMAL(Log10(mL/g))	
Default value used		Mean	2.20E+00
		Standard Deviation	1.40E+00
Pb:Coefficient	Partition coefficient for Pb	NORMAL(Log10(mL/g))	
Default value used		Mean	3.38E+00
		Standard Deviation	1.20E+00
Bi:Coefficient	Partition coefficient for Bi	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.40E+00
Po:Coefficient	Partition coefficient for Po	NORMAL(Log10(mL/g))	
Default value used		Mean	2.26E+00
		Standard Deviation	7.30E-01
Ra:Coefficient	Partition coefficient for Ra	NORMAL(Log10(mL/g))	
Default value used		Mean	3.55E+00
		Standard Deviation	7.40E-01
Ac:Coefficient	Partition coefficient for Ac	NORMAL(Log10(mL/g))	
Default value used		Mean	3.24E+00
		Standard Deviation	1.40E+00
Th:Coefficient	Partition coefficient for Th	NORMAL(Log10(mL/g))	
Default value used		Mean	3.77E+00
		Standard Deviation	1.57E+00
U:Coefficient	Partition coefficient for U	NORMAL(Log10(mL/g))	
Default value used		Mean	2.10E+00
		Standard Deviation	1.36E+00
Cl:Leafy	Leafy plant concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	4.25E+00
		Standard Deviation of Ln	9.04E-01
Ca:Leafy	Leafy plant concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	1.25E+00
		Standard Deviation of Ln	9.04E-01
Se:Leafy	Leafy plant concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	-3.69E+00
		Standard Deviation of Ln	9.04E-01
Zr:Leafy	Leafy plant concentration factor for Zr	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	-2.63E+00
		Standard Deviation of Ln	6.93E-01
Nb:Leafy	Leafy plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	-3.91E+00
		Standard Deviation of Ln	9.04E-01
Mo:Leafy	Leafy plant concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	7.88E-01
		Standard Deviation of Ln	1.19E+00

Sn:Leafy	Leafy plant concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.51E+00 Standard Deviation of Ln 9.04E-01
I:Leafy	Leafy plant concentration factor for I	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -1.83E+00 Standard Deviation of Ln 1.25E+00
Cs:Leafy	Leafy plant concentration factor for Cs	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.19E+00 Standard Deviation of Ln 1.25E+00
Sm:Leafy	Leafy plant concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Eu:Leafy	Leafy plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Ho:Leafy	Leafy plant concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Tl:Leafy	Leafy plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Pb:Leafy	Leafy plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.10E+00 Standard Deviation of Ln 9.04E-01
Bi:Leafy	Leafy plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.35E+00 Standard Deviation of Ln 9.04E-01
Po:Leafy	Leafy plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.99E+00 Standard Deviation of Ln 9.04E-01
Ra:Leafy	Leafy plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Ac:Leafy	Leafy plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.65E+00 Standard Deviation of Ln 9.04E-01
Th:Leafy	Leafy plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -7.07E+00 Standard Deviation of Ln 9.04E-01
U:Leafy	Leafy plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.77E+00 Standard Deviation of Ln 9.04E-01
Cl:Root	Root plant concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)

Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Root	Root plant concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Se:Root	Root plant concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Root	Root plant concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Root	Root plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Root	Root plant concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Root	Root plant concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Root	Root plant concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Root	Root plant concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Root	Root plant concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Eu:Root	Root plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Root	Root plant concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Root	Root plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Root	Root plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Root	Root plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01

Po:Root	Root plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Root	Root plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Root	Root plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Root	Root plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Root	Root plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Fruit	Fruit concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Fruit	Fruit concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Se:Fruit	Fruit concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Fruit	Fruit concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Fruit	Fruit concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Fruit	Fruit concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Fruit	Fruit concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Fruit	Fruit concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Fruit	Fruit concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Fruit	Fruit concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)

Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Eu:Fruit	Fruit concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Fruit	Fruit concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Fruit	Fruit concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Fruit	Fruit concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Fruit	Fruit concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Fruit	Fruit concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Fruit	Fruit concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Fruit	Fruit concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Fruit	Fruit concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Fruit	Fruit concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Grain	Grain concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Grain	Grain concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Se:Grain	Grain concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Grain	Grain concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00

Nb:Grain	Grain concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Grain	Grain concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Grain	Grain concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Grain	Grain concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Grain	Grain concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Grain	Grain concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Eu:Grain	Grain concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Grain	Grain concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Grain	Grain concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Grain	Grain concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Grain	Grain concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Grain	Grain concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Grain	Grain concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Grain	Grain concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Grain	Grain concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)

Default value used		Mean of Ln(X)	-9.37E+00
		Standard Deviation of Ln	9.04E-01
U:Grain	Grain concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)	
Default value used		Mean of Ln(X)	-5.52E+00
		Standard Deviation of Ln	9.04E-01
Cl:Beef	Beef transfer factor for Cl	CONSTANT(d/kg)	
Default value used		Value	8.00E-02
Ca:Beef	Beef transfer factor for Ca	CONSTANT(d/kg)	
Default value used		Value	7.00E-04
Se:Beef	Beef transfer factor for Se	CONSTANT(d/kg)	
Default value used		Value	1.50E-02
Zr:Beef	Beef transfer factor for Zr	CONSTANT(d/kg)	
Default value used		Value	5.50E-03
Nb:Beef	Beef transfer factor for Nb	CONSTANT(d/kg)	
Default value used		Value	2.50E-01
Mo:Beef	Beef transfer factor for Mo	CONSTANT(d/kg)	
Default value used		Value	6.00E-03
Sn:Beef	Beef transfer factor for Sn	CONSTANT(d/kg)	
Default value used		Value	8.00E-02
I:Beef	Beef transfer factor for I	CONSTANT(d/kg)	
Default value used		Value	7.00E-03
Cs:Beef	Beef transfer factor for Cs	CONSTANT(d/kg)	
Default value used		Value	2.00E-02
Sm:Beef	Beef transfer factor for Sm	CONSTANT(d/kg)	
Default value used		Value	5.00E-03
Eu:Beef	Beef transfer factor for Eu	CONSTANT(d/kg)	
Default value used		Value	5.00E-03
Ho:Beef	Beef transfer factor for Ho	CONSTANT(d/kg)	
Default value used		Value	4.50E-03
Tl:Beef	Beef transfer factor for Tl	CONSTANT(d/kg)	
Default value used		Value	4.00E-02
Pb:Beef	Beef transfer factor for Pb	CONSTANT(d/kg)	
Default value used		Value	3.00E-04
Bi:Beef	Beef transfer factor for Bi	CONSTANT(d/kg)	
Default value used		Value	4.00E-04
Po:Beef	Beef transfer factor for Po	CONSTANT(d/kg)	
Default value used		Value	3.00E-04
Ra:Beef	Beef transfer factor for Ra	CONSTANT(d/kg)	
Default value used		Value	2.50E-04
Ac:Beef	Beef transfer factor for Ac	CONSTANT(d/kg)	
Default value used		Value	2.50E-05
Th:Beef	Beef transfer factor for Th	CONSTANT(d/kg)	
Default value used		Value	6.00E-06
U:Beef	Beef transfer factor for U	CONSTANT(d/kg)	
Default value used		Value	2.00E-04
Cl:Poultry	Poultry transfer factor for Cl	CONSTANT(d/kg)	
Default value used		Value	3.00E-02
Ca:Poultry	Poultry transfer factor for Ca	CONSTANT(d/kg)	
Default value used		Value	4.40E-02

Se:Poultry	Poultry transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 8.50E+00
Zr:Poultry	Poultry transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 6.40E-05
Nb:Poultry	Poultry transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 3.10E-04
Mo:Poultry	Poultry transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 1.90E-01
Sn:Poultry	Poultry transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 2.00E-01
I:Poultry	Poultry transfer factor for I	CONSTANT(d/kg)
Default value used		Value 1.80E-02
Cs:Poultry	Poultry transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.40E+00
Sm:Poultry	Poultry transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Eu:Poultry	Poultry transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Ho:Poultry	Poultry transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Tl:Poultry	Poultry transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 3.00E-01
Pb:Poultry	Poultry transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 2.00E-01
Bi:Poultry	Poultry transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Po:Poultry	Poultry transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 9.00E-01
Ra:Poultry	Poultry transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Ac:Poultry	Poultry transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Th:Poultry	Poultry transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 4.00E-03
U:Poultry	Poultry transfer factor for U	CONSTANT(d/kg)
Default value used		Value 1.20E+00
Cl:Milk	Milk transfer factor for Cl	CONSTANT(d/L)
Default value used		Value 1.50E-02
Ca:Milk	Milk transfer factor for Ca	CONSTANT(d/L)
Default value used		Value 1.00E-02
Se:Milk	Milk transfer factor for Se	CONSTANT(d/L)
Default value used		Value 4.00E-03
Zr:Milk	Milk transfer factor for Zr	CONSTANT(d/L)
Default value used		Value 3.00E-05
Nb:Milk	Milk transfer factor for Nb	CONSTANT(d/L)
Default value used		Value 2.00E-02
Mo:Milk	Milk transfer factor for Mo	CONSTANT(d/L)
Default value used		Value 1.50E-03
Sn:Milk	Milk transfer factor for Sn	CONSTANT(d/L)

Default value used		Value 1.00E-03
I:Milk	Milk transfer factor for I	CONSTANT(d/L)
Default value used		Value 1.00E-02
Cs:Milk	Milk transfer factor for Cs	CONSTANT(d/L)
Default value used		Value 7.00E-03
Sm:Milk	Milk transfer factor for Sm	CONSTANT(d/L)
Default value used		Value 2.00E-05
Eu:Milk	Milk transfer factor for Eu	CONSTANT(d/L)
Default value used		Value 2.00E-05
Ho:Milk	Milk transfer factor for Ho	CONSTANT(d/L)
Default value used		Value 2.00E-05
Tl:Milk	Milk transfer factor for Tl	CONSTANT(d/L)
Default value used		Value 2.00E-03
Pb:Milk	Milk transfer factor for Pb	CONSTANT(d/L)
Default value used		Value 2.50E-04
Bi:Milk	Milk transfer factor for Bi	CONSTANT(d/L)
Default value used		Value 5.00E-04
Po:Milk	Milk transfer factor for Po	CONSTANT(d/L)
Default value used		Value 3.50E-04
Ra:Milk	Milk transfer factor for Ra	CONSTANT(d/L)
Default value used		Value 4.50E-04
Ac:Milk	Milk transfer factor for Ac	CONSTANT(d/L)
Default value used		Value 2.00E-05
Th:Milk	Milk transfer factor for Th	CONSTANT(d/L)
Default value used		Value 5.00E-06
U:Milk	Milk transfer factor for U	CONSTANT(d/L)
Default value used		Value 6.00E-04
Cl:Eggs	Egg transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 2.00E+00
Ca:Eggs	Egg transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 4.40E-01
Se:Eggs	Egg transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 9.30E+00
Zr:Eggs	Egg transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 1.90E-04
Nb:Eggs	Egg transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 1.30E-03
Mo:Eggs	Egg transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 7.80E-01
Sn:Eggs	Egg transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 8.00E-01
I:Eggs	Egg transfer factor for I	CONSTANT(d/kg)
Default value used		Value 2.80E+00
Cs:Eggs	Egg transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.90E-01
Sm:Eggs	Egg transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Eu:Eggs	Egg transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 7.00E-03

Ho:Eggs	Egg transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Tl:Eggs	Egg transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Pb:Eggs	Egg transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Bi:Eggs	Egg transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Po:Eggs	Egg transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 7.00E+00
Ra:Eggs	Egg transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.00E-05
Ac:Eggs	Egg transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 2.00E-03
Th:Eggs	Egg transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 2.00E-03
U:Eggs	Egg transfer factor for U	CONSTANT(d/kg)
Default value used		Value 9.90E-01
Cl:Factor	Bioaccumulation factor for Cl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01
Ca:Factor	Bioaccumulation factor for Ca in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 4.00E+01
Se:Factor	Bioaccumulation factor for Se in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.70E+02
Zr:Factor	Bioaccumulation factor for Zr in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Nb:Factor	Bioaccumulation factor for Nb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Mo:Factor	Bioaccumulation factor for Mo in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+01
Sn:Factor	Bioaccumulation factor for Sn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 3.00E+03
I:Factor	Bioaccumulation factor for I in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+02
Cs:Factor	Bioaccumulation factor for Cs in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Sm:Factor	Bioaccumulation factor for Sm in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Eu:Factor	Bioaccumulation factor for Eu in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Ho:Factor	Bioaccumulation factor for Ho in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Tl:Factor	Bioaccumulation factor for Tl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 0.00E+00
Pb:Factor	Bioaccumulation factor for Pb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Bi:Factor	Bioaccumulation factor for Bi in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Po:Factor	Bioaccumulation factor for Po in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)

Default value used		Value 5.00E+02
Ra:Factor	Bioaccumulation factor for Ra in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 7.00E+01
Ac:Factor	Bioaccumulation factor for Ac in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Th:Factor	Bioaccumulation factor for Th in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
U:Factor	Bioaccumulation factor for U in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		
NDEV:Porosity Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		

Summary Results:

90.00% **of the** 182 **calculated TEDE values are <** 9.75E-04 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 8.41E-04 **to** 1.20E-03 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
36Cl	1.40E-05	7.78E-10
93Zr	2.56E-09	5.63E-21
93mNb	0.00E+00	2.10E-18
41Ca	1.26E-07	2.44E-19
93Mo	7.38E-07	1.75E-18
79Se	1.56E-08	2.86E-20
134Cs	6.62E-07	1.36E-28
135Cs	9.97E-10	2.34E-21
121mSn	1.09E-08	1.31E-23
121Sn	0.00E+00	1.02E-23
129I	1.50E-11	5.92E-18
151Sm	2.55E-07	2.02E-21
155Eu	1.23E-06	1.14E-21
166mHo	4.09E-06	1.17E-18
233U	1.20E-08	5.44E-20
229Th	0.00E+00	1.26E-20
225Ra	0.00E+00	1.19E-20
225Ac	0.00E+00	1.72E-20

221Fr	0.00E+00	1.72E-20
217At	0.00E+00	1.72E-20
213Bi	0.00E+00	1.72E-20
213Po	0.00E+00	1.69E-20
209Tl	0.00E+00	3.72E-22
209Pb	0.00E+00	1.72E-20

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
1.20E-03	1.18E-03	9.86E-12	1.07E-11	2.07E-05	1.52E-09	1.74E-09	4.08E-10

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
36Cl	1.18E-03
93Zr	2.83E-11
93mNb	4.84E-10
41Ca	5.78E-08
93Mo	9.28E-08
79Se	2.01E-09
134Cs	2.95E-06
135Cs	1.20E-10
121mSn	1.52E-10
121Sn	6.48E-11
129I	1.68E-10
151Sm	3.57E-10
155Eu	1.08E-07
166mHo	1.84E-05
233U	1.50E-08
229Th	1.16E-11
225Ra	1.18E-12
225Ac	3.27E-13
221Fr	3.29E-14
217At	3.59E-16
213Bi	1.58E-13
213Po	0.00E+00
209Tl	5.20E-14
209Pb	7.69E-16
All Nuclides	1.20E-03

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
36Cl	1.18E-03	1.09E-12	1.17E-12	1.57E-08	8.98E-11	6.00E-10	6.53E-11
93Zr	2.82E-11	4.31E-24	1.96E-23	0.00E+00	2.40E-13	6.01E-14	9.42E-24

93mNb	4.83E-10	5.07E-22	2.22E-21	9.28E-13	1.36E-13	1.37E-13	6.51E-21
41Ca	5.78E-08	1.44E-22	1.34E-22	0.00E+00	4.96E-14	2.27E-12	1.25E-21
93Mo	9.26E-08	1.09E-21	2.56E-22	2.13E-10	6.13E-12	1.41E-11	3.02E-21
79Se	2.01E-09	1.15E-22	4.35E-22	1.42E-13	4.49E-14	1.92E-12	6.61E-22
134Cs	6.58E-07	4.62E-30	2.07E-28	2.30E-06	7.80E-12	5.83E-10	3.12E-29
135Cs	1.20E-10	7.63E-24	3.48E-22	1.86E-14	1.33E-15	9.97E-14	5.77E-23
121mSn	1.37E-10	9.41E-27	6.47E-25	1.04E-11	3.65E-14	2.38E-13	7.68E-26
121Sn	6.21E-11	4.25E-27	2.92E-25	7.97E-13	1.25E-15	1.07E-13	3.47E-26
129I	1.63E-10	7.55E-19	8.13E-18	9.47E-14	7.61E-16	5.86E-14	6.55E-18
151Sm	3.54E-10	3.62E-25	2.09E-25	1.22E-13	2.23E-12	1.40E-12	4.43E-25
155Eu	6.02E-09	8.08E-25	4.40E-25	1.02E-07	1.41E-11	2.48E-11	1.22E-24
166mHo	1.18E-07	4.34E-21	2.51E-21	1.83E-05	9.24E-10	4.67E-10	1.12E-20
233U	1.48E-08	7.27E-21	8.26E-21	7.92E-12	4.75E-10	4.91E-11	1.61E-20
229Th	1.12E-11	2.05E-20	4.60E-20	8.69E-14	3.06E-13	2.83E-14	4.03E-20
225Ra	1.15E-12	2.11E-21	3.32E-21	2.67E-15	9.74E-16	2.75E-15	4.52E-21
225Ac	3.06E-13	8.84E-22	4.81E-22	1.40E-14	1.24E-15	7.29E-16	1.30E-21
221Fr	0.00E+00	0.00E+00	0.00E+00	3.29E-14	0.00E+00	0.00E+00	0.00E+00
217At	0.00E+00	0.00E+00	0.00E+00	3.59E-16	0.00E+00	0.00E+00	0.00E+00
213Bi	1.99E-15	5.75E-24	3.12E-24	1.56E-13	1.96E-18	4.74E-18	8.43E-24
213Po	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	0.00E+00	0.00E+00	0.00E+00	5.20E-14	0.00E+00	0.00E+00	0.00E+00
209Pb	5.87E-16	1.69E-24	9.21E-25	1.70E-16	1.09E-20	1.40E-18	2.49E-24

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 6/22/2021 10:13:47 AM
Site Name: CR3
Description: Occupancy Not Discounted
FileName:C:\Users\mceri\Documents\CR3 Not Discounted Occupancy.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 182
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
36Cl	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.40E-05
93Zr	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	2.56E-09
41Ca	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.26E-07
93Mo	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	7.38E-07
79Se	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.56E-08
134Cs	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	6.62E-07
135Cs	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	9.97E-10
121mSn	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.09E-08
129I	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.50E-11
151Sm	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	2.55E-07
155Eu	UNLIMITED	CONSTANT(pCi/g)	

Justification for concentration: Site		Value	1.23E-06
166mHo	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	4.09E-06
233U	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.20E-08

Chain Data:

Number of chains: **13**

Chain No. 1: **36Cl**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
36Cl	1	1.10E+08					8.18E-10	5.93E-09	5.81E-14	1.06E-15

Chain No. 2: **41Ca**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
41Ca	1	5.11E+07					3.44E-10	3.64E-10	0.00E+00	0.00E+00

Chain No. 3: **79Se**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
79Se	1	2.37E+07					2.35E-09	2.66E-09	1.79E-15	8.60E-18

Chain No. 4: **93Zr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
93Zr	1	5.59E+08					4.48E-10	8.67E-08	0.00E+00	0.00E+00
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 5: **93Mo**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))

93Mo	1	1.28E+06					3.64E-10	7.68E-09	4.61E-13	2.73E-16
93mNb	2	4.97E+03	1	1	0	0	1.41E-10	7.90E-09	8.11E-14	4.80E-17

Chain No. 6: **121mSn**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
121mSn	1	2.01E+04					4.19E-10	3.11E-09	4.22E-13	9.11E-16
121Sn	2	1.13E+00	1	0.776	0	0	2.44E-10	1.38E-10	9.07E-15	9.02E-17

Chain No. 7: **129I**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
129I	1	5.73E+09					7.46E-08	4.69E-08	2.23E-12	5.98E-15

Chain No. 8: **134Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
134Cs	1	7.53E+02					1.98E-08	1.25E-08	1.31E-10	3.86E-12

Chain No. 9: **135Cs**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
135Cs	1	8.40E+08					1.91E-09	1.23E-09	2.87E-15	1.77E-17

Chain No. 10: **151Sm**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
151Sm	1	3.29E+04					1.05E-10	8.10E-09	4.34E-16	4.55E-19

Chain No. 11: **155Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE	Inhalation CEDE	Surface Dose Rate	15 cm Dose Rate

							Factor (Sv/Bq)	Factor (Sv/Bq)	Factor ((Sv/d)/(Bq/m^2))	Factor ((Sv/d)/(Bq/m^3))
155Eu	1	1.81E+03					4.13E-10	1.12E-08	5.10E-12	8.42E-14

Chain No. 12: **166mHo**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
166mHo	1	4.38E+05					2.18E-09	2.09E-07	1.47E-10	4.23E-12

Chain No. 13: **233U**
Nuclides in chain: **10**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
233U	1	5.79E+07					7.81E-08	3.66E-05	6.18E-14	6.25E-16
229Th	2	2.68E+06	1	1	0	0	9.54E-07	5.80E-04	7.38E-12	1.47E-13
225Ra	3	1.48E+01	2	1	0	0	1.04E-07	2.10E-06	1.15E-12	5.09E-15
225Ac	4	1.00E+01	3	1	0	0	3.00E-08	2.92E-06	1.37E-12	2.89E-14
221Fr	Implicit		4	1			0.00E+00	0.00E+00	2.57E-12	6.82E-14
217At	Implicit		4	1			0.00E+00	0.00E+00	2.61E-14	7.43E-16
213Bi	Implicit		4	1			1.95E-10	4.63E-09	1.14E-11	3.24E-13
213Po	Implicit		4	0.9784			0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	Implicit		4	0.0216			0.00E+00	0.00E+00	1.64E-10	4.99E-12
209Pb	Implicit		4	1			5.75E-11	2.56E-11	2.60E-14	3.52E-16

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Nuclide	Soil Concentration (pCi/g)
36Cl	1.40E-05
93Zr	2.56E-09
93mNb	0.00E+00
41Ca	1.26E-07
93Mo	7.38E-07
79Se	1.56E-08
134Cs	6.62E-07
135Cs	9.97E-10
121mSn	1.09E-08
121Sn	0.00E+00
129I	1.50E-11
151Sm	2.55E-07
155Eu	1.23E-06
166mHo	4.09E-06

233U	1.20E-08
229Th	0.00E+00
225Ra	0.00E+00
225Ac	0.00E+00
221Fr	0.00E+00
217At	0.00E+00
213Bi	0.00E+00
213Po	0.00E+00
209Tl	0.00E+00
209Pb	0.00E+00

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv(1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv(2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(4):Translocation:Layer Hen Forage	Translocation factor for forage consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
Th(1):Translocation:Beef	Translocation factor for stored hay	CONSTANT(none)

Hay	consumed by beef cattle	
Default value used		Value 1.00E+00
Th(2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Th(3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Th(4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT(none)
Default value used		Value 3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT(none)
Default value used		Value 1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT(none)
Default value used		Value 6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT(none)
Default value used		Value 1.60E-01
fcf(1):Beef Forage Carbon Fraction	Mass fraction of wet forage consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(4):Layer Hen Forage Carbon Fraction	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02

fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay Carbon Fraction	Mass fraction of wet stored hay consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage Contaminated Fraction	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)

Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01
Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)
Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)

Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)
Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)
Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)
Default value used		
PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)

Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing Rate	Breathing rate while gardening	CONSTANT(m**3/hr)
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)
Default value used		

Value	Probability
3.05E-01	0.00E+00
6.68E-01	4.76E-03
8.11E-01	9.52E-03
9.21E-01	1.43E-02
9.94E-01	1.91E-02
1.03E+00	2.38E-02
1.07E+00	2.86E-02
1.14E+00	3.33E-02
1.21E+00	3.81E-02
1.30E+00	4.29E-02
1.31E+00	4.76E-02
1.32E+00	5.24E-02
1.56E+00	5.71E-02
1.58E+00	6.19E-02
1.61E+00	6.67E-02
1.69E+00	7.62E-02
1.78E+00	8.57E-02
1.80E+00	9.05E-02
1.81E+00	9.52E-02
1.84E+00	1.00E-01
1.87E+00	1.05E-01
1.92E+00	1.10E-01
2.04E+00	1.14E-01
2.10E+00	1.19E-01
2.11E+00	1.24E-01
2.32E+00	1.29E-01
2.36E+00	1.33E-01
2.37E+00	1.38E-01
2.39E+00	1.43E-01
2.44E+00	1.48E-01
2.44E+00	1.52E-01
2.45E+00	1.57E-01
2.59E+00	1.62E-01
2.63E+00	1.67E-01
2.69E+00	1.71E-01
2.79E+00	1.76E-01
2.81E+00	1.81E-01
2.90E+00	1.86E-01
2.95E+00	1.91E-01
3.07E+00	1.95E-01
3.18E+00	2.00E-01
3.22E+00	2.05E-01
3.30E+00	2.10E-01
3.34E+00	2.14E-01

3.37E+00	2.19E-01
3.44E+00	2.24E-01
3.58E+00	2.29E-01
3.62E+00	2.33E-01
3.66E+00	2.38E-01
3.74E+00	2.43E-01
3.86E+00	2.48E-01
3.88E+00	2.52E-01
4.17E+00	2.57E-01
4.26E+00	2.62E-01
4.44E+00	2.71E-01
4.63E+00	2.76E-01
4.87E+00	2.81E-01
5.13E+00	2.86E-01
5.18E+00	2.91E-01
5.54E+00	2.95E-01
5.83E+00	3.00E-01
5.86E+00	3.05E-01
5.86E+00	3.10E-01
5.90E+00	3.14E-01
6.06E+00	3.19E-01
6.13E+00	3.24E-01
6.17E+00	3.29E-01
6.22E+00	3.33E-01
6.31E+00	3.38E-01
6.36E+00	3.43E-01
6.40E+00	3.48E-01
6.46E+00	3.52E-01
6.51E+00	3.57E-01
6.55E+00	3.62E-01
6.60E+00	3.67E-01
6.86E+00	3.71E-01
6.93E+00	3.76E-01
6.95E+00	3.86E-01
6.97E+00	3.91E-01
7.09E+00	3.95E-01
7.18E+00	4.00E-01
7.35E+00	4.05E-01
7.36E+00	4.10E-01
7.40E+00	4.14E-01
7.43E+00	4.19E-01
7.46E+00	4.24E-01
7.59E+00	4.29E-01
7.60E+00	4.33E-01
7.64E+00	4.38E-01
7.87E+00	4.43E-01
8.10E+00	4.48E-01
8.28E+00	4.52E-01
8.35E+00	4.57E-01
8.71E+00	4.62E-01
8.71E+00	4.67E-01
8.73E+00	4.71E-01
8.79E+00	4.76E-01
8.80E+00	4.81E-01
8.82E+00	4.86E-01
8.85E+00	4.91E-01
8.89E+00	4.95E-01
8.90E+00	5.00E-01
8.99E+00	5.05E-01
9.00E+00	5.10E-01
9.13E+00	5.14E-01
9.14E+00	5.19E-01
9.21E+00	5.24E-01
9.31E+00	5.29E-01
9.55E+00	5.33E-01
9.60E+00	5.38E-01

9.63E+00	5.43E-01
9.86E+00	5.48E-01
1.05E+01	5.52E-01
1.07E+01	5.57E-01
1.13E+01	5.62E-01
1.15E+01	5.67E-01
1.17E+01	5.71E-01
1.20E+01	5.76E-01
1.26E+01	5.81E-01
1.26E+01	5.86E-01
1.28E+01	5.91E-01
1.32E+01	5.95E-01
1.32E+01	6.00E-01
1.34E+01	6.05E-01
1.34E+01	6.10E-01
1.36E+01	6.14E-01
1.37E+01	6.19E-01
1.38E+01	6.24E-01
1.41E+01	6.29E-01
1.45E+01	6.33E-01
1.51E+01	6.38E-01
1.52E+01	6.43E-01
1.61E+01	6.48E-01
1.62E+01	6.52E-01
1.65E+01	6.57E-01
1.66E+01	6.62E-01
1.69E+01	6.67E-01
1.74E+01	6.71E-01
1.82E+01	6.76E-01
1.84E+01	6.81E-01
1.84E+01	6.86E-01
1.87E+01	6.91E-01
1.95E+01	6.95E-01
2.01E+01	7.00E-01
2.07E+01	7.05E-01
2.08E+01	7.10E-01
2.17E+01	7.14E-01
2.24E+01	7.19E-01
2.27E+01	7.24E-01
2.29E+01	7.29E-01
2.29E+01	7.33E-01
2.40E+01	7.38E-01
2.47E+01	7.43E-01
2.60E+01	7.48E-01
2.65E+01	7.52E-01
2.72E+01	7.57E-01
2.73E+01	7.62E-01
2.76E+01	7.67E-01
2.77E+01	7.71E-01
2.78E+01	7.76E-01
2.80E+01	7.81E-01
2.86E+01	7.86E-01
2.94E+01	7.91E-01
3.01E+01	7.95E-01
3.03E+01	8.00E-01
3.06E+01	8.10E-01
3.08E+01	8.14E-01
3.11E+01	8.19E-01
3.17E+01	8.24E-01
3.17E+01	8.29E-01
3.17E+01	8.33E-01
3.22E+01	8.38E-01
3.39E+01	8.43E-01
3.48E+01	8.48E-01
3.54E+01	8.52E-01
3.60E+01	8.57E-01

		3.68E+01	8.62E-01
		4.03E+01	8.67E-01
		4.07E+01	8.71E-01
		4.24E+01	8.76E-01
		4.29E+01	8.81E-01
		4.42E+01	8.86E-01
		4.72E+01	8.91E-01
		4.97E+01	8.95E-01
		5.12E+01	9.00E-01
		6.13E+01	9.05E-01
		6.19E+01	9.10E-01
		6.23E+01	9.14E-01
		6.32E+01	9.19E-01
		6.59E+01	9.24E-01
		6.73E+01	9.29E-01
		7.47E+01	9.33E-01
		7.92E+01	9.38E-01
		8.12E+01	9.43E-01
		8.28E+01	9.48E-01
		8.47E+01	9.52E-01
		8.96E+01	9.57E-01
		9.47E+01	9.62E-01
		1.08E+02	9.67E-01
		1.13E+02	9.71E-01
		1.15E+02	9.76E-01
		1.42E+02	9.81E-01
		1.77E+02	9.86E-01
		1.78E+02	9.91E-01
		1.80E+02	9.95E-01
		3.16E+02	1.00E+00
N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)	
Default value used			
N2:Unsaturated Zone Porosity	Porosity of the unsaturated zone	DERIVED(none)	
Default value used			
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)	
Default value used			
F2:Unsaturated Zone Saturation	Saturation ratio of the unsaturated zone	DERIVED(none)	
Default value used			
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)	
Default value used			
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)	
Default value used		Value	Probability
		1.00E+00	1.00E-04
		2.00E+00	1.34E-03
		3.00E+00	1.06E-02
		4.00E+00	2.51E-02
		5.00E+00	6.17E-02
		6.00E+00	1.09E-01
		7.00E+00	1.62E-01
		8.00E+00	2.12E-01
		9.00E+00	2.85E-01
		1.00E+01	5.10E-01
		1.10E+01	7.58E-01
		1.20E+01	1.00E+00
NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)	
Default value used		Lower Limit	0.00E+00
		Upper Limit	1.00E+00
KSDEV:Permeability	Relative permeability value within the	UNIFORM(none)	

Probability	distribution for this soil type	
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		Value / Probability 6.07E-01 / 0.00E+00 6.10E-01 / 4.62E-01 6.35E-01 / 4.76E-01 7.62E-01 / 5.40E-01 8.89E-01 / 6.29E-01 1.02E+00 / 7.05E-01 1.14E+00 / 8.04E-01 1.27E+00 / 8.79E-01 1.40E+00 / 9.41E-01 1.52E+00 / 9.82E-01 1.65E+00 / 9.98E-01 1.78E+00 / 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)
Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05
VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)
Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02
THV(1):Holdup Period : Leafy	Holdup period for leafy vegetables	CONSTANT(days)
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period :	Holdup period for fruits	CONSTANT(days)

Fruits		
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)
Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)
Default value used		Value 3.00E+01
TGF(2):Growing Period : Poultry Forage	Minimum growing period for forage consumed by poultry	DERIVED(days)
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01
TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		

TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		
TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction : Leafy	Interception fraction for leafy vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction : Poultry forage	Interception fraction for poultry forage	DERIVED(none)
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		
RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		

RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)
Default value used		
YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		

Value	Probability
2.70E+00	0.00E+00
2.71E+00	1.60E-03
2.74E+00	6.00E-03
2.76E+00	1.76E-02
2.78E+00	4.36E-02
2.80E+00	8.48E-02
2.82E+00	1.56E-01
2.85E+00	2.57E-01
2.87E+00	3.64E-01
2.89E+00	5.00E-01
2.91E+00	6.39E-01
2.93E+00	7.46E-01
2.96E+00	8.42E-01
2.98E+00	9.09E-01
3.00E+00	9.60E-01
3.02E+00	9.84E-01
3.04E+00	9.94E-01
3.07E+00	9.97E-01
3.09E+00	9.99E-01
3.11E+00	1.00E+00
3.13E+00	1.00E+00
3.15E+00	1.00E+00

YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		

Value	Probability
2.26E+00	0.00E+00
2.29E+00	8.00E-04
2.30E+00	1.20E-03
2.31E+00	6.40E-03
2.33E+00	1.52E-02
2.34E+00	3.28E-02
2.35E+00	7.44E-02
2.36E+00	1.40E-01
2.38E+00	2.49E-01
2.39E+00	3.80E-01
2.40E+00	5.30E-01
2.42E+00	6.61E-01
2.43E+00	7.88E-01
2.44E+00	8.86E-01
2.45E+00	9.42E-01
2.47E+00	9.75E-01
2.48E+00	9.88E-01
2.49E+00	9.96E-01
2.51E+00	9.97E-01
2.52E+00	9.99E-01
2.53E+00	1.00E+00
2.54E+00	1.00E+00

YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used		
		Value / Probability
		2.17E+00 / 0.00E+00
		2.20E+00 / 1.20E-03
		2.21E+00 / 2.40E-03
		2.23E+00 / 6.80E-03
		2.25E+00 / 1.80E-02
		2.27E+00 / 4.36E-02
		2.29E+00 / 7.64E-02
		2.31E+00 / 1.38E-01
		2.32E+00 / 2.14E-01
		2.34E+00 / 3.27E-01
		2.36E+00 / 4.50E-01
		2.38E+00 / 5.76E-01
		2.40E+00 / 6.87E-01
		2.42E+00 / 7.88E-01
		2.43E+00 / 8.68E-01
		2.45E+00 / 9.25E-01
		2.47E+00 / 9.60E-01
		2.49E+00 / 9.81E-01
		2.51E+00 / 9.92E-01
		2.53E+00 / 9.98E-01
		2.54E+00 / 1.00E+00
		2.56E+00 / 1.00E+00
YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		Value / Probability
		2.85E-01 / 0.00E+00
		2.90E-01 / 6.00E-04
		3.02E-01 / 2.80E-03
		3.14E-01 / 9.40E-03
		3.26E-01 / 2.14E-02
		3.38E-01 / 5.42E-02
		3.50E-01 / 1.08E-01
		3.62E-01 / 2.02E-01
		3.74E-01 / 3.15E-01
		3.86E-01 / 4.50E-01
		3.98E-01 / 5.92E-01
		4.10E-01 / 7.20E-01
		4.23E-01 / 8.26E-01
		4.35E-01 / 9.03E-01
		4.47E-01 / 9.51E-01
		4.59E-01 / 9.77E-01
		4.71E-01 / 9.91E-01
		4.83E-01 / 9.96E-01
		4.95E-01 / 9.99E-01
		5.07E-01 / 1.00E+00
		5.19E-01 / 1.00E+00
		5.31E-01 / 1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)
Default value used		Lower Limit 3.70E-01
		Upper Limit 5.24E-01
		p 2.36E+00
		q 1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)
Default value used		
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)
Default value used		

YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)
Default value used		Mean 5.78E-01 Standard Deviation 7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)
Default value used		
YH(1):Crop Yield : Beef Cow Hay	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)
Default value used		
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)
Default value used		
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)
Default value used		

Value	Probability
3.32E-02	0.00E+00
4.89E-02	3.45E-02
5.47E-02	6.91E-02
5.96E-02	1.04E-01
6.36E-02	1.38E-01
6.70E-02	1.73E-01
7.05E-02	2.07E-01
7.38E-02	2.42E-01
7.48E-02	2.50E-01
7.72E-02	2.76E-01
8.03E-02	3.11E-01
8.34E-02	3.45E-01
8.66E-02	3.80E-01
9.00E-02	4.15E-01
9.36E-02	4.49E-01
9.73E-02	4.84E-01
9.91E-02	4.99E-01
1.01E-01	5.18E-01
1.05E-01	5.53E-01
1.09E-01	5.87E-01
1.13E-01	6.22E-01
1.18E-01	6.56E-01
1.23E-01	6.91E-01
1.29E-01	7.25E-01
1.33E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.50E-01	8.29E-01
1.59E-01	8.64E-01
1.70E-01	8.98E-01
1.85E-01	9.33E-01

		Value / Probability (continued): 2.10E-01 / 9.67E-01 2.56E-01 / 9.91E-01 3.24E-01 / 1.00E+00
WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables	CONTINUOUS LINEAR(none)
Default value used		

Value	Probability
3.58E-02	0.00E+00
4.87E-02	3.45E-02
5.46E-02	6.91E-02
5.90E-02	1.04E-01
6.29E-02	1.38E-01
6.69E-02	1.73E-01
7.02E-02	2.07E-01
7.34E-02	2.42E-01
7.41E-02	2.50E-01
7.65E-02	2.76E-01
7.99E-02	3.11E-01
8.32E-02	3.45E-01
8.66E-02	3.80E-01
9.05E-02	4.15E-01
9.41E-02	4.49E-01
9.82E-02	4.84E-01
9.98E-02	4.99E-01
1.02E-01	5.18E-01
1.06E-01	5.53E-01
1.09E-01	5.87E-01
1.14E-01	6.22E-01
1.19E-01	6.56E-01
1.24E-01	6.91E-01
1.29E-01	7.25E-01
1.33E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.50E-01	8.29E-01
1.59E-01	8.64E-01
1.70E-01	8.98E-01
1.87E-01	9.33E-01
2.12E-01	9.67E-01
2.62E-01	9.91E-01
3.13E-01	1.00E+00

WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)
Default value used		

Value	Probability
3.66E-02	0.00E+00
4.87E-02	3.45E-02
5.45E-02	6.91E-02
5.93E-02	1.04E-01
6.31E-02	1.38E-01
6.72E-02	1.73E-01
7.10E-02	2.07E-01
7.44E-02	2.42E-01
7.52E-02	2.50E-01
7.78E-02	2.76E-01
8.13E-02	3.11E-01
8.45E-02	3.45E-01
8.78E-02	3.80E-01
9.11E-02	4.15E-01
9.46E-02	4.49E-01
9.82E-02	4.84E-01
9.97E-02	4.99E-01
1.02E-01	5.18E-01
1.06E-01	5.53E-01
1.10E-01	5.87E-01
1.14E-01	6.22E-01
1.19E-01	6.56E-01

		1.24E-01	6.91E-01
		1.29E-01	7.25E-01
		1.34E-01	7.50E-01
		1.35E-01	7.60E-01
		1.42E-01	7.94E-01
		1.49E-01	8.29E-01
		1.58E-01	8.64E-01
		1.70E-01	8.98E-01
		1.87E-01	9.33E-01
		2.14E-01	9.67E-01
		2.58E-01	9.91E-01
		3.25E-01	1.00E+00
WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)	
Default value used		Value	8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)	
Default value used		Lower Limit	1.83E-01
		Upper Limit	3.23E-01
		p	1.15E+00
		q	1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)	
Default value used			
WF(3):Wet/dry : Milk Cow Forage	Wet/dry conversion factor for milk cow forage	DERIVED(none)	
Default value used			
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)	
Default value used			
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)	
Default value used		Value	8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)	
Default value used			
WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)	
Default value used			
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)	
Default value used			
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)	
Default value used			
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)	
Default value used			
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)	
Default value used			
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)	
Default value used			
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)	

Default value used	Lower Limit	1.69E+00
	Upper Limit	2.29E+00
	p	1.99E+00
	q	9.11E-01

QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)

Default value used	Lower Limit	3.48E-03
	Upper Limit	2.82E-02
	p	1.51E+00
	q	1.41E+00

QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)

Default value used	Value	Probability
	6.35E+00	0.00E+00
	6.77E+00	3.45E-02
	6.96E+00	6.91E-02
	7.10E+00	1.04E-01
	7.24E+00	1.38E-01
	7.35E+00	1.73E-01
	7.47E+00	2.07E-01
	7.57E+00	2.42E-01
	7.60E+00	2.50E-01
	7.67E+00	2.76E-01
	7.77E+00	3.11E-01
	7.87E+00	3.45E-01
	7.98E+00	3.80E-01
	8.08E+00	4.15E-01
	8.18E+00	4.49E-01
	8.31E+00	4.84E-01
	8.37E+00	4.99E-01
	8.42E+00	5.18E-01
	8.54E+00	5.53E-01
	8.67E+00	5.87E-01
	8.81E+00	6.22E-01
	8.95E+00	6.56E-01
	9.10E+00	6.91E-01
	9.26E+00	7.25E-01
	9.38E+00	7.50E-01
	9.45E+00	7.60E-01
	9.68E+00	7.94E-01
	9.93E+00	8.29E-01
	1.02E+01	8.64E-01
	1.06E+01	8.98E-01
	1.11E+01	9.33E-01
	1.20E+01	9.67E-01
	1.33E+01	9.91E-01
	1.53E+01	1.00E+00

QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)

Default value used	Lower Limit	1.19E-02
	Upper Limit	2.22E-02
	p	1.45E+00
	q	7.92E-01

QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)

Default value used	Lower Limit	1.69E+00
	Upper Limit	2.29E+00
	p	1.99E+00
	q	9.11E-01

QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)

Default value used	Lower Limit	1.04E-02

		Upper Limit 8.45E-02 p 1.51E+00 q 1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)
Default value used		Mean 1.71E+00 Standard Deviation 2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)
Default value used		Lower Limit 3.58E-02 Upper Limit 6.67E-02 p 1.43E+00 q 7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)
Default value used		Lower Limit 3.38E+00 Upper Limit 4.58E+00 p 1.99E+00 q 9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)
Default value used		See table below

Value	Probability
5.12E+00	0.00E+00
5.43E+00	3.45E-02
5.57E+00	6.91E-02
5.68E+00	1.04E-01
5.79E+00	1.38E-01
5.89E+00	1.73E-01
5.98E+00	2.07E-01
6.06E+00	2.42E-01
6.08E+00	2.50E-01
6.14E+00	2.76E-01
6.22E+00	3.11E-01
6.30E+00	3.45E-01
6.38E+00	3.80E-01
6.46E+00	4.15E-01
6.54E+00	4.49E-01
6.63E+00	4.84E-01
6.67E+00	4.99E-01
6.72E+00	5.18E-01
6.81E+00	5.53E-01
6.92E+00	5.87E-01
7.03E+00	6.22E-01
7.13E+00	6.56E-01
7.26E+00	6.91E-01
7.39E+00	7.25E-01
7.49E+00	7.50E-01
7.56E+00	7.60E-01
7.70E+00	7.94E-01
7.89E+00	8.29E-01
8.11E+00	8.64E-01
8.39E+00	8.98E-01
8.75E+00	9.33E-01
9.44E+00	9.67E-01
1.05E+01	9.91E-01
1.27E+01	1.00E+00

QH(4):Ingestion Rate : Layer Hen Hay	Ingestion rate for layer hen hay	CONSTANT(kg dry wt hay/d)

Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT(L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT(L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT(L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT(L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef Cattle	Soil intake fraction for beef cattle	CONSTANT(none)
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT(none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)
Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(1):Mass-Loading :	Mass-loading factor for beef cattle grain	CONSTANT(none)

Beef Cattle Grain		
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT(days)
Default value used		Value 3.65E+02

TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT(days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT(none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT(none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT(none)
Default value used		Value 6.80E-02
fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction :	Hydrogen fraction for layer hen forage	CONSTANT(none)

Layer Hen Forage		
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)
Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00
sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product Yield : Poultry	Annual yield of chicken per individual animal	CONSTANT(kg/y)
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
ARExt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)

Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater Exposure Area	Minimum surface area to which resident is exposed via groundwater during residential period	DERIVED(m**2)
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution	
Cl:Coefficient	Partition coefficient for Cl	NORMAL(Log10(mL/g))	
Default value used		Mean	7.00E-01
		Standard Deviation	1.40E+00
Ca:Coefficient	Partition coefficient for Ca	NORMAL(Log10(mL/g))	
Default value used		Mean	3.17E+00
		Standard Deviation	1.40E+00
Se:Coefficient	Partition coefficient for Se	NORMAL(Log10(mL/g))	
Default value used		Mean	2.06E+00
		Standard Deviation	2.50E-01
Zr:Coefficient	Partition coefficient for Zr	NORMAL(Log10(mL/g))	
Default value used		Mean	3.38E+00
		Standard Deviation	1.40E+00
Nb:Coefficient	Partition coefficient for Nb	NORMAL(Log10(mL/g))	
Default value used		Mean	2.80E+00
		Standard Deviation	1.40E+00
Mo:Coefficient	Partition coefficient for Mo	NORMAL(Log10(mL/g))	
Default value used		Mean	1.42E+00
		Standard Deviation	7.50E-01
Sn:Coefficient	Partition coefficient for Sn	NORMAL(Log10(mL/g))	
Default value used		Mean	2.70E+00
		Standard Deviation	1.40E+00
I:Coefficient	Partition coefficient for I	NORMAL(Log10(mL/g))	
Default value used		Mean	6.60E-01
		Standard Deviation	9.50E-01
Cs:Coefficient	Partition coefficient for Cs	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.01E+00
Sm:Coefficient	Partition coefficient for Sm	NORMAL(Log10(mL/g))	

Default value used		Mean	2.97E+00
		Standard Deviation	1.40E+00
Eu:Coefficient	Partition coefficient for Eu	NORMAL(Log10(mL/g))	
Default value used		Mean	2.98E+00
		Standard Deviation	1.74E+00
Ho:Coefficient	Partition coefficient for Ho	NORMAL(Log10(mL/g))	
Default value used		Mean	2.97E+00
		Standard Deviation	1.40E+00
Tl:Coefficient	Partition coefficient for Tl	NORMAL(Log10(mL/g))	
Default value used		Mean	2.20E+00
		Standard Deviation	1.40E+00
Pb:Coefficient	Partition coefficient for Pb	NORMAL(Log10(mL/g))	
Default value used		Mean	3.38E+00
		Standard Deviation	1.20E+00
Bi:Coefficient	Partition coefficient for Bi	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.40E+00
Po:Coefficient	Partition coefficient for Po	NORMAL(Log10(mL/g))	
Default value used		Mean	2.26E+00
		Standard Deviation	7.30E-01
Ra:Coefficient	Partition coefficient for Ra	NORMAL(Log10(mL/g))	
Default value used		Mean	3.55E+00
		Standard Deviation	7.40E-01
Ac:Coefficient	Partition coefficient for Ac	NORMAL(Log10(mL/g))	
Default value used		Mean	3.24E+00
		Standard Deviation	1.40E+00
Th:Coefficient	Partition coefficient for Th	NORMAL(Log10(mL/g))	
Default value used		Mean	3.77E+00
		Standard Deviation	1.57E+00
U:Coefficient	Partition coefficient for U	NORMAL(Log10(mL/g))	
Default value used		Mean	2.10E+00
		Standard Deviation	1.36E+00
Cl:Leafy	Leafy plant concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	4.25E+00
		Standard Deviation of Ln	9.04E-01
Ca:Leafy	Leafy plant concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	1.25E+00
		Standard Deviation of Ln	9.04E-01
Se:Leafy	Leafy plant concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	-3.69E+00
		Standard Deviation of Ln	9.04E-01
Zr:Leafy	Leafy plant concentration factor for Zr	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	-2.63E+00
		Standard Deviation of Ln	6.93E-01
Nb:Leafy	Leafy plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	-3.91E+00
		Standard Deviation of Ln	9.04E-01
Mo:Leafy	Leafy plant concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)	
Default value used		Mean of Ln(X)	7.88E-01
		Standard Deviation of Ln	1.19E+00

Sn:Leafy	Leafy plant concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.51E+00 Standard Deviation of Ln 9.04E-01
I:Leafy	Leafy plant concentration factor for I	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -1.83E+00 Standard Deviation of Ln 1.25E+00
Cs:Leafy	Leafy plant concentration factor for Cs	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.19E+00 Standard Deviation of Ln 1.25E+00
Sm:Leafy	Leafy plant concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Eu:Leafy	Leafy plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Ho:Leafy	Leafy plant concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Tl:Leafy	Leafy plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Pb:Leafy	Leafy plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.10E+00 Standard Deviation of Ln 9.04E-01
Bi:Leafy	Leafy plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.35E+00 Standard Deviation of Ln 9.04E-01
Po:Leafy	Leafy plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.99E+00 Standard Deviation of Ln 9.04E-01
Ra:Leafy	Leafy plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Ac:Leafy	Leafy plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.65E+00 Standard Deviation of Ln 9.04E-01
Th:Leafy	Leafy plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -7.07E+00 Standard Deviation of Ln 9.04E-01
U:Leafy	Leafy plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.77E+00 Standard Deviation of Ln 9.04E-01
Cl:Root	Root plant concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)

Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Root	Root plant concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Se:Root	Root plant concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Root	Root plant concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Root	Root plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Root	Root plant concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Root	Root plant concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Root	Root plant concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Root	Root plant concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Root	Root plant concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Eu:Root	Root plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Root	Root plant concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Root	Root plant concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Root	Root plant concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Root	Root plant concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01

Po:Root	Root plant concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Root	Root plant concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Root	Root plant concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Root	Root plant concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Root	Root plant concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Fruit	Fruit concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Fruit	Fruit concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Se:Fruit	Fruit concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Fruit	Fruit concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00
Nb:Fruit	Fruit concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Fruit	Fruit concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Fruit	Fruit concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Fruit	Fruit concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Fruit	Fruit concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Fruit	Fruit concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)

Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Eu:Fruit	Fruit concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Fruit	Fruit concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Fruit	Fruit concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Fruit	Fruit concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Fruit	Fruit concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Fruit	Fruit concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Fruit	Fruit concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Fruit	Fruit concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Fruit	Fruit concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Fruit	Fruit concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Grain	Grain concentration factor for Cl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) 4.25E+00 Standard Deviation of Ln 9.04E-01
Ca:Grain	Grain concentration factor for Ca	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -1.05E+00 Standard Deviation of Ln 9.04E-01
Se:Grain	Grain concentration factor for Se	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -3.69E+00 Standard Deviation of Ln 9.04E-01
Zr:Grain	Grain concentration factor for Zr	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.17E+00 Standard Deviation of Ln 2.25E+00

Nb:Grain	Grain concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Mo:Grain	Grain concentration factor for Mo	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.81E+00 Standard Deviation of Ln 9.04E-01
Sn:Grain	Grain concentration factor for Sn	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
I:Grain	Grain concentration factor for I	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.40E+00 Standard Deviation of Ln 1.59E+00
Cs:Grain	Grain concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Sm:Grain	Grain concentration factor for Sm	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Eu:Grain	Grain concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Ho:Grain	Grain concentration factor for Ho	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Tl:Grain	Grain concentration factor for Tl	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Pb:Grain	Grain concentration factor for Pb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -4.71E+00 Standard Deviation of Ln 9.04E-01
Bi:Grain	Grain concentration factor for Bi	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Po:Grain	Grain concentration factor for Po	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.82E+00 Standard Deviation of Ln 9.04E-01
Ra:Grain	Grain concentration factor for Ra	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.50E+00 Standard Deviation of Ln 9.04E-01
Ac:Grain	Grain concentration factor for Ac	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.96E+00 Standard Deviation of Ln 9.04E-01
Th:Grain	Grain concentration factor for Th	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)

Default value used		Mean of Ln(X) -9.37E+00 Standard Deviation of Ln 9.04E-01
U:Grain	Grain concentration factor for U	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Cl:Beef	Beef transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 8.00E-02
Ca:Beef	Beef transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 7.00E-04
Se:Beef	Beef transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 1.50E-02
Zr:Beef	Beef transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 5.50E-03
Nb:Beef	Beef transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 2.50E-01
Mo:Beef	Beef transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 6.00E-03
Sn:Beef	Beef transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 8.00E-02
I:Beef	Beef transfer factor for I	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Cs:Beef	Beef transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 2.00E-02
Sm:Beef	Beef transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 5.00E-03
Eu:Beef	Beef transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 5.00E-03
Ho:Beef	Beef transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 4.50E-03
Tl:Beef	Beef transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 4.00E-02
Pb:Beef	Beef transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Bi:Beef	Beef transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 4.00E-04
Po:Beef	Beef transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Ra:Beef	Beef transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.50E-04
Ac:Beef	Beef transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 2.50E-05
Th:Beef	Beef transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 6.00E-06
U:Beef	Beef transfer factor for U	CONSTANT(d/kg)
Default value used		Value 2.00E-04
Cl:Poultry	Poultry transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Ca:Poultry	Poultry transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 4.40E-02

Se:Poultry	Poultry transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 8.50E+00
Zr:Poultry	Poultry transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 6.40E-05
Nb:Poultry	Poultry transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 3.10E-04
Mo:Poultry	Poultry transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 1.90E-01
Sn:Poultry	Poultry transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 2.00E-01
I:Poultry	Poultry transfer factor for I	CONSTANT(d/kg)
Default value used		Value 1.80E-02
Cs:Poultry	Poultry transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.40E+00
Sm:Poultry	Poultry transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Eu:Poultry	Poultry transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Ho:Poultry	Poultry transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Tl:Poultry	Poultry transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 3.00E-01
Pb:Poultry	Poultry transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 2.00E-01
Bi:Poultry	Poultry transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Po:Poultry	Poultry transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 9.00E-01
Ra:Poultry	Poultry transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Ac:Poultry	Poultry transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Th:Poultry	Poultry transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 4.00E-03
U:Poultry	Poultry transfer factor for U	CONSTANT(d/kg)
Default value used		Value 1.20E+00
Cl:Milk	Milk transfer factor for Cl	CONSTANT(d/L)
Default value used		Value 1.50E-02
Ca:Milk	Milk transfer factor for Ca	CONSTANT(d/L)
Default value used		Value 1.00E-02
Se:Milk	Milk transfer factor for Se	CONSTANT(d/L)
Default value used		Value 4.00E-03
Zr:Milk	Milk transfer factor for Zr	CONSTANT(d/L)
Default value used		Value 3.00E-05
Nb:Milk	Milk transfer factor for Nb	CONSTANT(d/L)
Default value used		Value 2.00E-02
Mo:Milk	Milk transfer factor for Mo	CONSTANT(d/L)
Default value used		Value 1.50E-03
Sn:Milk	Milk transfer factor for Sn	CONSTANT(d/L)

Default value used		Value 1.00E-03
I:Milk	Milk transfer factor for I	CONSTANT(d/L)
Default value used		Value 1.00E-02
Cs:Milk	Milk transfer factor for Cs	CONSTANT(d/L)
Default value used		Value 7.00E-03
Sm:Milk	Milk transfer factor for Sm	CONSTANT(d/L)
Default value used		Value 2.00E-05
Eu:Milk	Milk transfer factor for Eu	CONSTANT(d/L)
Default value used		Value 2.00E-05
Ho:Milk	Milk transfer factor for Ho	CONSTANT(d/L)
Default value used		Value 2.00E-05
Tl:Milk	Milk transfer factor for Tl	CONSTANT(d/L)
Default value used		Value 2.00E-03
Pb:Milk	Milk transfer factor for Pb	CONSTANT(d/L)
Default value used		Value 2.50E-04
Bi:Milk	Milk transfer factor for Bi	CONSTANT(d/L)
Default value used		Value 5.00E-04
Po:Milk	Milk transfer factor for Po	CONSTANT(d/L)
Default value used		Value 3.50E-04
Ra:Milk	Milk transfer factor for Ra	CONSTANT(d/L)
Default value used		Value 4.50E-04
Ac:Milk	Milk transfer factor for Ac	CONSTANT(d/L)
Default value used		Value 2.00E-05
Th:Milk	Milk transfer factor for Th	CONSTANT(d/L)
Default value used		Value 5.00E-06
U:Milk	Milk transfer factor for U	CONSTANT(d/L)
Default value used		Value 6.00E-04
Cl:Eggs	Egg transfer factor for Cl	CONSTANT(d/kg)
Default value used		Value 2.00E+00
Ca:Eggs	Egg transfer factor for Ca	CONSTANT(d/kg)
Default value used		Value 4.40E-01
Se:Eggs	Egg transfer factor for Se	CONSTANT(d/kg)
Default value used		Value 9.30E+00
Zr:Eggs	Egg transfer factor for Zr	CONSTANT(d/kg)
Default value used		Value 1.90E-04
Nb:Eggs	Egg transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 1.30E-03
Mo:Eggs	Egg transfer factor for Mo	CONSTANT(d/kg)
Default value used		Value 7.80E-01
Sn:Eggs	Egg transfer factor for Sn	CONSTANT(d/kg)
Default value used		Value 8.00E-01
I:Eggs	Egg transfer factor for I	CONSTANT(d/kg)
Default value used		Value 2.80E+00
Cs:Eggs	Egg transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.90E-01
Sm:Eggs	Egg transfer factor for Sm	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Eu:Eggs	Egg transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 7.00E-03

Ho:Eggs	Egg transfer factor for Ho	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Tl:Eggs	Egg transfer factor for Tl	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Pb:Eggs	Egg transfer factor for Pb	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Bi:Eggs	Egg transfer factor for Bi	CONSTANT(d/kg)
Default value used		Value 8.00E-01
Po:Eggs	Egg transfer factor for Po	CONSTANT(d/kg)
Default value used		Value 7.00E+00
Ra:Eggs	Egg transfer factor for Ra	CONSTANT(d/kg)
Default value used		Value 2.00E-05
Ac:Eggs	Egg transfer factor for Ac	CONSTANT(d/kg)
Default value used		Value 2.00E-03
Th:Eggs	Egg transfer factor for Th	CONSTANT(d/kg)
Default value used		Value 2.00E-03
U:Eggs	Egg transfer factor for U	CONSTANT(d/kg)
Default value used		Value 9.90E-01
Cl:Factor	Bioaccumulation factor for Cl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01
Ca:Factor	Bioaccumulation factor for Ca in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 4.00E+01
Se:Factor	Bioaccumulation factor for Se in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.70E+02
Zr:Factor	Bioaccumulation factor for Zr in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Nb:Factor	Bioaccumulation factor for Nb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Mo:Factor	Bioaccumulation factor for Mo in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+01
Sn:Factor	Bioaccumulation factor for Sn in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 3.00E+03
I:Factor	Bioaccumulation factor for I in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+02
Cs:Factor	Bioaccumulation factor for Cs in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Sm:Factor	Bioaccumulation factor for Sm in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Eu:Factor	Bioaccumulation factor for Eu in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Ho:Factor	Bioaccumulation factor for Ho in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Tl:Factor	Bioaccumulation factor for Tl in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 0.00E+00
Pb:Factor	Bioaccumulation factor for Pb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Bi:Factor	Bioaccumulation factor for Bi in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Po:Factor	Bioaccumulation factor for Po in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)

Default value used		Value 5.00E+02
Ra:Factor	Bioaccumulation factor for Ra in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 7.00E+01
Ac:Factor	Bioaccumulation factor for Ac in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Th:Factor	Bioaccumulation factor for Th in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
U:Factor	Bioaccumulation factor for U in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		
NDEV:Porosity Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		

Summary Results:

90.00% **of the** 182 **calculated TEDE values are <** 9.12E-04 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 8.33E-04 **to** 1.20E-03 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
36Cl	1.40E-05	1.85E-09
93Zr	2.56E-09	5.13E-21
93mNb	0.00E+00	2.29E-18
41Ca	1.26E-07	1.98E-19
93Mo	7.38E-07	2.03E-18
79Se	1.56E-08	3.23E-20
134Cs	6.62E-07	5.35E-27
135Cs	9.97E-10	2.44E-21
121mSn	1.09E-08	1.81E-24
121Sn	0.00E+00	1.41E-24
129I	1.50E-11	2.12E-18
151Sm	2.55E-07	1.02E-21
155Eu	1.23E-06	2.60E-25
166mHo	4.09E-06	4.32E-19
233U	1.20E-08	4.33E-18
229Th	0.00E+00	5.71E-20
225Ra	0.00E+00	5.40E-20
225Ac	0.00E+00	5.19E-20

221Fr	0.00E+00	5.19E-20
217At	0.00E+00	5.19E-20
213Bi	0.00E+00	5.19E-20
213Po	0.00E+00	5.08E-20
209Tl	0.00E+00	1.12E-21
209Pb	0.00E+00	5.19E-20

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
1.20E-03	1.18E-03	1.62E-11	2.97E-11	2.07E-05	1.52E-09	1.74E-09	5.57E-10

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
36Cl	1.17E-03
93Zr	2.98E-11
93mNb	5.85E-10
41Ca	6.30E-08
93Mo	9.24E-08
79Se	1.98E-09
134Cs	2.96E-06
135Cs	1.21E-10
121mSn	1.50E-10
121Sn	6.38E-11
129I	1.83E-10
151Sm	3.65E-10
155Eu	1.09E-07
166mHo	1.84E-05
233U	1.51E-08
229Th	1.16E-11
225Ra	1.17E-12
225Ac	3.26E-13
221Fr	3.29E-14
217At	3.59E-16
213Bi	1.58E-13
213Po	0.00E+00
209Tl	5.20E-14
209Pb	7.65E-16
All Nuclides	1.20E-03

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
36Cl	1.17E-03	2.58E-12	3.07E-12	1.57E-08	8.98E-11	6.00E-10	2.17E-10
93Zr	2.97E-11	3.93E-24	1.78E-23	0.00E+00	2.40E-13	6.01E-14	8.89E-24

93mNb	5.84E-10	5.53E-22	2.61E-21	9.28E-13	1.36E-13	1.37E-13	2.44E-20
41Ca	6.30E-08	1.17E-22	1.03E-22	0.00E+00	4.96E-14	2.27E-12	9.96E-22
93Mo	9.22E-08	1.27E-21	2.95E-22	2.13E-10	6.13E-12	1.41E-11	3.13E-21
79Se	1.98E-09	1.30E-22	5.09E-22	1.42E-13	4.49E-14	1.92E-12	9.27E-22
134Cs	6.61E-07	1.81E-28	8.88E-27	2.30E-06	7.80E-12	5.83E-10	1.51E-27
135Cs	1.21E-10	7.96E-24	3.53E-22	1.86E-14	1.33E-15	9.97E-14	6.33E-23
121mSn	1.39E-10	1.30E-27	8.41E-26	1.04E-11	3.65E-14	2.38E-13	9.27E-27
121Sn	6.27E-11	5.87E-28	3.80E-26	7.97E-13	1.25E-15	1.07E-13	4.19E-27
129I	1.66E-10	2.70E-19	2.91E-18	9.47E-14	7.61E-16	5.86E-14	2.36E-18
151Sm	3.62E-10	1.83E-25	1.08E-25	1.22E-13	2.23E-12	1.40E-12	3.70E-25
155Eu	6.29E-09	1.83E-28	9.67E-29	1.02E-07	1.41E-11	2.48E-11	4.22E-28
166mHo	1.16E-07	1.61E-21	8.91E-22	1.83E-05	9.24E-10	4.67E-10	3.39E-21
233U	1.46E-08	5.78E-19	5.73E-19	7.92E-12	4.75E-10	4.91E-11	1.44E-18
229Th	1.13E-11	9.31E-20	1.92E-19	8.69E-14	3.06E-13	2.83E-14	1.10E-19
225Ra	1.16E-12	9.59E-21	1.39E-20	2.67E-15	9.74E-16	2.75E-15	1.23E-20
225Ac	3.09E-13	2.66E-21	1.49E-21	1.40E-14	1.24E-15	7.29E-16	3.48E-21
221Fr	0.00E+00	0.00E+00	0.00E+00	3.29E-14	0.00E+00	0.00E+00	0.00E+00
217At	0.00E+00	0.00E+00	0.00E+00	3.59E-16	0.00E+00	0.00E+00	0.00E+00
213Bi	2.01E-15	1.73E-23	9.71E-24	1.56E-13	1.96E-18	4.74E-18	2.26E-23
213Po	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
209Tl	0.00E+00	0.00E+00	0.00E+00	5.20E-14	0.00E+00	0.00E+00	0.00E+00
209Pb	5.93E-16	5.10E-24	2.86E-24	1.70E-16	1.09E-20	1.40E-18	6.67E-24

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 6/22/2021 10:58:38 AM
Site Name: CR3
Description: Residential Not Discounted
FileName:C:\Users\mceri\Documents\CR3 Residential Not Discounted.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
3H	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	2.50E-04
14C	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	6.87E-04
55Fe	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.40E-01
59Ni	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	3.29E-03
63Ni	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	4.53E-01
90Sr	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	2.97E-05
94Nb	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.01E-05
99Tc	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	3.22E-06
137Cs	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	3.20E-05
152Eu	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	1.12E-07
154Eu	UNLIMITED	CONSTANT(pCi/g)	

Justification for concentration: Site		Value	9.21E-06
60Co	UNLIMITED	CONSTANT(pCi/g)	
Justification for concentration: Site		Value	4.03E-01

Chain Data:

Number of chains: **12**

Chain No. 1: **3H**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
3H	1	4.51E+03					1.73E-11	1.73E-11	0.00E+00	0.00E+00

Chain No. 2: **14C**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
14C	1	2.09E+06					5.64E-10	5.64E-10	1.39E-15	6.22E-18

Chain No. 3: **55Fe**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
55Fe	1	9.86E+02					1.64E-10	7.26E-10	0.00E+00	0.00E+00

Chain No. 4: **60Co**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
60Co	1	1.93E+03					7.28E-09	5.91E-08	2.03E-10	6.26E-12

Chain No. 5: **59Ni**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
59Ni	1	2.74E+07					5.67E-11	7.31E-10	0.00E+00	0.00E+00

Chain No. 6: **63Ni**

Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
63Ni	1	3.51E+04					1.56E-10	1.70E-09	0.00E+00	0.00E+00

Chain No. 7: **90Sr**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
90Sr	1	1.06E+04					3.85E-08	3.51E-07	2.46E-14	3.21E-16
90Y	2	2.67E+00	1	1	0	0	2.91E-09	2.28E-09	4.60E-13	1.03E-14

Chain No. 8: **94Nb**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
94Nb	1	7.41E+06					1.93E-09	1.12E-07	1.32E-10	3.91E-12

Chain No. 9: **99Tc**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
99Tc	1	7.78E+07					3.95E-10	2.25E-09	6.73E-15	5.79E-17

Chain No. 10: **137Cs**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
137Cs	1	1.10E+04					1.35E-08	8.63E-09	2.46E-14	3.40E-16
137mBa	Implicit		1	0.946			0.00E+00	0.00E+00	5.06E-11	1.48E-12

Chain No. 11: **152Eu**
Nuclides in chain: **2**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
152Eu	1	4.87E+03					1.75E-09	5.97E-08	9.53E-11	2.78E-12
152Gd	2	3.94E+16	1	0.2792			4.34E-08	1.01E-06	0.00E+00	0.00E+00

Chain No. 12: **154Eu**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
154Eu	1	3.21E+03					2.58E-09	7.73E-08	1.02E-10	3.04E-12

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Nuclide	Soil Concentration (pCi/g)
3H	2.50E-04
14C	6.87E-04
55Fe	1.40E-01
59Ni	3.29E-03
63Ni	4.53E-01
90Sr	2.97E-05
90Y	0.00E+00
94Nb	1.01E-05
99Tc	3.22E-06
137Cs	3.20E-05
137mBa	3.03E-05
152Eu	1.12E-07
152Gd	0.00E+00
154Eu	9.21E-06
60Co	4.03E-01

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
Tv(1):Translocation:Leafy	Translocation factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E+00
Tv(2):Translocation:Root	Translocation factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(3):Translocation:Fruit	Translocation factor for fruit	CONSTANT(none)
Default value used		Value 1.00E-01
Tv(4):Translocation:Grain	Translocation factor for grain	CONSTANT(none)
Default value used		Value 1.00E-01
Tf(1):Translocation:Beef Forage	Translocation factor for forage consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(2):Translocation:Poultry Forage	Translocation factor for forage consumed by poultry	CONSTANT(none)

Default value used		Value 1.00E+00
Tf(3):Translocation:Milk Cow	Translocatioin factor for forage consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Tf(4):Translocation:Layer Hen Forage	Translocation factor for forage consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
Tg(1):Translocation:Beef Grain	Translocation factor for stored grain consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(2):Translocation:Poultry Grain	Translocation factor for stored grain consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(3):Translocation:Milk Cow Grain	Translocation factor for stored grain consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E-01
Tg(4):Translocation:Layer Hen Grain	Translocation factor for stored grain consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
Th(1):Translocation:Beef Hay	Translocation factor for stored hay consumed by beef cattle	CONSTANT(none)
Default value used		Value 1.00E+00
Th(2):Translocation:Poultry Hay	Translocation factor for stored hay consumed by poultry	CONSTANT(none)
Default value used		Value 1.00E+00
Th(3):Translocation:Milk Cow Hay	Translocation factor for stored hay consumed by milk cows	CONSTANT(none)
Default value used		Value 1.00E+00
Th(4):Translocation:Layer Hen Hay	Translocation factor for stored hay consumed by layer hens	CONSTANT(none)
Default value used		Value 1.00E+00
fca(1):Beef Carbon Fraction	Mass fraction of beef cattle that is carbon	CONSTANT(none)
Default value used		Value 3.60E-01
fca(2):Poultry Carbon Fraction	Mass fraction of poultry that is carbon	CONSTANT(none)
Default value used		Value 1.80E-01
fca(3):Milk Carbon Fraction	Mass fraction of milk that is carbon	CONSTANT(none)
Default value used		Value 6.00E-02
fca(4):Eggs Carbon Fraction	Mass fraction of an egg that is carbon	CONSTANT(none)
Default value used		Value 1.60E-01
fcf(1):Beef Forage Carbon Fraction	Mass fraction of wet forage consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(2):Poultry Forage Carbon Fraction	Mass fraction of wet forage consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(3):Milk Cow Forage Carbon Fraction	Mass fraction of wet forage consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 1.10E-01
fcf(4):Layer Hen Forage	Mass fraction of wet forage consumed by layer hens that is carbon	CONSTANT(none)

Carbon Fraction		
Default value used		Value 1.10E-01
fcg(1):Beef Grain Carbon Fraction	Mass fraction of wet stored grain consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(2):Poultry Grain Carbon Fraction	Mass fraction of wet stored grain consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(3):Milk Cow Grain Carbon Fraction	Mass fraction of wet stored grain consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fcg(4):Layer Hen Grain Carbon Fraction	Mass fraction of wet stored grain consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 4.00E-01
fch(1):Beef Hay Carbon Fraction	Mass fraction of wet stored hay consumed by beef cattle that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(2):Poultry Hay Carbon Fraction	Mass fraction of wet stored hay consumed by poultry that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(3):Milk Cow Hay Carbon Fraction	Mass fraction of wet stored hay consumed by milk cows that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fch(4):Layer Hen Hay Carbon Fraction	Mass fraction of wet stored hay consumed by layer hens that is carbon	CONSTANT(none)
Default value used		Value 7.00E-02
fCd:Soil Carbon Fraction	Mass fraction of dry soil that is carbon	CONSTANT(none)
Default value used		Value 3.00E-02
SATac:Animal Product Specific Activity	Specific activity equivalence of animal product and specific activity of animal feed, forage, and soil	CONSTANT(none)
Default value used		Value 1.00E+00
xf(1):Beef Forage Contaminated Fraction	Fraction of forage consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(2):Poultry Forage Contaminated Fraction	Fraction of forage consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(3):Milk Cow Forage Contaminated Fraction	Fraction of forage consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xf(4):Layer Hen Forage Contaminated Fraction	Fraction of forage consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(1):Beef Grain Contaminated Fraction	Fraction of stored grain consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(2):Poultry Grain Contaminated Fraction	Fraction of stored grain consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xg(3):Milk Cow Grain Contaminated Fraction	Fraction of stored grain consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00

xg(4):Layer Hen Grain Contaminated Fraction	Fraction of stored grain that is consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(1):Beef Hay Contaminated Fraction	Fraction of stored hay consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(2):Poultry Hay Contaminated Fraction	Fraction of stored hay consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(3):Milk Cow Hay Contaminated Fraction	Fraction of stored hay consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xh(4):Layer Hen Hay Contaminated Fraction	Fraction of stored hay consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(1):Beef Water Contaminated Fraction	Fraction of water that is consumed by beef cattle that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(2):Poultry Water Contaminated Fraction	Fraction of water consumed by poultry that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(3):Milk Cow Water Contaminated Fraction	Fraction of water consumed by milk cows that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
xw(4):Layer Hen Water Contaminated Fraction	Fraction of water consumed by layer hens that is contaminated	CONSTANT(none)
Default value used		Value 1.00E+00
DIET:Garden Diet	Fraction of human diet grown onsite	CONSTANT(none)
Default value used		Value 1.00E+00
Uv(1):Diet - Leafy	Yearly human consumption of leafy vegetables	CONSTANT(kg/y)
Default value used		Value 2.14E+01
Uv(2):Diet - Roots	Yearly human consumption of other vegetables	CONSTANT(kg/y)
Default value used		Value 4.46E+01
Uv(3):Diet - Fruit	Yearly human consumption of fruits	CONSTANT(kg/y)
Default value used		Value 5.28E+01
Uv(4):Diet - Grain	Yearly human consumption of grains	CONSTANT(kg/y)
Default value used		Value 1.44E+01
Ua(1):Diet - Beef	Yearly human consumption of beef	CONSTANT(kg/y)
Default value used		Value 3.98E+01
Ua(2):Diet - Poultry	Yearly human consumption of poultry	CONSTANT(kg/y)
Default value used		Value 2.53E+01
Ua(3):Diet - Milk	Yearly human consumption of milk	CONSTANT(L/y)
Default value used		Value 2.33E+02
Ua(4):Diet - Egg	Yearly human consumption of eggs	CONSTANT(kg/y)
Default value used		Value 1.91E+01
Uf:Diet - Fish	Yearly human consumption of fish produced from an onsite pond	CONSTANT(kg/y)
Default value used		Value 2.06E+01
tf:Consumption Period	Consumption period for fish	CONSTANT(days)
Default value used		Value 3.65E+02

tcv(1):Consumption Period - Leafy	Food consumption period for leafy vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(2):Consumption Period - Roots	Food consumption period for other vegetables	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(3):Consumption Period - Fruit	Food consumption period for fruits	CONSTANT(days)
Default value used		Value 3.65E+02
tcv(4):Consumption Period - Grain	Food consumption period for grains	CONSTANT(days)
Default value used		Value 3.65E+02
tca(1):Consumption Period - Beef	Food consumption period for beef	CONSTANT(days)
Default value used		Value 3.65E+02
tca(2):Consumption Period - Poultry	Food consumption period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
tca(3):Consumption Period - Milk	Food consumption period for milk	CONSTANT(days)
Default value used		Value 3.65E+02
tca(4):Consumption Period - Egg	Food consumption period for eggs	CONSTANT(days)
Default value used		Value 3.65E+02
Nunsat:Number of Unsaturated Layers	Number of model layers used to represent the unsaturated zone	CONSTANT(none)
Default value used		Value 1.00E+01
TstartR:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
TendR:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+05
dtR:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
PstepR:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
TI:Indoor Exposure Period	The time the resident spends indoors	CONSTANT(days/year)
Default value used		Value 2.40E+02
TX:Outdoor Exposure Period	The time the resident spends outdoors	CONSTANT(days/year)
Default value used		Value 4.02E+01
TG:Gardening Period	The time the resident spends gardening	CONSTANT(days/year)
Default value used		Value 2.92E+00
TTR:Total time in period	Total time in the one year exposure period	CONSTANT(days/year)
Default value used		Value 3.65E+02
SFI:Indoor Shielding Factor	Shielding factor for the residence	CONSTANT(none)
Default value used		Value 5.52E-01
SFO:Outdoor Shielding Factor	Shielding factor for the cover soil	CONSTANT(none)
Default value used		Value 1.00E+00
PD:Floor dust loading	Floor dust loading	UNIFORM(g/m**2)

Default value used		Lower Limit 2.00E-02 Upper Limit 3.00E-01
RFR:Indoor Resuspension Factor	Resuspension factor for indoor dust	LOGUNIFORM(1/m)
Default value used		Lower Limit 1.00E-07 Upper Limit 8.00E-05
CDO:Outdoor Dust Loading	Average dust loading outdoors	LOGUNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-07 Upper Limit 1.00E-04
CDI:Indoor Dust Loading	Average dust loading indoors	DERIVED(g/m**3)
Default value used		
PF:Indoor/Outdoor Penetration Factor	Fraction of outdoor dust in indoor air	UNIFORM(none)
Default value used		Lower Limit 2.00E-01 Upper Limit 7.00E-01
CDG:Gardening Dust Loading	Average dust loading while gardening	UNIFORM(g/m**3)
Default value used		Lower Limit 1.00E-04 Upper Limit 7.00E-04
VR:Indoor Breathing Rate	Breathing rate while indoors	CONSTANT(m**3/hr)
Default value used		Value 9.00E-01
VX:Outdoor Breathing Rate	Breathing rate while outdoors	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
VG:Gardening Breathing Rate	Breathing rate while gardening	CONSTANT(m**3/hr)
Default value used		Value 1.70E+00
GR:Soil Ingestion Transfer Rate	Average rate of soil ingestion	CONSTANT(g/d)
Default value used		Value 5.00E-02
UW:Diet - Water	Drinking water ingestion rate	CONSTANT(L/d)
Default value used		Value 1.26E+00
H1:Surface Soil Thickness	Thickness of the surface soil layer	CONSTANT(m)
Default value used		Value 1.50E-01
H2:Unsaturated Zone Thickness	Thickness of the unsaturated zone	CONTINUOUS LINEAR(m)
Default value used		Value / Probability

Value	Probability
3.05E-01	0.00E+00
6.68E-01	4.76E-03
8.11E-01	9.52E-03
9.21E-01	1.43E-02
9.94E-01	1.91E-02
1.03E+00	2.38E-02
1.07E+00	2.86E-02
1.14E+00	3.33E-02
1.21E+00	3.81E-02
1.30E+00	4.29E-02
1.31E+00	4.76E-02
1.32E+00	5.24E-02
1.56E+00	5.71E-02
1.58E+00	6.19E-02
1.61E+00	6.67E-02
1.69E+00	7.62E-02
1.78E+00	8.57E-02
1.80E+00	9.05E-02
1.81E+00	9.52E-02

1.84E+00	1.00E-01
1.87E+00	1.05E-01
1.92E+00	1.10E-01
2.04E+00	1.14E-01
2.10E+00	1.19E-01
2.11E+00	1.24E-01
2.32E+00	1.29E-01
2.36E+00	1.33E-01
2.37E+00	1.38E-01
2.39E+00	1.43E-01
2.44E+00	1.48E-01
2.44E+00	1.52E-01
2.45E+00	1.57E-01
2.59E+00	1.62E-01
2.63E+00	1.67E-01
2.69E+00	1.71E-01
2.79E+00	1.76E-01
2.81E+00	1.81E-01
2.90E+00	1.86E-01
2.95E+00	1.91E-01
3.07E+00	1.95E-01
3.18E+00	2.00E-01
3.22E+00	2.05E-01
3.30E+00	2.10E-01
3.34E+00	2.14E-01
3.37E+00	2.19E-01
3.44E+00	2.24E-01
3.58E+00	2.29E-01
3.62E+00	2.33E-01
3.66E+00	2.38E-01
3.74E+00	2.43E-01
3.86E+00	2.48E-01
3.88E+00	2.52E-01
4.17E+00	2.57E-01
4.26E+00	2.62E-01
4.44E+00	2.71E-01
4.63E+00	2.76E-01
4.87E+00	2.81E-01
5.13E+00	2.86E-01
5.18E+00	2.91E-01
5.54E+00	2.95E-01
5.83E+00	3.00E-01
5.86E+00	3.05E-01
5.86E+00	3.10E-01
5.90E+00	3.14E-01
6.06E+00	3.19E-01
6.13E+00	3.24E-01
6.17E+00	3.29E-01
6.22E+00	3.33E-01
6.31E+00	3.38E-01
6.36E+00	3.43E-01
6.40E+00	3.48E-01
6.46E+00	3.52E-01
6.51E+00	3.57E-01
6.55E+00	3.62E-01
6.60E+00	3.67E-01
6.86E+00	3.71E-01
6.93E+00	3.76E-01
6.95E+00	3.86E-01
6.97E+00	3.91E-01
7.09E+00	3.95E-01
7.18E+00	4.00E-01
7.35E+00	4.05E-01
7.36E+00	4.10E-01
7.40E+00	4.14E-01
7.43E+00	4.19E-01

7.46E+00	4.24E-01
7.59E+00	4.29E-01
7.60E+00	4.33E-01
7.64E+00	4.38E-01
7.87E+00	4.43E-01
8.10E+00	4.48E-01
8.28E+00	4.52E-01
8.35E+00	4.57E-01
8.71E+00	4.62E-01
8.71E+00	4.67E-01
8.73E+00	4.71E-01
8.79E+00	4.76E-01
8.80E+00	4.81E-01
8.82E+00	4.86E-01
8.85E+00	4.91E-01
8.89E+00	4.95E-01
8.90E+00	5.00E-01
8.99E+00	5.05E-01
9.00E+00	5.10E-01
9.13E+00	5.14E-01
9.14E+00	5.19E-01
9.21E+00	5.24E-01
9.31E+00	5.29E-01
9.55E+00	5.33E-01
9.60E+00	5.38E-01
9.63E+00	5.43E-01
9.86E+00	5.48E-01
1.05E+01	5.52E-01
1.07E+01	5.57E-01
1.13E+01	5.62E-01
1.15E+01	5.67E-01
1.17E+01	5.71E-01
1.20E+01	5.76E-01
1.26E+01	5.81E-01
1.26E+01	5.86E-01
1.28E+01	5.91E-01
1.32E+01	5.95E-01
1.32E+01	6.00E-01
1.34E+01	6.05E-01
1.34E+01	6.10E-01
1.36E+01	6.14E-01
1.37E+01	6.19E-01
1.38E+01	6.24E-01
1.41E+01	6.29E-01
1.45E+01	6.33E-01
1.51E+01	6.38E-01
1.52E+01	6.43E-01
1.61E+01	6.48E-01
1.62E+01	6.52E-01
1.65E+01	6.57E-01
1.66E+01	6.62E-01
1.69E+01	6.67E-01
1.74E+01	6.71E-01
1.82E+01	6.76E-01
1.84E+01	6.81E-01
1.84E+01	6.86E-01
1.87E+01	6.91E-01
1.95E+01	6.95E-01
2.01E+01	7.00E-01
2.07E+01	7.05E-01
2.08E+01	7.10E-01
2.17E+01	7.14E-01
2.24E+01	7.19E-01
2.27E+01	7.24E-01
2.29E+01	7.29E-01
2.29E+01	7.33E-01

2.40E+01	7.38E-01
2.47E+01	7.43E-01
2.60E+01	7.48E-01
2.65E+01	7.52E-01
2.72E+01	7.57E-01
2.73E+01	7.62E-01
2.76E+01	7.67E-01
2.77E+01	7.71E-01
2.78E+01	7.76E-01
2.80E+01	7.81E-01
2.86E+01	7.86E-01
2.94E+01	7.91E-01
3.01E+01	7.95E-01
3.03E+01	8.00E-01
3.06E+01	8.10E-01
3.08E+01	8.14E-01
3.11E+01	8.19E-01
3.17E+01	8.24E-01
3.17E+01	8.29E-01
3.17E+01	8.33E-01
3.22E+01	8.38E-01
3.39E+01	8.43E-01
3.48E+01	8.48E-01
3.54E+01	8.52E-01
3.60E+01	8.57E-01
3.68E+01	8.62E-01
4.03E+01	8.67E-01
4.07E+01	8.71E-01
4.24E+01	8.76E-01
4.29E+01	8.81E-01
4.42E+01	8.86E-01
4.72E+01	8.91E-01
4.97E+01	8.95E-01
5.12E+01	9.00E-01
6.13E+01	9.05E-01
6.19E+01	9.10E-01
6.23E+01	9.14E-01
6.32E+01	9.19E-01
6.59E+01	9.24E-01
6.73E+01	9.29E-01
7.47E+01	9.33E-01
7.92E+01	9.38E-01
8.12E+01	9.43E-01
8.28E+01	9.48E-01
8.47E+01	9.52E-01
8.96E+01	9.57E-01
9.47E+01	9.62E-01
1.08E+02	9.67E-01
1.13E+02	9.71E-01
1.15E+02	9.76E-01
1.42E+02	9.81E-01
1.77E+02	9.86E-01
1.78E+02	9.91E-01
1.80E+02	9.95E-01
3.16E+02	1.00E+00

N1:Surface Soil Porosity	Porosity of the surface soil layer	DERIVED(none)
Default value used		
N2:Unsaturated Zone Porosity	Porosity of the unsaturated zone	DERIVED(none)
Default value used		
F1:Surface Soil Saturation	Saturation ratio of the surface soil layer	DERIVED(none)
Default value used		
F2:Unsaturated Zone	Saturation ratio of the unsaturated zone	DERIVED(none)

Saturation		
Default value used		
INFIL:Infiltration Rate	Net rate of infiltration to aquifer	DERIVED(m/y)
Default value used		
SCSST:Soil Classification	SCS soil classification ID	DISCRETE CUMULATIVE(none)
Default value used		Value / Probability 1.00E+00 / 1.00E-04 2.00E+00 / 1.34E-03 3.00E+00 / 1.06E-02 4.00E+00 / 2.51E-02 5.00E+00 / 6.17E-02 6.00E+00 / 1.09E-01 7.00E+00 / 1.62E-01 8.00E+00 / 2.12E-01 9.00E+00 / 2.85E-01 1.00E+01 / 5.10E-01 1.10E+01 / 7.58E-01 1.20E+01 / 1.00E+00
NDEV:Porosity Probability	Relative porosity value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
KSDEV:Permeability Probability	Relative permeability value within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
BDEV:Parameter "b" Probability	Relative value of "b" parameter within the distribution for this soil type	UNIFORM(none)
Default value used		Lower Limit 0.00E+00 Upper Limit 1.00E+00
AP:Water Application Rate	Total water application rate on cultivated area	CONTINUOUS LINEAR(m/y)
Default value used		Value / Probability 6.07E-01 / 0.00E+00 6.10E-01 / 4.62E-01 6.35E-01 / 4.76E-01 7.62E-01 / 5.40E-01 8.89E-01 / 6.29E-01 1.02E+00 / 7.05E-01 1.14E+00 / 8.04E-01 1.27E+00 / 8.79E-01 1.40E+00 / 9.41E-01 1.52E+00 / 9.82E-01 1.65E+00 / 9.98E-01 1.78E+00 / 1.00E+00
IR:Irrigation Rate	Annual average irrigation rate	CONSTANT(L/m**2-d)
Default value used		Value 1.29E+00
RHO1:Surface Soil Density	Bulk density of soil in the surface soil layer	DERIVED(g/mL)
Default value used		
RHO2:Unsaturated Zone Density	Bulk density of soil in the unsaturated zone	DERIVED(g/mL)
Default value used		
Ksat1:Surface Soil Permeabiliy	Saturated permeability of the surface soil layer	DERIVED(cm/sec)
Default value used		
VDR:Volume of Water Consumed	Volume of water withdrawn for consumptive use	CONSTANT(L)
Default value used		Value 1.18E+05

VSW:Volume of Water in Pond	Volume of water in the pond	CONSTANT(L)
Default value used		Value 1.30E+06
AR:Cultivated Area	Area of land cultivated	DERIVED(m**2)
Default value used		
sh:Soil Moisture Content	Moisture content of soil	DERIVED(none)
Default value used		
TTG:Gardening Period	Total time in gardening period	CONSTANT(days)
Default value used		Value 9.00E+01
TD:Drinking-water consumption period	Drinking-water consumption period	CONSTANT(days)
Default value used		Value 3.65E+02
THV(1):Holdup Period : Leafy	Holdup period for leafy vegetables	CONSTANT(days)
Default value used		Value 1.00E+00
THV(2):Holdup Period : Other vegetables	Holdup period for other vegetables	CONSTANT(days)
Default value used		Value 1.40E+01
THV(3):Holdup Period : Fruits	Holdup period for fruits	CONSTANT(days)
Default value used		Value 1.40E+01
THV(4):Holdup Period : Grains	Holdup period for grains	CONSTANT(days)
Default value used		Value 1.40E+01
THA(1):Holdup Period : Beef	Holdup period for beef	CONSTANT(days)
Default value used		Value 2.00E+01
THA(2):Holdup Period : Poultry	Holdup period for poultry	CONSTANT(days)
Default value used		Value 1.00E+00
THA(3):Holdup Period : Milk	Holdup period for milk	CONSTANT(days)
Default value used		Value 1.00E+00
THA(4):Holdup Period : Eggs	Holdup period for eggs	CONSTANT(days)
Default value used		Value 1.00E+00
TGV(1):Growing Period : Leafy	Minimum growing period for leafy vegetables	CONSTANT(days)
Default value used		Value 4.50E+01
TGV(2):Growing Period : Other vegetables	Minimum growing period for other vegetables	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(3):Growing Period : Fruits	Minimum growing period for fruits	CONSTANT(days)
Default value used		Value 9.00E+01
TGV(4):Growing Period : Grains	Minimum growing period for grains	CONSTANT(days)
Default value used		Value 9.00E+01
TGF(1):Growing Period : Beef Forage	Minimum growing period for forage consumed by beef cattle	CONSTANT(days)
Default value used		Value 3.00E+01
TGF(2):Growing Period :	Minimum growing period for forage	DERIVED(days)

Poultry Forage	consumed by poultry	
Default value used		
TGF(3):Growing Period : Milk Cow Forage	Minimum growing period for forage consumed by milk cows	DERIVED(days)
Default value used		
TGF(4):Growing Period : Layer Hen Forage	Minimum growing period for forage consumed by layer hens	DERIVED(days)
Default value used		
TGG(1):Growing Period : Beef Cow Grain	Minimum growing period for stored grain consumed by beef cattle	CONSTANT(days)
Default value used		Value 9.00E+01
TGG(2):Growing Period : Poultry Grain	Minimum growing period for stored grain consumed by poultry	DERIVED(days)
Default value used		
TGG(3):Growing Period : Milk Cow Grain	Minimum growing period for stored grain consumed by milk cows	DERIVED(days)
Default value used		
TGG(4):Growing Period : Layer Hen Grain	Minimum growing period for stored grain consumed by layer hens	DERIVED(days)
Default value used		
TGH(1):Growing Period : Beef Cow Hay	Minimum growing period for stored hay consumed by beef cattle	CONSTANT(days)
Default value used		Value 4.50E+01
TGH(2):Growing Period : Poultry Hay	Minimum growing period for stored hay consumed by poultry	DERIVED(days)
Default value used		
TGH(3):Growing Period : Milk Cow Hay	Minimum growing period for stored hay consumed by milk cows	DERIVED(days)
Default value used		
TGH(4):Growing Period : Layer Hen Hay	Minimum growing period for stored hay consumed by layer hens	DERIVED(days)
Default value used		
RV(1):Interception Fraction : Leafy	Interception fraction for leafy vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(2):Interception Fraction : Other vegetables	Interception fraction for other vegetables	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(3):Interception Fraction : Fruits	Interception fraction for fruits	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RV(4):Interception Fraction : Grains	Interception fraction for grains	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(1):Interception Fraction : Beef Forage	Interception fraction for beef cattle forage	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RF(2):Interception Fraction	Interception fraction for poultry forage	DERIVED(none)

: Poultry forage		
Default value used		
RF(3):Interception Fraction : Milk Cow Forage	Interception fraction for milk cow forage	DERIVED(none)
Default value used		
RF(4):Interception Fraction : Layer Hen Forage	Interception fraction for layer hen forage	DERIVED(none)
Default value used		
RG(1):Interception Fraction : Beef Cow Grain	Interception fraction for beef cattle grain	UNIFORM(none)
Default value used		Lower Limit 1.00E-01 Upper Limit 6.00E-01
RG(2):Interception Fraction : Poultry Grain	Interception fraction for poultry grain	DERIVED(none)
Default value used		
RG(3):Interception Fraction : Milk Cow Grain	Interception fraction for milk cow grain	DERIVED(none)
Default value used		
RG(4):Interception Fraction : Layer Hen Grain	Interception fraction for layer hen grain	DERIVED(none)
Default value used		
RH(1):Interception Fraction : Beef Cow Hay	Interception fraction for beef cattle hay	DERIVED(none)
Default value used		
RH(2):Interception Fraction : Poultry Hay	Interception fraction for poultry hay	DERIVED(none)
Default value used		
RH(3):Interception Fraction : Milk Cow Hay	Interception fraction for milk cow hay	DERIVED(none)
Default value used		
RH(4):Interception Fraction : Layer Hen Hay	Interception fraction for layer hen hay	DERIVED(none)
Default value used		
YV(1):Crop Yield : Leafy	Crop yield for leafy vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)
Default value used		

Value	Probability
2.70E+00	0.00E+00
2.71E+00	1.60E-03
2.74E+00	6.00E-03
2.76E+00	1.76E-02
2.78E+00	4.36E-02
2.80E+00	8.48E-02
2.82E+00	1.56E-01
2.85E+00	2.57E-01
2.87E+00	3.64E-01
2.89E+00	5.00E-01
2.91E+00	6.39E-01
2.93E+00	7.46E-01
2.96E+00	8.42E-01
2.98E+00	9.09E-01
3.00E+00	9.60E-01
3.02E+00	9.84E-01
3.04E+00	9.94E-01
3.07E+00	9.97E-01
3.09E+00	9.99E-01
3.11E+00	1.00E+00
3.13E+00	1.00E+00
3.15E+00	1.00E+00

YV(2):Crop Yield : Other	Crop yield for other vegetables	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used

Value	Probability
2.26E+00	0.00E+00
2.29E+00	8.00E-04
2.30E+00	1.20E-03
2.31E+00	6.40E-03
2.33E+00	1.52E-02
2.34E+00	3.28E-02
2.35E+00	7.44E-02
2.36E+00	1.40E-01
2.38E+00	2.49E-01
2.39E+00	3.80E-01
2.40E+00	5.30E-01
2.42E+00	6.61E-01
2.43E+00	7.88E-01
2.44E+00	8.86E-01
2.45E+00	9.42E-01
2.47E+00	9.75E-01
2.48E+00	9.88E-01
2.49E+00	9.96E-01
2.51E+00	9.97E-01
2.52E+00	9.99E-01
2.53E+00	1.00E+00
2.54E+00	1.00E+00

YV(3):Crop Yield : Fruits	Crop yield for fruits	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used

Value	Probability
2.17E+00	0.00E+00
2.20E+00	1.20E-03
2.21E+00	2.40E-03
2.23E+00	6.80E-03
2.25E+00	1.80E-02
2.27E+00	4.36E-02
2.29E+00	7.64E-02
2.31E+00	1.38E-01
2.32E+00	2.14E-01
2.34E+00	3.27E-01
2.36E+00	4.50E-01
2.38E+00	5.76E-01
2.40E+00	6.87E-01
2.42E+00	7.88E-01
2.43E+00	8.68E-01
2.45E+00	9.25E-01
2.47E+00	9.60E-01
2.49E+00	9.81E-01
2.51E+00	9.92E-01
2.53E+00	9.98E-01
2.54E+00	1.00E+00
2.56E+00	1.00E+00

YV(4):Crop Yield : Grains	Crop yield for grains	CONTINUOUS LINEAR(kg wet wt/m**2)

Default value used

Value	Probability
2.85E-01	0.00E+00
2.90E-01	6.00E-04
3.02E-01	2.80E-03
3.14E-01	9.40E-03
3.26E-01	2.14E-02
3.38E-01	5.42E-02
3.50E-01	1.08E-01
3.62E-01	2.02E-01
3.74E-01	3.15E-01
3.86E-01	4.50E-01
3.98E-01	5.92E-01
4.10E-01	7.20E-01
4.23E-01	8.26E-01
4.35E-01	9.03E-01

		4.47E-01	9.51E-01
		4.59E-01	9.77E-01
		4.71E-01	9.91E-01
		4.83E-01	9.96E-01
		4.95E-01	9.99E-01
		5.07E-01	1.00E+00
		5.19E-01	1.00E+00
		5.31E-01	1.00E+00
YF(1):Crop Yield : Beef Forage	Crop yield for beef cattle forage	BETA(kg dry wt forage/m**2)	
Default value used		Lower Limit	3.70E-01
		Upper Limit	5.24E-01
		p	2.36E+00
		q	1.40E+00
YF(2):Crop Yield : Poultry Forage	Crop yield for poultry forage	DERIVED(kg wet wt forage/m**2)	
Default value used			
YF(3):Crop Yield : Milk Cow Forage	Crop yield for milk cow forage	DERIVED(kg wet wt forage/m**2)	
Default value used			
YF(4):Crop Yield : Layer Hen Forage	Crop yield for layer hen forage	DERIVED(kg wet wt forage/m**2)	
Default value used			
YG(1):Crop Yield : Beef Cow Grain	Crop yield for beef cattle grain	NORMAL(kg dry wt grain /m**2)	
Default value used		Mean	5.78E-01
		Standard Deviation	7.77E-02
YG(2):Crop Yield : Poultry Grain	Crop yield for poultry grain	DERIVED(kg wet wt grain /m**2)	
Default value used			
YG(3):Crop Yield : Milk Cow Grain	Crop yield for milk cow grain	DERIVED(kg wet wt grain /m**2)	
Default value used			
YG(4):Crop Yield : Layer Hen Grain	Crop yield for layer hen grain	DERIVED(kg wet wt grain /m**2)	
Default value used			
YH(1):Crop Yield : Beef Cow Hay	Crop yield for beef cattle hay	DERIVED(kg wet wt/m**2)	
Default value used			
YH(2):Crop Yield : Poultry Hay	Crop yield for poultry hay	DERIVED(kg wet wt/m**2)	
Default value used			
YH(3):Crop Yield : Milk Cow Hay	Crop yield for milk cow hay	DERIVED(kg wet wt/m**2)	
Default value used			
YH(4):Crop Yield : Layer Hen Hay	Crop yield for layer hen hay	DERIVED(kg wet wt/m**2)	
Default value used			
WV(1):Wet/dry : Leafy Vegetables	Wet/dry conversion factor for leafy vegetables	CONTINUOUS LINEAR(none)	
Default value used		Value	Probability
		3.32E-02	0.00E+00
		4.89E-02	3.45E-02
		5.47E-02	6.91E-02
		5.96E-02	1.04E-01
		6.36E-02	1.38E-01

6.70E-02	1.73E-01
7.05E-02	2.07E-01
7.38E-02	2.42E-01
7.48E-02	2.50E-01
7.72E-02	2.76E-01
8.03E-02	3.11E-01
8.34E-02	3.45E-01
8.66E-02	3.80E-01
9.00E-02	4.15E-01
9.36E-02	4.49E-01
9.73E-02	4.84E-01
9.91E-02	4.99E-01
1.01E-01	5.18E-01
1.05E-01	5.53E-01
1.09E-01	5.87E-01
1.13E-01	6.22E-01
1.18E-01	6.56E-01
1.23E-01	6.91E-01
1.29E-01	7.25E-01
1.33E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.50E-01	8.29E-01
1.59E-01	8.64E-01
1.70E-01	8.98E-01
1.85E-01	9.33E-01
2.10E-01	9.67E-01
2.56E-01	9.91E-01
3.24E-01	1.00E+00

WV(2):Wet/dry : Other Vegetables	Wet/dry conversion factor for other vegetables	CONTINUOUS LINEAR(none)

Default value used

Value	Probability
3.58E-02	0.00E+00
4.87E-02	3.45E-02
5.46E-02	6.91E-02
5.90E-02	1.04E-01
6.29E-02	1.38E-01
6.69E-02	1.73E-01
7.02E-02	2.07E-01
7.34E-02	2.42E-01
7.41E-02	2.50E-01
7.65E-02	2.76E-01
7.99E-02	3.11E-01
8.32E-02	3.45E-01
8.66E-02	3.80E-01
9.05E-02	4.15E-01
9.41E-02	4.49E-01
9.82E-02	4.84E-01
9.98E-02	4.99E-01
1.02E-01	5.18E-01
1.06E-01	5.53E-01
1.09E-01	5.87E-01
1.14E-01	6.22E-01
1.19E-01	6.56E-01
1.24E-01	6.91E-01
1.29E-01	7.25E-01
1.33E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.50E-01	8.29E-01
1.59E-01	8.64E-01
1.70E-01	8.98E-01
1.87E-01	9.33E-01
2.12E-01	9.67E-01
2.62E-01	9.91E-01

3.15E-01	1.00E+00

WV(3):Wet/dry : Fruit	Wet/dry conversion factor for fruits	CONTINUOUS LINEAR(none)
Default value used		

Value	Probability
3.66E-02	0.00E+00
4.87E-02	3.45E-02
5.45E-02	6.91E-02
5.93E-02	1.04E-01
6.31E-02	1.38E-01
6.72E-02	1.73E-01
7.10E-02	2.07E-01
7.44E-02	2.42E-01
7.52E-02	2.50E-01
7.78E-02	2.76E-01
8.13E-02	3.11E-01
8.45E-02	3.45E-01
8.78E-02	3.80E-01
9.11E-02	4.15E-01
9.46E-02	4.49E-01
9.82E-02	4.84E-01
9.97E-02	4.99E-01
1.02E-01	5.18E-01
1.06E-01	5.53E-01
1.10E-01	5.87E-01
1.14E-01	6.22E-01
1.19E-01	6.56E-01
1.24E-01	6.91E-01
1.29E-01	7.25E-01
1.34E-01	7.50E-01
1.35E-01	7.60E-01
1.42E-01	7.94E-01
1.49E-01	8.29E-01
1.58E-01	8.64E-01
1.70E-01	8.98E-01
1.87E-01	9.33E-01
2.14E-01	9.67E-01
2.58E-01	9.91E-01
3.25E-01	1.00E+00

WV(4):Wet/dry : Grain	Wet/dry conversion factor for grains	CONSTANT(none)
Default value used		Value 8.80E-01
WF(1):Wet/dry : Beef Cow Forage	Wet/dry conversion factor for beef cattle forage	BETA(none)
Default value used		Lower Limit 1.83E-01 Upper Limit 3.23E-01 p 1.15E+00 q 1.18E+00
WF(2):Wet/dry : Poultry Forage	Wet/dry conversion factor for poultry forage	DERIVED(none)
Default value used		
WF(3):Wet/dry : Milk Cow Forage	Wet/dry conversion factor for milk cow forage	DERIVED(none)
Default value used		
WF(4):Wet/dry : Layer Hen Forage	Wet/dry conversion factor for layer hen forage	DERIVED(none)
Default value used		
WG(1):Wet/dry : Beef Cow Grain	Wet/dry conversion factor for beef cattle grain	CONSTANT(none)
Default value used		Value 8.80E-01
WG(2):Wet/dry : Poultry Grain	Wet/dry conversion factor for poultry grain	DERIVED(none)
Default value used		

WG(3):Wet/dry : Milk Cow Grain	Wet/dry conversion factor for milk cow grain	DERIVED(none)
Default value used		
WG(4):Wet/dry : Layer Hen Grain	Wet/dry conversion factor for layer hen grain	DERIVED(none)
Default value used		
WH(1):Wet/dry : Beef Cow Hay	Wet/dry conversion factor for beef cattle hay	DERIVED(none)
Default value used		
WH(2):Wet/dry : Poultry Hay	Wet/dry conversion factor for poultry hay	DERIVED(none)
Default value used		
WH(3):Wet/dry : Milk Cow Hay	Wet/dry conversion factor for milk cow hay	DERIVED(none)
Default value used		
WH(4):Wet/dry : Layer Hen Hay	Wet/dry conversion factor for layer hen hay	DERIVED(none)
Default value used		
QF(1):Ingestion Rate : Beef Cow Forage	Ingestion rate for beef cattle forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 1.69E+00 Upper Limit 2.29E+00 p 1.99E+00 q 9.11E-01
QF(2):Ingestion Rate : Poultry Forage	Ingestion rate for poultry forage	BETA(kg dry wt forage/d)
Default value used		Lower Limit 3.48E-03 Upper Limit 2.82E-02 p 1.51E+00 q 1.41E+00
QF(3):Ingestion Rate : Milk Cow Forage	Ingestion rate for milk cow forage	CONTINUOUS LINEAR(kg dry wt forage/d)
Default value used		

Value	Probability
6.35E+00	0.00E+00
6.77E+00	3.45E-02
6.96E+00	6.91E-02
7.10E+00	1.04E-01
7.24E+00	1.38E-01
7.35E+00	1.73E-01
7.47E+00	2.07E-01
7.57E+00	2.42E-01
7.60E+00	2.50E-01
7.67E+00	2.76E-01
7.77E+00	3.11E-01
7.87E+00	3.45E-01
7.98E+00	3.80E-01
8.08E+00	4.15E-01
8.18E+00	4.49E-01
8.31E+00	4.84E-01
8.37E+00	4.99E-01
8.42E+00	5.18E-01
8.54E+00	5.53E-01
8.67E+00	5.87E-01
8.81E+00	6.22E-01
8.95E+00	6.56E-01
9.10E+00	6.91E-01
9.26E+00	7.25E-01
9.38E+00	7.50E-01
9.45E+00	7.60E-01

		9.68E+00	7.94E-01
		9.93E+00	8.29E-01
		1.02E+01	8.64E-01
		1.06E+01	8.98E-01
		1.11E+01	9.33E-01
		1.20E+01	9.67E-01
		1.33E+01	9.91E-01
		1.53E+01	1.00E+00
QF(4):Ingestion Rate : Layer Hen Forage	Ingestion rate for layer hen forage	BETA(kg dry wt forage/d)	
Default value used		Lower Limit	1.19E-02
		Upper Limit	2.22E-02
		p	1.45E+00
		q	7.92E-01
QG(1):Ingestion Rate : Beef Cattle Grain	Ingestion rate for beef cattle grain	BETA(kg dry wt grain/d)	
Default value used		Lower Limit	1.69E+00
		Upper Limit	2.29E+00
		p	1.99E+00
		q	9.11E-01
QG(2):Ingestion Rate : Poultry Grain	Ingestion rate for poultry grain	BETA(kg dry wt grain/d)	
Default value used		Lower Limit	1.04E-02
		Upper Limit	8.45E-02
		p	1.51E+00
		q	1.41E+00
QG(3):Ingestion Rate : Milk Cow Grain	Ingestion rate for milk cow grain	NORMAL(kg dry wt grain/d)	
Default value used		Mean	1.71E+00
		Standard Deviation	2.62E-01
QG(4):Ingestion Rate : Layer Hen Grain	Ingestion rate for layer hen grain	BETA(kg dry wt grain/d)	
Default value used		Lower Limit	3.58E-02
		Upper Limit	6.67E-02
		p	1.43E+00
		q	7.92E-01
QH(1):Ingestion Rate : Beef Cattle Hay	Ingestion rate for beef cattle hay	BETA(kg dry wt hay/d)	
Default value used		Lower Limit	3.38E+00
		Upper Limit	4.58E+00
		p	1.99E+00
		q	9.11E-01
QH(2):Ingestion Rate : Poultry Hay	Ingestion rate for poultry hay	CONSTANT(kg dry wt hay/d)	
Default value used		Value	0.00E+00
QH(3):Ingestion Rate : Milk Cow Hay	Ingestion rate for milk cow hay	CONTINUOUS LINEAR(kg dry wt hay/d)	
Default value used		Value	Probability
		5.12E+00	0.00E+00
		5.43E+00	3.45E-02
		5.57E+00	6.91E-02
		5.68E+00	1.04E-01
		5.79E+00	1.38E-01
		5.89E+00	1.73E-01
		5.98E+00	2.07E-01
		6.06E+00	2.42E-01
		6.08E+00	2.50E-01
		6.14E+00	2.76E-01
		6.22E+00	3.11E-01
		6.30E+00	3.45E-01

6.38E+00	3.80E-01
6.46E+00	4.15E-01
6.54E+00	4.49E-01
6.63E+00	4.84E-01
6.67E+00	4.99E-01
6.72E+00	5.18E-01
6.81E+00	5.53E-01
6.92E+00	5.87E-01
7.03E+00	6.22E-01
7.13E+00	6.56E-01
7.26E+00	6.91E-01
7.39E+00	7.25E-01
7.49E+00	7.50E-01
7.56E+00	7.60E-01
7.70E+00	7.94E-01
7.89E+00	8.29E-01
8.11E+00	8.64E-01
8.39E+00	8.98E-01
8.75E+00	9.33E-01
9.44E+00	9.67E-01
1.05E+01	9.91E-01
1.27E+01	1.00E+00

QH(4):Ingestion Rate : Layer Hen Hay	Ingestion rate for layer hen hay	CONSTANT(kg dry wt hay/d)
Default value used		Value 0.00E+00
QW(1):Water Rate : Beef Cattle	Water ingestion rate for beef cattle	CONSTANT(L/d)
Default value used		Value 5.00E+01
QW(2):Water Rate : Poultry	Water ingestion rate for poultry	CONSTANT(L/d)
Default value used		Value 3.00E-01
QW(3):Water Rate : Milk Cows	Water ingestion rate for milk cows	CONSTANT(L/d)
Default value used		Value 6.00E+01
QW(4):Water Rate : Layer Hens	Water ingestion rate for layer hens	CONSTANT(L/d)
Default value used		Value 3.00E-01
QD(1):Soil Fraction : Beef Cattle	Soil intake fraction for beef cattle	CONSTANT(none)
Default value used		Value 2.00E-02
QD(2):Soil Fraction : Poultry	Soil intake fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
QD(3):Soil Fraction : Milk Cows	Soil intake fraction for milk cows	CONSTANT(none)
Default value used		Value 2.00E-02
QD(4):Soil Fraction : Layer Hens	Soil intake fraction for layer hens	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(1):Mass-Loading : Leafy Vegetables	Mass-loading factor for leafy vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(2):Mass-Loading : Other Vegetables	Mass-loading factor for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
MLV(3):Mass-Loading : Fruits	Mass-loading factor for fruits	CONSTANT(none)

Default value used		Value 1.00E-01
MLV(4):Mass-Loading : Grains	Mass-loading factor for grains	CONSTANT(none)
Default value used		Value 1.00E-01
LAMBDW:Weathering Rate	Weathering rate for activity removal from plants	CONSTANT(1/d)
Default value used		Value 4.95E-02
MLF(1):Mass-Loading : Beef Cow Forage	Mass-loading factor for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(2):Mass-Loading : Poultry Forage	Mass-loading factor for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(3):Mass-Loading : Milk Cow Forage	Mass-loading factor for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLF(4):Mass-Loading : Layer Hen Forage	Mass-loading factor for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(1):Mass-Loading : Beef Cattle Grain	Mass-loading factor for beef cattle grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(2):Mass-Loading : Poultry Grain	Mass-loading factor for poultry grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(3):Mass-Loading : Milk Cow Grain	Mass-loading factor for milk cow grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLG(4):Mass-Loading : Layer Hen Grain	Mass-loading factor for layer hen grain	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(1):Mass-Loading : Beef Cattle Hay	Mass-loading factor for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(2):Mass-Loading : Poultry Hay	Mass-loading factor for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(3):Mass-Loading : Milk Cow Hay	Mass-loading factor for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
MLH(4):Mass-Loading : Layer Hen Hay	Mass-loading factor for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
TFF(1):Feeding Period : Beef Cow Forage	Feeding period for beef cattle forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(2):Feeding Period : Poultry Forage	Feeding period for poultry forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFF(3):Feeding Period : Milk Cow Forage	Feeding period for milk cow forage	CONSTANT(days)
Default value used		Value 3.65E+02

TFF(4):Feeding Period : Layer Hen Forage	Feeding period for layer hen forage	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(1):Feeding Period : Beef Cattle Grain	Feeding period for beef cattle grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(2):Feeding Period : Poultry Grain	Feeding period for poultry grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(3):Feeding Period : Milk Cow Grain	Feeding period for milk cow grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFG(4):Feeding Period : Layer Hen Grain	Feeding period for layer hen grain	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(1):Feeding Period : Beef Cattle Hay	Feeding period for beef cattle hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(2):Feeding Period : Poultry Hay	Feeding period for poultry hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(3):Feeding Period : Milk Cow Hay	Feeding period for milk cow hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFH(4):Feeding Period : Layer Hen Hay	Feeding period for layer hen hay	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(1):Water Period : Beef Cattle	Water ingestion period for beef cattle	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(2):Water Period : Poultry	Water ingestion period for poultry	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(3):Water Period : Milk Cows	Water ingestion period for milk cows	CONSTANT(days)
Default value used		Value 3.65E+02
TFW(4):Water Period : Layer Hens	Water ingestion period for layer hens	CONSTANT(days)
Default value used		Value 3.65E+02
fha(1):Hydrogen Fraction : Beef Cattle	Hydrogen fraction for beef cattle	CONSTANT(none)
Default value used		Value 1.00E-01
fha(2):Hydrogen Fraction : Poultry	Hydrogen fraction for poultry	CONSTANT(none)
Default value used		Value 1.00E-01
fha(3):Hydrogen Fraction : Milk Cows	Hydrogen fraction for milk cows	CONSTANT(none)
Default value used		Value 1.10E-01
fha(4):Hydrogen Fraction : Eggs	Hydrogen fraction for eggs	CONSTANT(none)
Default value used		Value 1.10E-01
fhv(1):Hydrogen Fraction : Leafy Vegetables	Hydrogen fraction for leafy vegetables	CONSTANT(none)

Default value used		Value 1.00E-01
fhv(2):Hydrogen Fraction : Other Vegetables	Hydrogen fraction for other vegetables	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(3):Hydrogen Fraction : Fruits	Hydrogen fraction for fruits	CONSTANT(none)
Default value used		Value 1.00E-01
fhv(4):Hydrogen Fraction : Grains	Hydrogen fraction for grains	CONSTANT(none)
Default value used		Value 6.80E-02
fhf(1):Hydrogen Fraction : Beef Cow Forage	Hydrogen fraction for beef cattle forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(2):Hydrogen Fraction : Poultry Forage	Hydrogen fraction for poultry forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(3):Hydrogen Fraction : Milk Cow Forage	Hydrogen fraction for milk cow forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhf(4):Hydrogen Fraction : Layer Hen Forage	Hydrogen fraction for layer hen forage	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(1):Hydrogen Fraction : Beef Cattle Hay	Hydrogen fraction for beef cattle hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(2):Hydrogen Fraction : Poultry Hay	Hydrogen fraction for poultry hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(3):Hydrogen Fraction : Milk Cow Hay	Hydrogen fraction for milk cow hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhh(4):Hydrogen Fraction : Layer Hen Hay	Hydrogen fraction for layer hen hay	CONSTANT(none)
Default value used		Value 1.00E-01
fhg(1):Hydrogen Fraction : Beef Cattle Grain	Hydrogen fraction for beef cattle grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(2):Hydrogen Fraction : Poultry Grain	Hydrogen fraction for poultry grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(3):Hydrogen Fraction : Milk Cow Grain	Hydrogen fraction for milk cow grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhg(4):Hydrogen Fraction : Layer Hen Grain	Hydrogen fraction for layer hen grain	CONSTANT(none)
Default value used		Value 6.80E-02
fhd016:Hydrogen Fraction : Soil	Fraction of hydrogen in soil	DERIVED(none)
Default value used		
sasvh:Tritium Equivalence: Plant/Soil	Tritium equivalence: plant/soil	CONSTANT(none)
Default value used		Value 1.00E+00

sawvh:Tritium Equivalence: Plant/Water	Tritium equivalence: plant/water	CONSTANT(none)
Default value used		Value 1.00E+00
satah:Tritium Equivalence: Animal Products	Tritium equivalence: animal product intake	CONSTANT(none)
Default value used		Value 1.00E+00
YA(1):Animal Product Yield : Beef Cattle	Annual yield of beef per individual animal	CONSTANT(kg/y)
Default value used		Value 2.09E+02
YA(2):Animal Product Yield : Poultry	Annual yield of chicken per individual animal	CONSTANT(kg/y)
Default value used		Value 1.53E+00
YA(3):Animal Product Yield : Milk Cows	Annual yield of milk per individual animal	CONSTANT(L/y)
Default value used		Value 7.41E+03
YA(4):Animal Product Yield : Layer Hens	Annual yield of eggs per individual animal	CONSTANT(kg/y)
Default value used		Value 1.26E+01
ARExt:External Exposure Area	Minimum surface area to which resident is exposed via external radiation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARInh:Inhalation Exposure Area	Minimum surface area to which resident is exposed via inhalation during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARIng:Secondary Ingestion Exposure Area	Minimum surface area to which resident is exposed via secondary ingestion during residential period	CONSTANT(m**2)
Default value used		Value 1.00E+02
ARAgr:Agricultural Exposure Area	Minimum surface area to which resident is exposed via any agricultural product during residential period	DERIVED(m**2)
Default value used		
ARH2O:Groundwater Exposure Area	Minimum surface area to which resident is exposed via groundwater during residential period	DERIVED(m**2)
Default value used		
ARAll:Exposure Area	Minimum surface area to which resident is exposed via any pathway during the residential period	DERIVED(m**2)
Default value used		

Element Dependant Parameters

Parameter Name	Description	Distribution
H:Coefficient	Partition coefficient for H	CONSTANT(mL/g)
Default value used		Value 0.00E+00
C:Coefficient	Partition coefficient for C	CONTINUOUS LINEAR(Log10(mL/g))
Default value used		Value / Probability
		-5.67E-01 / 0.00E+00
		-4.70E-01 / 1.03E-02
		-3.63E-01 / 3.44E-02

-2.73E-01	6.71E-02
-1.99E-01	9.98E-02
-1.30E-01	1.33E-01
-6.49E-02	1.65E-01
-3.96E-03	1.98E-01
5.94E-02	2.31E-01
1.24E-01	2.63E-01
1.86E-01	2.96E-01
2.51E-01	3.29E-01
3.18E-01	3.61E-01
3.89E-01	3.94E-01
4.64E-01	4.27E-01
5.40E-01	4.60E-01
6.19E-01	4.92E-01
6.40E-01	5.01E-01
7.07E-01	5.25E-01
7.99E-01	5.58E-01
9.00E-01	5.90E-01
1.01E+00	6.23E-01
1.13E+00	6.56E-01
1.26E+00	6.88E-01
1.41E+00	7.21E-01
1.59E+00	7.54E-01
1.78E+00	7.87E-01
2.03E+00	8.19E-01
2.32E+00	8.52E-01
2.71E+00	8.85E-01
3.26E+00	9.17E-01
4.14E+00	9.50E-01
5.03E+00	9.69E-01
6.32E+00	9.83E-01
8.02E+00	9.91E-01
1.44E+01	1.00E+00

Fe:Coefficient	Partition coefficient for Fe	CONTINUOUS LINEAR(Log10(mL/g))

Default value used

Value	Probability
-1.11E+00	0.00E+00
9.49E-01	3.45E-02
1.35E+00	6.91E-02
1.62E+00	1.04E-01
1.80E+00	1.38E-01
1.94E+00	1.73E-01
2.07E+00	2.07E-01
2.17E+00	2.42E-01
2.20E+00	2.50E-01
2.26E+00	2.76E-01
2.35E+00	3.11E-01
2.43E+00	3.45E-01
2.50E+00	3.80E-01
2.57E+00	4.15E-01
2.64E+00	4.49E-01
2.70E+00	4.84E-01
2.73E+00	4.99E-01
2.76E+00	5.18E-01
2.82E+00	5.53E-01
2.87E+00	5.87E-01
2.93E+00	6.22E-01
2.99E+00	6.56E-01
3.05E+00	6.91E-01
3.11E+00	7.25E-01
3.15E+00	7.50E-01
3.17E+00	7.60E-01
3.23E+00	7.94E-01
3.29E+00	8.29E-01
3.36E+00	8.64E-01
3.45E+00	8.98E-01

		3.55E+00	9.33E-01
		3.69E+00	9.67E-01
		3.89E+00	9.91E-01
		4.14E+00	1.00E+00
Co:Coefficient	Partition coefficient for Co	CONTINUOUS LINEAR(Log10(mL/g))	
Default value used		Value	Probability
		-2.47E+00	0.00E+00
		1.95E-01	3.45E-02
		7.70E-01	6.91E-02
		1.13E+00	1.04E-01
		1.39E+00	1.38E-01
		1.59E+00	1.73E-01
		1.77E+00	2.07E-01
		1.91E+00	2.42E-01
		1.95E+00	2.50E-01
		2.04E+00	2.76E-01
		2.16E+00	3.11E-01
		2.28E+00	3.45E-01
		2.38E+00	3.80E-01
		2.47E+00	4.15E-01
		2.56E+00	4.49E-01
		2.65E+00	4.84E-01
		2.69E+00	4.99E-01
		2.73E+00	5.18E-01
		2.82E+00	5.53E-01
		2.90E+00	5.87E-01
		2.97E+00	6.22E-01
		3.05E+00	6.56E-01
		3.13E+00	6.91E-01
		3.21E+00	7.25E-01
		3.28E+00	7.50E-01
		3.30E+00	7.60E-01
		3.39E+00	7.94E-01
		3.48E+00	8.29E-01
		3.58E+00	8.64E-01
		3.70E+00	8.98E-01
		3.84E+00	9.33E-01
		4.03E+00	9.67E-01
		4.30E+00	9.91E-01
		4.65E+00	1.00E+00
Ni:Coefficient	Partition coefficient for Ni	NORMAL(Log10(mL/g))	
Default value used		Mean	1.57E+00
		Standard Deviation	1.48E+00
Sr:Coefficient	Partition coefficient for Sr	NORMAL(Log10(mL/g))	
Default value used		Mean	1.50E+00
		Standard Deviation	9.20E-01
Y:Coefficient	Partition coefficient for Y	NORMAL(Log10(mL/g))	
Default value used		Mean	2.90E+00
		Standard Deviation	1.40E+00
Nb:Coefficient	Partition coefficient for Nb	NORMAL(Log10(mL/g))	
Default value used		Mean	2.80E+00
		Standard Deviation	1.40E+00
Tc:Coefficient	Partition coefficient for Tc	NORMAL(Log10(mL/g))	
Default value used		Mean	8.70E-01
		Standard Deviation	1.33E+00
Cs:Coefficient	Partition coefficient for Cs	NORMAL(Log10(mL/g))	
Default value used		Mean	2.65E+00
		Standard Deviation	1.01E+00
Ba:Coefficient	Partition coefficient for Ba	NORMAL(Log10(mL/g))	
Default value used		Mean	1.65E+00

		Standard Deviation 3.53E+00
Eu:Coefficient	Partition coefficient for Eu	NORMAL(Log10(mL/g))
Default value used		Mean 2.98E+00 Standard Deviation 1.74E+00
Gd:Coefficient	Partition coefficient for Gd	NORMAL(Log10(mL/g))
Default value used		Mean 7.00E-01 Standard Deviation 1.40E+00
H:Leafy	Leafy plant concentration factor for H	CONSTANT(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Value 0.00E+00
C:Leafy	Leafy plant concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Leafy	Leafy plant concentration factor for Fe	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -5.18E+00 Standard Deviation of Ln 1.34E+00
Co:Leafy	Leafy plant concentration factor for Co	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -2.43E+00 Standard Deviation of Ln 1.55E+00
Ni:Leafy	Leafy plant concentration factor for Ni	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.38E+00 Standard Deviation of Ln 1.16E+00
Sr:Leafy	Leafy plant concentration factor for Sr	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 5.88E-01 Standard Deviation of Ln 1.34E+00
Y:Leafy	Leafy plant concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 9.04E-01
Nb:Leafy	Leafy plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.91E+00 Standard Deviation of Ln 9.04E-01
Tc:Leafy	Leafy plant concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) 2.25E+00 Standard Deviation of Ln 9.04E-01
Cs:Leafy	Leafy plant concentration factor for Cs	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.19E+00 Standard Deviation of Ln 1.25E+00
Ba:Leafy	Leafy plant concentration factor for Ba	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -3.24E+00 Standard Deviation of Ln 1.06E+00
Eu:Leafy	Leafy plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01
Gd:Leafy	Leafy plant concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt leafy per pCi/kg soil)
Default value used		Mean of Ln(X) -4.61E+00 Standard Deviation of Ln 9.04E-01

H:Root	Root plant concentration factor for H	CONSTANT(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Value 0.00E+00
C:Root	Root plant concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Root	Root plant concentration factor for Fe	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -7.78E+00 Standard Deviation of Ln 1.25E+00
Co:Root	Root plant concentration factor for Co	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 1.19E+00
Ni:Root	Root plant concentration factor for Ni	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -3.86E+00 Standard Deviation of Ln 9.16E-01
Sr:Root	Root plant concentration factor for Sr	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -2.59E+00 Standard Deviation of Ln 1.34E+00
Y:Root	Root plant concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
Nb:Root	Root plant concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Tc:Root	Root plant concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) 4.05E-01 Standard Deviation of Ln 9.04E-01
Cs:Root	Root plant concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Ba:Root	Root plant concentration factor for Ba	LOGNORMAL-N(pCi/kg wet-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -6.65E+00 Standard Deviation of Ln 1.13E+00
Eu:Root	Root plant concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Gd:Root	Root plant concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt roots per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
H:Fruit	Fruit concentration factor for H	CONSTANT(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Value 0.00E+00
C:Fruit	Fruit concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Fruit	Fruit concentration factor for Fe	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)

Default value used		Mean of Ln(X) -7.78E+00 Standard Deviation of Ln 1.25E+00
Co:Fruit	Fruit concentration factor for Co	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 1.19E+00
Ni:Fruit	Fruit concentration factor for Ni	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -3.86E+00 Standard Deviation of Ln 9.16E-01
Sr:Fruit	Fruit concentration factor for Sr	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -2.59E+00 Standard Deviation of Ln 1.34E+00
Y:Fruit	Fruit concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
Nb:Fruit	Fruit concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Tc:Fruit	Fruit concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) 4.05E-01 Standard Deviation of Ln 9.04E-01
Cs:Fruit	Fruit concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Ba:Fruit	Fruit concentration factor for Ba	LOGNORMAL-N(pCi/kg wet-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -6.65E+00 Standard Deviation of Ln 1.13E+00
Eu:Fruit	Fruit concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Gd:Fruit	Fruit concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt fruit per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
H:Grain	Grain concentration factor for H	CONSTANT(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Value 0.00E+00
C:Grain	Grain concentration factor for C	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -3.57E-01 Standard Deviation of Ln 9.04E-01
Fe:Grain	Grain concentration factor for Fe	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -7.78E+00 Standard Deviation of Ln 1.25E+00
Co:Grain	Grain concentration factor for Co	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -4.20E+00 Standard Deviation of Ln 1.19E+00
Ni:Grain	Grain concentration factor for Ni	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)

Default value used		Mean of Ln(X) -3.86E+00 Standard Deviation of Ln 9.16E-01
Sr:Grain	Grain concentration factor for Sr	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -2.59E+00 Standard Deviation of Ln 1.34E+00
Y:Grain	Grain concentration factor for Y	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.12E+00 Standard Deviation of Ln 9.04E-01
Nb:Grain	Grain concentration factor for Nb	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 9.04E-01
Tc:Grain	Grain concentration factor for Tc	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) 4.05E-01 Standard Deviation of Ln 9.04E-01
Cs:Grain	Grain concentration factor for Cs	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.30E+00 Standard Deviation of Ln 1.41E+00
Ba:Grain	Grain concentration factor for Ba	LOGNORMAL-N(pCi/kg wet-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -6.65E+00 Standard Deviation of Ln 1.13E+00
Eu:Grain	Grain concentration factor for Eu	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
Gd:Grain	Grain concentration factor for Gd	LOGNORMAL-N(pCi/kg dry-wt grain per pCi/kg soil)
Default value used		Mean of Ln(X) -5.52E+00 Standard Deviation of Ln 9.04E-01
H:Beef	Beef transfer factor for H	CONSTANT(d/kg)
Default value used		Value 0.00E+00
C:Beef	Beef transfer factor for C	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Fe:Beef	Beef transfer factor for Fe	CONSTANT(d/kg)
Default value used		Value 2.00E-02
Co:Beef	Beef transfer factor for Co	CONSTANT(d/kg)
Default value used		Value 2.00E-02
Ni:Beef	Beef transfer factor for Ni	CONSTANT(d/kg)
Default value used		Value 6.00E-03
Sr:Beef	Beef transfer factor for Sr	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Y:Beef	Beef transfer factor for Y	CONSTANT(d/kg)
Default value used		Value 3.00E-04
Nb:Beef	Beef transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 2.50E-01
Tc:Beef	Beef transfer factor for Tc	CONSTANT(d/kg)
Default value used		Value 8.50E-03
Cs:Beef	Beef transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 2.00E-02

Ba:Beef	Beef transfer factor for Ba	CONSTANT(d/kg)
Default value used		Value 1.50E-04
Eu:Beef	Beef transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 5.00E-03
Gd:Beef	Beef transfer factor for Gd	CONSTANT(d/kg)
Default value used		Value 3.50E-03
H:Poultry	Poultry transfer factor for H	CONSTANT(d/kg)
Default value used		Value 0.00E+00
C:Poultry	Poultry transfer factor for C	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Fe:Poultry	Poultry transfer factor for Fe	CONSTANT(d/kg)
Default value used		Value 1.50E+00
Co:Poultry	Poultry transfer factor for Co	CONSTANT(d/kg)
Default value used		Value 5.00E-01
Ni:Poultry	Poultry transfer factor for Ni	CONSTANT(d/kg)
Default value used		Value 1.00E-03
Sr:Poultry	Poultry transfer factor for Sr	CONSTANT(d/kg)
Default value used		Value 3.50E-02
Y:Poultry	Poultry transfer factor for Y	CONSTANT(d/kg)
Default value used		Value 1.00E-02
Nb:Poultry	Poultry transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 3.10E-04
Tc:Poultry	Poultry transfer factor for Tc	CONSTANT(d/kg)
Default value used		Value 3.00E-02
Cs:Poultry	Poultry transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.40E+00
Ba:Poultry	Poultry transfer factor for Ba	CONSTANT(d/kg)
Default value used		Value 8.10E-04
Eu:Poultry	Poultry transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 4.00E-03
Gd:Poultry	Poultry transfer factor for Gd	CONSTANT(d/kg)
Default value used		Value 4.00E-03
H:Milk	Milk transfer factor for H	CONSTANT(d/L)
Default value used		Value 0.00E+00
C:Milk	Milk transfer factor for C	CONSTANT(d/L)
Default value used		Value 0.00E+00
Fe:Milk	Milk transfer factor for Fe	CONSTANT(d/L)
Default value used		Value 2.50E-04
Co:Milk	Milk transfer factor for Co	CONSTANT(d/L)
Default value used		Value 2.00E-03
Ni:Milk	Milk transfer factor for Ni	CONSTANT(d/L)
Default value used		Value 1.00E-03
Sr:Milk	Milk transfer factor for Sr	CONSTANT(d/L)
Default value used		Value 1.50E-03
Y:Milk	Milk transfer factor for Y	CONSTANT(d/L)
Default value used		Value 2.00E-05
Nb:Milk	Milk transfer factor for Nb	CONSTANT(d/L)
Default value used		Value 2.00E-02
Tc:Milk	Milk transfer factor for Tc	CONSTANT(d/L)

Default value used		Value 1.00E-02
Cs:Milk	Milk transfer factor for Cs	CONSTANT(d/L)
Default value used		Value 7.00E-03
Ba:Milk	Milk transfer factor for Ba	CONSTANT(d/L)
Default value used		Value 3.50E-04
Eu:Milk	Milk transfer factor for Eu	CONSTANT(d/L)
Default value used		Value 2.00E-05
Gd:Milk	Milk transfer factor for Gd	CONSTANT(d/L)
Default value used		Value 2.00E-05
H:Eggs	Egg transfer factor for H	CONSTANT(d/kg)
Default value used		Value 0.00E+00
C:Eggs	Egg transfer factor for C	CONSTANT(d/kg)
Default value used		Value 0.00E+00
Fe:Eggs	Egg transfer factor for Fe	CONSTANT(d/kg)
Default value used		Value 1.30E+00
Co:Eggs	Egg transfer factor for Co	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Ni:Eggs	Egg transfer factor for Ni	CONSTANT(d/kg)
Default value used		Value 1.00E-01
Sr:Eggs	Egg transfer factor for Sr	CONSTANT(d/kg)
Default value used		Value 3.00E-01
Y:Eggs	Egg transfer factor for Y	CONSTANT(d/kg)
Default value used		Value 2.00E-03
Nb:Eggs	Egg transfer factor for Nb	CONSTANT(d/kg)
Default value used		Value 1.30E-03
Tc:Eggs	Egg transfer factor for Tc	CONSTANT(d/kg)
Default value used		Value 3.00E+00
Cs:Eggs	Egg transfer factor for Cs	CONSTANT(d/kg)
Default value used		Value 4.90E-01
Ba:Eggs	Egg transfer factor for Ba	CONSTANT(d/kg)
Default value used		Value 1.50E+00
Eu:Eggs	Egg transfer factor for Eu	CONSTANT(d/kg)
Default value used		Value 7.00E-03
Gd:Eggs	Egg transfer factor for Gd	CONSTANT(d/kg)
Default value used		Value 7.00E-03
H:Factor	Bioaccumulation factor for H in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+00
C:Factor	Bioaccumulation factor for C in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 4.60E+03
Fe:Factor	Bioaccumulation factor for Fe in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Co:Factor	Bioaccumulation factor for Co in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 3.30E+02
Ni:Factor	Bioaccumulation factor for Ni in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.00E+02
Sr:Factor	Bioaccumulation factor for Sr in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 5.00E+01
Y:Factor	Bioaccumulation factor for Y in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01

Nb:Factor	Bioaccumulation factor for Nb in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Tc:Factor	Bioaccumulation factor for Tc in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 1.50E+01
Cs:Factor	Bioaccumulation factor for Cs in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+03
Ba:Factor	Bioaccumulation factor for Ba in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.00E+02
Eu:Factor	Bioaccumulation factor for Eu in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01
Gd:Factor	Bioaccumulation factor for Gd in fish	CONSTANT(pCi/kg wet-wt fish per pCi/L water)
Default value used		Value 2.50E+01

Correlation Coefficients:

Parameter One	Parameter Two	Correlation Coefficient
KSDEV:Permeability Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		
NDEV:Porosity Probability	**BDEV:Parameter "b" Probability**	-0.35
Default value used		

Summary Results:

90.00% **of the** 129 **calculated TEDE values are <** 2.66E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 2.64E+00 **to** 2.67E+00 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Soil Concentration (pCi/g)	Water Concentration (pCi/g)
3H	2.50E-04	7.33E-03
14C	6.87E-04	4.80E-11
55Fe	1.40E-01	1.78E-23
59Ni	3.29E-03	5.63E-09
63Ni	4.53E-01	7.70E-07
90Sr	2.97E-05	3.63E-18
90Y	0.00E+00	9.88E-18
94Nb	1.01E-05	1.15E-17
99Tc	3.22E-06	8.88E-14
137Cs	3.20E-05	1.54E-21
137mBa	3.03E-05	1.46E-21
152Eu	1.12E-07	8.86E-28
152Gd	0.00E+00	9.61E-28
154Eu	9.21E-06	2.68E-24
60Co	4.03E-01	3.32E-22

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
2.67E+00	1.74E-01	4.97E-07	1.72E-06	2.50E+00	2.58E-05	1.49E-04	1.69E-06

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
3H	7.15E-05
14C	4.56E-04
55Fe	3.37E-04
59Ni	7.94E-06
63Ni	2.99E-03
90Sr	5.95E-04
90Y	2.71E-05
94Nb	4.36E-05
99Tc	5.43E-06
137Cs	2.82E-05
137mBa	4.68E-05
152Eu	3.23E-07
152Gd	8.87E-23
154Eu	2.87E-05
60Co	2.67E+00
All Nuclides	2.67E+00

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	Agricultural	Drinking Water	Surface Water	External	Inhalation	Secondary Ingestion	Irrigation
3H	7.15E-05	2.17E-07	4.59E-09	0.00E+00	4.66E-12	2.20E-10	1.99E-07
14C	4.56E-04	4.63E-14	4.58E-12	4.51E-09	4.29E-10	2.03E-08	4.69E-13
55Fe	3.36E-04	4.99E-27	2.14E-25	0.00E+00	1.00E-07	1.06E-06	1.02E-26
59Ni	7.61E-06	5.46E-13	1.17E-12	0.00E+00	2.66E-09	9.77E-09	1.09E-12
63Ni	2.87E-03	2.05E-10	4.40E-10	0.00E+00	8.49E-07	3.69E-06	4.09E-10
90Sr	5.95E-04	2.39E-19	2.73E-19	9.95E-09	1.14E-08	5.92E-08	6.30E-19
90Y	2.68E-05	4.91E-20	2.84E-20	3.16E-07	7.30E-11	4.43E-09	9.92E-20
94Nb	1.96E-06	3.79E-20	1.65E-19	4.17E-05	1.25E-09	1.02E-09	1.20E-18
99Tc	5.43E-06	6.00E-17	1.92E-17	1.97E-10	8.01E-12	6.66E-11	8.03E-16
137Cs	2.81E-05	3.56E-23	1.64E-21	1.14E-08	3.02E-10	2.24E-08	1.46E-22
137mBa	0.00E+00	0.00E+00	0.00E+00	4.68E-05	0.00E+00	0.00E+00	0.00E+00
152Eu	2.47E-09	2.65E-30	1.48E-30	3.20E-07	7.22E-12	1.00E-11	4.69E-30
152Gd	8.52E-23	7.13E-29	3.77E-29	0.00E+00	1.02E-25	2.24E-25	1.64E-28
154Eu	2.93E-07	1.18E-26	6.48E-27	2.84E-05	7.60E-10	1.20E-09	2.46E-26
60Co	1.69E-01	4.14E-24	3.00E-23	2.50E+00	2.48E-05	1.44E-04	1.24E-23

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 6/22/2021 1:39:53 PM
Site Name: CR3
Description: CR3 Residential Pu239
FileName:C:\Users\mceri\Documents\CR3 Residential Pu239.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
239Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Site		Value 1.60E-07

Chain Data:

Number of chains: **1**

Chain No. 1: **239Pu**
Nuclides in chain: **14**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
239Pu	1	8.79E+06					9.56E-07	1.16E-04	3.17E-14	1.31E-16
235U	2	2.57E+11	1	1	0	0	7.19E-08	3.32E-05	1.28E-11	3.24E-13
231Th	3	1.06E+00	2	1	0	0	3.65E-10	2.37E-10	1.60E-12	1.68E-14
231Pa	4	1.20E+07	3	1	0	0	2.86E-06	3.47E-04	3.52E-12	8.30E-14
227Ac	5	7.95E+03	4	1	0	0	3.80E-06	1.81E-03	1.36E-14	2.26E-16
223Fr	Implicit		5	0.0138			2.33E-09	1.68E-09	4.88E-12	8.74E-14
227Th	6	1.87E+01	5	0.9862	0	0	1.03E-08	4.37E-06	8.94E-12	2.29E-13
223Ra	7	1.14E+01	6	1	5	0.0138	1.78E-07	2.12E-06	1.11E-11	2.67E-13
219Rn	Implicit		7	1			0.00E+00	0.00E+00	4.74E-12	1.33E-13
215Po	Implicit		7	1			0.00E+00	0.00E+00	1.51E-14	4.30E-16

211Pb	Implicit		7	1			1.42E-10	2.35E-09	4.38E-12	1.26E-13
211Bi	Implicit		7	1			0.00E+00	0.00E+00	3.96E-12	1.10E-13
211Po	Implicit		7	0.0028			0.00E+00	0.00E+00	6.57E-13	1.94E-14
207Tl	Implicit		7	0.9972			0.00E+00	0.00E+00	3.25E-13	8.19E-15

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Nuclide	Surface Concentration (dpm/100 cm**2)
239Pu	1.60E-07
235U	0.00E+00
231Th	0.00E+00
231Pa	0.00E+00
227Ac	0.00E+00
223Fr	0.00E+00
227Th	0.00E+00
223Ra	0.00E+00
219Rn	0.00E+00
215Po	0.00E+00
211Pb	0.00E+00
211Bi	0.00E+00
211Po	0.00E+00
207Tl	0.00E+00

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
To:Time In Building	The time in the building during the occupancy period	CONSTANT(hr/week)
Default value used		Value 4.50E+01
Tto:Occupancy Period	The duration of the occupancy exposure period	CONSTANT(days)
Default value used		Value 3.65E+02
Vo:Breathing Rate	The average volumetric breathing rate during building occupancy for an 8-hour work day	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	DERIVED(1/m)
Default value used		
GO*:Ingestion Rate	Effective secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy = GO * Fl	DERIVED(m**2/hr)
Default value used		
Tstart:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
Tend:End Time	The ending time of the scenario in days	CONSTANT(days)

Default value used		Value 3.65E+02
dt:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
Pstep:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
AOExt:External Exposure Area	Minimum surface area to which occupant is exposed via external radiation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOInh:Inhalation Exposure Area	Minimum surface area to which occupant is exposed via inhalation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOIng:Secondary Ingestion Exposure Area	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AO:Exposure Area	Minimum surface area to which occupant is exposed during the occupancy period	DERIVED(m**2)
Default value used		
Fl:Loose Fraction	Fraction of surface contamination available for resuspension and ingestion	CONSTANT(none)
Default value used		Value 1.00E-01
Rfo:Loose Resuspension Factor	Resuspension factor for loose contamination	CONTINUOUS LOGARITHMIC(1/m)
Default value used		Value / Probability 9.12E-06 / 0.00E+00 1.10E-04 / 7.67E-01 1.46E-04 / 9.09E-01 1.62E-04 / 9.50E-01 1.85E-04 / 9.90E-01 1.90E-04 / 1.00E+00
GO:Loose Ingestion Rate	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	CONSTANT(m**2/hr)
Default value used		Value 1.10E-04

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are <** 1.44E-07 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.28E-07 **to** 1.64E-07 **mrem/year**

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Concentration at Time of Peak Dose:

Nuclide	Surface Concentration (dpm/100 cm**2)

239Pu	1.60E-07
235U	7.88E-17
231Th	7.82E-17
231Pa	5.47E-22
227Ac	4.31E-24
223Fr	5.95E-26
227Th	3.23E-24
223Ra	2.74E-24
219Rn	2.74E-24
215Po	2.74E-24
211Pb	2.74E-24
211Bi	2.74E-24
211Po	7.68E-27
207Tl	2.73E-24

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	External	Inhalation	Secondary Ingestion
1.64E-07	8.24E-14	1.63E-07	6.56E-10

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
239Pu	1.64E-07
235U	2.31E-17
231Th	2.32E-21
231Pa	1.68E-21
227Ac	6.87E-23
223Fr	6.19E-30
227Th	1.25E-25
223Ra	5.37E-26
219Rn	2.11E-28
215Po	6.73E-31
211Pb	2.53E-28
211Bi	1.76E-28
211Po	8.20E-32
207Tl	1.44E-29
All Nuclides	1.64E-07

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	External	Inhalation	Secondary Ingestion
239Pu	8.24E-14	1.63E-07	6.56E-10
235U	1.64E-20	2.30E-17	2.43E-20
231Th	2.03E-21	1.63E-22	1.22E-22
231Pa	3.13E-26	1.67E-21	6.72E-24

227Ac	9.53E-31	6.87E-23	7.03E-26
223Fr	4.72E-30	8.80E-31	5.95E-31
227Th	4.69E-28	1.24E-25	1.43E-28
223Ra	4.94E-28	5.12E-26	2.09E-27
219Rn	2.11E-28	0.00E+00	0.00E+00
215Po	6.73E-31	0.00E+00	0.00E+00
211Pb	1.95E-28	5.67E-29	1.67E-30
211Bi	1.76E-28	0.00E+00	0.00E+00
211Po	8.20E-32	0.00E+00	0.00E+00
207Tl	1.44E-29	0.00E+00	0.00E+00

Enclosure 6

"Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations in Support of the Final Status Survey at VYNPS and CR3"

August 14, 2022

BEGINS ON NEXT PAGE

Instrument Efficiency Determination for Use in Minimum Detectable Concentration Calculations in Support of the Final Status Surveys at VYNPS and CR3

Revision 3

August 14, 2022

Prepared by: Marty Erickson

Reviewed by: Marshall Blake

Reviewed by: GL Wood (Aug 24, 2022 07:57 EDT)

Approved by: Bryant Akins

Approved by: Michael Pletcher
Michael Pletcher (Aug 24, 2022 15:38 EDT)

Approved by: Gordon Madison
Gordon Madison (Aug 26, 2022 16:14 EDT)

Table of Contents

Executive Summary

The minimum detectable concentration (MDC) of the field survey instrumentation is an important factor affecting the quality of the Final Status Survey (FSS). The efficiency of an instrument inversely impacts the MDC value. The objective of this report is to determine the instrument and source efficiency values used to calculate MDC. Several factors were considered when determining these efficiencies and are discussed in the body of this report. Instrument efficiencies (e_i), and source efficiencies (e_s), for alpha beta detection equipment under various field conditions, and instrument conversion factors (E_i), for gamma scanning detectors were determined and the results are provided herein.

1.0 INTRODUCTION

Before performing Final Status Surveys of building surfaces and land areas, the MDC must be calculated to establish the instrument sensitivity. The Vermont Yankee Nuclear Power Station (VYNPS) and Crystal River Unit 3 (CR3) License Termination Plans (LTPs) list the available instrumentation and nominal detection sensitivities; however, for the purposes of this basis document, efficiencies for the nominal 100 cm^2 gas proportional/scintillation and the 2" x 2" NaI (TI) detectors will be determined. Efficiencies for the other instrumentation listed in the LTP shall be determined on an as needed basis. The 100 cm^2 scintillation probe, or the gas proportional probe will be used to perform building surface surveys (i.e., direct measurements). A 2" x 2" NaI (TI) detector will be used to perform gamma surveys (i.e., surface scans) of portions of land areas and possibly supplemental structural scans at the sites. Although surface scans and fixed-point measurements can be performed using the same instrumentation, the calculated MDCs will be quite different. MDC is dependent on many factors and may include but is not limited to:

- Instrument Efficiency
- Background
- Integration Time
- Surface Type
- Source to Detector Geometry
- Source Efficiency

A significant factor in determining an instrument MDC is the total efficiency, which is dependent on the instrument efficiency, the source efficiency and the type and energy of the radiation. MDC values are inversely affected by efficiency, as efficiencies increase, MDC values will decrease. Accounting for both the instrument and source components of the total efficiency provides for a more accurate assessment of surface activity.

2.0 CALIBRATION SOURCES

For accurate measurement of surface activity, it is desirable that the field instrumentation be calibrated with source standards similar to the type and energy of the anticipated contamination. The nuclides listed in Tables 2.1 and 2.2 illustrate the nuclides found in soil and building surface area DCGL results that are listed in the VYNPS and CR3 LTPs, respectively.

Instrument response varies with incident radiations and energies; therefore, instrumentation selection for field surveys must be modeled on the expected surface activity. For the purposes of this report, isotopes with max beta energies less than that of C-14 (0.158 MeV) will be considered difficult to detect (reference tables 2.1 and 2.2).

The detectability of radionuclides with max beta energies less than 0.158 MeV, utilizing scintillation detectors, will be negligible at typical source to detector distances of approximately 0.5 inches. The source to detector distance of 1.27 cm (0.5 inches) is the distance to the detector' with the recommended standoff. Tables 2.1 and 2.2 provide a summary of the LTP radionuclides and their detectability using Radiological Health Handbook data.

Table 2.1 VYNPS Nuclides and Major Radiations: Approximate Energies

Nuclide	α Energy (MeV)	$E_{\beta max}$ (MeV)	Average E_β (MeV)	Photon Energy (MeV)	α Detectable w/100cm² Detector	β Detectable w/100cm² Detector	γ Detectable w/NaI 2x2
H-3		0.018	0.005				
C-14		0.158	0.049				
Fe-55				0.00590 (16.3%) X-Ray 0.00649 (3.29%) X-Ray			
Ni-59				0.00693 (19.8%) X-Ray 0.00765 (4%) X-Ray			
Co-60		0.314	0.094	1.173 (100%) 1.332 (100%)		✓	✓
Ni-63		0.066	0.017				
Sr-90		0.544 2.245 (Y-90)	0.200 0.931			✓	
Nb-94		0.50	0.156	0.702 (100%) 0.871 (100%)		✓	✓
Tc-99		0.295	0.085			✓	
Cs-137		1.167 (5.4%) 0.512 (95%)	0.195	0.662 (85%) Ba-137m X-Rays		✓	✓
Eu-152		1.840	0.288	0.122 (37%) 0.245 (8%) 0.344 (27%) 0.779 (14%) 0.965 (15%) 1.087 (12%) 1.113 (14%) 1.408 (22%)		✓	✓
Eu-154		1.850 (10%)	0.228	0.143 (40%) 1.274 (35%)		✓	✓
Pu-239	5.16 (88%) 5.11 (11%)			0.039 (0.007%) 0.052 (0.20%) 0.129 (0.005%)	✓		
Pu-240	5.17 (73%) 5.12 (27%)				✓		
Pu-241	4.90 (0.0019%) 4.85 (0.0003%)	0.021	0.005	0.145 (1.6E-4%)			
Am-241	5.49 (85%) 5.44 (13%)			0.060 (36%) 0.101 (0.04%)	✓		
Cm-243	6.06 (6%) 5.99 (6%) 5.79 (73%) 5.74 (11.5%)			0.209 (4%) 0.228 (12%) 0.278 (14%)	✓		
Cm-244	5.8 (76%) 5.76 (24%)				✓		

Table 2.2 CR3 Nuclides and Major Radiations: Approximate Energies

Nuclide	α Energy (MeV)	$E_{\beta max}$ (MeV)	Average E_{β} (MeV)	Photon Energy (MeV)	α Detectable w/100cm² Detector	β Detectable w/100cm² Detector	γ Detectable w/NaI 2x2
H-3		0.018	0.005				
C-14		0.158	0.049				
Fe-55				0.00590 (16.3%) X-Ray 0.00649 (3.29%) X-Ray			
Ni-59				0.00693 (19.8%) X-Ray 0.00765 (4%) X-Ray			
Co-60		0.314	0.094	1.173 (100%) 1.332 (100%)		✓	✓
Ni-63		0.066	0.017				
Sr-90		0.544 2.245 (Y-90)	0.200 0.931			✓	
Nb-94		0.50	0.156	0.702 (100%) 0.871 (100%)		✓	✓
Tc-99		0.295	0.085			✓	
Cs-137		1.167 (5.4%) 0.512 (95%)	0.195	0.662 (85%) Ba-137m X-Rays		✓	✓
Eu-152		1.840	0.288	0.122 (37%) 0.245 (8%) 0.344 (27%) 0.779 (14%) 0.965 (15%) 1.087 (12%) 1.113 (14%) 1.408 (22%)		✓	✓
Eu-154		1.850 (10%)	0.228	0.143 (40%) 1.274 (35%)		✓	✓
Pu-238	5.50 (72%) 5.46 (28%)			0.099 (8E-3%) 0.150 (1E-3%) 0.77 (5E-5%)	✓		
Pu-239	5.16 (88%) 5.11 (11%)			0.039 (0.007%) 0.052 (0.20%) 0.129 (0.005%)	✓		
Pu-240	5.17 (73%) 5.12 (27%)				✓		
Pu-241	4.90 (0.0019%) 4.85 (0.0003%)	0.021	0.005	0.145 (1.6E-4%)			
Am-241	5.49 (85%) 5.44 (13%)			0.060 (36%) 0.101 (0.04%)	✓		
Cm-243	6.06 (6%) 5.99 (6%) 5.79 (73%) 5.74 (11.5%)			0.209 (4%) 0.228 (12%) 0.278 (14%)	✓		
Cm-244	5.8 (76%) 5.76 (24%)				✓		

NUREG-1507 and ISO 7503-1 provide guidance for selecting calibration sources and their use in determining total efficiency. It is common practice to calibrate instrument efficiency for a single beta energy; however, the energy of this reference source should not be significantly greater than the beta energy of the lowest energy to be measured. Calibration sources should be selected that emit alpha or beta radiation with energies similar to those expected of the contaminant in the field.

Tc-99 (0.295 MeV at 100%) and Am-241 (5.49 MeV at 85% and 5.44 MeV at 13%) have been selected as the beta and alpha calibration standards respectively, because their energies approximate the beta and alpha energies of the plant specific radionuclides most prevalent in the field at both sites.

3.0 EFFICIENCY DETERMINATION

Typically, using the instrument 4π efficiency exclusively provides a good approximation of surface activity. Using these means for calculating the efficiency often results in an underestimate of activity levels in the field. Applying both the instrument 2π efficiency and the surface efficiency components to determine the total efficiency allows for a more accurate measurement due to consideration of the actual characteristics of the source surfaces. ISO 7503-1 recommends that the total surface activity be calculated using:

$$A_s = \frac{R_{S+B} - R_B}{(e_i)\,(W)\,(e_s)}$$

Where:
A_S is the total surface activity in dpm/cm^2,
$R_S + B$ is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
e_i is the instrument or detector 2π efficiency,
e_s is the efficiency of the source and
W is the area of the detector window (cm^2) (100 cm^2 active for the 43-93/Scintillation detector)

3.1 Alpha and Beta Instrument Efficiency (e_i)

Instrument efficiency (e_i) reflects instrument characteristics and counting geometry, such as source construction, activity distribution, source area, particles incident on the detector per unit time and therefore source to detector geometry. Theoretically the maximum value of e_s is 1.0, assuming all the emissions from the source are 2π and that all emissions from the source are detected. The ISO 7503-1 methodology for determining the instrument efficiency is similar to the historical 4π approach; however, the detector response, in cpm, is divided by the 2π surface emission rate of the calibration source. The instrument efficiency is calculated by dividing the net count rate by the 2π surface emission rate ($q_{2\pi}$) (Includes absorption in detector window, source detector geometry). The instrument efficiency is expressed in ISO 7503-1 by:

$$e_i = \frac{R_{S+B} - R_B}{q_{2\pi}}$$

Where:
R_{S+B} is the gross count rate of the measurement in cpm,
R_B is the background count rate in cpm,
$q_{2\pi}$ is the 2π surface emission rate in reciprocal seconds

Note that both the 2π surface emission rate and the source activity are usually stated on the certification sheet provided by the calibration source manufacturer and certified as National Institute of Standards and Technology (NIST) traceable. Table 3.1 depicts nominal instrument efficiencies that have been determined during calibration using the 2π surface emission rate of the source.

Table 3.1 Nominal Instrument Efficiencies (e_s)

Source	Emission	Active Area of the Source (cm^2)	Area of the Detector	100 cm^2 Nominal Instrument Efficiency (e_i) (Contact)
Tc-99	β	15.2	100 cm^2	0.1203
Am-241	α	15.2	100 cm^2	0.1393

4.0 SOURCE TO DETECTOR DISTANCE CONSIDERATIONS

A major factor affecting instrument efficiency is source to detector distance. Consideration must be given to this distance when selecting accurate instrument efficiency. The distance from the source to the detector shall be as close as practicable to geometric conditions that exist in the field. A range of source to detector distances has been chosen, considering site specific survey conditions. In an effort to minimize the error associated with geometry, instrument efficiencies have been determined for source to detector distances representative of those survey distances expected in the field. The results shown in Table 4.1 illustrate the imposing reduction in detector response with increased distance from the source. Typically, this source to detector distance will be 0.5 inches for fixed point measurements and 0.5 inches for scan surveys on flat surfaces, however they may differ for other surfaces. Table 4.1 makes provisions for the selection of source to detector distances for field survey conditions of up to 2.0 cm. If surface conditions dictate the placement of the detector at distances greater than 2.0 cm instrument efficiencies will be determined on an as needed basis.

4.1 Methodology

The practical application of choosing the proper instrument efficiency may be determined by averaging the surface variation (peaks and valleys narrower than the length of the detector) and adding 0.5 inches, the spacing that should be maintained between the detector and the highest peaks of the surface. The source-to-detector distance was evaluated using a Ludlum 43-93 scintillation detector with a 1.2 mg/cm^2 window for Tc-99 and Am-241. Five 1-minute measurements were made on contact and at distances of 0.5, 1 and 2 centimeters. Measurement results are contained in Appendix B.

Select the source to detector distance from Table 4.1 that best reflects this pre-determined geometry.

Table 4.1 Source-to-Detector Distance Effects on Instrument Efficiencies for $\alpha - \beta$ Emitters

Source to Detector Distance (cm)	**Instrument Efficiency (e_i)**	
	Tc-99 Distributed	**Am-241 Distributed**
Contact	1	1
0.5	0.9111	0.9179
1.0	0.8255	0.7737
2.0	0.6520	0.2821

4.2 Source (or surface) Efficiency (e_s) Determination

Source efficiency (e_S), reflects the physical characteristics of the surface and any surface coatings. The source efficiency is the ratio between the number of particles emerging from surface and the total number of particles released within the source. The source efficiency accounts for attenuation and backscatter. e_s is nominally 0.5 (no self-absorption/attenuation, no backscatter) backscatter increases the value, self-absorption decreases the value. Source efficiencies may either be derived experimentally or simply selected from the guidance contained in ISO 7503-1. ISO 7503-1 takes a conservative approach by recommending the use of factors to correct for alpha and beta self-absorption/attenuation when determining surface activity. However, this approach may prove to be too conservative for radionuclides with max beta energies that are marginally lower than 0.400 MeV, such as Co-60 with a βmax of 0.314 MeV. In this situation, it may be more appropriate to determine the source efficiency by considering the energies of other beta emitting radionuclides. Using this approach, it is possible to determine weighted average source efficiency. For example, a source efficiency of 0.375 may be calculated based on a 50/50 mix of Co-60 and Cs-137. The source efficiencies for Co-60 and Cs-137 are 0.25 and 0.5 respectively, since the radionuclide fraction for Co-60 and Cs-137 is 50% for each, the weighted average source efficiency for the mix may be calculated in the following manner:

$$(.25)\,(.5) + (.5)\,(.5) = 0.375$$

Table 4.2 Source Efficiencies as Listed in ISO 7503-1

	<0.400 MeV_{max}	**≥0.400 MeV_{max}**
Beta Emitters	$e_s = 0.25$	$e_s = 0.5$
Alpha Emitters	$e_s = 0.25$	$e_s = 0.25$

5.0 INSTRUMENT CONVERSION FACTOR (E_i) (INSTRUMENT EFFICIENCY FOR GAMMA SCANNING)

Separate modeling analysis (Megashield) was conducted using the common gamma emitters with a concentration of 1 pCi/g of uniformly distributed contamination throughout the volume. Megashield is a comprehensive photon/gamma ray shielding and dose assessment program, which is widely used throughout the radiological safety community. An activity concentration of 1 pCi/g for the nuclides was entered as the source term. The radial dimension of the cylindrical source was 28 cm, the depth was 15 cm, and the dose point above the surface was 10 cm with a soil density of 1.6 g/cm^3. The instrument efficiency when scanning, E_i, is the product of the modeled exposure rate (Megashield) mR/hr per 1/pCi/g and the energy response factor in cpm/mR/hr as derived from the energy response curve provided by Ludlum Instruments (Appendix A). Table 5.1 demonstrates the derived efficiencies for the major gamma emitting isotopes listed in Tables 2.1 and 2.2.

Table 5.1 Energy Response and Efficiency for Photon Emitting Isotopes

Isotope	E_i (cpm/pCi/g)
Co-60	290
Nb-94	322
Cs-137	150
Eu-152	288
Eu-154	264

When performing gamma scan measurements on soil surfaces the effective source to detector geometry is as close as is reasonably possible (less than 3 inches).

6.0 APPLYING EFFICIENCY CORRECTIONS BASED ON THE EFFECTS OF FIELD CONDITIONS FOR TOTAL EFFICIENCY

The total efficiency for any given condition can now be calculated from the product of the instrument efficiency e_i and the source efficiency e_s.

$$e_{total} = e_i \times e_s$$

The following example illustrates the process of determining total efficiency. For this example, we will assume the following:

- Surface activity readings need to be made in the VYNPS East Cooling Tower Basin concrete surfaces using the 2360 and 43-93 scintillation detector.
- Data obtained from characterization results from the basin indicate the presence of beta emitters with energies greater than 0.400 MeV.
- The source (activity on the surface) to detector distance is 0.5-inch detector standoff.
- To calculate the total efficiency, e_{total}, refer to Table 4.2 "Source to Detector Distance Effects on Instrument Efficiencies for a - β Emitters" to obtain the appropriate e_i value.
- Contamination on all surfaces is distributed relative to the effective detector area.
- When performing fixed-point measurements with scintillation instrumentation the effective source-to-detector geometry is representative of the calibrated geometries listed in Table 3.1.
- Correction for pressure and temperature are not substantial.

In this example, the 2π value for e_i is 0.1203 as depicted in Table 3.1 *"Instrument Efficiencies"*. The source-to-detector correction for 0.5 cm is 0.9111 as depicted in Table 4.1 *"Source to Detector Distance Effects on Instrument Efficiencies for a-β Emitters"*. The e_s value of 0.5 is chosen, refer to Table 4.2 *"Source Efficiencies as listed in ISO 7503-1"*. Therefore, the total efficiency for this condition becomes: $e_{total} = e_i \times e_s, = 0.1203 \times 0.9111 \times 0.5 = 0.0548$ or 5.48%.

7.0 CONCLUSION

Field conditions may significantly influence the usefulness of a survey instrument. When applying the instrument and source efficiencies in MDC calculations, field conditions must be considered. Tables have been constructed to assist in the selection of appropriate instrument and source efficiencies. Table 4.1 *"Source to Detector Distance Effects on Instrument Efficiencies for a-β Emitters"* lists instrument efficiencies (e_i) at various source to detector distances for alpha and beta emitters. The appropriate e_i value should be applied, accounting for the field condition, i.e., the relation between the detector and the surface to be measured.

Source efficiencies shall be selected from Table 4.2 *"Source Efficiencies as listed in ISO 7503-1"*. This table lists conservative e_s values that correct for self-absorption and attenuation of surface activity. Table 5.1 *"Energy Response and Efficiency for Photon Emitting Isotopes"* lists E_i values that apply to scanning MDC calculations. The Megashield™ model code was used to determine instrument efficiency assuming contamination conditions and detector geometry cited in the section *"MDCs for Gamma Scans of Land Areas"* of the respective License Termination Plans.

Detector and source conditions equivalent to those modeled herein may directly apply to the results of this report.

Guidance from the ISO 7503 standards (1988 and 2016) was utilized in the development of this TBD. The 2016 update to the ISO 7503 series occurred during the drafting of this TBD. As such, a comparison of the 1988 and 2016 ISO 7503 standards was performed in order to determine if it is necessary to update methods and terminology for the sake of Revision 1, while recognizing that many of the MDC methods, equations, and terminology currently used in practice were directly resultant from the 1988 series. As a result, this TBD considers aspects from both the original and revised ISO 7503 series (1988 and 2016, respectively). For example, many of the traditional definitions, such as detector and source efficiency data, found in ISO 7503-1:1988, are used to be consistent with current industry methods also presented in MARSSIM and other references commonly used during a decommissioning action.

8.0 REFERENCES

8.1 NUREG-1507, *"Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various contaminants and Field Conditions,"* Revision 1, August 2020

8.2 ISO 7503-1, *"Evaluation of Surface Contamination - Part I: Beta Emitters and Alpha Emitters,"* 1988-08-01.

8.3 ISO 7503-1, *"Measurement of radioactivity – Measurement and evaluation of Surface contamination - Part I: Beta Emitters and Alpha Emitters,"* Second Edition, Revised January 2016

8.4 ISO 8769, *"Reference Sources for the Calibration of Surface Contamination Monitors-Beta- emitters (maximum beta energy greater 0.15 MeV) and Alpha-emitters,"* Fourth Edition, Revised June 2020.

8.5 *"Radiological Health Handbook,"* Revised Edition 1970.

Attachment A

Megashield and Excel Forms

MegaShield 3.0 - Source Input Data

Case Title: CR3 Inst Eff

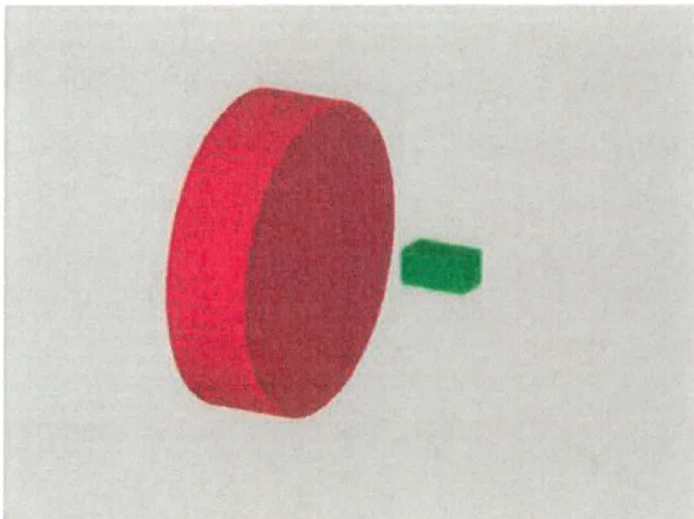
Run By:

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3

Run Date: 7/28/2021 12:14:11 PM

Reviewed By:

Case Model



Source Data

Geometry:	Cylinder-Hrz	
Radius:	28.00	cm
Length:	15.00	cm
Mass:	5.911E+04	gm
Volume:	3.695E+04	cm^3
Material/Den:	Silicon	1.60

Integration Parameters

Radial:	10
Circumferential:	10
Axial:	10

Case Data

Buildup Region:	Source	
Energy Grouping:	NONE	
Minimum Energy:	0.000E+00	MeV
Minimum %:	0.00	

Source Nuclides

Nuclide	Curies	milliCuries	uCi/cc	uCi/gm	Bequerels	Bq/cc	Bq/gm
Co-60	5.911E-08	5.911E-05	1.600E-06	1.000E-06	2.187E+03	5.920E-02	3.700E-02
Totals:	**5.911E-08**	**5.911E-05**	**1.600E-06**	**1.000E-06**	**2.187E+03**	**5.920E-02**	**3.700E-02**

MegaShield 3.0 - Shield Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 12:14:11 PM

This case has no shields.

MegaShield 3.0 - Material Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 12:14:11 PM Buildup Method: EAN

Region Composition Density Table
All densities in gm/cc

Material	Source Outer	Gap
Air		1.220E-03
Silicon	1.600E+00	
Totals:	**1.600E+00**	**1.220E-03**

MegaShield 3.0 - Dose Results

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 12:14:11 PM No Energy Grouping

Detector #1: X = 25.00 cm Y = 0.00 cm Z = 0.00 cm

Energy	Disintegrations	Flux (photons/sq cm/sec)		Fluence (MeV/sq cm/sec)		Exposure (mR/hr)	
(MeV)	(photons/sec)	w/o Buildup	with Buildup	w/o Buildup	with Buildup	w/o Buildup	with Buildup
1.173E+00	2.187E+03	9.921E-02	1.480E-01	1.164E-01	1.736E-01	2.064E-04	3.079E-04
1.333E+00	2.187E+03	1.027E-01	1.487E-01	1.368E-01	1.981E-01	2.357E-04	3.413E-04
6.938E-01	3.568E-01	1.395E-05	2.376E-05	9.677E-06	1.648E-05	1.859E-08	3.167E-08
Totals:	**4.375E+03**	**2.019E-01**	**2.967E-01**	**2.532E-01**	**3.718E-01**	**4.421E-04**	**6.493E-04**

Total Dose Equivalent Rate in mRem/hr, w/o Buildup: 3.963E-04 with Buildup: 5.821E-04

Energy (Mev)	Energy (Kev)	Exposure Rate (mR/hr - 1 pCi/g)	Energy Response (cpm/mR/hr)	E_i (cpm/pCi/g)
0.6938	693.8	3.17E-08	856,217	0
1.173	1173	3.08E-04	480,720	148
1.333	1333	3.41E-04	417,000	142
Total				290

MegaShield 3.0 - Source Input Data

Case Title: CR3 Inst Eff

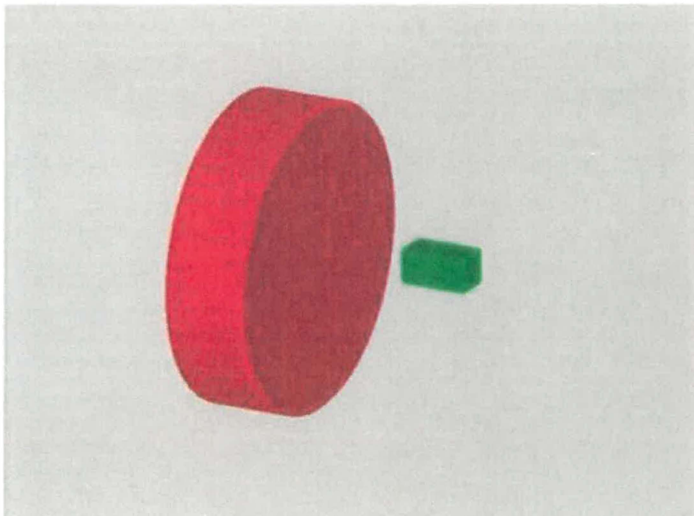
Run By: [signature]

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94MS3

Run Date: 7/28/2021 11:55:58 AM

Reviewed By: [signature]

Case Model



Source Data

Geometry:	Cylinder-Hrz	
Radius:	28.00	cm
Length:	15.00	cm
Mass:	5.911E+04	gm
Volume:	3.695E+04	cm^3
Material/Den:	Silicon	1.60

Integration Parameters

Radial:	10
Circumferential:	10
Axial:	10

Case Data

Buildup Region:	Source	
Energy Grouping:	NONE	
Minimum Energy:	0.000E+00	MeV
Minimum %:	0.00	

Source Nuclides

Nuclide	Curies	milliCuries	uCi/cc	uCi/gm	Bequerels	Bq/cc	Bq/gm
Nb-94	5.911E-08	5.911E-05	1.600E-06	1.000E-06	2.187E+03	5.920E-02	3.700E-02
Totals:	**5.911E-08**	**5.911E-05**	**1.600E-06**	**1.000E-06**	**2.187E+03**	**5.920E-02**	**3.700E-02**

MegaShield 3.0 - Shield Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 11:55:58 AM

This case has no shields.

MegaShield 3.0 - Material Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 11:55:58 AM Buildup Method: EAN

Region Composition Density Table
All densities in gm/cc

Material	Source Outer	Gap
Air		1.220E-03
Silicon	1.600E+00	
Totals:	**1.600E+00**	**1.220E-03**

MegaShield 3.0 - Dose Results

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 11:55:58 AM No Energy Grouping

Detector #1: X = 25.00 cm Y = 0.00 cm Z = 0.00 cm

Energy	Disintegrations	Flux (photons/sq cm/sec)		Fluence (MeV/sq cm/sec)		Exposure (mR/hr)	
(MeV)	(photons/sec)	w/o Buildup	with Buildup	w/o Buildup	with Buildup	w/o Buildup	with Buildup
2.290E-03	1.451E-01	2.828E-25	3.425E-25	6.476E-28	7.843E-28	1.976E-28	2.393E-28
1.737E-02	7.734E-01	7.967E-10	9.028E-10	1.384E-11	1.569E-11	7.442E-13	8.434E-13
1.748E-02	1.482E+00	1.777E-09	2.012E-09	3.105E-11	3.517E-11	1.638E-12	1.855E-12
1.960E-02	4.352E-01	5.969E-09	6.682E-09	1.170E-10	1.310E-10	4.303E-12	4.817E-12
7.026E-01	2.187E+03	8.582E-02	1.457E-01	6.030E-02	1.023E-01	1.157E-04	1.964E-04
8.711E-01	2.187E+03	9.127E-02	1.464E-01	7.951E-02	1.276E-01	1.488E-04	2.387E-04
Totals:	**4.377E+03**	**1.771E-01**	**2.921E-01**	**1.398E-01**	**2.299E-01**	**2.645E-04**	**4.351E-04**

Total Dose Equivalent Rate in mRem/hr, w/o Buildup: 2.404E-04 with Buildup: 3.954E-04

Energy (Mev)	Energy (Kev)	Exposure Rate (mR/hr - 1 pCi/g)	Energy Response (cpm/mR/hr)	Ei (cpm/pCi/g)
0.0023	2	2.39E-28	177,867	0
0.0174	17	8.43E-13	1,635,200	0
0.0175	18	1.86E-12	1,655,000	0
0.0196	20	4.82E-12	2,070,800	0
0.7026	703	1.96E-04	843,551	166
0.8711	871	2.39E-04	653,200	156
Total				322

MegaShield 3.0 - Source Input Data

Case Title: CR3 Inst Eff

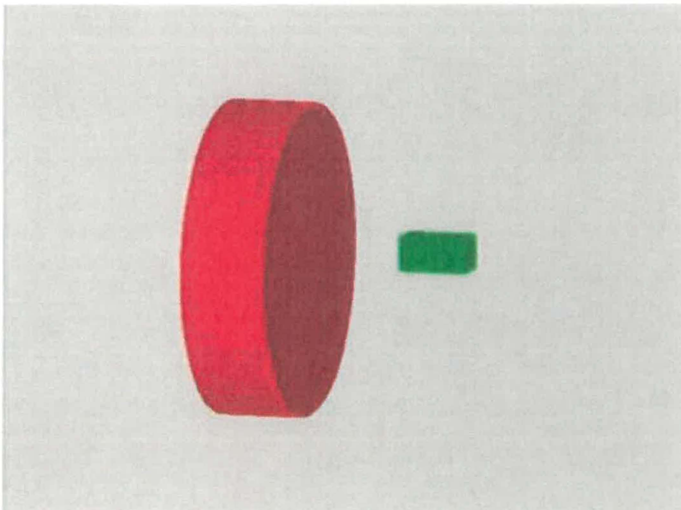
Run By:

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Cs137.MS3

Run Date: 7/28/2021 11:51:52 AM

Reviewed By:

Case Model



Source Data

Geometry:	Cylinder-Hrz
Radius:	28.00 cm
Length:	15.00 cm
Mass:	5.911E+04 gm
Volume:	3.695E+04 cm^3
Material/Den:	Silicon 1.60

Integration Parameters

Radial:	10
Circumferential:	10
Axial:	10

Case Data

Buildup Region:	Source
Energy Grouping:	NONE
Minimum Energy:	0.000E+00 MeV
Minimum %:	0.00

Source Nuclides

Nuclide	Curies	milliCuries	uCi/cc	uCi/gm	Bequerels	Bq/cc	Bq/gm
Cs-137	5.911E-08	5.911E-05	1.600E-06	1.000E-06	2.187E+03	5.920E-02	3.700E-02
Ba-137m	5.911E-08	5.911E-05	1.600E-06	1.000E-06	2.187E+03	5.920E-02	3.700E-02
Totals:	**1.182E-07**	**1.182E-04**	**3.200E-06**	**2.000E-06**	**4.374E+03**	**1.184E-01**	**7.400E-02**

MegaShield 3.0 - Shield Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Cs137.MS3
Run Date: 7/28/2021 11:51:52 AM

This case has no shields.

MegaShield 3.0 - Material Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Nb94.MS3
Run Date: 7/28/2021 11:51:52 AM Buildup Method: EAN

Region Composition Density Table
All densities in gm/cc

Material	Source Outer	Gap
Air		1.220E-03
Silicon	1.600E+00	
Totals:	**1.600E+00**	**1.220E-03**

MegaShield 3.0 - Dose Results

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Cs137.MS3
Run Date: 7/28/2021 11:51:52 AM No Energy Grouping

Detector #1: X = 25.00 cm Y = 0.00 cm Z = 0.00 cm

Energy	Disintegrations	Flux (photons/sq cm/sec)		Fluence (MeV/sq cm/sec)		Exposure (mR/hr)	
(MeV)	(photons/sec)	w/o Buildup	with Buildup	w/o Buildup	with Buildup	w/o Buildup	with Buildup
4.470E-03	2.270E+01	4.425E-23	5.360E-23	1.978E-25	2.396E-25	6.036E-26	7.311E-26
3.182E-02	4.528E+01	9.162E-05	1.274E-04	2.915E-06	4.054E-06	2.414E-08	3.357E-08
3.219E-02	8.354E+01	1.793E-04	2.502E-04	5.772E-06	8.054E-06	4.618E-08	6.445E-08
3.640E-02	3.040E+01	1.102E-04	1.595E-04	4.012E-06	5.807E-06	2.266E-08	3.279E-08
6.617E-01	1.968E+03	7.588E-02	1.310E-01	5.021E-02	8.668E-02	9.682E-05	1.671E-04
Totals:	**2.150E+03**	**7.626E-02**	**1.315E-01**	**5.022E-02**	**8.670E-02**	**9.691E-05**	**1.673E-04**

Total Dose Equivalent Rate in mRem/hr, w/o Buildup: 8.894E-05 with Buildup: 1.535E-04

Energy (Mev)	Energy (Kev)	Exposure Rate (mR/hr - 1 pCi/g)	Energy Response (cpm/mR/hr)	Ei (cpm/pCi/g)
0.0045	5	7.31E-26	348,000	0
0.0318	32	3.36E-08	5,651,000	0
0.0322	32	6.45E-08	5,789,000	0
0.0364	36	3.28E-08	7,238,000	0
0.6616	662	1.67E-04	900,000	150
Total				150

MegaShield 3.0 - Source Input Data

Case Title: CR3 Inst Eff

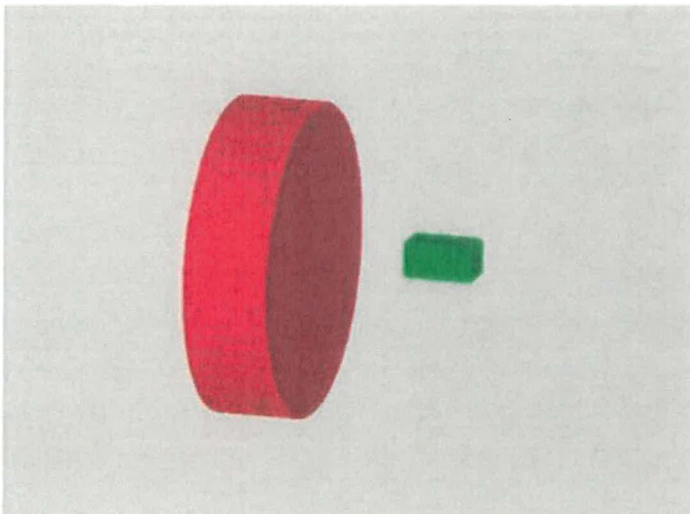
Run By: Matt Erickson

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu152.MS3

Run Date: 7/28/2021 1:13:02 PM

Reviewed By: C Burton

Case Model



Source Data

Geometry:	Cylinder-Hrz	
Radius:	28.00	cm
Length:	15.00	cm
Mass:	5.911E+04	gm
Volume:	3.695E+04	cm^3
Material/Den:	Silicon	1.60

Integration Parameters

Radial:	20
Circumferential:	10
Axial:	10

Case Data

Buildup Region:	Source	
Energy Grouping:	STD	
Minimum Energy:	1.500E-02	MeV
Minimum %:	0.00	

Source Nuclides

Nuclide	Curies	milliCuries	uCi/cc	uCi/gm	Bequerels	Bq/cc	Bq/gm
Eu-152	5.911E-08	5.911E-05	1.600E-06	1.000E-06	2.187E+03	5.920E-02	3.700E-02
Totals:	**5.911E-08**	**5.911E-05**	**1.600E-06**	**1.000E-06**	**2.187E+03**	**5.920E-02**	**3.700E-02**

MegaShield 3.0 - Shield Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu152.MS3
Run Date: 7/28/2021 1:13:02 PM

This case has no shields.

MegaShield 3.0 - Material Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu152.MS3
Run Date: 7/28/2021 1:13:02 PM Buildup Method: EAN

Region Composition Density Table
All densities in gm/cc

Material	Source Outer	Gap
Air		1.220E-03
Silicon	1.600E+00	
Totals:	**1.600E+00**	**1.220E-03**

MegaShield 3.0 - Dose Results

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu152.MS3
Run Date: 7/28/2021 1:13:02 PM Standard Grouping

Detector #1: X = 25.00 cm Y = 0.00 cm Z = 0.00 cm

Energy	Disintegrations	Flux (photons/sq cm/sec)		Fluence (MeV/sq cm/sec)		Exposure (mR/hr)	
(MeV)	(photons/sec)	w/o Buildup	with Buildup	w/o Buildup	with Buildup	w/o Buildup	with Buildup
4.000E-02	1.294E+03	6.439E-03	9.620E-03	2.575E-04	3.848E-04	1.132E-06	1.691E-06
5.000E-02	3.236E+02	2.848E-03	4.685E-03	1.424E-04	2.342E-04	3.769E-07	6.200E-07
1.000E-01	6.219E+02	1.266E-02	3.149E-02	1.266E-03	3.149E-03	1.927E-06	4.795E-06
2.000E-01	1.639E+02	4.426E-03	1.159E-02	8.853E-04	2.319E-03	1.554E-06	4.070E-06
3.000E-01	5.914E+02	1.805E-02	4.158E-02	5.414E-03	1.247E-02	1.021E-05	2.352E-05
4.000E-01	1.374E+02	4.566E-03	9.379E-03	1.826E-03	3.752E-03	3.537E-06	7.265E-06
5.000E-01	1.234E+01	4.377E-04	8.261E-04	2.189E-04	4.130E-04	4.263E-07	8.046E-07
6.000E-01	9.275E+01	3.471E-03	6.169E-03	2.082E-03	3.701E-03	4.039E-06	7.180E-06
8.000E-01	3.894E+02	1.584E-02	2.597E-02	1.267E-02	2.078E-02	2.398E-05	3.933E-05
1.000E+00	9.358E+02	4.055E-02	6.288E-02	4.055E-02	6.288E-02	7.421E-05	1.151E-04
1.500E+00	5.074E+02	2.453E-02	3.461E-02	3.679E-02	5.191E-02	6.149E-05	8.677E-05
Totals:	**5.070E+03**	**1.338E-01**	**2.388E-01**	**1.021E-01**	**1.620E-01**	**1.829E-04**	**2.911E-04**

Total Dose Equivalent Rate in mRem/hr, w/o Buildup: 1.666E-04 with Buildup: 2.653E-04

Energy (Mev)	Energy (Kev)	Exposure Rate (mR/hr - 1 pCi/g)	Energy Response (cpm/mR/hr)	Ei (cpm/pCi/g)
0.04	40	1.69E-06	8,480,000	14
0.05	50	6.20E-07	11,300,000	7
0.1	100	4.80E-06	9,970,000	48
0.2	200	4.07E-06	4,320,000	18
0.3	300	2.35E-05	2,540,000	60
0.4	400	7.27E-06	1,710,000	12
0.5	500	8.05E-07	1,270,000	1
0.6	600	7.18E-06	1,010,000	7
0.8	800	3.93E-05	710,000	28
1	1000	1.15E-04	550,000	63
1.5	1500	8.68E-05	350,000	30
Total				288

MegaShield 3.0 - Source Input Data

Case Title: CR3 Inst Eff

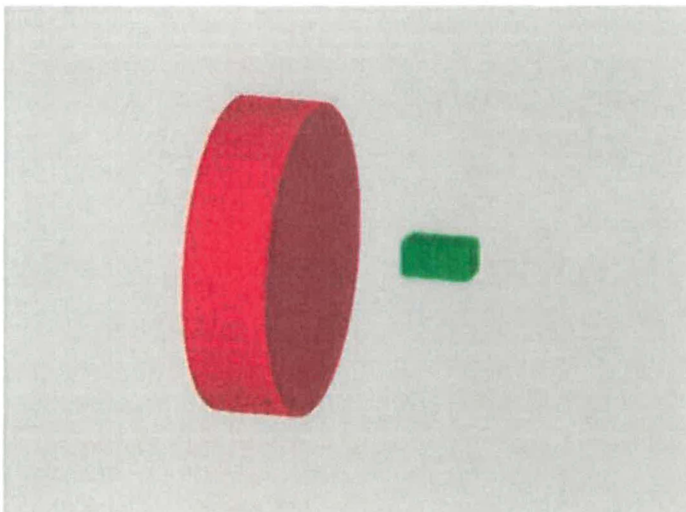
Run By:

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu154.MS3

Run Date: 7/28/2021 1:28:36 PM

Reviewed By:

Case Model



Source Data

Geometry:	Cylinder-Hrz	
Radius:	28.00	cm
Length:	15.00	cm
Mass:	5.911E+04	gm
Volume:	3.695E+04	cm^3
Material/Den:	Silicon	1.60

Integration Parameters

Radial:	20
Circumferential:	10
Axial:	10

Case Data

Buildup Region:	Source	
Energy Grouping:	STD	
Minimum Energy:	1.500E-02	MeV
Minimum %:	0.00	

Source Nuclides

Nuclide	Curies	milliCuries	uCi/cc	uCi/gm	Bequerels	Bq/cc	Bq/gm
Eu-154	5.911E-08	5.911E-05	1.600E-06	1.000E-06	2.187E+03	5.920E-02	3.700E-02
Totals:	**5.911E-08**	**5.911E-05**	**1.600E-06**	**1.000E-06**	**2.187E+03**	**5.920E-02**	**3.700E-02**

MegaShield 3.0 - Shield Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu154.MS3
Run Date: 7/28/2021 1:28:36 PM

This case has no shields.

MegaShield 3.0 - Material Input Data

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu154.MS3
Run Date: 7/28/2021 1:28:36 PM Buildup Method: EAN

Region Composition Density Table
All densities in gm/cc

Material	Source Outer	Gap
Air		1.220E-03
Silicon	1.600E+00	
Totals:	**1.600E+00**	**1.220E-03**

MegaShield 3.0 - Dose Results

Case Title: CR3 Inst Eff

File Name: C:\Users\merickson\OneDrive - NorthStar Group Services, Inc\Laptop\Desktop\Megashield Eu154.MS3
Run Date: 7/28/2021 1:28:36 PM Standard Grouping

Detector #1: X = 25.00 cm Y = 0.00 cm Z = 0.00 cm

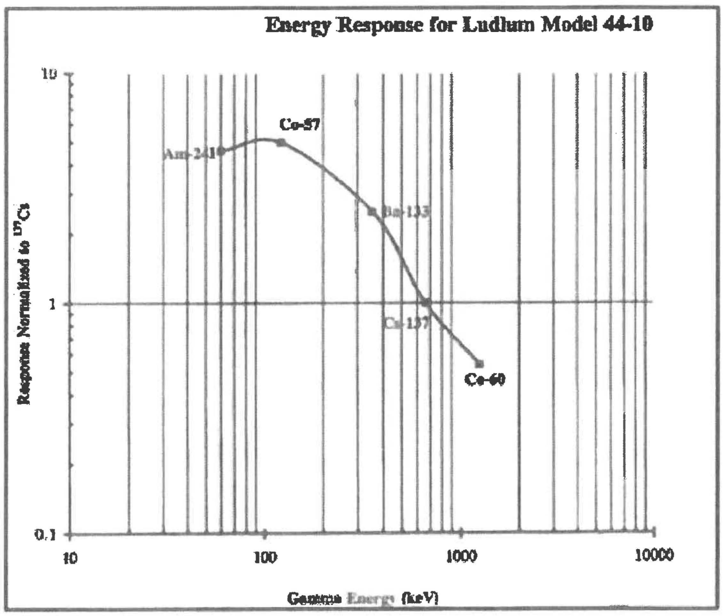
Energy	Disintegrations	Flux (photons/sq cm/sec)		Fluence (MeV/sq cm/sec)		Exposure (mR/hr)	
(MeV)	(photons/sec)	w/o Buildup	with Buildup	w/o Buildup	with Buildup	w/o Buildup	with Buildup
4.000E-02	4.451E+02	2.215E-03	3.309E-03	8.859E-05	1.324E-04	3.894E-07	5.818E-07
5.000E-02	1.131E+02	9.950E-04	1.637E-03	4.975E-05	8.184E-05	1.317E-07	2.166E-07
1.000E-01	8.850E+02	1.801E-02	4.481E-02	1.801E-03	4.481E-03	2.743E-06	6.824E-06
2.000E-01	1.494E+02	4.034E-03	1.057E-02	8.068E-04	2.113E-03	1.416E-06	3.710E-06
4.000E-01	1.560E+01	5.184E-04	1.065E-03	2.074E-04	4.259E-04	4.015E-07	8.248E-07
5.000E-01	4.736E+00	1.680E-04	3.171E-04	8.401E-05	1.585E-04	1.637E-07	3.088E-07
6.000E-01	1.764E+02	6.602E-03	1.173E-02	3.961E-03	7.041E-03	7.683E-06	1.366E-05
8.000E-01	8.529E+02	3.469E-02	5.688E-02	2.775E-02	4.551E-02	5.253E-05	8.614E-05
1.000E+00	6.728E+02	2.915E-02	4.521E-02	2.915E-02	4.521E-02	5.336E-05	8.275E-05
1.500E+00	8.534E+02	4.126E-02	5.821E-02	6.188E-02	8.732E-02	1.034E-04	1.460E-04
Totals:	**4.168E+03**	**1.376E-01**	**2.337E-01**	**1.258E-01**	**1.925E-01**	**2.223E-04**	**3.410E-04**

Total Dose Equivalent Rate in mRem/hr, w/o Buildup: 2.014E-04 with Buildup: 3.090E-04

Energy (Mev)	Energy (Kev)	Exposure Rate (mR/hr - 1 pCi/g)	Energy Response (cpm/mR/hr)	Ei (cpm/pCi/g)
0.04	40	5.82E-07	8,480,000	5
0.05	50	2.17E-07	11,300,000	2
0.1	100	6.82E-06	9,970,000	68
0.2	200	3.71E-06	4,320,000	16
0.4	400	8.25E-07	1,710,000	1
0.5	500	3.09E-07	1,270,000	0
0.6	600	1.37E-05	1,010,000	14
0.8	800	8.61E-05	710,000	61
1	1000	8.28E-05	550,000	46
1.5	1500	1.46E-04	350,000	51
Total				264

Appendix A

Ludlum Response Curve



Appendix B

Tc-99 and Am-241 Source-to-Detector Distance Effects

Ludlum 2360 s/n 347137
10 Minute Bkg - 2450 counts, 245 cpm
Alpha Bkg - 0.1 cpm
Beta Bkg - 244.9 cpm

Am-241 - VY20 - 5.95 nCi 6-4-1991.
Tc-99 - VY12 - 7.329 nCi 2-1-1993

Am-241

Contact		0.5 cm		1.0 cm		2.0 cm	
Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
2705	369	2582	341	2106	379	756	360
2744	400	2462	446	2097	352	735	360
2726	363	2460	390	2149	325	819	371
2704	367	2533	403	2108	347	788	353
2733	259	2457	326	2071	344	742	310
2722		2499		2106		768	

Tc-99

Contact		0.5 cm		1.0 cm		2.0 cm	
Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
0	3051	0	2737	1	2594	0	1919
1	3010	0	2809	0	2560	1	2001
0	3059	1	2759	0	2607	0	1909
2	3107	1	2905	1	2571	0	2043
1	3068	0	2725	0	2294	0	2101
	3059		2787		2525		1995

α Eff. Correction			
Contact	0.5 cm	1.0 cm	2.0 cm
1	0.9179	0.7737	0.2821

β Eff. Correction			
Contact	0.5 cm	1.0 cm	2.0 cm
1	0.9111	0.8255	0.652

Enclosure 7

"Gross Activity DCGL in Support of the Final Status Survey at CR3"

October 21, 2021

BEGINS ON NEXT PAGE

NorthStar

Gross Activity DCGL in Support of the Final Status Survey at Crystal River Nuclear Power Station (CR3)

February 16, 2022

Martin C. Erickson

Reviewed by: Marshall Blake

Reviewed by: Gordon Madison
Gordon Madison (Oct 17, 2022 12:35 EDT)

Approved by: Bryant Akins

Contents

Tables

Executive Summary

When surveying building surfaces for release it is most appropriate to use the actual site radionuclide mixture gross activity derived concentration guideline level (DCGL). CR3 site characterization data was used to determine the radionuclide fractions and in turn, used to derive the appropriate beta/gamma gross activity DCGL. Alpha fractions are unknown at this time so the most conservative DCGL for the predominant alpha emitters will be used as the alpha gross activity DCGL. As always, when determining the release of a unit where both beta/gamma and alpha emitters are present, the unity rule will be used to determine if the survey unit meets the release criteria.

THIS SPACE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

CR3 is undergoing a site decommissioning with the ultimate goal of partially terminating the 10 CFR 50 license. The final state of the site at license termination will consist of mostly open land areas and structures below three (3) feet. In order for the site to achieve license termination both the soils and structures remaining must meet the release criteria as outlined in the CR3 License Termination Plan (LTP). Residual levels of radioactive material that correspond to the allowable dose standards were derived by analysis of various pathways and scenarios through which exposures to a member of the critical group at CR3 could occur. These derived levels, known as DCGLs, are radionuclide specific and are expressed in units of picocuries per gram (pCi/g) for soils and disintegrations per minute per 100 centimeters squared (dpm/100 cm^2) for building surfaces. Determining if the CR3 soils meet the release criteria is relatively straightforward insofar as the analysis of the soils is a radionuclide specific analysis. Individual nuclides are compared to their respective DCGL using the unity rule. In the case of building surfaces, however, the portable hand-held instrumentation utilized at CR3 are not nuclide specific and read out in a gross activity reading. In this instance a gross activity DCGL must be calculated based on a site-specific radionuclide mixture.

2.0 METHODOLOGY

Surface contamination DCGLs apply to the total of fixed plus removable surface activity. For surfaces where the radionuclide fractions are unknown the conservative approach would be to compare the measurements to the most conservative DCGL assuming that all activity present was due to the presence of that nuclide. The most realistic approach would be to determine a gross activity DCGL based upon the fractions of nuclides present at the site. The gross activity DCGL is calculated as follows:

1. Determine the relative fraction (f) of the total activity contributed by the radionuclide from previous radionuclide-specific analyses.

2. Obtain the DCGL for each significant radionuclide present at the time of the final status survey (FSS).

3. Substitute the values of f and DCGL in the following equation;

$$Gross\ Activity\ DCGL = \frac{1}{\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \cdots \frac{f_n}{DCGL_n}}$$

3.0 CR3 CHARACTERIZATION DATA

A characterization was performed on the CR3 site in 2020 [Ref 6.2]. The composited smear samples of components in the Reactor Building (RB) were analyzed using a nuclide-specific gamma spectroscopy. Samples with identifiable amounts of plant-related activity were found on Class 1 and Class 2 areas, presently designated for disposition. While the structures identified as remaining at license termination are primarily classified as Class 3, using the data from the other class structures would be a conservative approach. The sample results for the positively identified nuclides are contained in Table 3-1.

Table 3-1 Radionuclides and Percent Total

Location	Cs-137 (pCi/unit)	% Total Cs	Co-60 (pCi/unit)	% Total Co
"A" RCP	2.42E-03	97.4	6.36E-05	2.6
"B" RCP	3.02E-03	96.6	1.07E-04	3.4
"C" RCP	9.28E-04	91.7	8.37E-05	8.3
"D" RCP	1.91E-03	90.3	2.05E-04	9.7
"A" CL	2.22E-04	100	ND	0
"B" CL	1.97E-04	100	ND	0
"C" CL	2.70E-04	90.6	2.79E-05	9.4
"D" CL	4.30E-04	85.0	7.60E-05	15.0
PZR Insulation	1.02E-03	100	ND	0
PZR Bare Metal*	ND	0	ND	0

- Results removed because of no nuclides identified

ND = Non-Detectable

As can be seen Co-60 represents approximately 5.4% of the total activity with Cs-137 contributing approximately 94.6%. As was stated earlier only significant radionuclides should be considered, significant radionuclides are typically based on the guidance provided in NUREG-5849 and DG-4006 which states that only radionuclides that contribute greater than 10% of the radiation dose from all contamination, or which are present at concentrations exceeding 10% of their respective guideline values are considered as significant. As further decay occurs the fraction of Co-60 to Cs-1 37 is reduced, thus the calculated gross activity value will be conservative over the course of the decommissioning project.

4.0 GROSS ACTIVITY DCGL CALCULATION

Based on the analysis of the data presented in Table 3-1, the following calculation for the gross activity DCGL can be determined:

$$Gross\ Activity\ DCGL = \frac{1}{\frac{0.946}{1.4E+04} + \frac{0.054}{4.7E+04}} = 1.46E + 04\ dpm/100cm^2$$

Since there is limited data concerning the fractional composition of alpha emitters at CR3, when surveying for alpha the DCGL of 1.34E+03 dpm/100 cm^2 (i.e. the DCGL for Pu-239/240 which is the most limiting prevalent alpha emitter at CR3) will be used for alpha readings.

5.0 CONCLUSION

Based on the characterization data taken at CR3, a gross activity DCGL of 1.746E+04 dpm/100 cm^2 for beta/gamma emitters should be used. A gross activity DCGL of 1.34E+03 dpm/100 cm^2 should be used for alpha emitters. When surveying for both beta/gamma and alpha activity the unity rule will be used for determining if the survey unit meets the release criteria.

6.0 REFERENCES

6.1 Abelquist, E. (2001). *Decommissioning Health Physics.* New York: Yaylor & Francis Group.

6.2 CR3, A. (2020, September 9). RB Characterization Survey.

6.3 NRC. (1998, August). *Demonstrating Compliance with the Radiological Criteria for License Termination.*

6.4 NRC. (2000). NUREG-1575 Revision 1 . *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*.

Enclosure 8

BHI Energy Engineering Calculation

"*RESRAD-Onsite Input Parameter Sensitivity Analysis – Crystal River 3*"

ENG-CR3-001

Revision 0

February 2022

BEGINS ON NEXT PAGE

BHI ENERGY ENGINEERING CALCULATION

RESRAD-Onsite Input Parameter Sensitivity Analysis – Crystal River 3

ENG-CR3-001

Revision: 0

February 2022

Prepared by:
BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA

Prepared by	Joseph Bisson
Approved by	Christopher Messina

1.0 PURPOSE

This calculation identifies sensitive input parameters (i.e., those input parameters that produce a significant change in the calculated dose with changes in their value) in the modeling of the Resident Farmer occupancy scenario using the RESRAD-Onsite code (version 7.2). Identification of sensitive input parameters is a necessary process to account for uncertainty in input values. The uncertainty associated with sensitive input parameters is addressed in subsequent derived concentration guideline levels (DCGL) calculations by determining and assigning reasonably conservative input values based on the results of RESRAD-Onsite probabilistic analyses. Thus, the results of this calculation support the development of DCGL values for soil in open land areas at the Crystal River 3 (CR3) site.

2.0 APPLICABILITY

This calculation addresses only the sensitivity analysis for input parameters for the resident farmer scenario that will be used to develop the DCGLs for soils at the CR3 site.

3.0 REFERENCES

3.1 ENG-AP-02, *Verification of Software Operability*

3.2 ANL/EAD-4, User's Manual for RESRAD Version 6, U.S. Department of Energy – Argonne National Laboratory, July 2001

3.3 ANL/EVS/TM-18/1, *RESRAD-Onsite 7.2 User's Guide*, April 2018

3.4 NUREG/CR-7267, *Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes,* February 2020

3.5 NUREG/CR-5512, Volume 3, *Residual Radioactive Contamination from Decommissioning: Parameter Analysis, Draft Report for Comment*, October 1999

- Volume 1: *Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, Oct. 1992 (PNL-7994)
- Volume 3: *Parameter Analysis,* Oct. 1999 (SAND99-2148)

3.6 NUREG/CR-6697, *Development of Probabilistic RESRAD 6.0 AND RESRAD-BUILD 3.0 Computer Codes*, November 2000

3.7 *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection For DCGL Development*, June 21, 2021

3.8 *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station*, Haley & Aldrich, Inc, August 2020

3.9 Technical Support Document File No. 134300, Haley & Aldrich, Inc, 12/9/2021

3.10 *CR3 Groundwater Flow Study Summary Report*, GHS, 2016

3.11 Technical Support Document No. 16-015, *Historical Site Assessment for Crystal River 3*, June 2016

3.12 Health Physics, Vol. 39, *Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations*, 1980

3.13 ANL/EVS/TM-14/4 ANL/EVS/TM-14/4, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil and Building Structures*, Yu, C. et al., Argonne National Laboratory-Environmental Science Division, September 2015

1.0 METHOD OF CALCULATION

The operability of the RESRAD-Onsite 7.2 computer code was verified on each computer used for code executions in accordance with BHI Energy Engineering procedure ENG-AP-02, *Verification of Software Operability* [3.1]. The RESRAD code has undergone extensive review, benchmarking, verification, and validation [3.2]. The *RESRAD-Onsite 7.2 User's Guide* [3.3] provided instructions for code use.

The RESidual RADioactivity (RESRAD) model and computer code was developed at Argonne National Laboratory as a multifunctional tool to assist in developing radiological criteria for unrestricted release and assessing the dose or risk associated with residual radioactive material. The RESRAD-Onsite computer code is a pathway analysis model designed to evaluate the potential radiological dose associated with residual radioactive material for a defined receptor scenario. The RESRAD software allows the user to evaluate radiation exposure through several pathways: direct external radiation, inhalation, ingestion of plants, meat, milk, aquatic foods, and drinking water, inadvertent ingestion of contaminated soil, and radon exposure.

The code requires input for numerous parameters to calculate the dose via various exposure pathways. The probabilistic modules in RESRAD permit the user to identify parameters that have the greatest impact on dose. In addition, the probabilistic modules allow the evaluation of dose as a function of parameter distributions.

The approach taken in this calculation consists of two primary phases: the selection of input parameter values and performing RESRAD-Onsite code executions.

Physical, behavioral, and metabolic classifications of input parameters are discussed in detail in NUREG/CR-7267 [3.4]. Behavioral parameters depend on the behavior of the receptor and the scenario definition. Metabolic parameters are independent of the defined scenario and represent the metabolic characteristics of the receptor. Physical parameters are those parameters that would not change if the receptor changed. The parameter classification provided in NUREG/CR-7267 were applied in the development of DCGL values for the CR3 site

Input parameters were treated as either deterministic (a single value is assigned) or stochastic (a probability distribution is assigned). Treatment depended on parameter type, availability of site-specific data, and the relevance of the parameter in the dose calculations.

- Behavioral and metabolic parameters were treated as deterministic, and the assigned values were from NUREG/CR-5512 [3.5], NUREG/CR-7267, or the RESRAD User Manual.
- Physical parameters were assigned the priority values provided in NUREG/CR-6697 [3.6]. Physical parameters for which site-specific data are unavailable were assigned input values as follows:
    - Priority 1 and 2 physical parameters were treated stochastic and assigned probability distributions from NUREG/CR-7267 or assigned a deterministic value from NUREG/CR-5512.
    - Priority 3 physical parameters were treated as deterministic and were assigned values from NUREG/CR-5512 or the RESRAD User's Manual.

RESRAD input files were developed based on the results of the parameter selection process and a parameter sensitivity analysis was performed for each radionuclide-of-concern (ROC). The following correlations coefficient was used for each code execution:

- Fraction of vegetative C absorbed from Air and Fraction of Vegetative C absorbed from soil = -0.95 (C-14 only)

Parameter correlation coefficients that are positive in value reflect both parameters (variables) moving (increase or decrease) in tandem; that is, both move in the same direction. Parameter correlation coefficients that are negative in value reflect both parameters moving opposite each other; that is, when one increases, the other decreases (or vice versa).

The RESRAD Probabilistic Output Report provides regression and correlation coefficients for the average doses at the user defined evaluation times. The Partial Rank Correlation Coefficient (PRCC) has been used to identify sensitive parameters. NUREG/CR-7267 and NUREG/CR-6697 recommend the use of the PRCC for cases where a non-linear relationship such as in the case for the Resident Farmer Scenario. PRCC values greater than zero (positive value) or less than zero (negative value) identify whether sensitive parameters are positively or negatively correlated to dose, respectively.

The criterion for sensitivity used in this calculation was a PRCC value with an absolute value greater than 0.25. To address the uncertainties associated with the input parameters identified as "sensitive," the 25th percentile value of the parameter's distribution was selected for sensitive parameters that had a negative PRCC value, and the 75th percentile value of the parameter's distribution was selected for sensitive parameters that had a positive PRCC value. The 75th percentile and 25th percentile values are recommended as reasonably conservative input values for calculations of DCGL values for open land areas at the CR3 site. This approach of assigning 25th and 75th percentile values of a sensitive parameter's distribution has been found acceptable as a reasonably conservative approach by the U.S. Nuclear Regulatory Commission (NRC) and State regulators.

2.0 ASSUMPTIONS AND INPUT

2.1 Assumptions

2.1.1 Nineteen ROCs have been identified for the CR3 site [3.6] and are shown in Table 1 below.

NOTE: RESRAD-Onsite 7.2 automatically accounts for progeny radionuclides with input for several of the CR3 ROCs (also shown in Table 1).

Table 1: Radionuclides-of-Concern for input to RESRAD-Onsite

ROC[a]	Progeny[b]	ROC[a]	Progeny[b]
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-59	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Ni-63	---
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sr-90	---
Fe-55	---	Tc-99	---
H-3	---		

[a] ROC = radionuclide-of-concern identified for the CR3 site [3.7].

[b] Included automatically with input of parent ROC.

2.1.2 The exposure scenario modelled in the sensitivity analyses is the Resident Farmer Scenario defined in NUREG/CR-5512 Volume 3. The average member of the critical group is the resident farmer that lives on the plant site, grows all or a portion of his/her diet onsite, and drinks water from a groundwater source onsite. The pathways used to estimate human radiation exposure resulting from residual radioactivity in the soil for this scenario are:

- Direct external radiation exposure pathway
- Inhalation exposure pathway
- Ingestion exposure pathway:

- plant foods grown in the soil material containing residual radioactivity,
- meat and milk from livestock fed with fodder grown in soil containing residual radioactivity and water containing residual radioactivity,
- drinking water containing residual radioactivity from a well, and
- aquatic food from a pond containing residual radioactivity;

- Inadvertent ingestion of contaminated soil

2.1.3 The conceptual hydrological model for this resident farmer scenario has three geological strata:

a) a contaminated zone (CZ),
b) an unsaturated zone (UZ), and
c) a saturated zone (SZ) that begins at the site average depth to groundwater (19ft, or 5.8m).

The CZ is assumed to be an uncovered area equivalent in size to the CR3 Protected Area (38,185 m^2) with a thickness ranging from 6-inches to 16 feet. The UZ is initially uncontaminated with a thickness ranging from 3 feet to 18.5 feet. The groundwater in the SZ is assumed initially uncontaminated.

2.2 Input

2.2.1 Contaminated zone:

a) The CR3 contaminated zone (CZ) is estimated to be 64,821 m^2 (file "CZ_Zone_11-22-2021,dwg").

b) The thickness of the CZ is assumed equal to 6-inches, which is consistent with the depth of the soil mixing layer as defined for the Resident Farmer Scenario.

c) Soil in and around the area of the CR3 site identified as the CZ is described as:

   i. "heterogeneous mix of sands and finer materials (loam and clay loam)," "crushed limestone," and "loam and clay" in Technical Support Document File No. 134300 [3.9],
   ii. "sandy soils underlain by limestone" in *2016 CR3 Groundwater Flow Study Summary Report* [3.10],
   iii. Undefined "surface fill" with underlying soil consisting of "thinly laminated, organic sandy silts and clays" in Technical Support Document No. 16-015 *Historical Site Assessment for Crystal River 3* [3.11].

Due to variations in the soil descriptions, selected input for distribution coefficient (kd) values is based on the generic soil type in ANL/EVS/TM-14/4 [3.12] because "data for that soil type includes all soil types combined including sand, loam, clay, organic, and the "unspecified" soil type."

2.2.2 Unsaturated zone:

a) A distribution was developed from depth range for site groundwater, 5 ft – 9 ft (H&A *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station* [3.8]); thickness of burm area, 21ft (H&A Technical Support Document, File No. 134300, 12/9/2021 [3.9]), and scenario default thickness of CZ, 0.5 ft.

The minimum thickness of the UZ extends from the bottom of the CZ through the berm thickness to site GW at 5.5 ft, or a total minimum thickness = 26 ft (7.92 m), and the maximum thickness of the UZ extends from the bottom of the CZ through the berm thickness to site GW at 9 ft, or a total minimum thickness = 29.5 ft (8.99 m). This allows a uniform distribution with a minimum value = 7.92 m, a maximum value = 8.99 m, and a mean value = 8.46 m as RESRAD input for thickness of the UZ.

b) Due to variations in the soil descriptions, selected input for distribution coefficient (kd) values for the UZ is based on the generic soil type for the reason stated in step 2.2.1.c.

2.2.3 Saturated zone:

a) Due to variations in the soil descriptions, selected input for distribution coefficient (kd) values for the SZ is based on the generic soil type for the reason stated in step 2.2.1.c.

2.2.4 Input for hydrogeologic parameters was obtained from H&A Technical Support Document, File No. 134300.

2.2.4.1 Soil density = 1.5 g/cm^2

2.2.4.2 Total porosity for CZ, UZ, and SZ = 0.4

2.2.4.3 Effective porosity for UZ and SZ = 0.2

2.2.4.4 Field capacity for CZ, UZ, and SZ = 0.2

2.2.4.5 Hydraulic conductivity in CZ, UZ, and SZ = 100,000 m/y

2.2.5 Input for the RESRAD parameter watershed area for nearby stream or pond was determined from the following information: Crystal River is a very short river, "just seven miles (eleven kilometers) long, and has a drainage basin of five square miles (thirteen square kilometers),…" (https://en.wikipedia.org/wiki/Crystal_River_(Florida)).

The watershed area is approximately 13 km^2 X 10^6 m^2/1 km^2 = 1.3E+07 m^2.

2.2.6 For the CR3 site, rainfall averages about 50 to 60 inches per year (Technical Support document No. 16-015). The upper end of that range, 60 in/y (1.5 m/y), was assigned as the input value for annual precipitation.

2.2.7 The reference, *Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations* [3.11] provides a figure of absolute humidity by geographical regions within the U.S. The value of 13.8 g/m^3 was selected for the RESRAD humidity parameter.

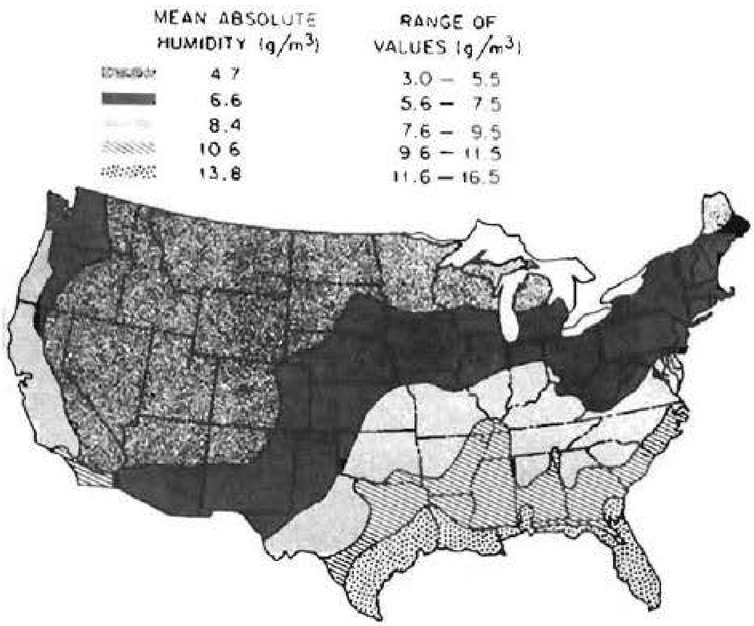


FIG. 1. Absolute humidity by geographical region.

2.2.8 Table 2 summarizes the parameter name, type, priority, treatment, values/distribution and the reference source that provides the bases for each input parameter. Some parameter values required calculations. These calculations are documented in the next section.

3.0 CALCULATIONS AND RESULTS

3.1 The parameter "length parallel to the aquifer flow" is defined as is the maximum horizontal distance measured in the CZ, from its up-gradient edge to the down-gradient edge, along the direction of the groundwater flow in the underlying aquifer. The area of the CZ was be approximated by a circle with an area of 64,821 m^2 (the area of the CR3 PA). The diameter of the circle was used as input for the length parallel to the aquifer parameter: 287 m.

3.2 An erosion rate equal to $6.0x10^{-4}$ m/y is selected for the CR3 site because, based on information provided in NUREG/CR-7267 and the shallow slope of the PA at the site, the erosion rate is suitable for the farmer scenario and the erosion rate for the site would not be expected to exceed $6.0x10^{-4}$ m/y.

3.3 Runoff Coefficient (Cr) was calculated based on information in section 3.2 and Table 3.2.1 in ANL/EVS/TM-14/4. For the CR3 site, Cr = 0.2.

3.4 <u>Fraction of Time Spent Indoors</u>: NUREG/CR-5512 provides values for the residential parameters. The indoors time is given as 240 days. The fraction of time spent indoors equal to 0.6571.

3.5 <u>Fraction of Time Spent Outdoor</u>: NUREG/CR-5512 provides values for the residential parameters. The outdoor time value includes the period outdoors, 40.2 days, and time spent gardening, 2.92 days, yielding a fraction of time spent outdoors = 0.1181.

3.6 <u>Inhalation Rate</u>: NUREG/CR-6697 provides an estimated daily inhalation rate equal to 23 m^3/d for an adult male. This results an annual inhalation rate equal to approximately 8400 m^3/y.

3.7 <u>Soil Ingestion Rate</u>: NUREG/CR-5512 provides values for the residential parameters. The soil ingestion rate is given as 0.05 g/d, which yields a soil ingestion rate of 18.26 g/y.

3.8 Drinking Water Intake: NUREG/CR-5512 provides values for the residential parameters. The drinking water ingestion rate is given as 1.31 liters/d, which yields a drinking water ingestion rate of 478.5 liters/y.

3.9 Irrigation Rate:

The Irrigation Rate can be expressed as:

$$IRr = (ETr/Ce)-(1-Cr)(Pr)$$

ETr = estimated Evapotranspiration Rate (m/y) = 0.9 (Figure 3.3.1 in ANL/EVS/TM-14/4)
Pr = the Precipitation Rate (m/y) = 1.5
Ce = Evapotranspiration Coefficient (per section 3.3 in ANL/EVS/TM-14/4, min value = 0.5, max value = 0.75
Cr = the Runoff Coefficient = 0.2

The input values for the variables in the equation above follow:

Variable	Use of Min Ce Value	Use of Max Ce Value
ETr (m/y)	0.9	0.9
Pr (m/y)	1.5	1.5
Cr	0.2	0.2
Ce	0.5	0.75
IRr (m/y)	0.6	0.0

The irrigation rate equation yields a minimum IRr value equal to 0.0 m/y and a maximum IRr value equal to 0.6 m/y. A uniform distribution with minimum and maximum value equal to 0.0 and 0.6, respectively, and a mean equal to 0.3 m/y was assigned as input for this parameter.

3.10 Well Pumping Rate: Information from NUREG/CR-7267 was used.

Water Use Component (general case)	**Minimum Water Use, m^3/y**	**Maximum Water Use, m^3/y**
Household (family of 4), m^3/y	328.7	328.7
Livestock, m^3/y	76.7	76.7
Irrigation Water, $m^3/y = f_p \times I_r \times 2000$	0	1200
Contaminated fraction (fp)	1	1
Irrigation Rate (I_r), m/y	0.0	0.6
Drinking Water[a] (family of 4), m^3/y	1.64	1.64
Total, m^3/y	407	1605

[a] From NUREG/CR-7267.

A uniform distribution with a minimum value equal to 407 m^3/y, a maximum value equal to 1605 m^3/y, and a mean value equal to 802.5 m^3/y was assigned as input for the Well Pump Rate parameter.

3.11 Wind speed : The average wind speed for the on-site 33-foot has been reported as 7.9 mph [3.11], Unit conversion yeilds a wind speed = 3.5 m/s.

4.0 RESULTS

4.1 RESRAD-Onsite 7.2 was executed for each of the 19 CR3 ROCs using the input values provided in Table 6. An absolute PRCC value ≥0.25 was used as the criterion for identifying sensitive input parameters.

4.2 Table 7 summarizes the sensitive parameters for each ROC. Selected pages from the RESRAD-Onsite 7.2 Uncertainty Reports from each code execution are provided in Appendix A. Sensitive RESRAD parameters are highlighted in yellow.

4.3 For the sensitive parameters, the 75th percentile value of the distribution was selected when the absolute value of the PRCC was ≥0.25 and the PRCC had a positive value. The 25th percentile value was selected when the absolute value of the PRCC value was ≥0.25 but had a negative value. Table 8, *RESRAD-Generated Percentile Values for Sensitive Input Parameters*, summarizes the 25th and 75th percentile values for each identified sensitive input parameter and identifies the ROC for which a parameter was found to be sensitive.

4.4 The 25th and 75th percentile values were obtained from RESRAD-Onsite uncertainty results and recorded in Table 8.

5.0 CONCLUSION

5.1 Sensitive input parameters varied among the ROCs and included parameters such as

- K_d values in CZ
- Plant, meat, and milk transfer factors
- Depth of roots
- External shielding factor
- Depth of soil mixing layer
- SZ hydraulic gradient
- Well pump intake depth

5.2 The 25th and 75th percentile values for sensitive input parameters have been determined from the parameter distributions and provide reasonably conservative input for DCGL development.

Table 2. Summary of Values for RESRAD Input Parameters

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (generic soil type values assigned to contaminated, unsaturated. and saturated zones) (cm^3/g)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.44	1.1	0.001	0.999	1700
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.04	1.82	0.001	0.999	21
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.17	2.77	0.001	0.999	480
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.09	1.95	0.001	0.999	1200
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.86	4.01	0.001	0.999	955
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.86	4.01	0.001	0.999	955
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.78	0.69	0.001	0.999	880
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.61	3.22	0.001	0.999	5
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.81	0.5	0.001	0.999	0.06
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.31	1.39	0.001	0.999	1500
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.58	1.79	0.001	0.999	36
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.6	1.1	0.001	0.999	2000
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.65	2.30	0.001	0.999	2100
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.19	1.61	0.001	0.999	180
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Sr-90	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.95	1.79	0.001	0.999	52
Tc-99	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-1.61	2.20	0.001	0.999	0.2
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-232	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	Ground water uncontaminated	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0		NR	NR	NR	NR	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	64,821	CR3 PA= 64,821 m^2 (file "CZ_Zone_11-22-2021,dwg")	NR	NR	NR	NR	
Thickness of contaminated zone (m)	P	2	D	0.1524	Depth of soil mixing layer (6 inches) as defined for the Resident Farmer Scenario in NUREG/CR-5512	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	287	Site-specific – assumed diameter of a circle with an area = CR3 contaminated zone, 64,821 m^2	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	Consistent with resident farmer scenario - no cover assumed	NR	NR	NR	NR	
Density of contaminated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone erosion rate (m/y)	P	2	D	6E-04	NUREG/CR-7267; assumed erosion rate for site with shallow slope	NR	NR	NR	NR	

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	**Type[a]**	**Priority[b]**	**Treatment[c]**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters[d]**				**Median/ Mean**
						1	**2**	**3**	**4**	
Contaminated zone total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021					
Contaminated zone hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Humidity in air (g/m^3)	P	3	D	13.8	Figure 1 in *Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations* (see figure below)	NR	NR	NR	NR	
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-7267	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	D	3.5	TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Precipitation (m/y)	P	2	D	1.5	Upper end of precipitation range is applied: "rainfall averages about 50 to 60 inches per year" TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Irrigation (m/y)	B	3	S	Uniform	Distribution determined using methodology described in 2015 updated *Data Collection Handbook* and NUREG/CR-6697.	0	0.6	NR	NR	0.3
Irrigation mode	B	3	D	Overhead	Overhead irrigation is common practice for crops in U.S.	NR	NR	NR	NR	
Runoff coefficient	P	2	D	0.2	Value determined using methodology described in *Data Collection Handbook* and NUREG/CR-7267	NR	NR	NR	NR	
Watershed area for nearby stream or pond (m^2)	P	3	D	1.3E+07	**Crystal River** is a very short river, "just seven miles (eleven kilometers) long, and has a drainage basin of five square miles (thirteen square kilometers),…" (https://en.wikipedia.org/wiki/Crystal_River_(Florida))	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Saturated zone effective porosity	P	1	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	S	Bounded Lognormal-n	NUREG/CR-7267	-5.11	1.77	7.0E-05	0.5	0.006
Saturated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Water table drop rate (m/y)	P	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Well pump intake depth (m below water table)	P	2	S	Triangular	NUREG/CR-7267	6	10	30		14.51
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	ND model recommended for contaminant areas >1,000 m2	NR	NR	NR	NR	
Well pumping rate (m^3/y)	P	2	S	Uniform	Min, and max value based on site irrigation rate and information from NUREG/CR-7267.	407	1605			802.5
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	Based on suggested uniform input for RESRAD-Onsite hydrologic parameters for the UZ (H&A Technical Support Document, File No. 134300, 12/9/2021) and assignment of generic soil type for UZ	NR	NR	NR	NR	
Unsat. zone 1, thickness (m)	P	1	S	uniform	Distribution developed from depth range for site groundwater, 5 ft – 9 ft (H&A *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station*); thickness of burm area, 21ft (H&A Technical Support Document, File No. 134300, 12/9/2021), and scenario default thickness of CZ, 0.5 ft.	7.92	8.99			8.46
Unsat. zone 1, soil density (g/cm^3)	P	2	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, effective porosity	P	2	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Unsat. zone 1, hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, soil-specific b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Occupancy										
Inhalation rate (m^3/y)	B	3	D	8400	NUREG/CR-7267	NR	NR	NR	NR	
Mass loading for inhalation (g/m^3)	P	2	S	Continuous linear	NUREG/CR-7267					2.3E-5
Exposure duration	B	3	D	30	RESRAD Default	NR	NR	NR	NR	
Indoor dust filtration factor	P	2	S	Uniform	NUREG/CR-7267	0.15	0.95			0.55
Shielding factor, external gamma	P	2	S	Bounded lognormal-n	NUREG/CR-7267	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.6571	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Fraction of time spent outdoors	B	3	D	0.1181	NUREG/CR-5512, Vol. 3 (outdoors + gardening)	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	RESRAD Default - Circular contaminated zone assumed	NR	NR	NR	NR	
Ingestion, Dietary										
Fruits, vegetables, grain consumption (kg/y)	B	2	D	112	NUREG/CR-5512, Vol. 3 (other vegetables + fruits + grain)	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	B	3	D	21.4	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk consumption (L/y)	B	2	D	233	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	B	3	D	65.1	NUREG/CR5512, Vol. 3 (beef + poultry)	NR	NR	NR	NR	
Fish consumption (kg/y)	B	3	D	20.6	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Other seafood consumption (kg/y)	B	3	D	0.9	RESRAD Default	NR	NR	NR	NR	
Soil ingestion rate (g/yr)	B	2	D	18.26	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Drinking water intake (L/y)	B	2	D	478.5	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of drinking water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water	P	3		NA						
Contamination fraction of livestock water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of irrigation water	P	3	D	1	RESRAD Default - all water assumed contaminate	NR	NR	NR	NR	
Contamination fraction of aquatic food	P	2	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Contamination fraction of plant food	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of meat	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of milk	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/d)	M	3	D	27.1	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/d)	M	3	D	63.2	NUREG/CR5512, Vol. 3 , forage + grain + hay	NR	NR	NR	NR	
Livestock water intake for meat (L/d)	M	3	D	50.6	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock water intake for milk (L/d)	M	3	D	60	NUREG/CR5512, Vol. 3	NR	NR	NR	NR	
Livestock soil intake (kg/d)	M	3	D	0.5	RESRAD Default	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	4.00E-04	NUREG/CR-5512, Vol. 3, gardening	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	S	Triangular	NUREG/CR-7267, App. C	0	0.15	0.6		0.23
Depth of roots (m)	P	1	S	Uniform	NUREG/CR-7267, Att. C	0.3	4			1.85
Drinking water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Household water fraction from ground water (if used)	P	3		NA						
Livestock water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Irrigation fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	Truncated lognormal-n	NUREG/CR-7267, App. C	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	2.88921	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	1.8868	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	0.246	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	0.123	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	0.082	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	0.1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Weathering Removal Constant for Vegetation (1/y)	P	2	S	Triangular	NUREG/CR-7267	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy	P	2	S	Triangular	NUREG/CR-7267	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	14	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Leafy vegetables	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry	B	3	D	20	NUREG/CR-5512, Vol. 3 (holdup period for beef)	NR	NR	NR	NR	
Fish	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Well water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Surface water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Livestock fodder	B	3	D	45	RESRAD Default	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	2.00E-05	RESRAD Default	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	3.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	2.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	9.80E-01	RESRAD Default	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	S	Triangular	NUREG/CR-7267, App. C (Ref. 4)	0.2	0.3	0.6		0.3
C-14 evasion flux rate from soil (1/s)	P	3	D	7.00E-07	RESRAD Default	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/s)	P	3	D	1.00E-10	RESRAD Default	NR	NR	NR	NR	

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Fraction of grain in beef cattle feed	B	3	D	0.2500	NUREG/CR-7267	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	0.1000	NUREG/CR-7267	NR	NR	NR	NR	
Inhalation Dose Conversion Factors **(mrem/pCi inhaled) from FGR11 (contained in RESRAD Dose Conversion Library)**										
Ingestion Dose Conversion Factors **(mrem/pCi ingested) from FGR11 (contained in RESRAD Dose Conversion Library)**										
Plant Transfer Factors **(pCi/g plant)/(pCi/g soil)**										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	1.1	0.001	0.999	1.0E-03
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-0.4	0.9	0.001	0.999	6.7E-01
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.5	0.9	0.001	0.999	8.0E-02
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	1.0	0.001	0.999	4.0E-02
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	1.1	0.001	0.999	5.0E+00
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.0	0.001	0.999	2.0E-03
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.0	0.9	0.001	0.999	5.0E-02
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.0	0.9	0.001	0.999	5.0E-02
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.9	0.9	0.001	0.999	2.0E-02
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.1	0.001	0.999	1.0E-02
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-5.5	0.9	0.001	0.999	4.0E-04
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Sr-90	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-1.2	1.0	0.001	0.999	3.0E-01
Tc-99	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	0.9	0.001	0.999	5.0E+00
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.47	1.0	0.001	0.999	3.1E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.75	0.8	0.001	0.999	4.3E-04
Cs-137	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.82	0.9	0.001	0.999	2.2E-02
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.27	0.4	0.001	0.999	1.4E-02
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.42	1.0	0.001	0.999	1.2E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.9	0.001	0.999	1.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	1.0	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.26	0.9	0.001	0.999	7.0E-04

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.7	0.001	0.999	5.0E-03
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	1.1	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.21	0.7	0.001	0.999	1.0E-04
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-232	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.4	0.9	0.001	0.999	1.2E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.12	0.7	0.001	0.999	1.1E-04
Cs-137	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.38	0.7	0.001	0.999	4.6E-03
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.26	0.7	0.001	0.999	3.5E-05
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	0.9	0.001	0.999	1.0E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.91	0.7	0.001	0.999	2.0E-02
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.91	0.7	0.001	0.999	2.0E-02
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-11.51	0.7	0.001	0.999	1.0E-05
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.11	0.9	0.001	0.999	3.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.47	0.6	0.001	0.999	2.1E-04
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	0.5	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+01
Am-241	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
Am-243	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
C-14	P	2	S	Lognormal-n	NUREG/CR-7267	13.0	1.1			4.4E+05
Cm-243	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Cm-244	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Co-60	P	2	S	Lognormal-n	NUREG/CR-7267	4.3	0.9			7.4E+01
Cs-137	P	2	S	Lognormal-n	NUREG/CR-7267	7.8	0.9			2.4E+03
Eu-152	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Eu-154	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Fe-55	P	2	S	Lognormal-n	NUREG/CR-7267	5.1	1.9			1.6E+02
Gd-152	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
H-3	P	2	S	Lognormal-n	NUREG/CR-7267	0	0.1			1.0E+00
Nb-94	P	2	S	Lognormal-n	NUREG/CR-7267	5.7	1.1			3.0E+02
Ni-59	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Ni-63	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Np-237	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Pa-231	P	2	S	Lognormal-n	NUREG/CR-7267	2.3	1.1			1.0E+01
Pb-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.4E+01
Po-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.6	1.5			3.7E+01
Pu-238	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-239	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-240	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-241	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Ra-226	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Ra-228	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Sr-90	P	2	S	Lognormal-n	NUREG/CR-7267	1.1	1.4			3.0E+00
Tc-99	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Th-228	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-229	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-230	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
U-233	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-234	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-235	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-236	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L)) RESRAD default value for each radionuclide applied										

Values and Bases for RESRAD-Onsite Parameters for Sensitivity Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Notes:

[a] P = physical, B = behavioral, M = metabolic
[b] 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter
[c] D = deterministic, S = stochastic
NR = none recommended

[d] Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Beta: 1 = minimum, 2 = maximum, 3 = P-value, 4 = Q-value
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum

Table 3: Sensitive Input Parameter by Radionuclide

Radionuclide	Sensitive Parameter	PRCC Value
Am-241	Plant transfer factor for Am External gamma shielding factor Depth of soil mixing layer Depth of roots	0.90 0.27 -0.73 -0.82
C-14	Depth of roots K_d of C14 in CZ	-0.45 0.88
Cm-243	External gamma shielding factor Depth of soil mixing layer Depth of roots Plant Transfer Factor for Cm	0.90 -0.39 -0.65 0.75
Cm-244	Depth of soil mixing layer Depth of roots Plant Transfer Factor for Cm	-0.72 -0.82 0.90
Co-60	External gamma shielding factor K_d of Co-60 in CZ	0.95 0.47
Cs-137	External gamma shielding factor Depth of roots Plant transfer factor for Cs Meat Transfer Factor for Cs Milk transfer factor for Cs	0.96 -0.46 0.58 0.39 0.31
Eu-152	External gamma shielding factor K_d of Eu-152 in CZ	0.91 0.53
Eu-154	External gamma shielding factor K_d of Eu-154 in CZ	0.90 0.53
Fe-55	Depth of soil mixing layer Depth of roots Plant transfer factor for Fe Meat transfer factor for Fe	-0.93 -0.32 0.38 0.92
H-3	SZ hydraulic gradient Well pump intake depth Depth of roots	-0.69 -0.27 -0.75
Nb-94	External gamma shielding factor K_d of Nb-94 in CZ	1.00 0.48
Ni-59	Depth of soil mixing later Depth of roots Plant Transfer Factor for Ni Milk Transfer Factor for Ni	-0.55 -0.76 0.84 0.88
Ni-63	Depth of soil mixing later Depth of roots Plant Transfer Factor for Ni Milk Transfer Factor for Ni	-0.55 -0.76 0.84 0.88
Pu-238	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu	-0.65 -0.77 0.85
Pu-239	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu	-0.62 -0.74 0.84

Radionuclide	Sensitive Parameter	PRCC Value
Pu-240	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu	-0.56 -0.71 0.82
Pu-241	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu Plant transfer factor for Am	-0.56 -0.75 0.50 0.68
Sr-90	Depth of roots K_d of Sr-90 in CZ Plant Transfer Factor for Sr	-0.89 0.30 0.95
Tc-99	SZ hydraulic gradient Depth of roots K_d of Tc-99 in CZ Plant transfer factor for Tc	-0.39 -0.57 0.70 0.71

Table 4: RESRAD-Generated Percentile Values for Sensitive Input Parameters

Sensitive Input Parameter	Affected Nuclide	RESRAD Percentile Value[a] 25th	75th
Depth of roots (m)	Am-241	1.2E+00	
	C-14	1.2E+00	
	Cm-243	1.2E+00	
	Cm-244	1.2E+00	
	Cs-137	1.2E+00	
	Fe-55	1.2E+00	
	H-3	1.2E+00	
	Ni-59	1.2E+00	
	Ni-63	1.2E+00	
	Pu-238	1.2E+00	
	Pu-239	1.2E+00	
	Pu-240	1.2E+00	
	Pu-241	1.2E+00	
	Sr-90	1.2E+00	
	Tc-99	1.2E+00	
Depth of soil mixing layer	Am-241	1.5E-01	
	Cm-243	1.5E-01	
	Cm-244	1.5E-01	
	Fe-55	1.5E-01	
	Ni-59	1.5E-01	
	Ni-63	1.5E-01	
	Pu-238	1.5E-01	
	Pu-239	1.5E-01	
	Pu-240	1.5E-01	
	Pu-241	1.5E-01	
External gamma shielding factor	Am-241		4.0E-01
	Cm-243		4.0E-01
	Co-60		4.0E-01
	Cs-137		4.0E-01
	Eu-152		4.0E-01
	Eu-154		4.0E-01
	Nb-94		4.0E-01
Well Pump Intake Depth (m)	H-3	1.1E+01	
Plant transfer factor (pCi/g plant per pCi/g soil)	Am-241		1.8E-03
	(the plant transfer factor was also found sensitive for the Am-241 as Pu-241daughter)		1.8E-03
	Cm-243		1.8E-03
	Cm-244		1.8E-03
	Cs-137		8.0E-02
	Fe-55		1.8E-03
	Ni-59		9.1E-02
	Ni-63		9.1E-02
	Pu-238		1.8E-03
	Pu-239		1.8E-03
	Pu-240		1.8E-03
	Pu-241		1.8E-03
	Sr-90		5.9E-01
	Tc-99		9.1E+00

Sensitive Input Parameter	Affected Nuclide	RESRAD Percentile Value[a] 25th	75th
Meat transfer factor (pCi/kg per pCi/d)	Cs-137		4.0E-02
	Fe-55		1.8E-02
	Pu-238		9.4E-06
Milk transfer factor (pCi/l per pCi/d)	Cs-137		7.4E-03
	Ni-59		3.2E-02
	Ni-63		3.2E-02
K_d in CZ (cm^3/g)	C-14		7.1E+01
	Co-60		3.1E+03
	Eu-152		1.4E+04
	Eu-154		1.4E+04
	Nb-94		3.8E+03
	Sr-90		1.7E+02
	Tc-99		8.8E-01
SZ hydraulic gradient	H-3	1.8E-03	
	Tc-99	1.8E-03	

[a] The 75th percentile value was selected when the absolute value of the PRCC for a given parameter was ≥0.25 and PRCC had a positive value. The 25th percentile value was selected when the absolute value of the PRCC value for a given parameter was ≥0.25 and the PRCC had a negative value.

Appendix A

Selected Pages from RESRAD-Onsite Code Executions

Am-241 Results:

```
1 RESRAD Regression and Correlation output  01/20/22 11:10 Page: Coef    2
 Title      : CR3 Sensitivity Analysis - Am241
 Input File : CR3_SA_AM241.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

	PCC		SRC		PRCC		SRRC	
	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Kd of Am-241 in Contaminated Zone	36	0.01	36	0.00	43	0.00	43	0.00
Kd of Am-241 in Unsaturated Zone 1	20	-0.02	20	-0.01	31	0.01	31	0.00
Kd of Am-241 in Saturated Zone	12	-0.03	12	-0.02	42	0.00	42	0.00
Kd of Np-237 in Contaminated Zone	11	-0.03	11	-0.02	19	-0.02	19	-0.01
Kd of Np-237 in Unsaturated Zone 1	45	0.00	45	0.00	34	-0.01	34	0.00
Kd of Np-237 in Saturated Zone	30	-0.01	30	-0.01	44	0.00	44	0.00
Kd of Th-229 in Contaminated Zone	16	0.02	16	0.01	9	0.04	9	0.01
Kd of Th-229 in Unsaturated Zone 1	5	0.05	5	0.03	33	-0.01	33	0.00
Kd of Th-229 in Saturated Zone	29	0.01	29	0.01	36	-0.01	36	0.00
Kd of U-233 in Contaminated Zone	28	0.01	27	0.01	16	0.02	16	0.01
Kd of U-233 in Unsaturated Zone 1	6	0.05	6	0.03	37	0.00	37	0.00
Kd of U-233 in Saturated Zone	10	0.04	10	0.02	40	0.00	40	0.00
Plant transfer factor for Am	1	0.71	1	0.63	1	0.90	1	0.69
Meat transfer factor for Am	17	0.02	17	0.01	6	0.07	6	0.02
Milk transfer factor for Am	8	0.04	8	0.03	8	0.05	8	0.02
Fish transfer factor for Am	37	-0.01	37	0.00	32	0.01	32	0.00
Plant transfer factor for Np	26	0.01	26	0.01	30	-0.01	30	0.00
Meat transfer factor for Np	15	0.02	15	0.01	13	-0.03	13	-0.01
Milk transfer factor for Np	44	0.00	44	0.00	15	0.02	15	0.01
Fish transfer factor for Np	24	0.02	24	0.01	29	0.01	29	0.00
Plant transfer factor for Th	39	0.00	39	0.00	41	0.00	41	0.00
Meat transfer factor for Th	38	-0.01	38	0.00	12	0.03	12	0.01
Milk transfer factor for Th	35	0.01	35	0.01	11	-0.04	11	-0.01
Fish transfer factor for Th	25	-0.02	25	-0.01	35	0.01	35	0.00
Plant transfer factor for U	34	-0.01	34	-0.01	21	0.02	21	0.01
Meat transfer factor for U	9	0.04	9	0.03	24	-0.01	24	-0.01
Milk transfer factor for U	19	0.02	19	0.01	23	0.02	23	0.01
Fish transfer factor for U	32	-0.01	32	-0.01	14	0.03	14	0.01
Contaminated zone b parameter	33	0.01	33	0.01	22	0.02	22	0.01
Evapotranspiration coefficient	43	0.00	43	0.00	10	-0.04	10	-0.01
Irrigation	27	-0.01	28	-0.01	26	-0.01	26	0.00
Saturated zone hydraulic gradient	21	-0.02	21	-0.01	17	-0.02	17	-0.01
Saturated zone b parameter	31	-0.01	31	-0.01	38	0.00	38	0.00
Well pump intake depth	18	-0.02	18	-0.01	25	0.01	25	0.00
Well pumping rate	14	-0.03	14	-0.02	45	0.00	45	0.00
Thickness of Unsaturated zone 1	41	0.00	41	0.00	27	0.01	27	0.00
b Parameter of Unsaturated zone 1	22	-0.02	22	-0.01	28	0.01	28	0.00
Mass loading for inhalation	4	0.08	4	0.05	5	0.09	5	0.03
Indoor dust filtration factor	13	-0.03	13	-0.02	7	0.07	7	0.02
External gamma shielding factor	7	0.05	7	0.03	4	0.27	4	0.10
Depth of soil mixing layer	3	-0.20	3	-0.13	3	-0.73	3	-0.37
Depth of roots	2	-0.56	2	-0.42	2	-0.82	2	-0.50
Wet weight crop yield of fruit, grain and non-leafy vegetables	42	0.00	42	0.00	18	0.02	18	0.01
Weathering removal constant of all vegetation	23	-0.02	23	-0.01	39	0.00	39	0.00
Wet foliar interception fraction of leafy vegetables	40	0.00	40	0.00	20	-0.02	20	-0.01

C-14 Results:

```
1 RESRAD Regression and Correlation output  01/24/22 14:48 Page: Coef    1
 Title      : CR3 Sensitivity Analysis - C14
 Input File : CR3_SA_C14.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

	PCC		SRC		PRCC		SRRC	
	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Contaminated zone b parameter	16	-0.01	16	-0.01	24	0.00	24	0.00
Evapotranspiration coefficient	25	0.00	25	0.00	3	0.22	3	0.10
Irrigation	6	0.03	6	0.03	5	-0.13	5	-0.06
Saturated zone hydraulic gradient	17	0.01	17	0.01	17	0.02	17	0.01
Saturated zone b parameter	2	0.05	2	0.05	15	0.02	15	0.01
Well pump intake depth	20	0.00	20	0.00	18	-0.01	18	-0.01
Well pumping rate	8	-0.02	8	-0.02	22	0.00	22	0.00
Thickness of Unsaturated zone 1	21	0.00	21	0.00	9	-0.05	9	-0.02
b Parameter of Unsaturated zone 1	22	0.00	22	0.00	10	-0.04	10	-0.02
Indoor dust filtration factor	11	0.02	11	0.02	21	0.00	21	0.00
External gamma shielding factor	3	0.03	3	0.03	19	0.01	19	0.00
Depth of soil mixing layer	24	0.00	24	0.00	7	-0.08	7	-0.04
Depth of roots	10	-0.02	10	-0.02	2	-0.45	2	-0.23
Wet weight crop yield of fruit, grain and non-leafy vegetables	4	0.03	4	0.03	12	0.02	12	0.01
Weathering removal constant of all vegetation	14	0.02	14	0.02	11	0.04	11	0.02
Plant transfer factor for C	9	-0.02	9	-0.02	14	0.02	14	0.01
Meat transfer factor for C	15	0.02	15	0.02	8	0.06	8	0.03
Milk transfer factor for C	19	-0.01	19	-0.01	23	0.00	23	0.00
Fish transfer factor for C	1	0.10	1	0.10	4	0.14	4	0.06
Thickness of evasion layer of C-14 in soil	23	0.00	23	0.00	25	0.00	25	0.00
Kd of C-14 in Unsaturated Zone 1	7	-0.03	7	-0.03	6	-0.12	6	-0.06
Kd of C-14 in Contaminated Zone	12	-0.02	12	-0.02	1	0.88	1	0.84
Kd of C-14 in Saturated Zone	5	-0.03	5	-0.03	16	-0.02	16	-0.01
Mass loading for inhalation	18	-0.01	18	-0.01	20	-0.01	20	0.00
Wet foliar interception fraction of leafy vegetables	13	0.02	13	0.02	13	0.02	13	0.01

Cm-243 Results:

```
1 RESRAD Regression and Correlation output  01/25/22 10:15 Page: Coef    1
 Title      : CR3 Sensitivity Analysis - Cm243
 Input File : CR3_SA_CM243.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

	PCC	1	SRC	1	PRCC	1	SRRC	1
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Contaminated zone b parameter	53	0.00	53	0.00	46	0.01	46	0.00
Evapotranspiration coefficient	40	0.01	40	0.01	24	0.02	24	0.01
Irrigation	56	0.00	56	0.00	53	0.00	53	0.00
Saturated zone hydraulic gradient	49	-0.01	49	0.00	21	0.03	21	0.01
Saturated zone b parameter	24	-0.02	24	-0.01	19	0.03	19	0.01
Well pump intake depth	51	-0.01	51	0.00	44	0.01	44	0.00
Well pumping rate	57	0.00	57	0.00	10	-0.05	10	-0.02
Thickness of unsaturated zone 1	43	0.01	43	0.00	34	-0.01	34	0.00
b Parameter of unsaturated zone 1	34	0.02	34	0.01	28	-0.02	28	-0.01
Indoor dust filtration factor	10	0.04	10	0.02	13	0.04	13	0.01
External gamma shielding factor	1	0.76	1	0.59	1	0.90	1	0.76
Depth of soil mixing layer	4	-0.18	4	-0.09	4	-0.39	4	-0.16
Depth of roots	3	-0.54	3	-0.32	3	-0.65	3	-0.32
Wet weight crop yield of fruit, grain and non-leafy vegetables	38	-0.01	38	-0.01	15	-0.04	15	-0.01
Weathering removal constant of all vegetation	36	-0.02	36	-0.01	22	-0.03	22	-0.01
Mass loading for inhalation	7	0.08	7	0.04	7	0.07	7	0.02
Wet foliar interception fraction of leafy vegetables	14	-0.03	14	-0.02	8	0.05	8	0.02
Kd of Ac-227 in Contaminated Zone	23	-0.02	23	-0.01	27	0.02	27	0.01
Kd of Ac-227 in Unsaturated Zone 1	19	-0.03	19	-0.01	32	-0.01	32	-0.01
Kd of Ac-227 in Saturated Zone	58	0.00	58	0.00	47	-0.01	47	0.00
Kd of Am-243 in Contaminated Zone	30	0.02	30	0.01	48	0.01	48	0.00
Kd of Am-243 in Unsaturated Zone 1	22	-0.02	22	-0.01	31	0.01	31	0.01
Kd of Am-243 in Saturated Zone	37	-0.01	37	-0.01	49	0.01	49	0.00
Kd of Cm-243 in Contaminated Zone	26	0.02	26	0.01	29	0.02	29	0.01
Kd of Cm-243 in Unsaturated Zone 1	42	-0.01	42	-0.01	39	-0.01	39	0.00
Kd of Cm-243 in Saturated Zone	35	-0.02	35	-0.01	26	0.02	26	0.01
Kd of Pa-231 in Contaminated Zone	39	0.01	39	0.01	38	0.01	38	0.00
Kd of Pa-231 in Unsaturated Zone 1	41	0.01	41	0.01	41	0.01	41	0.00
Kd of Pa-231 in Saturated Zone	32	0.02	32	0.01	45	-0.01	45	0.00
Kd of Pu-239 in Contaminated Zone	15	0.03	15	0.02	54	0.00	54	0.00
Kd of Pu-239 in Unsaturated Zone 1	28	0.02	28	0.01	14	0.04	14	0.01
Kd of Pu-239 in Saturated Zone	31	0.02	31	0.01	17	0.03	17	0.01
Kd of U-235 in Contaminated Zone	48	-0.01	48	0.00	18	-0.03	18	-0.01
Kd of U-235 in Unsaturated Zone 1	27	0.02	27	0.01	6	0.08	6	0.03
Kd of U-235 in Saturated Zone	55	0.00	55	0.00	56	0.00	56	0.00
Plant transfer factor for Ac	20	0.03	20	0.01	20	0.03	20	0.01
Meat transfer factor for Ac	6	0.08	6	0.04	42	-0.01	42	0.00
Milk transfer factor for Ac	33	0.02	33	0.01	37	-0.01	37	0.00
Fish transfer factor for Ac	5	0.08	5	0.04	35	0.01	35	0.00
Plant transfer factor for Am	54	0.00	54	0.00	55	0.00	55	0.00
Meat transfer factor for Am	25	0.02	25	0.01	23	-0.03	23	-0.01
Milk transfer factor for Am	47	0.01	47	0.00	11	-0.05	11	-0.02
Fish transfer factor for Am	46	0.01	46	0.00	59	0.00	59	0.00
Plant transfer factor for Cm	2	0.72	2	0.53	2	0.75	2	0.41
Meat transfer factor for Cm	9	0.06	9	0.03	5	0.08	5	0.03
Milk transfer factor for Cm	12	0.03	12	0.02	16	0.03	16	0.01
Fish transfer factor for Cm	44	-0.01	45	0.00	43	-0.01	43	0.00
Plant transfer factor for Pa	29	-0.02	29	-0.01	50	0.01	50	0.00
Meat transfer factor for Pa	16	0.03	16	0.02	9	0.05	9	0.02
Milk transfer factor for Pa	21	0.02	21	0.01	57	0.00	57	0.00
Fish transfer factor for Pa	59	0.00	59	0.00	40	-0.01	40	0.00
Plant transfer factor for Pu	13	0.03	13	0.02	25	0.02	25	0.01
Meat transfer factor for Pu	18	0.03	18	0.01	36	-0.01	36	0.00
Milk transfer factor for Pu	50	-0.01	50	0.00	51	-0.01	51	0.00
Fish transfer factor for Pu	17	0.03	17	0.01	58	0.00	58	0.00
Plant transfer factor for U	11	0.04	11	0.02	30	-0.02	30	-0.01
Meat transfer factor for U	8	-0.07	8	-0.04	12	-0.04	12	-0.01
Milk transfer factor for U	52	0.00	52	0.00	52	0.00	52	0.00
Fish transfer factor for U	45	-0.01	44	0.00	33	-0.01	33	0.00

Cm-244 Results:

1 RESRAD Regression and Correlation output 01/25/22 12:41 Page: Coef 1
Title : CR3 Sensitivity Analysis - CM244
Input File : CR3_SA_CM244.RAD

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

	PCC	1	SRC	1	PRCC	1	SRRC	1
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Contaminated zone b parameter	45	0.01	45	0.00	51	0.00	51	0.00
Evapotranspiration coefficient	46	-0.01	46	0.00	33	0.01	33	0.00
Irrigation	11	-0.04	11	-0.02	50	0.00	50	0.00
Saturated zone hydraulic gradient	10	0.04	9	0.03	49	0.00	49	0.00
Saturated zone b parameter	17	-0.03	17	-0.02	48	0.00	48	0.00
Well pump intake depth	47	-0.01	47	0.00	14	0.03	14	0.01
Well pumping rate	4	0.06	4	0.03	19	0.02	19	0.01
Thickness of unsaturated zone 1	16	0.03	16	0.02	37	-0.01	37	0.00
b Parameter of unsaturated zone 1	32	-0.02	32	-0.01	39	-0.01	39	0.00
Indoor dust filtration factor	23	0.02	23	0.01	6	0.08	6	0.03
External gamma shielding factor	5	0.06	5	0.03	31	-0.01	31	0.00
Depth of soil mixing layer	3	-0.21	3	-0.14	3	-0.72	3	-0.36
Depth of roots	2	-0.54	2	-0.40	2	-0.82	2	-0.50
Wet weight crop yield of fruit, grain and non-leafy vegetables	30	-0.02	30	-0.01	43	0.01	43	0.00
Weathering removal constant of all vegetation	26	-0.02	26	-0.01	44	0.01	44	0.00
Mass loading for inhalation	9	0.05	10	0.03	5	0.11	5	0.04
Wet foliar interception fraction of leafy vegetables	55	0.00	55	0.00	47	0.00	47	0.00
Kd of Cm-244 in Contaminated Zone	25	-0.02	25	-0.01	40	-0.01	40	0.00
Kd of Cm-244 in Unsaturated Zone 1	43	-0.01	43	0.00	21	-0.02	21	-0.01
Kd of Cm-244 in Saturated Zone	39	-0.01	39	-0.01	23	0.02	23	0.01
Kd of Pu-240 in Contaminated Zone	6	0.05	6	0.03	17	-0.02	17	-0.01
Kd of Pu-240 in Unsaturated Zone 1	20	-0.02	20	-0.02	32	0.01	32	0.00
Kd of Pu-240 in Saturated Zone	44	-0.01	44	0.00	20	0.02	20	0.01
Kd of Ra-228 in Contaminated Zone	52	0.00	52	0.00	27	-0.01	27	0.00

Kd of Ra-228 in Unsaturated Zone 1	29	0.02	29	0.01	54	0.00	54	0.00
Kd of Ra-228 in Saturated Zone	51	0.00	51	0.00	30	0.01	30	0.00
Kd of Th-228 in Contaminated Zone	33	-0.01	33	-0.01	18	0.02	18	0.01
Kd of Th-228 in Unsaturated Zone 1	13	0.04	13	0.02	7	0.05	7	0.02
Kd of Th-228 in Saturated Zone	24	-0.02	24	-0.01	24	-0.02	24	-0.01
Kd of Th-232 in Contaminated Zone	18	0.03	18	0.02	42	0.01	42	0.00
Kd of Th-232 in Unsaturated Zone 1	50	0.00	50	0.00	34	-0.01	34	0.00
Kd of Th-232 in Saturated Zone	49	0.00	49	0.00	22	0.02	22	0.01
Kd of U-236 in Contaminated Zone	21	-0.02	21	-0.01	46	0.00	46	0.00
Kd of U-236 in Unsaturated Zone 1	34	-0.01	35	-0.01	10	-0.03	10	-0.01
Kd of U-236 in Saturated Zone	27	-0.02	27	-0.01	35	0.01	35	0.00
Plant transfer factor for Cm	1	0.73	1	0.66	1	0.90	1	0.71
Meat transfer factor for Cm	12	0.04	12	0.02	4	0.17	4	0.06
Milk transfer factor for Cm	40	-0.01	40	-0.01	25	0.02	25	0.01
Fish transfer factor for Cm	54	0.00	54	0.00	8	0.05	8	0.02
Plant transfer factor for Pu	31	0.02	31	0.01	53	0.00	53	0.00
Meat transfer factor for Pu	42	-0.01	42	0.00	26	0.01	26	0.00
Milk transfer factor for Pu	28	-0.02	28	-0.01	12	-0.03	12	-0.01
Fish transfer factor for Pu	22	-0.02	22	-0.01	29	0.01	29	0.00
Plant transfer factor for Ra	15	0.03	15	0.02	41	-0.01	41	0.00
Meat transfer factor for Ra	19	0.03	19	0.02	13	-0.03	13	-0.01
Milk transfer factor for Ra	37	-0.01	37	-0.01	15	0.03	15	0.01
Fish transfer factor for Ra	41	0.01	41	0.01	36	-0.01	36	0.00
Plant transfer factor for Th	36	-0.01	36	-0.01	11	-0.03	11	-0.01
Meat transfer factor for Th	14	-0.03	14	-0.02	28	0.01	28	0.00
Milk transfer factor for Th	53	0.00	53	0.00	52	0.00	52	0.00
Fish transfer factor for Th	35	-0.01	34	-0.01	45	0.01	45	0.00
Plant transfer factor for U	8	-0.05	8	-0.03	16	0.03	16	0.01
Meat transfer factor for U	48	-0.01	48	0.00	55	0.00	55	0.00
Milk transfer factor for U	7	0.05	7	0.03	9	-0.04	9	-0.01
Fish transfer factor for U	38	-0.01	38	-0.01	38	0.01	38	0.00

Co-60 Results:

1 RESRAD Regression and Correlation output 01/25/22 13:58 Page: Coef 1
Title : CR3 Sensitivity Analysis - Co60
Input File : CR3_SA_CO60.RAD

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	9	0.03	9	0.01	24	0.00	24	0.00
Evapotranspiration coefficient	4	0.07	4	0.02	5	0.07	5	0.02
Irrigation	19	-0.01	19	0.00	23	0.00	23	0.00
Saturated zone hydraulic gradient	20	0.01	20	0.00	15	-0.01	15	0.00
Saturated zone b parameter	21	0.01	21	0.00	14	0.01	14	0.00
Well pump intake depth	6	0.05	6	0.02	6	0.05	6	0.02
Well pumping rate	18	0.01	18	0.00	8	0.02	8	0.01
Thickness of Unsaturated zone 1	10	0.02	10	0.01	7	0.03	7	0.01
b Parameter of Unsaturated zone 1	17	-0.02	17	-0.01	18	0.01	18	0.00
Indoor dust filtration factor	16	0.02	16	0.01	12	0.02	12	0.00
External gamma shielding factor	1	0.94	1	0.94	1	0.95	1	0.94
Depth of soil mixing layer	23	-0.01	23	0.00	20	0.00	20	0.00
Depth of roots	3	-0.08	3	-0.03	4	-0.10	4	-0.03
Wet weight crop yield of fruit, grain and non-leafy vegetables	24	0.01	24	0.00	21	0.00	21	0.00
Weathering removal constant of all vegetation	14	0.02	14	0.01	10	0.02	10	0.01
Mass loading for inhalation	7	-0.05	7	-0.02	17	-0.01	17	0.00
Wet foliar interception fraction of leafy vegetables	13	0.02	13	0.01	16	0.01	16	0.00
Kd of Co-60 in Contaminated Zone	5	0.05	5	0.02	2	0.47	2	0.16
Kd of Co-60 in Unsaturated Zone 1	8	-0.03	8	-0.01	19	0.00	19	0.00
Kd of Co-60 in Saturated Zone	12	0.02	12	0.01	11	0.02	11	0.00
Plant transfer factor for Co	2	0.10	2	0.03	3	0.10	3	0.03
Meat transfer factor for Co	11	-0.02	11	-0.01	22	0.00	22	0.00
Milk transfer factor for Co	22	-0.01	22	0.00	9	0.02	9	0.01
Fish transfer factor for Co	15	-0.02	15	-0.01	13	-0.02	13	0.00

Cs-137 Results:

1 RESRAD Regression and Correlation output 01/25/22 08:38 Page: Coef 1
Title : CR3 Sensitivity Analysis - Cs137
Input File : CR3_SA_CS137.RAD

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	17	0.01	17	0.00	18	-0.01	18	0.00
Evapotranspiration coefficient	15	0.01	15	0.00	21	0.00	21	0.00
Irrigation	12	0.02	12	0.01	22	0.00	22	0.00
Saturated zone hydraulic gradient	7	0.06	7	0.02	9	0.03	9	0.01
Saturated zone b parameter	9	-0.02	9	-0.01	19	-0.01	19	0.00
Well pump intake depth	23	0.01	23	0.00	16	0.01	16	0.00
Well pumping rate	14	-0.01	14	0.00	12	0.02	12	0.00
Thickness of Unsaturated zone 1	16	0.01	16	0.00	8	-0.04	8	-0.01
b Parameter of Unsaturated zone 1	13	-0.01	13	0.00	17	0.01	17	0.00
Indoor dust filtration factor	22	0.01	22	0.00	24	0.00	24	0.00
External gamma shielding factor	1	0.95	1	0.88	1	0.96	1	0.92
Depth of soil mixing layer	6	-0.18	6	-0.05	6	-0.19	6	-0.05
Depth of roots	3	-0.48	3	-0.16	3	-0.46	3	-0.14
Wet weight crop yield of fruit, grain and non-leafy vegetables	8	0.03	8	0.01	11	0.02	11	0.01
Weathering removal constant of all vegetation	21	-0.01	21	0.00	23	0.00	23	0.00
Mass loading for inhalation	11	0.02	11	0.01	14	0.01	14	0.00
Wet foliar interception fraction of leafy vegetables	10	0.02	10	0.01	10	0.03	10	0.01
Plant transfer factor for Cs	2	0.68	2	0.27	2	0.58	2	0.20
Meat transfer factor for Cs	4	0.48	4	0.16	4	0.39	4	0.12
Milk transfer factor for Cs	5	0.30	5	0.09	5	0.31	5	0.09
Fish transfer factor for Cs	18	0.01	18	0.00	15	-0.01	15	0.00
Kd of Cs-137 in Contaminated Zone	24	0.00	24	0.00	7	0.06	7	0.02

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Kd of Cs-137 in Unsaturated Zone 1	20	-0.01	20	0.00	20	0.00	20	0.00
Kd of Cs-137 in Saturated Zone	19	-0.01	19	0.00	13	-0.02	13	0.00

Eu-152 Results:

1 RESRAD Regression and Correlation output 01/25/22 14:29 Page: Coef 1
Title : CR3 Sensitivity Analysis - Eu152
Input File : CR3_SA_EU152.RAD

Coefficients for peak All Pathways Dose
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Contaminated zone b parameter	24	0.01	24	0.00	18	-0.02	18	-0.01
Evapotranspiration coefficient	12	0.02	12	0.01	8	0.03	8	0.01
Irrigation	9	0.02	9	0.01	4	0.04	4	0.02
Saturated zone hydraulic gradient	11	-0.02	11	-0.01	24	0.01	24	0.00
Saturated zone b parameter	25	-0.01	25	0.00	25	-0.01	25	0.00
Well pump intake depth	28	0.00	28	0.00	31	0.00	31	0.00
Well pumping rate	20	0.01	20	0.00	15	0.02	15	0.01
Thickness of Unsaturated zone 1	22	-0.01	22	0.00	30	0.00	30	0.00
b Parameter of Unsaturated zone 1	5	0.03	5	0.02	12	0.02	12	0.01
Indoor dust filtration factor	23	0.01	23	0.00	11	0.03	11	0.01
External gamma shielding factor	1	0.88	1	0.87	1	0.91	1	0.87
Depth of soil mixing layer	10	-0.02	10	-0.01	10	-0.03	10	-0.01
Depth of roots	21	-0.01	21	0.00	22	-0.01	22	-0.01
Wet weight crop yield of fruit, grain and non-leafy vegetables	30	0.00	30	0.00	17	0.02	17	0.01
Weathering removal constant of all vegetation	14	0.01	14	0.01	29	0.00	29	0.00
Mass loading for inhalation	8	0.03	8	0.01	9	0.03	9	0.01
Wet foliar interception fraction of leafy vegetables	7	0.03	7	0.01	6	0.04	6	0.01
Kd of Eu-152 in Contaminated Zone	3	0.04	3	0.02	2	0.53	2	0.26
Kd of Eu-152 in Unsaturated Zone 1	26	-0.01	26	0.00	7	-0.03	7	-0.01
Kd of Eu-152 in Saturated Zone	29	0.00	29	0.00	23	0.01	23	0.00
Kd of Gd-152 in Contaminated Zone	2	-0.06	2	-0.03	16	0.02	16	0.01
Kd of Gd-152 in Unsaturated Zone 1	27	0.00	27	0.00	21	-0.01	21	-0.01
Kd of Gd-152 in Saturated Zone	18	0.01	18	0.01	19	-0.01	19	-0.01
Plant transfer factor for Eu	13	0.02	13	0.01	28	-0.01	28	0.00
Meat transfer factor for Eu	6	-0.03	6	-0.02	27	-0.01	27	0.00
Milk transfer factor for Eu	15	0.01	15	0.01	20	0.01	20	0.01
Fish transfer factor for Eu	17	0.01	17	0.01	5	0.04	5	0.02
Plant transfer factor for Gd	31	0.00	31	0.00	26	-0.01	26	0.00
Meat transfer factor for Gd	4	-0.04	4	-0.02	3	-0.07	3	-0.03
Milk transfer factor for Gd	16	0.01	16	0.01	13	0.02	13	0.01
Fish transfer factor for Gd	19	0.01	19	0.01	14	0.02	14	0.01

Eu-154 Results:

1 RESRAD Regression and Correlation output 01/25/22 14:58 Page: Coef 1
Title : CR3 Sensitivity Analysis -Eu154
Input File : CR3_SA_EU_154.RAD

Coefficients for peak All Pathways Dose
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Contaminated zone b parameter	14	0.02	15	0.01	8	-0.03	8	-0.01
Evapotranspiration coefficient	3	0.05	3	0.02	4	0.04	4	0.02
Irrigation	20	-0.01	20	0.00	22	0.00	22	0.00
Saturated zone hydraulic gradient	13	0.02	13	0.01	11	-0.02	11	-0.01
Saturated zone b parameter	23	0.00	23	0.00	9	0.02	9	0.01
Well pump intake depth	2	0.05	2	0.02	3	0.05	3	0.02
Well pumping rate	22	0.01	22	0.00	14	0.01	14	0.01
Thickness of Unsaturated zone 1	8	0.03	8	0.01	6	0.03	6	0.01
b Parameter of Unsaturated zone 1	10	-0.03	10	-0.01	17	-0.01	17	0.00
Indoor dust filtration factor	11	0.03	11	0.01	7	0.03	7	0.01
External gamma shielding factor	1	0.86	1	0.86	1	0.90	1	0.87
Depth of soil mixing layer	19	-0.01	19	0.00	16	-0.01	16	0.00
Depth of roots	9	-0.03	9	-0.01	5	-0.04	5	-0.02
Wet weight crop yield of fruit, grain and non-leafy vegetables	21	0.01	21	0.00	24	0.00	24	0.00
Weathering removal constant of all vegetation	17	0.02	17	0.01	23	0.00	23	0.00
Mass loading for inhalation	6	-0.04	6	-0.02	19	-0.01	19	0.00
Wet foliar interception fraction of leafy vegetables	12	0.02	12	0.01	10	0.02	10	0.01
Kd of Eu-154 in Contaminated Zone	7	0.03	7	0.02	2	0.53	2	0.27
Kd of Eu-154 in Unsaturated Zone 1	18	-0.01	18	-0.01	13	0.01	13	0.01
Kd of Eu-154 in Saturated Zone	15	0.02	14	0.01	21	0.00	21	0.00
Plant transfer factor for Eu	24	0.00	24	0.00	18	0.01	18	0.00
Meat transfer factor for Eu	5	-0.04	5	-0.02	15	-0.01	15	0.00
Fish transfer factor for Eu	4	-0.04	4	-0.02	20	0.01	20	0.00
Milk transfer factor for Eu	16	-0.02	16	-0.01	12	-0.01	12	-0.01

Fe-55 Results:

1 RESRAD Regression and Correlation output 01/25/22 15:20 Page: Coef 1
Title : CR3 Sensitivity Analysis -Fe55
Input File : CR3_SA_FE55.RAD

Coefficients for peak All Pathways Dose
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Contaminated zone b parameter	7	-0.03	7	-0.01	6	0.04	6	0.01
Evapotranspiration coefficient	24	0.00	24	0.00	22	0.00	22	0.00

Irrigation	22	0.00	22	0.00	19	0.01	19	0.00
Saturated zone hydraulic gradient	19	-0.01	19	0.00	9	-0.03	9	-0.01
Saturated zone b parameter	6	-0.04	6	-0.01	17	-0.01	17	0.00
Well pump intake depth	21	0.00	21	0.00	11	-0.02	11	-0.01
Well pumping rate	15	0.02	15	0.01	12	-0.02	12	-0.01
Thickness of unsaturated zone 1	8	0.03	8	0.01	15	0.02	15	0.00
b Parameter of unsaturated zone 1	12	-0.02	12	-0.01	20	0.00	20	0.00
Indoor dust filtration factor	10	0.03	10	0.01	24	0.00	24	0.00
External gamma shielding factor	17	0.01	17	0.00	13	0.02	13	0.01
Depth of soil mixing layer	2	-0.88	2	-0.63	1	-0.93	1	-0.70
Depth of roots	4	-0.22	4	-0.08	4	-0.32	4	-0.09
Wet weight crop yield of fruit, grain and non-leafy vegetables	20	0.00	20	0.00	7	-0.03	7	-0.01
Weathering removal constant of all vegetation	14	-0.02	14	-0.01	18	-0.01	18	0.00
Mass loading for inhalation	13	0.02	13	0.01	23	0.00	23	0.00
Wet foliar interception fraction of leafy vegetables	23	0.00	23	0.00	16	-0.01	16	0.00
Kd of Fe-55 in Contaminated Zone	11	0.02	11	0.01	10	0.03	10	0.01
Kd of Fe-55 in Unsaturated Zone 1	16	-0.02	16	-0.01	14	-0.02	14	0.00
Kd of Fe-55 in Saturated Zone	18	-0.01	18	0.00	21	0.00	21	0.00
Plant transfer factor for Fe	3	0.36	3	0.14	3	0.38	3	0.11
Meat transfer factor for Fe	1	0.89	1	0.68	2	0.92	2	0.64
Milk transfer factor for Fe	5	0.04	5	0.01	5	0.04	5	0.01
Fish transfer factor for Fe	9	-0.03	9	-0.01	8	-0.03	8	-0.01

H-3 Results:

1 RESRAD Regression and Correlation output 01/25/22 15:49 Page: Coef 1
Title : CR3 Sensitivity Analysis -H3
Input File : CR3_SA_H3.RAD

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	Coeff	SRC 1 Sig	Coeff	PRCC 1 Sig	Coeff	SRRC 1 Sig	Coeff
Contaminated zone b parameter	11	0.02	11	0.02	16	0.02	16	0.01
Evapotranspiration coefficient	17	-0.01	17	-0.01	17	0.02	17	0.01
Irrigation	8	-0.03	8	-0.02	4	-0.13	4	-0.07
Saturated zone hydraulic gradient	3	-0.19	3	-0.16	2	-0.69	2	-0.52
Saturated zone b parameter	7	-0.03	7	-0.03	5	-0.05	5	-0.03
Well pump intake depth	2	-0.22	2	-0.19	3	-0.27	3	-0.15
Well pumping rate	13	0.02	13	0.02	13	0.02	13	0.01
Thickness of unsaturated zone 1	18	-0.01	18	-0.01	19	-0.01	19	-0.01
b Parameter of unsaturated zone 1	21	-0.01	21	-0.01	23	-0.01	23	0.00
Indoor dust filtration factor	23	0.01	23	0.01	6	0.05	6	0.03
External gamma shielding factor	12	0.02	12	0.02	21	-0.01	21	-0.01
Depth of soil mixing layer	10	0.02	10	0.02	20	0.01	20	0.01
Depth of roots	1	-0.49	1	-0.47	1	-0.75	1	-0.63
Wet weight crop yield of fruit, grain and non-leafy vegetables	9	0.03	9	0.02	12	0.02	12	0.01
Weathering removal constant of all vegetation	14	-0.02	14	-0.02	11	-0.02	11	-0.01
Mass loading for inhalation	24	0.00	24	0.00	14	-0.02	14	-0.01
Wet foliar interception fraction of leafy vegetables	5	0.04	5	0.03	18	0.02	18	0.01
Kd of H-3 in Contaminated Zone	16	-0.01	16	-0.01	10	-0.03	10	-0.02
Kd of H-3 in Unsaturated Zone 1	19	-0.01	19	-0.01	24	-0.01	24	0.00
Kd of H-3 in Saturated Zone	4	-0.05	4	-0.04	7	-0.04	7	-0.02
Plant transfer factor for H	22	0.01	22	0.01	22	0.01	22	0.01
Meat transfer factor for H	15	-0.02	15	-0.01	8	-0.04	8	-0.02
Milk transfer factor for H	20	-0.01	20	-0.01	15	0.02	15	0.01
Fish transfer factor for H	6	-0.04	6	-0.03	9	-0.04	9	-0.02

Nb-94 Results:

1 RESRAD Regression and Correlation output 01/26/22 08:20 Page: Coef 1
Title : CR3 Sensitivity Analysis -Nb94
Input File : CR3_SA_NB94.RAD

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	Coeff	SRC 1 Sig	Coeff	PRCC 1 Sig	Coeff	SRRC 1 Sig	Coeff
Contaminated zone b parameter	10	0.03	10	0.00	7	0.03	7	0.00
Evapotranspiration coefficient	5	0.11	5	0.00	4	0.11	4	0.00
Irrigation	9	-0.03	9	0.00	9	-0.02	9	0.00
Saturated zone hydraulic gradient	22	0.01	22	0.00	6	-0.03	6	0.00
Saturated zone b parameter	20	0.01	20	0.00	10	-0.02	10	0.00
Well pump intake depth	8	0.05	8	0.00	18	0.01	18	0.00
Well pumping rate	24	0.00	24	0.00	20	0.01	20	0.00
Thickness of unsaturated zone 1	12	0.03	12	0.00	22	0.00	22	0.00
b Parameter of unsaturated zone 1	13	-0.02	13	0.00	23	0.00	23	0.00
Indoor dust filtration factor	19	0.01	19	0.00	14	0.01	14	0.00
External gamma shielding factor	1	1.00	1	1.00	1	1.00	1	1.00
Depth of soil mixing layer	14	-0.02	14	0.00	17	-0.01	17	0.00
Depth of roots	4	-0.11	4	0.00	5	-0.10	5	0.00
Wet weight crop yield of fruit, grain and non-leafy vegetables	23	0.00	23	0.00	21	-0.01	21	0.00
Weathering removal constant of all vegetation	18	0.01	18	0.00	16	-0.01	16	0.00
Mass loading for inhalation	6	-0.05	6	0.00	19	0.01	19	0.00
Wet foliar interception fraction of leafy vegetables	21	0.01	21	0.00	8	-0.02	8	0.00
Kd of Nb-94 in Contaminated Zone	2	0.21	2	0.00	2	0.48	2	0.01
Kd of Nb-94 in Unsaturated Zone 1	7	-0.05	7	0.00	24	0.00	24	0.00
Kd of Nb-94 in Saturated Zone	11	0.03	11	0.00	11	0.02	11	0.00
Plant transfer factor for Nb	3	0.18	3	0.00	3	0.14	3	0.00
Meat transfer factor for Nb	17	-0.01	17	0.00	15	-0.01	15	0.00
Milk transfer factor for Nb	15	-0.02	15	0.00	12	0.02	12	0.00
Fish transfer factor for Nb	16	-0.02	16	0.00	13	-0.01	13	0.00

Ni-59 Results:

```
1 RESRAD Regression and Correlation output  01/26/22 08:42 Page: Coef    1
 Title      : CR3 Sensitivity Analysis - Ni59
 Input File : CR3_SA_NI59.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	16	0.01	16	0.01	13	0.02	13	0.01
Evapotranspiration coefficient	14	0.01	14	0.01	10	0.02	10	0.01
Irrigation	9	0.02	9	0.01	15	-0.01	15	-0.01
Saturated zone hydraulic gradient	20	0.00	20	0.00	9	0.04	9	0.01
Saturated zone b parameter	5	0.02	5	0.02	11	-0.02	11	-0.01
Well pump intake depth	19	0.01	19	0.00	20	0.00	20	0.00
Well pumping rate	11	0.02	11	0.01	24	0.00	24	0.00
Thickness of Unsaturated zone 1	12	-0.01	12	-0.01	12	-0.02	12	-0.01
b Parameter of Unsaturated zone 1	22	0.00	22	0.00	22	0.00	22	0.00
Indoor dust filtration factor	24	0.00	24	0.00	23	0.00	23	0.00
External gamma shielding factor	8	0.02	8	0.01	18	0.01	18	0.00
Depth of soil mixing layer	4	-0.14	4	-0.10	4	-0.55	4	-0.23
Depth of roots	3	-0.40	3	-0.30	3	-0.76	3	-0.40
Wet weight crop yield of fruit, grain and non-leafy vegetables	10	-0.02	10	-0.01	19	-0.01	19	0.00
Weathering removal constant of all vegetation	13	0.01	13	0.01	8	-0.04	8	-0.01
Mass loading for inhalation	18	-0.01	18	-0.01	16	-0.01	16	0.00
Wet foliar interception fraction of leafy vegetables	15	-0.01	15	-0.01	21	0.00	21	0.00
Kd of Ni-59 in Contaminated Zone	23	0.00	23	0.00	6	0.08	6	0.03
Kd of Ni-59 in Unsaturated Zone 1	7	0.02	7	0.01	17	-0.01	17	0.00
Kd of Ni-59 in Saturated Zone	21	0.00	21	0.00	14	-0.02	14	-0.01
Plant transfer factor for Ni	1	0.59	1	0.51	2	0.84	2	0.53
Meat transfer factor for Ni	17	0.01	17	0.01	5	0.19	5	0.07
Milk transfer factor for Ni	2	0.50	2	0.40	1	0.88	1	0.63
Fish transfer factor for Ni	6	-0.02	6	-0.02	7	-0.04	7	-0.02

Ni-63 Results:

```
1 RESRAD Regression and Correlation output  01/26/22 09:10 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Ni63
 Input File : CR3_SA_NI63.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	16	0.01	16	0.01	13	0.02	13	0.01
Evapotranspiration coefficient	14	0.01	14	0.01	10	0.02	10	0.01
Irrigation	9	0.02	9	0.01	15	-0.01	15	-0.01
Saturated zone hydraulic gradient	20	0.00	20	0.00	9	0.04	9	0.01
Saturated zone b parameter	5	0.02	5	0.02	11	-0.02	11	-0.01
Well pump intake depth	19	0.01	19	0.00	20	0.00	20	0.00
Well pumping rate	11	0.02	11	0.01	24	0.00	24	0.00
Thickness of Unsaturated zone 1	12	-0.01	12	-0.01	12	-0.02	12	-0.01
b Parameter of Unsaturated zone 1	22	0.00	22	0.00	22	0.00	22	0.00
Indoor dust filtration factor	24	0.00	24	0.00	23	0.00	23	0.00
External gamma shielding factor	8	0.02	8	0.01	18	0.01	18	0.00
Depth of soil mixing layer	4	-0.14	4	-0.10	4	-0.55	4	-0.23
Depth of roots	3	-0.40	3	-0.30	3	-0.76	3	-0.40
Wet weight crop yield of fruit, grain and non-leafy vegetables	10	-0.02	10	-0.01	19	-0.01	19	0.00
Weathering removal constant of all vegetation	13	0.01	13	0.01	8	-0.04	8	-0.01
Mass loading for inhalation	18	-0.01	18	-0.01	16	-0.01	16	0.00
Wet foliar interception fraction of leafy vegetables	15	-0.01	15	-0.01	21	0.00	21	0.00
Kd of Ni-63 in Contaminated Zone	23	0.00	23	0.00	6	0.08	6	0.03
Kd of Ni-63 in Unsaturated Zone 1	7	0.02	7	0.01	17	-0.01	17	0.00
Kd of Ni-63 in Saturated Zone	21	0.00	21	0.00	14	-0.02	14	-0.01
Plant transfer factor for Ni	1	0.59	1	0.51	2	0.84	2	0.53
Meat transfer factor for Ni	17	0.01	17	0.01	5	0.19	5	0.07
Milk transfer factor for Ni	2	0.50	2	0.40	1	0.88	1	0.63
Fish transfer factor for Ni	6	-0.02	6	-0.02	7	-0.04	7	-0.02

Pu-238 Results:

```
1 RESRAD Regression and Correlation output  01/28/22 10:01 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Pu238
 Input File : CR3_SA_PU238.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	44	0.01	44	0.01	27	-0.02	27	-0.01
Evapotranspiration coefficient	23	-0.02	23	-0.01	44	-0.01	44	0.00
Irrigation	5	-0.05	5	-0.03	12	-0.03	12	-0.01
Saturated zone hydraulic gradient	39	0.01	39	0.01	40	0.01	40	0.00
Saturated zone b parameter	25	-0.02	25	-0.01	38	0.01	38	0.01
Well pump intake depth	17	0.02	19	0.01	57	0.00	57	0.00
Well pumping rate	31	-0.02	31	-0.01	52	0.00	52	0.00
Thickness of Unsaturated zone 1	12	0.03	12	0.02	11	-0.04	11	-0.01
b Parameter of Unsaturated zone 1	54	0.00	54	0.00	55	0.00	55	0.00
Indoor dust filtration factor	37	0.01	37	0.01	6	0.08	6	0.03
External gamma shielding factor	34	0.02	34	0.01	17	0.03	17	0.01
Depth of soil mixing layer	4	-0.23	4	-0.15	3	-0.65	3	-0.35
Depth of roots	2	-0.53	2	-0.39	2	-0.77	2	-0.49

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Wet weight crop yield of fruit, grain and non-leafy vegetables	28	-0.02	27	-0.01	23	0.02	23	0.01
Weathering removal constant of all vegetation	27	-0.02	28	-0.01	7	-0.05	7	-0.02
Mass loading for inhalation	38	0.01	38	0.01	5	0.10	5	0.04
Wet foliar interception fraction of leafy vegetables	42	-0.01	42	-0.01	14	-0.03	14	-0.01
Kd of Pu-238 in Contaminated Zone	58	0.00	58	0.00	18	0.03	18	0.01
Kd of Pu-238 in Unsaturated Zone 1	13	-0.03	13	-0.02	59	0.00	59	0.00
Kd of Pu-238 in Saturated Zone	8	-0.04	8	-0.03	45	-0.01	45	0.00
Kd of Pb-210 in Contaminated Zone	43	-0.01	43	-0.01	54	0.00	54	0.00
Kd of Pb-210 in Unsaturated Zone 1	47	-0.01	47	-0.01	29	0.02	29	0.01
Kd of Pb-210 in Saturated Zone	29	-0.02	29	-0.01	28	-0.02	28	-0.01
Kd of Ra-226 in Contaminated Zone	35	-0.01	35	-0.01	19	0.02	19	0.01
Kd of Ra-226 in Unsaturated Zone 1	21	-0.02	20	-0.01	16	0.03	16	0.01
Kd of Ra-226 in Saturated Zone	36	-0.01	36	-0.01	42	0.01	42	0.00
Kd of Th-230 in Contaminated Zone	11	0.03	11	0.02	15	0.03	15	0.01
Kd of Th-230 in Unsaturated Zone 1	7	0.04	7	0.03	56	0.00	56	0.00
Kd of Th-230 in Saturated Zone	10	-0.04	10	-0.02	32	0.02	32	0.01
Kd of U-234 in Contaminated Zone	57	0.00	57	0.00	48	0.01	48	0.00
Kd of U-234 in Unsaturated Zone 1	15	-0.03	15	-0.02	22	0.02	22	0.01
Kd of U-234 in Saturated Zone	50	0.01	50	0.01	49	0.00	49	0.00
Plant transfer factor for Pu	1	0.67	1	0.56	1	0.85	1	0.67
Meat transfer factor for Pu	3	0.51	3	0.36	4	0.25	4	0.10
Milk transfer factor for Pu	18	0.02	17	0.01	25	-0.02	25	-0.01
Fish transfer factor for Pu	20	0.02	21	0.01	43	0.01	43	0.00
Plant transfer factor for Pb	19	0.02	18	0.01	47	-0.01	47	0.00
Meat transfer factor for Pb	46	0.01	46	0.01	50	0.00	50	0.00
Milk transfer factor for Pb	30	-0.02	30	-0.01	51	0.00	51	0.00
Fish transfer factor for Pb	41	0.01	41	0.01	39	0.01	39	0.00
Plant transfer factor for Ra	45	-0.01	45	-0.01	35	-0.01	35	-0.01
Meat transfer factor for Ra	55	0.00	55	0.00	24	-0.02	24	-0.01
Milk transfer factor for Ra	6	0.05	6	0.03	53	0.00	53	0.00
Fish transfer factor for Ra	52	0.01	52	0.00	30	0.02	30	0.01
Plant transfer factor for Th	26	0.02	26	0.01	34	-0.01	34	-0.01
Meat transfer factor for Th	9	0.04	9	0.02	46	0.01	46	0.00
Milk transfer factor for Th	48	-0.01	48	-0.01	8	0.04	8	0.02
Fish transfer factor for Th	40	0.01	40	0.01	36	-0.01	36	-0.01
Plant transfer factor for U	16	0.02	16	0.01	31	0.02	31	0.01
Meat transfer factor for U	14	0.03	14	0.02	9	0.04	9	0.02
Milk transfer factor for U	59	0.00	59	0.00	20	0.02	20	0.01
Fish transfer factor for U	56	0.00	56	0.00	33	0.01	33	0.01
Kd of Po-210 in Contaminated Zone	49	-0.01	49	-0.01	26	-0.02	26	-0.01
Kd of Po-210 in Unsaturated Zone 1	24	-0.02	24	-0.01	13	0.03	13	0.01
Kd of Po-210 in Saturated Zone	53	0.01	53	0.00	10	-0.04	10	-0.01
Plant transfer factor for Po	33	-0.02	33	-0.01	21	0.02	21	0.01
Meat transfer factor for Po	51	-0.01	51	-0.01	37	-0.01	37	-0.01
Milk transfer factor for Po	32	0.02	32	0.01	41	-0.01	41	0.00
Fish transfer factor for Po	22	0.02	22	0.01	58	0.00	58	0.00

Pu-239 Results:

```
1 RESRAD Regression and Correlation output  01/26/22 11:30 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Pu239
 Input File : CR3_SA_PU239.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	28	0.01	28	0.01	37	0.00	37	0.00
Evapotranspiration coefficient	5	-0.05	5	-0.05	17	-0.02	17	-0.01
Irrigation	41	0.00	41	0.00	36	-0.01	36	0.00
Saturated zone hydraulic gradient	2	0.06	2	0.06	29	0.01	29	0.01
Saturated zone b parameter	26	0.01	26	0.01	31	-0.01	31	0.00
Well pump intake depth	33	0.01	33	0.01	34	-0.01	34	0.00
Well pumping rate	6	0.04	6	0.04	25	0.01	25	0.01
Thickness of Unsaturated zone 1	21	-0.02	21	-0.02	45	0.00	45	0.00
b Parameter of Unsaturated zone 1	43	0.00	43	0.00	42	0.00	42	0.00
Indoor dust filtration factor	45	0.00	45	0.00	6	0.07	6	0.03
External gamma shielding factor	16	0.02	16	0.02	35	-0.01	35	0.00
Depth of soil mixing layer	8	-0.04	8	-0.04	3	-0.62	3	-0.34
Depth of roots	4	-0.05	4	-0.05	2	-0.74	2	-0.48
Wet weight crop yield of fruit, grain and non-leafy vegetables	19	-0.02	19	-0.02	40	0.00	40	0.00
Weathering removal constant of all vegetation	30	-0.01	30	-0.01	15	-0.03	15	-0.01
Mass loading for inhalation	35	0.01	35	0.01	9	0.06	9	0.03
Wet foliar interception fraction of leafy vegetables	24	-0.02	24	-0.02	27	0.01	27	0.01
Kd of Pu-239 in Contaminated Zone	22	-0.02	22	-0.02	39	0.00	39	0.00
Kd of Pu-239 in Unsaturated Zone 1	7	-0.04	7	-0.04	5	-0.09	5	-0.04
Kd of Pu-239 in Saturated Zone	9	-0.03	9	-0.03	8	-0.06	8	-0.03
Kd of Ac-227 in Contaminated Zone	12	-0.03	12	-0.03	13	-0.03	13	-0.01
Kd of Ac-227 in Unsaturated Zone 1	15	-0.02	15	-0.02	11	-0.03	11	-0.01
Kd of Ac-227 in Saturated Zone	11	-0.03	11	-0.03	16	0.02	16	0.01
Kd of Pa-231 in Contaminated Zone	20	-0.02	20	-0.02	43	0.00	43	0.00
Kd of Pa-231 in Unsaturated Zone 1	36	-0.01	36	-0.01	26	0.01	26	0.01
Kd of Pa-231 in Saturated Zone	44	0.00	44	0.00	10	0.04	10	0.02
Kd of U-235 in Contaminated Zone	42	0.00	42	0.00	44	0.00	44	0.00
Kd of U-235 in Unsaturated Zone 1	29	-0.01	29	-0.01	20	-0.02	20	-0.01
Kd of U-235 in Saturated Zone	40	0.00	40	0.00	21	-0.02	21	-0.01
Plant transfer factor for Pu	3	0.05	3	0.05	1	0.84	1	0.67
Meat transfer factor for Pu	23	0.02	23	0.02	4	0.19	4	0.08
Milk transfer factor for Pu	17	-0.02	17	-0.02	32	-0.01	32	0.00
Fish transfer factor for Pu	14	0.02	14	0.02	22	0.02	22	0.01
Plant transfer factor for Ac	32	0.01	32	0.01	7	0.06	7	0.03
Meat transfer factor for Ac	27	-0.01	27	-0.01	38	0.00	38	0.00
Milk transfer factor for Ac	34	-0.01	34	-0.01	19	-0.02	19	-0.01
Fish transfer factor for Ac	25	-0.02	25	-0.02	33	-0.01	33	0.00
Plant transfer factor for Pa	38	0.01	38	0.01	23	-0.02	23	-0.01
Meat transfer factor for Pa	13	-0.02	13	-0.02	14	0.03	14	0.01
Milk transfer factor for Pa	39	-0.01	39	-0.01	24	0.01	24	0.01
Fish transfer factor for Pa	31	0.01	31	0.01	12	-0.03	12	-0.01
Plant transfer factor for U	10	-0.03	10	-0.03	30	-0.01	30	0.00
Meat transfer factor for U	18	0.02	18	0.02	28	0.01	28	0.01
Milk transfer factor for U	37	0.01	37	0.01	18	0.02	18	0.01
Fish transfer factor for U	1	0.08	1	0.08	41	0.00	41	0.00
R-SQUARE		0.03		0.03		0.81		0.81

Pu-240 Results:

```
1 RESRAD Regression and Correlation output  01/28/22 09:02 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Pu240
 Input File : CR3_SA_PU240.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	13	-0.02	13	-0.02	43	0.00	43	0.00
Evapotranspiration coefficient	27	0.01	27	0.01	24	-0.02	24	-0.01
Irrigation	20	0.01	20	0.01	42	0.00	42	0.00
Saturated zone hydraulic gradient	31	0.01	31	0.01	28	0.02	28	0.01
Saturated zone b parameter	18	-0.01	18	-0.01	39	0.01	39	0.00
Well pump intake depth	15	0.02	15	0.02	44	0.00	44	0.00
Well pumping rate	1	0.04	1	0.04	36	0.01	36	0.00
Thickness of Unsaturated zone 1	9	-0.02	9	-0.02	41	-0.01	41	0.00
b Parameter of Unsaturated zone 1	38	0.00	38	0.00	40	-0.01	40	0.00
Indoor dust filtration factor	21	-0.01	21	-0.01	13	0.03	13	0.02
External gamma shielding factor	3	0.03	3	0.03	15	0.03	15	0.01
Depth of soil mixing layer	46	0.00	46	0.00	3	-0.56	3	-0.32
Depth of roots	29	0.01	29	0.01	2	-0.71	2	-0.47
Wet weight crop yield of fruit, grain and non-leafy vegetables	22	-0.01	22	-0.01	14	-0.03	14	-0.02
Weathering removal constant of all vegetation	14	0.02	14	0.02	30	-0.02	30	-0.01
Mass loading for inhalation	16	0.01	16	0.01	5	0.10	5	0.05
Wet foliar interception fraction of leafy vegetables	6	-0.02	6	-0.02	26	0.02	26	0.01
Kd of Pu-240 in Contaminated Zone	10	-0.02	10	-0.02	22	0.02	22	0.01
Kd of Pu-240 in Unsaturated Zone 1	12	-0.02	12	-0.02	6	-0.09	6	-0.04
Kd of Pu-240 in Saturated Zone	11	-0.02	11	-0.02	7	-0.08	7	-0.04
Kd of Ra-228 in Contaminated Zone	36	0.00	36	0.00	32	-0.01	32	-0.01
Kd of Ra-228 in Unsaturated Zone 1	48	0.00	48	0.00	19	-0.02	19	-0.01
Kd of Ra-228 in Saturated Zone	34	0.00	34	0.00	34	0.01	34	0.01
Kd of Th-228 in Contaminated Zone	23	-0.01	23	-0.01	37	0.01	37	0.00
Kd of Th-228 in Unsaturated Zone 1	45	0.00	45	0.00	23	0.02	23	0.01
Kd of Th-228 in Saturated Zone	26	-0.01	26	-0.01	9	-0.05	9	-0.03
Kd of Th-232 in Contaminated Zone	33	0.00	33	0.00	25	-0.02	25	-0.01
Kd of Th-232 in Unsaturated Zone 1	39	0.00	39	0.00	11	0.04	11	0.02
Kd of Th-232 in Saturated Zone	30	-0.01	30	-0.01	17	-0.03	17	-0.01
Kd of U-236 in Contaminated Zone	25	-0.01	25	-0.01	29	0.02	29	0.01
Kd of U-236 in Unsaturated Zone 1	28	-0.01	28	-0.01	47	0.00	47	0.00
Kd of U-236 in Saturated Zone	24	0.01	24	0.01	31	0.01	31	0.01
Plant transfer factor for Pu	32	0.00	32	0.00	1	0.82	1	0.66
Meat transfer factor for Pu	37	0.00	37	0.00	4	0.23	4	0.11
Milk transfer factor for Pu	2	0.03	2	0.03	20	0.02	20	0.01
Fish transfer factor for Pu	19	0.01	19	0.01	46	0.00	46	0.00
Plant transfer factor for Ra	47	0.00	47	0.00	21	0.02	21	0.01
Meat transfer factor for Ra	5	0.02	5	0.02	10	-0.04	10	-0.02
Milk transfer factor for Ra	42	0.00	42	0.00	18	0.02	18	0.01
Fish transfer factor for Ra	40	0.00	40	0.00	12	-0.04	12	-0.02
Plant transfer factor for Th	4	-0.02	4	-0.02	16	0.03	16	0.01
Meat transfer factor for Th	17	-0.01	17	-0.01	33	0.01	33	0.01
Milk transfer factor for Th	44	0.00	44	0.00	48	0.00	48	0.00
Fish transfer factor for Th	41	0.00	41	0.00	38	0.01	38	0.00
Plant transfer factor for U	7	-0.02	7	-0.02	27	-0.02	27	-0.01
Meat transfer factor for U	8	-0.02	8	-0.02	45	0.00	45	0.00
Milk transfer factor for U	43	0.00	43	0.00	35	0.01	35	0.00
Fish transfer factor for U	35	0.00	35	0.00	8	-0.06	8	-0.03

Pu-241 Results:

```
1 RESRAD Regression and Correlation output  01/26/22 14:49 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Pu241
 Input File : CR3_SA_PU241.RAD
```

Coefficients for peak All Pathways Dose
Coefficient =
Repetition =

Description of Probabilistic Variable	PCC 1 Sig	PCC 1 Coeff	SRC 1 Sig	SRC 1 Coeff	PRCC 1 Sig	PRCC 1 Coeff	SRRC 1 Sig	SRRC 1 Coeff
Contaminated zone b parameter	30	-0.02	30	-0.01	40	0.01	40	0.01
Evapotranspiration coefficient	12	0.04	12	0.02	30	0.02	30	0.01
Irrigation	42	-0.01	42	-0.01	19	-0.04	19	-0.02
Saturated zone hydraulic gradient	39	-0.01	39	-0.01	13	0.04	13	0.02
Saturated zone b parameter	24	0.02	23	0.01	20	0.04	20	0.02
Well pump intake depth	22	0.02	22	0.01	43	-0.01	43	0.00
Well pumping rate	41	0.01	41	0.01	49	0.00	49	0.00
Thickness of Unsaturated zone 1	44	0.01	44	0.00	24	0.03	24	0.02
b Parameter of Unsaturated zone 1	40	-0.01	40	-0.01	18	-0.04	18	-0.02
Indoor dust filtration factor	21	0.03	21	0.02	23	0.03	23	0.02
External gamma shielding factor	8	0.06	8	0.03	7	0.09	7	0.05
Depth of soil mixing layer	5	-0.20	5	-0.12	3	-0.56	3	-0.33
Depth of roots	1	-0.61	1	-0.47	1	-0.75	1	-0.56
Wet weight crop yield of fruit, grain and non-leafy vegetables	13	0.04	13	0.02	28	0.02	28	0.01
Weathering removal constant of all vegetation	11	-0.04	11	-0.03	25	-0.03	25	-0.01
Mass loading for inhalation	9	0.05	9	0.03	14	0.04	14	0.02
Wet foliar interception fraction of leafy vegetables	14	-0.03	14	-0.02	31	-0.02	31	-0.01
Kd of Pu-241 in Contaminated Zone	15	0.03	15	0.02	5	0.24	5	0.12
Kd of Pu-241 in Unsaturated Zone 1	7	0.06	7	0.04	22	-0.03	22	-0.02
Kd of Pu-241 in Saturated Zone	18	0.03	18	0.02	15	0.04	15	0.02
Kd of Am-241 in Contaminated Zone	28	0.02	27	0.01	6	0.18	6	0.09
Kd of Am-241 in Unsaturated Zone 1	37	-0.01	37	-0.01	39	0.01	39	0.01
Kd of Am-241 in Saturated Zone	43	-0.01	43	-0.01	37	-0.01	37	-0.01
Kd of Np-237 in Contaminated Zone	19	0.03	19	0.02	16	0.04	16	0.02
Kd of Np-237 in Unsaturated Zone 1	52	0.00	52	0.00	46	0.00	46	0.00
Kd of Np-237 in Saturated Zone	20	-0.03	20	-0.02	41	-0.01	41	0.00
Kd of Th-229 in Contaminated Zone	50	-0.01	50	0.00	42	-0.01	42	0.00
Kd of Th-229 in Unsaturated Zone 1	6	0.06	6	0.04	36	-0.01	36	-0.01
Kd of Th-229 in Saturated Zone	45	-0.01	45	0.00	32	-0.02	32	-0.01
Kd of U-233 in Contaminated Zone	25	-0.02	25	-0.01	26	0.03	26	0.01
Kd of U-233 in Unsaturated Zone 1	47	0.01	47	0.00	47	0.00	47	0.00
Kd of U-233 in Saturated Zone	49	-0.01	49	0.00	34	0.02	34	0.01

Plant transfer factor for Pu	3	0.50	3	0.35	4	0.50	4	0.28
Meat transfer factor for Pu	4	0.43	4	0.28	9	0.07	9	0.03
Milk transfer factor for Pu	27	0.02	28	0.01	33	0.02	33	0.01
Fish transfer factor for Pu	48	0.01	48	0.00	51	0.00	51	0.00
Plant transfer factor for Am	2	0.58	2	0.43	2	0.68	2	0.46
Meat transfer factor for Am	51	0.00	51	0.00	11	0.06	11	0.03
Milk transfer factor for Am	23	-0.02	24	-0.01	35	0.02	35	0.01
Fish transfer factor for Am	33	-0.02	33	-0.01	17	-0.04	17	-0.02
Plant transfer factor for Np	31	-0.02	31	-0.01	12	0.05	12	0.03
Meat transfer factor for Np	17	0.03	17	0.02	8	0.08	8	0.04
Milk transfer factor for Np	35	-0.01	36	-0.01	52	0.00	52	0.00
Fish transfer factor for Np	16	-0.03	16	-0.02	21	-0.03	21	-0.02
Plant transfer factor for Th	34	-0.02	34	-0.01	38	0.01	38	0.01
Meat transfer factor for Th	26	0.02	26	0.01	50	0.00	50	0.00
Milk transfer factor for Th	29	0.02	29	0.01	27	0.02	27	0.01
Fish transfer factor for Th	32	-0.02	32	-0.01	29	-0.02	29	-0.01
Plant transfer factor for U	46	-0.01	46	0.00	45	0.00	45	0.00
Meat transfer factor for U	10	0.05	10	0.03	10	0.06	10	0.03
Milk transfer factor for U	38	-0.01	38	-0.01	44	0.01	44	0.00
Fish transfer factor for U	36	-0.01	35	-0.01	48	0.00	48	0.00

Sr-90 Results:

```
1 RESRAD Regression and Correlation output  01/28/22 07:46 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Sr90
 Input File : CR3_SA_SR90.RAD
```

Coefficients for peak All Pathways Dose
Coefficient = PCC 1, SRC 1, PRCC 1, SRRC 1
Repetition = 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Contaminated zone b parameter	7	0.02	7	0.01	13	-0.01	13	0.00
Evapotranspiration coefficient	14	0.01	14	0.01	6	0.08	6	0.02
Irrigation	21	0.00	21	0.00	18	0.00	18	0.00
Saturated zone hydraulic gradient	8	0.02	8	0.01	22	0.00	22	0.00
Saturated zone b parameter	11	0.02	11	0.01	23	0.00	23	0.00
Well pump intake depth	17	0.01	17	0.01	21	0.00	21	0.00
Well pumping rate	12	0.02	12	0.01	15	-0.01	15	0.00
Thickness of Unsaturated zone 1	6	-0.02	6	-0.02	14	0.01	14	0.00
b Parameter of Unsaturated zone 1	20	0.00	20	0.00	11	-0.02	11	0.00
Indoor dust filtration factor	19	0.00	19	0.00	10	0.02	10	0.00
External gamma shielding factor	4	0.03	4	0.02	24	0.00	24	0.00
Depth of soil mixing layer	5	-0.03	5	-0.02	8	-0.04	8	-0.01
Depth of roots	2	-0.50	2	-0.36	2	-0.89	2	-0.51
Wet weight crop yield of fruit, grain and non-leafy vegetables	24	0.00	24	0.00	12	-0.01	12	0.00
Weathering removal constant of all vegetation	10	0.02	10	0.01	9	-0.04	9	-0.01
Mass loading for inhalation	22	0.00	22	0.00	17	0.01	17	0.00
Wet foliar interception fraction of leafy vegetables	16	0.01	16	0.01	19	0.00	19	0.00
Kd of Sr-90 in Contaminated Zone	15	0.01	15	0.01	3	0.30	3	0.08
Kd of Sr-90 in Unsaturated Zone 1	23	0.00	23	0.00	20	0.00	20	0.00
Kd of Sr-90 in Saturated Zone	18	-0.01	18	-0.01	16	-0.01	16	0.00
Plant transfer factor for Sr	1	0.73	1	0.68	1	0.95	1	0.82
Meat transfer factor for Sr	13	-0.01	13	-0.01	5	0.16	5	0.04
Milk transfer factor for Sr	3	0.08	3	0.05	4	0.24	4	0.06
Fish transfer factor for Sr	9	-0.02	9	-0.01	7	-0.04	7	-0.01

Tc-99 Results:

```
1 RESRAD Regression and Correlation output  01/26/22 15:12 Page: Coef    1
 Title      : CR3 Sensitivity Analysis -Tc99
 Input File : CR3_SA_TC99.RAD
```

Coefficients for peak All Pathways Dose
Coefficient = PCC 1, SRC 1, PRCC 1, SRRC 1
Repetition = 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Contaminated zone b parameter	10	0.03	10	0.03	18	0.01	18	0.01
Evapotranspiration coefficient	6	0.04	6	0.03	5	0.21	5	0.11
Irrigation	21	0.01	21	0.01	21	0.00	21	0.00
Saturated zone hydraulic gradient	18	0.01	18	0.01	4	-0.39	4	-0.22
Saturated zone b parameter	15	-0.02	15	-0.01	24	0.00	24	0.00
Well pump intake depth	5	-0.05	5	-0.04	7	-0.16	7	-0.09
Well pumping rate	22	0.00	22	0.00	23	0.00	23	0.00
Thickness of Unsaturated zone 1	14	-0.02	14	-0.02	12	-0.04	12	-0.02
b Parameter of Unsaturated zone 1	17	0.01	17	0.01	19	0.00	19	0.00
Indoor dust filtration factor	12	-0.02	12	-0.02	22	0.00	22	0.00
External gamma shielding factor	9	0.03	9	0.03	20	0.00	20	0.00
Depth of soil mixing layer	19	0.01	19	0.01	11	0.04	11	0.02
Depth of roots	2	-0.30	2	-0.27	3	-0.57	3	-0.36
Wet weight crop yield of fruit, grain and non-leafy vegetables	8	0.03	8	0.03	14	0.03	14	0.01
Weathering removal constant of all vegetation	24	0.00	24	0.00	10	-0.05	10	-0.03
Mass loading for inhalation	23	0.00	23	0.00	17	-0.02	17	-0.01
Wet foliar interception fraction of leafy vegetables	20	0.01	20	0.01	16	0.02	16	0.01
Kd of Tc-99 in Contaminated Zone	3	0.19	3	0.16	2	0.70	2	0.51
Kd of Tc-99 in Unsaturated Zone 1	11	-0.02	11	-0.02	8	-0.15	8	-0.08
Kd of Tc-99 in Saturated Zone	16	-0.02	16	-0.01	6	-0.17	6	-0.09
Plant transfer factor for Tc	1	0.48	1	0.46	1	0.71	1	0.52
Meat transfer factor for Tc	7	-0.04	7	-0.03	15	-0.03	15	-0.01
Milk transfer factor for Tc	4	0.06	4	0.05	9	0.10	9	0.05
Fish transfer factor for Tc	13	0.02	13	0.02	13	0.03	13	0.02

Enclosure 9

BHI Energy Engineering Calculation

"RESRAD-Build Input Parameter Sensitivity Analysis – Crystal River 3"

ENG-CR3-002

Revision 0

January 2022

BEGINS ON NEXT PAGE

BHI ENERGY ENGINEERING CALCULATION

RESRAD-Build Input Parameter Sensitivity Analysis – Crystal River 3

ENG-CR3-002

Revision: 0

January, 2022

Prepared by:
BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA

Prepared by	Joseph Bissm
Approved by	

1.0 PURPOSE

This calculation identifies sensitive input parameters (i.e., those input parameters that produce a significant change in the calculated dose with changes in their value) in the evaluation of the building occupancy scenario using the RESRAD-Build code (version 3.5). Identification of sensitive input parameters is a necessary process to account for uncertainty in input values. The uncertainty associated with sensitive input parameters is addressed in subsequent DCGL calculations by determining and assigning reasonably conservative input values from the results of RESRAD-Build probabilistic analyses. Thus, the results of this calculation support the development of building surface derived concentration guideline levels (DCGLs) for the Crystal River 3 (CR3) site.

2.0 APPLICABILITY

This calculation addresses only the sensitivity analysis for input parameters for the building occupancy scenario as defined for the CR3 site.

3.0 REFERENCES

3.1 BHI Energy Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 User's Manual for RESRAD-Build Version 3.0, June 2003 (ANL/EAD/03-1)

3.3 NUREG/CR-7267, *Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes*, February 2020

3.4 NUREG/CR-5512, *Residual Radioactive Contamination from Decommissioning*

3.4.1 Volume 1: *Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, Oct. 1992 (PNL-7994)

3.4.2 Volume 3, *Residual Radioactive Contamination from Decommissioning: Parameter Analysis*, Draft Report for Comment, October 1999

3.5 NUREG/CR-6697, *Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes*, November 2000

3.6 NUREG/CR-6755, *Technical Basis for Calculating Radiation Doses for the Building Occupancy Scenario Using the Probabilistic RESRAD-Build 3.0 Code*, February 2002 (ANL/EAD/TM/02-1)

3.7 *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection For DCGL Development*, June 21, 2021

3.8 NUREG/CR-6676, *Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes*, May 2000

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Build code version 3.5 was verified on each computer use for code executions in accordance with the BHI Energy Engineering procedure ENG-AP-02, *Verification of Software Operability* [3.1]. The RESRAD-Build User's Manual [3.2] provided guidance for code operation.

The sensitivity analysis for the building scenario input parameters was performed using Version 3.5 of the RESRAD-Build computer code, which was developed by Argonne National Laboratory under the sponsorship of the U.S. Department of Energy and other federal agencies. The probabilistic modules in RESRAD-Build permit the user to perform a sensitivity analysis to identify those parameters that have the greatest impact on dose. Verification of the RESRAD-Build code is documented in the RESRAD-Build User's Manual and testing for the probabilistic codes is discussed in NUREG/CR-7267 [3.3].

The exposure scenario modeled in this calculation is the building occupancy scenario, which provides estimates of human radiation exposures to residual radioactivity on surfaces inside standing buildings and permits the determination of DCGLs for building surfaces. The exposure pathways considered are:

- direct external exposure from the source (i.e., radioactive material deposited on the floor, walls, and ceiling),
- external exposure from deposited material,
- external exposure due to air submersion,
- exposure due to inhalation of airborne radioactive material, and
- ingestion of radioactive material directly from the sources and material deposited on the surfaces.

Input parameters were treated as either deterministic (a single value is assigned) or stochastic (a probability distribution is assigned).

- Behavioral and metabolic parameters were treated as deterministic, and the assigned values were from NUREG/CR-5512, volume 3 [3.4.2], NUREG/CR-7267, or the RESRAD-Build User's Manual.
- Physical parameters were assigned the priority values provided in NUREG/CR-6697 [3.6]. Priority 1 and 2 physical parameters were treated stochastic and assigned probability distributions from NUREG/CR-5512, volume 3, NUREG/CR-7267, NUREG/CR-6755 [3.6], or assigned a deterministic value from NUREG/CR-5512, volume 3, NUREG/CR-7267, or NUREG/CR-6755. Priority 3 physical parameters were treated as deterministic and were assigned values from NUREG/CR-5512, volume 3, NUREG/CR-7267, NUREG/CR-6755, or the RESRAD-Build User's Manual.

RESRAD-Build parameter sensitivity analysis was performed for each radionuclide-of-concern (ROC).

The RESRAD-Build Probabilistic Output Report provides regression and correlation coefficients for the average doses at the user defined evaluation times. The Partial Rank Correlation Coefficient (PRCC) has been used to identify sensitive parameters. NUREG/CR-7267 and NUREG/CR-6697 recommend the use of the PRCC for cases where non-linear relationships exist. PRCC values greater than zero (positive value) or less than zero (negative value) identify whether sensitive parameters are positively or negatively correlated to dose, respectively.

The criterion for sensitivity used in this calculation was a PRCC value with an absolute value equal to or greater than 0.1. To address the uncertainties associated with the input parameters identified as "sensitive," the 25th percentile value of the parameter's distribution was selected for sensitive parameters that had a negative PRCC value, and the 75th percentile value of the parameter's distribution was selected for sensitive parameters that had a positive PRCC value. The 75th percentile and 25th percentile values are recommended as reasonably conservative input values for calculations of DCGL values for buildings/structures at the CR3 site. The approach of assigning 25th and 75th percentile values of a sensitive parameter's distribution has been found acceptable as a reasonably conservative approach by the U.S. Nuclear Regulatory Commission (NRC) and State regulators.

5.0 ASSUMPTIONS AND INPUT

5.1 Assumptions

5.1.1 Building Scenario description: The RESRAD-Build code v3.5 was used to model the building occupancy scenario defined in NUREG/CR-5512, volume 1 [3.4.2]. Five exposure pathways are assumed active: (i) direct external exposure from the source (i.e., radioactive material deposited on the floor, walls, and ceiling), (ii) external exposure from deposited material, (iii) external exposure due to air submersion, (iv) exposure due to inhalation of airborne radioactive material, and (v) ingestion of radioactive material directly from the sources and material deposited on the surfaces.

5.1.2 Nineteen ROCs have been identified for the CR3 site [3.7] and are shown in Table 1 below.

Table 1. Radionuclide Input for RESRAD-Build

ROC[a]	Progeny[b]	ROC[a]	Progeny[b]
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-59	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Ni-63	---
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sr-90	---
Fe-55	---	Tc-99	---
H-3	---		

[a] ROC identified for the CR3 site [3.7].
[b] Progeny radionuclides automatically included with ROC input.

5.1.3 The hypothetical worker is assumed to perform activities inside an office room for a full occupational year; 45 hours per week for 52 weeks.

5.1.4 The representative room modeled for the CR3 site is based on the room described for the occupancy scenario in Volume 1 of NUREG/CR-5512 and in NUREG/CR-6755 [3.6]: an 8m by 8m room with 3m walls. This room includes 6 area sources (i.e. floor, 4 walls, and ceiling).

5.2 Input

Table 2 summarizes the classification, prioritization, values, and their bases for all input parameters.

Values from NUREG/CR-5512, volume 3, and NUREG/CR-7267, NUREG/CR-6755, were assigned for the following scenario-defined parameters:

- Exposure duration: 365.25 d
- Indoor fraction: 0.267
- Inhalation rate: 33.6 m^3/d
- Receptor location (center of room, x, y, z coordinates): 4m, 4m, 1.0m
- Air fraction: 1.0 for H-3 (triangular distribution used for all other nuclides)
- Removable fraction: 0.1 (all ROCs)

- Room area: 64 m^2
- Room height: 3 m
- Receptor location: center
- Location of center of source: center point of floor, walls, and ceiling

Statistical distributions from NUREG/CR-7267 and NUREG/CR-6755 provided input for:

- deposition velocity,
- air exchange rate for room,
- re-suspension rate,
- indirect ingestion rate,
- air release fraction, and
- time for source removal.

An input correlation of 0.9 between the deposition velocity and the resuspension rate was applied based on guidance in NUREG/CR-6676 [3.8]. In addition, because the sources are assumed constructed of the same material and subject to the same environment, an input correlation of 0.9 was applied for the time for source removal between sources.

6.0 CALCULATIONS AND RESULTS

6.1 Room dimensions: dimensions of a representative room are 8m by 8m by 3m.

6.2 Direct ingestion rate (h^{-1}) is based on the direct ingestion rate given in NUREG/CR-6755: 4.91E-07 h^{-1}.

6.3 Using the dimensions for the modelled room, the locations of the centers of the sources were determined as the mid-point on the X, Y, and Z-axes.

Source No.	Source Description	Location of Center of Source (m)		
		X-axis	Y-axis	Z-axis
1	Floor	4	4	0
2	Wall 1	4	0	1.5
3	Wall 2	0	4	1.5
4	Wall 3	4	8	1.5
5	Wall 4	8	4	1.5
6	Ceiling	4	4	3

6.4 RESRAD-Build v3.5 results: Table 2 summarizes the input used in RESRAD-Build code executions. Appendix A provides copies of selected pages from the RESRAD-Build uncertainty reports.

6.4.1 Each of the ROCs listed in Table 1 was evaluated in separate code executions.

6.5 PRCC values were reviewed against the sensitivity criterion (i.e., $|PRCC| \geq 0.1$). The building air exchange rate, and the air release fraction were identified as sensitive input parameters for all ROCs. Table 3 summarizes the sensitive parameters by radionuclide.

NOTE

In DCGL calculations, 25th or 75th percentile values will be input values for ROCs for which one of the above-listed parameters was identified as sensitive. The 50th percentile value will be used as input if a parameter is not identified as sensitive.

6.6 The 25th, 50th, and 75th percentile values are obtained from the RESRAD-Build probabilistic results. Table 4 presents these values.

7.0 CONCLUSION

7.1 The building air exchange rate, deposition velocity, resuspension rate, ingestion rate, time of source removal, and the air release fraction are sensitive parameters for one or more of the ROCs in the modelling of the building occupancy scenario using RESRAD-Build.

7.2 The building air exchange rate (LAMDAT), deposition velocity (UD), resuspension rate (DKSUS), and ingestion rate (INGE) characterize the room. The uncertainty in the input values for each of these parameters was considered by applying the 25th or 75th percentile value to all 6 sources if a parameter was identified as sensitive for any one of the 6 sources.

7.3 The source removal time (RFO) and air fraction (AIRFR) characterize the source. Use of the 25th and 75th percentile values provided conservative input to account for the uncertainty in parameter value when the parameter was identified as sensitive.

7.4 The 25th and 75th percentile values from the distributions for sensitive input parameters are recommended for use as input for calculating building surfaces DCGLs using RESRAD-Build.

Table 2. Values for RESRAD-Build Parameters

RESRAD-BUILD Input Parameter Values for Sensitivity Analysis Building Occupancy Scenario									
Parameter	**Type**	**Priority**	**Treatment**	**Value or Distribution**	**Value/Distribution Reference Source**	**Distribution's Statistical Parameters[a]**			
						1	**2**	**3**	**4**
Exposure Duration (d)	B	3	D	365.25	NUREG/CR-5512, NUREG/CR-7267				
Indoor Fraction	B	2	D	0.267	NUREG/CR-5512, NUREG/CR-7267				
Evaluation Time (y)	P	3	D	1 or multiple (e.g., 1,10, 50, 100)	T=1 corresponds to dose over the 1st year				
Number of Rooms	P	3	D	1	NUREG/CR-5512 building occupancy scenario assumes one contaminated room				
Deposition Velocity (m/s)	P	2	S	Loguniform	NUREG/CR-6755, NUREG/CR-7267	2.7E-06	2.7E-03	-	-
Resuspension Rate (s^{-1})	P	1	S	Loguniform	NUREG/CR-6755, NUREG/CR-7267	2.5E-11	1.3E-5	-	-
Air Exchange Rate for Room (h^{-1})	B	2	S	Truncated Lognormal	NUREG/CR-6755	0.4187	0.88	0.001	0.999
Room Area (m^2)	P	2	S	64	NUREG/CR-6755				
Room Height (m)	P	2	D	3	NUREG/CR-6755				
Time Fraction	B	3	D	1	Defined as most conservative value in NUREG/CR-7267				
Inhalation Rate (m^3/d)	M	2	D	33.6	NUREG/CR-5512				
Indirect Ingestion Rate (m^2/h)	B	2	S	Loguniform	NUREG/CR-6755, NUREG/CR-7267	2.8E-5	2.9E-4	-	-
Receptor Location x, y, z (m)	B	3	D	4, 4,1	Center of room based on scenario room dimensions defined in NUREG/CR-5512 and NUREG/CR-7267				
Shielding Thickness (cm)	P	2	D	0	No shielding assumed				

RESRAD-BUILD Input Parameter Values for Sensitivity Analysis Building Occupancy Scenario									
Parameter	**Type**	**Priority**	**Treatment**	**Value or Distribution**	**Value/Distribution Reference Source**	**Distribution's Statistical Parameters[a]**			
						1	**2**	**3**	**4**
Shielding Density (g/cm^3)	P	1	D	1	Input value required by code execution – input has **no** impact due to shielding thickness input				
Shielding Material	P	3	D	water	Input value required by code execution – input has **no** impact due to shielding thickness input				
Number of Sources	P	3	D	6	Includes floor, ceiling and 4 walls consistent to scenario assumptions stated in NUREG/CR-7267				
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.12 (FGR-12).				
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.12 (FGR-12).				
Inhalation Dose Conversion Factor, (mrem/pCi)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.11 (FGR-11).				
Ingestion Dose Conversion Factor, (mrem/pCi)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.11 (FGR-11).				
Source 1: Floor									
Type	P	3	D	area	NUREG/CR-5512				
Direction	P	3	D	Z	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 4, 0	Center of floor based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				

RESRAD-BUILD Input Parameter Values for Sensitivity Analysis Building Occupancy Scenario									
Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755, NUREG/CR-5512				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 2: Wall 1									
Type	P	3	D	Area	NUREG/CR-5512				
Direction	P	3	D	Y	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 0, 1.5	Center of wall based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-

RESRAD-BUILD Input Parameter Values for Sensitivity Analysis
Building Occupancy Scenario

Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 3: Wall 2									
Type	P	3	D	Area	NUREG/CR-5512				
Direction	P	3	D	X	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	0, 4, 1.5	center of wall based on dimensions for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 4: Wall 3									
Type	P	3	D	area	NUREG/CR-5512				
Direction	P	3	D	Y	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 8, 1.5	center of wall based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				

RESRAD-BUILD Input Parameter Values for Sensitivity Analysis Building Occupancy Scenario									
Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 5: Wall 4									
Type	P	3	D	area	NUREG/CR-5512				
Direction	P	3	D	X	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	8, 4, 1.5	center of wall based on dimensions for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 6: Ceiling									

RESRAD-BUILD Input Parameter Values for Sensitivity Analysis Building Occupancy Scenario									
Parameter	**Type**	**Priority**	**Treatment**	**Value or Distribution**	**Value/Distribution Reference Source**	**Distribution's Statistical Parameters[a]**			
						1	**2**	**3**	**4**
Type	P	3	D	Area	NUREG/CR-5512				
Direction	P	3	D	Z	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 4, 3	center of ceiling based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-5512, NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-

Table notes:

[a] Distribution Statistical Parameters:

Loguniform: 1= minimum, 2 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Triangular: 1 = minimum, 2 = maximum, 3 = most likely

<u>Input Rank Correlation Coefficients:</u>
Resuspension Rate and Deposition Velocity = 0.9
Time for source removal (correlation set between sources) = 0.9

Table 3: PRCC Values Identifying Sensitive RESRAD-Build Parameters by Radionuclide

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	**DKSUS** (resuspension rate)	**LAMBDAT** (building air exchange rate)	**INGE** (ingestion rate)	**AIRFR**[a] (air fraction)	**RFO** (source Release time)
Am-241	1	NS[b]	NS	-0.92	NS	0.91	-0.53
	2	NS	NS	-0.94	NS	0.92	-0.58
	3	NS	NS	-0.92	-0.11	0.91	-0.55
	4	NS	NS	-0.92	NS	0.91	-0.53
	5	NS	NS	-0.92	NS	0.90	-0.50
	6	NS	NS	-0.91	NS	0.90	-0.48
C-14	1	0.23	-0.45	-0.66	0.24	0.59	0.30
	2	0.28	-0.51	-0.67	0.26	0.58	0.22
	3	0.31	-0.50	-0.63	0.28	0.60	0.27
	4	0.27	-0.49	-0.68	0.24	0.57	0.26
	5	0.27	-0.46	-0.66	0.26	0.62	0.24
	6	0.32	-0.52	-0.66	0.28	0.60	0.30
Cm-243	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.11	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.87
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Cm-244	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.11	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.87
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	**DKSUS** (resuspension rate)	**LAMBDAT** (building air exchange rate)	**INGE** (ingestion rate)	**AIRFR**[a] (air fraction)	**RFO** (source Release time)
Co-60	1	NS	NS	-0.63	NS	0.55	0.54
	2	NS	NS	-0.78	NS	0.74	0.23
	3	0.15	-0.14	-0.77	NS	0.72	0.24
	4	NS	-0.12	-0.79	NS	0.70	0.26
	5	0.12	-0.10	-0.78	NS	0.75	0.23
	6	0.12	-0.11	-0.69	NS	0.64	0.38
Cs-137	1	0.28	-0.35	-0.52	0.16	0.47	0.56
	2	0.38	-0.45	-0.60	0.19	0.53	0.47
	3	0.34	-0.43	-0.56	0.15	0.53	0.47
	4	0.33	-0.41	-0.59	0.24	0.46	0.42
	5	0.35	-0.42	-0.60	0.20	0.52	0.42
	6	0.32	-0.40	-0.57	0.17	0.48	0.45
Eu-152	1	0.10	-0.10	-0.76	NS	0.70	0.35
	2	NS	NS	-0.82	NS	0.82	NS
	3	0.13	-0.11	-0.85	-0.10	0.82	NS
	4	0.13	-0.18	-0.83	NS	0.80	NS
	5	0.22	-0.22	-0.85	NS	0.83	NS
	6	0.10	NS	-0.82	NS	0.78	0.20
Eu-154	1	NS	NS	-0.78	NS	0.72	0.31
	2	NS	NS	-0.83	NS	0.84	NS
	3	0.10	NS	-0.86	NS	0.83	NS
	4	NS	-0.14	-0.83	NS	0.82	NS
	5	0.15	-0.13	-0.84	NS	0.83	NS
	6	NS	NS	-0.83	NS	0.79	0.14
Fe-55	1	NS	NS	-0.85	NS	0.83	NS
	2	NS	NS	-0.84	0.13	0.84	NS
	3	NS	NS	-0.86	NS	0.84	NS
	4	NS	NS	-0.84	NS	0.82	NS
	5	0.11	NS	-0.85	NS	0.84	NS
	6	NS	NS	-0.86	NS	0.83	NS

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	**DKSUS** (resuspension rate)	**LAMBDAT** (building air exchange rate)	**INGE** (ingestion rate)	**AIRFR**[a] (air fraction)	**RFO** (source Release time)
H-3	1	0.44	-0.48	-0.93	0.22	NA - Deterministic value of 1.0 used.	-0.33
	2	0.38	-0.46	-0.93	0.22		-0.22
	3	0.38	-0.45	-0.92	0.25		-0.17
	4	0.43	-0.49	-0.93	0.28		-0.35
	5	0.40	-0.49	-0.93	0.22		-0.21
	6	0.37	-0.43	-0.93	0.23		-0.29
Nb-94	1	NS	-0.24	-0.76	NS	0.71	0.51
	2	0.14	-0.32	-0.85	NS	0.83	-0.33
	3	0.22	-0.33	-0.86	NS	0.81	-0.41
	4	0.23	-0.39	-0.84	NS	0.84	-0.33
	5	0.32	-0.45	-0.86	NS	0.85	-0.27
	6	0.14	-0.26	-0.84	0.10	0.81	0.19
Ni-59	1	NS	-0.20	-0.88	0.19	0.89	-0.64
	2	0.12	-0.23	-0.89	0.19	0.89	-0.69
	3	0.17	-0.26	-0.89	NS	0.86	-0.66
	4	0.19	-0.32	-0.89	0.12	0.89	-0.66
	5	0.22	-0.31	-0.90	0.12	0.89	-0.66
	6	0.10	-0.22	-0.89	0.21	0.87	-0.63
Ni-63	1	NS	-0.11	-0.88	0.13	0.88	-0.58
	2	0.10	-0.14	-0.90	0.14	0.89	-0.63
	3	0.16	-0.18	-0.89	NS	0.86	-0.61
	4	0.16	-0.24	-0.88	NS	0.88	-0.58
	5	0.20	-0.22	-0.89	NS	0.89	-0.57
	6	NS	-0.11	-0.89	0.16	0.87	-0.56
Pu-238	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.10	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	DKSUS (resuspension rate)	LAMBDAT (building air exchange rate)	INGE (ingestion rate)	AIRFR[a] (air fraction)	RFO (source Release time)
Pu-239	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	0.10	0.91	-0.89
	3	NS	NS	-0.92	NS	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Pu-240	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	NS	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Pu-241	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.10	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Sr-90	1	NS	NS	-0.88	0.11	0.88	-0.45
	2	NS	NS	-0.88	0.10	0.87	-0.44
	3	0.13	-0.13	-0.89	NS	0.85	-0.52
	4	0.15	-0.21	-0.86	NS	0.87	-0.43
	5	0.19	-0.18	-0.88	NS	0.88	-0.41
	6	NS	NS	-0.88	0.14	0.86	-0.43
Tc-99	1	0.12	-0.28	-0.85	0.21	0.84	-0.23
	2	0.13	-0.31	-0.84	0.21	0.82	-0.24
	3	0.22	-0.34	-0.85	0.12	0.80	-0.36
	4	0.23	-0.40	-0.84	0.20	0.83	-0.25
	5	0.35	-0.47	-0.86	0.15	0.85	-0.18
	6	0.12	-0.29	-0.84	0.28	0.82	-0.25

[a] Air fraction for tritium (all sources) = 1.0, which is a recommended value for the gasous form of tritium (NUREG/CR-7267).

[b] Not sensitive.

NOTE: The building air exchange rate, deposition velocity, resuspension rate, and ingestion rate characterize the room, which means if the parameter was identified as sensitive for one of the sources, then the 25th or 75th percentile value is applied to all 6 sources.

Table 4: Summary of 25th, 50th, and 75th Percentile Values for Sensitive Parameters

Sensitive Parameter[a]	Percentile Value		
	25th	50th	75th
LAMBDAT	8.4E-01	1.5E+00	2.7E+00
UD	1.5E-05	8.5E-05	4.8E-04
DKSUS	6.6E-10	1.8E-08	4.7E-07
INGE	5.0E-05	9.0E-05	1.6E-04
AIRFR(1)	1.6E-01	3.2E-01	5.2E-01
AIRFR(2)	1.6E-01	3.2E-01	5.2E-01
AIRFR(3)	1.6E-01	3.2E-01	5.2E-01
AIRFR(4)	1.6E-01	3.2E-01	5.2E-01
AIRFR(5)	1.6E-01	3.2E-01	5.2E-01
AIRFR(6)	1.6E-01	3.2E-01	5.2E-01
RFO(1)	1.8E+04	3.3E+04	5.3E+04
RFO(2)	1.8E+04	3.3E+04	5.3E+04
RFO(3)	1.8E+04	3.3E+04	5.3E+04
RFO(4)	1.8E+04	3.3E+04	5.3E+04
RFO(5)	1.8E+04	3.3E+04	5.3E+04
RFO(6)	1.8E+04	3.3E+04	5.3E+04

[a] LAMBDAT = building air exchange rate, UD = deposition velocity, DKSUS = resuspension rate, INGE = ingestion rate, AIRFR(#) = air release fraction (for source number), and RFO(#) = source removal time (for source number).

Appendix A
RESRAD-Build 3.5 Results

Am-241 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:33:36 Page: 37 **
Title : CR3 Sensitivity Analysis - Am241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	13	0.01	12	0.01	16	0.00	16	0.00
Resuspension Rate	10	-0.02	11	-0.03	12	-0.03	10	-0.02
Building Exchange Rate	2	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	12	0.01	14	0.01	6	0.05	11	0.01
Air fraction of 1	1	0.26	2	0.24	2	0.91	2	0.59
Release time of 1	3	-0.09	1	-0.25	3	-0.53	3	-0.49
Air fraction of 2	6	-0.04	9	-0.04	10	-0.04	14	-0.01
Release time of 2	9	0.03	5	0.07	15	-0.02	9	-0.02
Air fraction of 3	16	0.00	16	0.00	8	0.04	12	0.01
Release time of 3	11	-0.02	6	-0.04	5	0.07	4	0.05
Air fraction of 4	4	-0.05	7	-0.04	13	0.03	15	0.01
Release time of 4	14	0.00	13	-0.01	11	-0.03	7	-0.02
Air fraction of 5	7	0.04	10	0.04	9	-0.04	13	-0.01
Release time of 5	15	0.00	15	-0.01	7	0.04	5	0.03
Air fraction of 6	5	0.04	8	0.04	4	0.11	6	0.03
Release time of 6	8	-0.03	4	-0.07	14	-0.02	8	-0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:33:36 Page: 38 **
Title : CR3 Sensitivity Analysis - Am241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	12	-0.02	12	-0.03	13	-0.01	14	0.00
Resuspension Rate	11	-0.03	11	-0.04	10	0.04	7	0.02
Building Exchange Rate	2	-0.35	2	-0.31	1	-0.94	1	-0.63
Receptor Ingestion Rate of receptor 1	4	0.11	6	0.09	12	0.03	12	0.01
Air fraction of 1	13	0.02	13	0.02	9	0.05	10	0.01
Release time of 1	7	0.05	5	0.13	14	0.01	13	0.00
Air fraction of 2	1	0.37	1	0.32	2	0.92	2	0.57
Release time of 2	3	-0.13	3	-0.29	3	-0.58	3	-0.49
Air fraction of 3	8	0.05	9	0.04	6	0.07	9	0.02
Release time of 3	16	0.00	16	0.01	16	0.01	15	0.00
Air fraction of 4	9	0.05	10	0.04	5	-0.08	8	-0.02
Release time of 4	10	-0.03	8	-0.07	4	-0.12	4	-0.08
Air fraction of 5	14	-0.02	14	-0.01	15	-0.01	16	0.00
Release time of 5	15	-0.01	15	-0.01	8	0.06	6	0.04
Air fraction of 6	5	0.10	7	0.08	11	0.03	11	0.01
Release time of 6	6	-0.06	4	-0.14	7	0.06	5	0.04

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:33:36 Page: 39 **
Title : CR3 Sensitivity Analysis - Am241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	13	0.02	13	0.03	11	0.02	10	0.01
Resuspension Rate	9	-0.04	8	-0.06	15	0.00	15	0.00
Building Exchange Rate	1	-0.35	2	-0.31	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	5	0.09	6	0.08	4	-0.11	7	-0.03
Air fraction of 1	14	0.02	15	0.01	9	-0.03	11	-0.01
Release time of 1	12	0.02	7	0.06	8	0.04	6	0.03
Air fraction of 2	11	-0.03	14	-0.02	5	-0.10	8	-0.03
Release time of 2	15	-0.01	12	-0.03	7	-0.06	5	-0.04
Air fraction of 3	2	0.35	3	0.31	2	0.91	2	0.57
Release time of 3	3	-0.13	1	-0.32	3	-0.55	3	-0.49
Air fraction of 4	8	0.04	11	0.04	12	0.01	13	0.00
Release time of 4	16	0.00	16	0.00	14	-0.01	12	0.00
Air fraction of 5	7	-0.05	10	-0.04	16	0.00	16	0.00
Release time of 5	10	0.03	9	0.06	10	-0.03	9	-0.02
Air fraction of 6	4	0.10	5	0.08	13	-0.01	14	0.00
Release time of 6	6	-0.07	4	-0.16	6	0.07	4	0.05

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:33:36 Page: 40 **
Title : CR3 Sensitivity Analysis - Am241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.02	12	-0.03	13	-0.02	12	-0.01

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Resuspension Rate	9	-0.03	11	-0.04	11	-0.03	8	-0.02
Building Exchange Rate	2	-0.31	2	-0.28	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	3	0.17	5	0.14	7	-0.06	10	-0.02
Air fraction of 1	13	0.02	14	0.02	14	-0.02	15	-0.01
Release time of 1	6	0.07	4	0.18	4	-0.13	4	-0.10
Air fraction of 2	16	-0.01	16	-0.01	8	0.06	11	0.01
Release time of 2	10	-0.03	9	-0.07	16	0.01	16	0.00
Air fraction of 3	15	0.01	15	0.01	6	0.08	7	0.02
Release time of 3	8	-0.03	8	-0.08	15	0.01	14	0.01
Air fraction of 4	1	0.32	1	0.28	2	0.91	2	0.58
Release time of 4	5	-0.08	3	-0.20	3	-0.53	3	-0.45
Air fraction of 5	11	-0.03	13	-0.02	5	-0.09	6	-0.02
Release time of 5	12	-0.03	10	-0.06	12	0.02	9	0.02
Air fraction of 6	4	0.12	7	0.10	10	0.03	13	0.01
Release time of 6	7	-0.05	6	-0.12	9	0.04	5	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:33:36 Page: 41 **
Title : CR3 Sensitivity Analysis - Am241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	16	0.00	16	0.00	5	0.10	4	0.06
Resuspension Rate	14	-0.01	13	-0.02	6	-0.09	5	-0.06
Building Exchange Rate	2	-0.30	2	-0.26	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	5	0.10	7	0.08	14	0.01	16	0.00
Air fraction of 1	13	-0.01	14	-0.01	9	0.04	12	0.01
Release time of 1	9	0.04	6	0.09	16	-0.01	15	-0.01
Air fraction of 2	6	-0.07	10	-0.05	7	0.08	7	0.02
Release time of 2	10	-0.03	8	-0.07	12	-0.02	9	-0.02
Air fraction of 3	15	0.00	15	0.00	4	0.16	6	0.04
Release time of 3	12	-0.02	11	-0.05	11	-0.02	8	-0.02
Air fraction of 4	8	0.04	12	0.04	8	0.04	11	0.01
Release time of 4	11	0.02	9	0.06	15	-0.01	14	-0.01
Air fraction of 5	1	0.37	1	0.34	2	0.90	2	0.58
Release time of 5	4	-0.11	3	-0.25	3	-0.50	3	-0.43
Air fraction of 6	3	0.11	5	0.09	10	0.04	13	0.01
Release time of 6	7	-0.06	4	-0.13	13	0.02	10	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:33:36 Page: 42 **
Title : CR3 Sensitivity Analysis - Am241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	11	-0.03	12	-0.04	11	-0.05	8	-0.03
Resuspension Rate	10	0.03	9	0.04	15	0.00	15	0.00
Building Exchange Rate	2	-0.27	3	-0.25	1	-0.91	1	-0.63
Receptor Ingestion Rate of receptor 1	3	0.16	4	0.14	9	0.05	11	0.02
Air fraction of 1	6	-0.06	8	-0.05	6	0.07	9	0.02
Release time of 1	7	0.05	5	0.13	16	0.00	16	0.00
Air fraction of 2	5	-0.07	7	-0.06	4	0.12	7	0.04
Release time of 2	13	-0.02	11	-0.04	5	0.10	4	0.08
Air fraction of 3	14	0.01	15	0.01	13	0.02	14	0.01
Release time of 3	16	-0.01	14	-0.01	10	-0.05	6	-0.04
Air fraction of 4	8	0.03	13	0.03	7	0.06	10	0.02
Release time of 4	12	0.02	10	0.04	14	0.01	12	0.01
Air fraction of 5	15	0.01	16	0.01	12	-0.02	13	-0.01
Release time of 5	9	-0.03	6	-0.08	8	-0.06	5	-0.05
Air fraction of 6	1	0.32	2	0.29	2	0.90	2	0.58
Release time of 6	4	-0.14	1	-0.34	3	-0.48	3	-0.45

C-14 Results:

* RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:27:06 Page: 37 **
Title : CR3 Sensitivity Analysis - C14
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	6	-0.07	5	-0.11	6	0.23	5	0.28
Resuspension Rate	16	0.00	16	0.00	3	-0.45	1	-0.62
Building Exchange Rate	2	-0.17	3	-0.16	1	-0.66	3	-0.47
Receptor Ingestion Rate of receptor 1	3	0.14	4	0.14	5	0.24	6	0.13
Air fraction of 1	1	0.24	1	0.24	2	0.59	4	0.39
Release time of 1	11	-0.03	8	-0.08	4	0.30	2	0.50
Air fraction of 2	5	0.08	11	0.07	8	-0.05	11	-0.03
Release time of 2	7	0.07	2	0.18	12	-0.02	9	-0.04
Air fraction of 3	15	0.00	15	0.00	10	0.04	12	0.02
Release time of 3	9	-0.03	7	-0.08	16	0.00	16	0.00
Air fraction of 4	12	-0.03	13	-0.02	13	0.02	15	0.01
Release time of 4	8	-0.04	6	-0.10	9	-0.05	7	-0.07
Air fraction of 5	4	-0.08	9	-0.08	11	0.03	13	0.02
Release time of 5	10	0.03	10	0.07	15	-0.01	14	-0.02
Air fraction of 6	13	0.02	14	0.02	7	0.08	8	0.04

Release time of 6	14	-0.01	12	-0.02	14	0.02	10	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:27:06 Page: 38 **
Title : CR3 Sensitivity Analysis - C14
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	6	-0.06	4	-0.09	4	0.28	5	0.33
Resuspension Rate	14	-0.01	14	-0.01	3	-0.51	1	-0.67
Building Exchange Rate	2	-0.14	2	-0.13	1	-0.67	2	-0.46
Receptor Ingestion Rate of receptor 1	4	0.07	7	0.06	5	0.26	6	0.14
Air fraction of 1	5	0.06	9	0.06	7	-0.09	8	-0.04
Release time of 1	15	0.01	13	0.02	16	0.00	16	0.00
Air fraction of 2	1	0.21	1	0.21	2	0.58	3	0.37
Release time of 2	12	0.02	10	0.05	6	0.22	4	0.33
Air fraction of 3	13	0.01	15	0.01	12	0.02	14	0.01
Release time of 3	16	0.00	16	0.00	10	0.03	9	0.04
Air fraction of 4	10	-0.03	12	-0.02	14	-0.01	15	-0.01
Release time of 4	8	-0.04	3	-0.12	9	0.05	7	0.07
Air fraction of 5	3	-0.07	6	-0.07	11	-0.02	12	-0.01
Release time of 5	9	0.03	5	0.08	13	0.01	11	0.02
Air fraction of 6	7	0.05	11	0.05	8	0.07	10	0.04
Release time of 6	11	-0.02	8	-0.06	15	-0.01	13	-0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:27:06 Page: 39 **
Title : CR3 Sensitivity Analysis - C14
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	6	-0.07	5	-0.11	4	0.31	5	0.39
Resuspension Rate	16	0.00	16	0.00	3	-0.50	1	-0.70
Building Exchange Rate	2	-0.21	2	-0.20	1	-0.63	3	-0.43
Receptor Ingestion Rate of receptor 1	3	0.14	4	0.13	5	0.28	6	0.16
Air fraction of 1	5	0.07	10	0.06	16	0.00	16	0.00
Release time of 1	13	-0.03	9	-0.08	8	0.04	7	0.06
Air fraction of 2	4	0.09	7	0.09	7	-0.04	11	-0.02
Release time of 2	10	0.04	6	0.10	11	-0.04	8	-0.06
Air fraction of 3	1	0.22	1	0.21	2	0.60	4	0.40
Release time of 3	11	0.03	8	0.09	6	0.27	2	0.43
Air fraction of 4	12	-0.03	15	-0.03	10	0.04	13	0.02
Release time of 4	15	-0.02	14	-0.04	12	0.04	10	0.05
Air fraction of 5	8	-0.06	12	-0.05	9	-0.04	12	-0.02
Release time of 5	14	0.02	13	0.05	15	0.00	15	0.01
Air fraction of 6	7	0.06	11	0.06	14	0.03	14	0.02
Release time of 6	9	-0.05	3	-0.14	13	-0.03	9	-0.05

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:27:06 Page: 40 **
Title : CR3 Sensitivity Analysis - C14
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	6	-0.07	4	-0.11	4	0.27	5	0.33
Resuspension Rate	16	0.00	16	0.00	3	-0.49	1	-0.67
Building Exchange Rate	1	-0.16	1	-0.16	1	-0.68	2	-0.48
Receptor Ingestion Rate of receptor 1	2	0.14	2	0.14	6	0.24	6	0.13
Air fraction of 1	5	0.07	7	0.07	8	0.04	9	0.02
Release time of 1	14	0.00	14	0.01	10	0.02	8	0.03
Air fraction of 2	8	0.05	9	0.05	13	0.01	15	0.00
Release time of 2	13	0.01	12	0.02	15	0.00	13	0.01
Air fraction of 3	10	-0.02	13	-0.02	14	0.01	16	0.00
Release time of 3	12	-0.01	11	-0.03	16	0.00	14	0.00
Air fraction of 4	3	0.12	3	0.11	2	0.57	4	0.36
Release time of 4	9	-0.03	5	-0.08	5	0.26	3	0.39
Air fraction of 5	7	-0.06	8	-0.06	9	-0.03	11	-0.01
Release time of 5	11	0.01	10	0.04	12	0.01	12	0.01
Air fraction of 6	4	0.08	6	0.08	7	0.15	7	0.08
Release time of 6	15	0.00	15	0.01	11	-0.01	10	-0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:27:06 Page: 41 **
Title : CR3 Sensitivity Analysis - C14
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	-0.10	5	-0.15	4	0.27	5	0.34
Resuspension Rate	8	0.03	9	0.05	3	-0.46	1	-0.64

Building Exchange Rate	2	-0.21	2	-0.19	1	-0.66	2	-0.48
Receptor Ingestion Rate of receptor 1	3	0.20	3	0.19	5	0.26	6	0.14
Air fraction of 1	9	-0.02	12	-0.02	12	0.04	14	0.02
Release time of 1	14	0.01	11	0.02	16	0.01	16	0.01
Air fraction of 2	13	-0.01	15	-0.01	14	-0.03	15	-0.02
Release time of 2	12	-0.01	10	-0.03	15	0.02	13	0.02
Air fraction of 3	11	0.02	14	0.01	11	0.06	12	0.03
Release time of 3	10	0.02	8	0.05	13	-0.03	9	-0.05
Air fraction of 4	15	-0.01	16	-0.01	8	0.09	11	0.05
Release time of 4	16	0.01	13	0.02	9	0.07	7	0.11
Air fraction of 5	1	0.29	1	0.28	2	0.62	3	0.42
Release time of 5	7	0.05	6	0.12	6	0.24	4	0.37
Air fraction of 6	5	0.09	7	0.09	7	0.10	10	0.05
Release time of 6	6	-0.06	4	-0.16	10	-0.06	8	-0.10

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:27:06 Page: 42 **
Title : CR3 Sensitivity Analysis - C14
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	5	-0.05	7	-0.08	4	0.32	4	0.39
Resuspension Rate	11	-0.02	12	-0.02	3	-0.52	1	-0.70
Building Exchange Rate	2	-0.21	3	-0.20	1	-0.66	3	-0.45
Receptor Ingestion Rate of receptor 1	3	0.16	4	0.15	6	0.28	6	0.15
Air fraction of 1	15	0.00	15	0.00	10	0.04	14	0.02
Release time of 1	6	0.04	5	0.12	11	-0.04	8	-0.06
Air fraction of 2	16	0.00	16	0.00	13	-0.03	15	-0.01
Release time of 2	12	-0.01	9	-0.03	9	0.04	7	0.07
Air fraction of 3	14	0.00	14	0.00	16	0.00	16	0.00
Release time of 3	7	0.04	6	0.10	15	-0.02	13	-0.03
Air fraction of 4	8	-0.03	10	-0.03	7	0.11	9	0.06
Release time of 4	10	-0.02	8	-0.06	12	-0.03	10	-0.04
Air fraction of 5	9	0.03	11	0.03	8	-0.06	12	-0.03
Release time of 5	13	0.01	13	0.02	14	0.03	11	0.04
Air fraction of 6	1	0.29	1	0.28	2	0.60	5	0.39
Release time of 6	4	-0.08	2	-0.20	5	0.30	2	0.47

Cm-243 Results:

* RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 10:22:21 Page: 37 **
Title : CR3 Sensitivity Analysis - Cm243
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	0.01	14	0.02	11	-0.02	6	-0.01
Resuspension Rate	13	-0.01	11	-0.02	13	0.01	13	0.00
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	10	0.03	11	0.01
Air fraction of 1	2	0.26	2	0.24	2	0.91	2	0.59
Release time of 1	1	-0.33	1	-0.31	3	-0.87	3	-0.47
Air fraction of 2	6	-0.05	6	-0.04	6	-0.04	8	-0.01
Release time of 2	4	0.09	4	0.08	15	0.01	15	0.00
Air fraction of 3	16	0.00	16	0.00	7	0.04	7	0.01
Release time of 3	12	0.02	13	0.02	5	0.08	5	0.02
Air fraction of 4	9	-0.04	9	-0.04	9	0.03	10	0.01
Release time of 4	10	-0.04	10	-0.04	12	-0.02	12	-0.01
Air fraction of 5	8	0.04	8	0.04	8	-0.04	9	-0.01
Release time of 5	5	-0.05	5	-0.04	14	0.01	14	0.00
Air fraction of 6	7	0.04	7	0.04	4	0.12	4	0.03
Release time of 6	11	-0.02	12	-0.02	16	0.00	16	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 10:22:21 Page: 38 **
Title : CR3 Sensitivity Analysis - Cm243
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	-0.02	15	-0.03	14	0.02	11	0.01
Resuspension Rate	16	-0.01	16	-0.01	8	0.05	5	0.03
Building Exchange Rate	2	-0.27	2	-0.25	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.08	6	0.02
Air fraction of 1	13	0.05	13	0.04	7	-0.05	8	-0.01
Release time of 1	6	-0.08	6	-0.07	13	0.03	14	0.01
Air fraction of 2	3	0.24	3	0.22	2	0.92	2	0.58
Release time of 2	1	-0.34	1	-0.31	3	-0.89	3	-0.50
Air fraction of 3	11	0.05	11	0.04	15	-0.01	15	0.00
Release time of 3	9	-0.06	9	-0.05	16	-0.01	16	0.00
Air fraction of 4	7	0.07	7	0.06	4	-0.13	4	-0.03
Release time of 4	12	-0.05	12	-0.04	11	-0.03	12	-0.01
Air fraction of 5	14	0.05	14	0.04	12	0.03	13	0.01
Release time of 5	10	-0.05	10	-0.04	10	0.04	10	0.01
Air fraction of 6	5	0.09	5	0.08	9	0.04	9	0.01

Release time of 6	8	-0.06	8	-0.06	6	0.07	7	0.02

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 10:22:21 Page:  39 **
 Title      : CR3 Sensitivity Analysis - Cm243
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.12	4	0.16	13	0.02	10	0.01
Resuspension Rate	5	-0.09	5	-0.12	15	0.01	14	0.01
Building Exchange Rate	3	-0.38	3	-0.33	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	11	0.03	11	0.02	5	-0.11	5	-0.03
Air fraction of 1	7	0.05	7	0.04	6	-0.08	6	-0.02
Release time of 1	8	-0.05	8	-0.04	10	-0.04	11	-0.01
Air fraction of 2	10	-0.03	10	-0.02	4	-0.11	4	-0.03
Release time of 2	15	-0.01	15	0.00	8	-0.06	8	-0.02
Air fraction of 3	2	0.39	2	0.34	2	0.90	2	0.56
Release time of 3	1	-0.45	1	-0.40	3	-0.87	3	-0.48
Air fraction of 4	9	0.04	9	0.03	14	-0.02	15	0.00
Release time of 4	13	0.02	13	0.02	12	0.02	13	0.01
Air fraction of 5	12	0.03	12	0.02	16	0.00	16	0.00
Release time of 5	14	0.01	14	0.01	9	-0.04	9	-0.01
Air fraction of 6	16	0.00	16	0.00	11	-0.03	12	-0.01
Release time of 6	6	-0.05	6	-0.04	7	0.07	7	0.02

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 10:22:21 Page:  40 **
 Title      : CR3 Sensitivity Analysis - Cm243
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.03	9	0.05	14	-0.02	10	-0.01
Resuspension Rate	7	-0.07	6	-0.10	16	0.00	16	0.00
Building Exchange Rate	3	-0.31	3	-0.27	1	-0.91	1	-0.61
Receptor Ingestion Rate of receptor 1	5	0.15	5	0.12	8	-0.05	8	-0.01
Air fraction of 1	16	-0.01	16	-0.01	7	-0.06	7	-0.02
Release time of 1	12	-0.03	12	-0.02	4	-0.11	4	-0.03
Air fraction of 2	14	-0.02	14	-0.02	12	0.03	13	0.01
Release time of 2	13	0.02	13	0.02	10	0.04	11	0.01
Air fraction of 3	6	0.08	7	0.06	9	-0.05	9	-0.01
Release time of 3	9	-0.05	10	-0.04	11	0.03	12	0.01
Air fraction of 4	1	0.42	1	0.37	2	0.90	2	0.58
Release time of 4	2	-0.39	2	-0.34	3	-0.87	3	-0.47
Air fraction of 5	15	-0.01	15	-0.01	13	-0.02	14	-0.01
Release time of 5	11	-0.03	11	-0.03	15	0.02	15	0.00
Air fraction of 6	4	0.16	4	0.13	6	0.08	6	0.02
Release time of 6	8	-0.06	8	-0.05	5	0.11	5	0.03

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 10:22:21 Page:  41 **
 Title      : CR3 Sensitivity Analysis - Cm243
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.08	4	0.11	11	0.01	9	0.01
Resuspension Rate	6	-0.06	5	-0.09	15	0.01	13	0.00
Building Exchange Rate	3	-0.33	3	-0.29	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	13	0.01	13	0.01	7	-0.05	7	-0.01
Air fraction of 1	11	0.02	11	0.01	13	-0.01	14	0.00
Release time of 1	7	0.05	7	0.04	12	0.01	12	0.00
Air fraction of 2	15	0.00	15	0.00	5	0.05	5	0.01
Release time of 2	8	-0.05	8	-0.04	16	0.00	16	0.00
Air fraction of 3	10	0.02	10	0.02	10	0.02	11	0.01
Release time of 3	5	-0.07	6	-0.06	8	-0.04	8	-0.01
Air fraction of 4	9	0.03	9	0.02	9	0.02	10	0.01
Release time of 4	14	0.00	14	0.00	14	-0.01	15	0.00
Air fraction of 5	1	0.40	1	0.35	2	0.91	2	0.56
Release time of 5	2	-0.38	2	-0.34	3	-0.88	3	-0.47
Air fraction of 6	16	0.00	16	0.00	4	0.12	4	0.03
Release time of 6	12	-0.01	12	-0.01	6	0.05	6	0.01

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 10:22:21 Page:  42 **
 Title      : CR3 Sensitivity Analysis - Cm243
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	13	-0.02	11	-0.03	16	0.00	16	0.00
Resuspension Rate	8	0.04	4	0.07	14	0.01	12	0.01

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Building Exchange Rate	3	-0.23	3	-0.22	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	12	0.02	13	0.02	9	-0.04	9	-0.01
Air fraction of 1	16	0.00	16	0.00	4	0.12	4	0.03
Release time of 1	6	0.05	7	0.04	10	0.04	10	0.01
Air fraction of 2	5	0.05	6	0.04	15	-0.01	15	0.00
Release time of 2	15	0.01	15	0.01	8	0.05	8	0.01
Air fraction of 3	7	0.04	8	0.04	11	-0.03	11	-0.01
Release time of 3	4	-0.06	5	-0.05	7	-0.06	7	-0.02
Air fraction of 4	14	-0.02	14	-0.02	6	0.06	6	0.02
Release time of 4	9	-0.04	9	-0.04	13	0.02	14	0.00
Air fraction of 5	10	-0.04	10	-0.03	12	0.02	13	0.01
Release time of 5	11	-0.03	12	-0.03	5	-0.07	5	-0.02
Air fraction of 6	2	0.28	2	0.27	2	0.91	2	0.58
Release time of 6	1	-0.28	1	-0.27	3	-0.87	3	-0.46

Cm-244 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 18:17:16 Page: 37 **
Title : CR3 Sensitivity Analysis - Cm244
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	14	0.01	14	0.02	11	-0.03	6	-0.02
Resuspension Rate	13	-0.01	11	-0.02	13	0.02	10	0.01
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	10	0.03	12	0.01
Air fraction of 1	2	0.26	2	0.23	2	0.91	2	0.59
Release time of 1	1	-0.33	1	-0.31	3	-0.87	3	-0.47
Air fraction of 2	5	-0.05	6	-0.04	6	-0.04	7	-0.01
Release time of 2	4	0.09	4	0.08	15	0.01	15	0.00
Air fraction of 3	16	0.00	16	0.00	7	0.04	8	0.01
Release time of 3	11	0.02	12	0.02	5	0.08	5	0.02
Air fraction of 4	9	-0.04	9	-0.04	9	0.03	11	0.01
Release time of 4	10	-0.04	10	-0.03	12	-0.02	13	-0.01
Air fraction of 5	7	0.04	7	0.04	8	-0.04	9	-0.01
Release time of 5	6	-0.05	5	-0.04	14	0.01	14	0.00
Air fraction of 6	8	0.04	8	0.04	4	0.12	4	0.03
Release time of 6	12	-0.02	13	-0.02	16	0.00	16	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 18:17:16 Page: 38 **
Title : CR3 Sensitivity Analysis - Cm244
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	15	-0.02	15	-0.03	16	0.01	14	0.00
Resuspension Rate	16	-0.01	16	-0.01	7	0.06	5	0.03
Building Exchange Rate	2	-0.27	2	-0.25	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.07	6	0.02
Air fraction of 1	13	0.05	13	0.04	8	-0.05	8	-0.01
Release time of 1	6	-0.08	6	-0.07	13	0.02	13	0.01
Air fraction of 2	3	0.24	3	0.22	2	0.92	2	0.58
Release time of 2	1	-0.34	1	-0.31	3	-0.89	3	-0.50
Air fraction of 3	11	0.05	11	0.04	14	-0.01	15	0.00
Release time of 3	9	-0.06	9	-0.05	15	-0.01	16	0.00
Air fraction of 4	7	0.08	7	0.07	4	-0.13	4	-0.03
Release time of 4	12	-0.05	12	-0.04	11	-0.03	11	-0.01
Air fraction of 5	14	0.05	14	0.04	12	0.03	12	0.01
Release time of 5	10	-0.05	10	-0.04	9	0.04	9	0.01
Air fraction of 6	5	0.08	5	0.07	10	0.04	10	0.01
Release time of 6	8	-0.06	8	-0.06	6	0.07	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 18:17:16 Page: 39 **
Title : CR3 Sensitivity Analysis - Cm244
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	4	0.12	4	0.16	15	0.01	14	0.00
Resuspension Rate	5	-0.09	5	-0.12	13	0.02	9	0.01
Building Exchange Rate	3	-0.38	3	-0.33	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	11	0.03	11	0.02	5	-0.11	5	-0.03
Air fraction of 1	8	0.05	8	0.04	6	-0.08	6	-0.02
Release time of 1	6	-0.05	6	-0.04	10	-0.04	11	-0.01
Air fraction of 2	10	-0.03	10	-0.03	4	-0.11	4	-0.03
Release time of 2	15	-0.01	15	-0.01	8	-0.06	8	-0.02
Air fraction of 3	2	0.39	2	0.34	2	0.90	2	0.56
Release time of 3	1	-0.45	1	-0.40	3	-0.87	3	-0.48
Air fraction of 4	9	0.04	9	0.03	14	-0.01	15	0.00
Release time of 4	13	0.02	13	0.02	12	0.02	13	0.01
Air fraction of 5	12	0.03	12	0.02	16	0.00	16	0.00
Release time of 5	14	0.01	14	0.01	9	-0.04	10	-0.01
Air fraction of 6	16	0.00	16	0.00	11	-0.03	12	-0.01
Release time of 6	7	-0.05	7	-0.04	7	0.07	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 18:17:16 Page: 40 **
Title : CR3 Sensitivity Analysis - Cm244
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.03	9	0.05	12	-0.03	7	-0.02
Resuspension Rate	7	-0.07	6	-0.10	16	0.01	13	0.01
Building Exchange Rate	3	-0.31	3	-0.27	1	-0.91	1	-0.61
Receptor Ingestion Rate of receptor 1	5	0.15	5	0.12	8	-0.05	9	-0.01
Air fraction of 1	16	-0.01	16	-0.01	7	-0.06	8	-0.02
Release time of 1	12	-0.03	12	-0.02	4	-0.12	4	-0.03
Air fraction of 2	14	-0.02	14	-0.02	13	0.02	14	0.01
Release time of 2	13	0.02	13	0.02	10	0.04	11	0.01
Air fraction of 3	6	0.08	7	0.06	9	-0.05	10	-0.01
Release time of 3	9	-0.05	10	-0.04	11	0.03	12	0.01
Air fraction of 4	1	0.42	1	0.37	2	0.90	2	0.58
Release time of 4	2	-0.39	2	-0.34	3	-0.87	3	-0.47
Air fraction of 5	15	-0.01	15	-0.01	15	-0.02	16	0.00
Release time of 5	11	-0.03	11	-0.03	14	0.02	15	0.01
Air fraction of 6	4	0.16	4	0.13	6	0.08	6	0.02
Release time of 6	8	-0.06	8	-0.05	5	0.12	5	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 18:17:16 Page: 41 **
Title : CR3 Sensitivity Analysis - Cm244
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.08	4	0.11	15	0.00	14	0.00
Resuspension Rate	6	-0.06	5	-0.09	11	0.02	9	0.01
Building Exchange Rate	3	-0.33	3	-0.29	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	13	0.01	13	0.01	6	-0.05	6	-0.01
Air fraction of 1	11	0.02	11	0.01	13	-0.01	13	0.00
Release time of 1	7	0.05	7	0.04	12	0.01	12	0.00
Air fraction of 2	14	0.00	14	0.00	7	0.05	7	0.01
Release time of 2	8	-0.05	8	-0.04	16	0.00	16	0.00
Air fraction of 3	10	0.02	10	0.02	10	0.02	11	0.00
Release time of 3	5	-0.07	6	-0.06	8	-0.04	8	-0.01
Air fraction of 4	9	0.03	9	0.02	9	0.02	10	0.01
Release time of 4	15	0.00	15	0.00	14	-0.01	15	0.00
Air fraction of 5	1	0.40	1	0.35	2	0.91	2	0.56
Release time of 5	2	-0.38	2	-0.34	3	-0.88	3	-0.47
Air fraction of 6	16	0.00	16	0.00	4	0.12	4	0.03
Release time of 6	12	-0.01	12	-0.01	5	0.05	5	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 18:17:16 Page: 42 **
Title : CR3 Sensitivity Analysis - Cm244
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	13	-0.02	9	-0.04	15	-0.01	14	-0.01
Resuspension Rate	5	0.05	4	0.08	13	0.02	9	0.01
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	12	0.03	13	0.03	9	-0.04	10	-0.01
Air fraction of 1	16	-0.01	16	-0.01	4	0.12	4	0.03
Release time of 1	9	0.04	10	0.04	10	0.03	11	0.01
Air fraction of 2	8	0.04	8	0.04	16	-0.01	16	0.00
Release time of 2	15	0.01	15	0.01	8	0.05	8	0.01
Air fraction of 3	6	0.04	6	0.04	11	-0.03	12	-0.01
Release time of 3	4	-0.06	5	-0.06	6	-0.06	6	-0.02
Air fraction of 4	14	-0.01	14	-0.01	7	0.06	7	0.02
Release time of 4	7	-0.04	7	-0.04	14	0.02	15	0.00
Air fraction of 5	10	-0.04	11	-0.03	12	0.02	13	0.01
Release time of 5	11	-0.03	12	-0.03	5	-0.07	5	-0.02
Air fraction of 6	2	0.30	2	0.28	2	0.91	2	0.58
Release time of 6	1	-0.30	1	-0.28	3	-0.87	3	-0.46

Co-60 Results:

* RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:42:14 Page: 37 **
Title : CR3 Sensitivity Analysis - Co60
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	6	0.03	7	0.04	9	0.05	8	0.05
Resuspension Rate	16	0.00	15	0.00	7	-0.06	7	-0.06
Building Exchange Rate	3	-0.25	3	-0.20	1	-0.63	2	-0.34
Receptor Ingestion Rate of receptor 1	7	0.03	10	0.02	14	0.02	14	0.01
Air fraction of 1	1	0.28	2	0.22	2	0.55	3	0.28
Release time of 1	2	0.25	1	0.58	3	0.54	1	0.81
Air fraction of 2	5	0.06	6	0.04	4	0.15	5	0.07
Release time of 2	9	0.02	8	0.04	12	-0.03	10	-0.03
Air fraction of 3	13	0.01	13	0.01	5	0.08	9	0.04
Release time of 3	11	-0.02	9	-0.03	6	-0.06	4	-0.08
Air fraction of 4	14	0.00	16	0.00	11	-0.03	13	-0.01
Release time of 4	15	0.00	14	0.00	13	0.02	11	0.03
Air fraction of 5	10	0.02	12	0.01	15	-0.02	15	-0.01
Release time of 5	8	0.03	5	0.05	8	0.06	6	0.06
Air fraction of 6	4	-0.08	4	-0.06	10	-0.03	12	-0.01
Release time of 6	12	-0.01	11	-0.02	16	0.00	16	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:42:14 Page: 38 **
Title : CR3 Sensitivity Analysis - Co60
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	0.01	14	0.02	8	0.07	5	0.07
Resuspension Rate	4	-0.05	5	-0.07	7	-0.08	4	-0.09
Building Exchange Rate	2	-0.30	2	-0.28	1	-0.78	1	-0.58
Receptor Ingestion Rate of receptor 1	7	0.04	12	0.04	6	0.08	9	0.04
Air fraction of 1	15	0.01	15	0.01	4	-0.15	6	-0.07
Release time of 1	10	0.02	7	0.05	11	0.03	10	0.04
Air fraction of 2	1	0.41	1	0.39	2	0.74	2	0.52
Release time of 2	5	0.04	3	0.11	3	0.23	3	0.32
Air fraction of 3	9	0.03	13	0.02	5	0.14	7	0.07
Release time of 3	13	0.01	11	0.04	13	-0.01	12	-0.01
Air fraction of 4	16	0.00	16	0.00	12	0.01	15	0.00
Release time of 4	12	-0.02	8	-0.05	15	-0.01	13	-0.01
Air fraction of 5	6	-0.04	10	-0.04	9	0.05	11	0.02
Release time of 5	11	0.02	9	0.05	16	0.01	14	0.01
Air fraction of 6	3	0.07	6	0.06	14	0.01	16	0.00
Release time of 6	8	-0.03	4	-0.08	10	0.04	8	0.05

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:42:14 Page: 39 **
Title : CR3 Sensitivity Analysis - Co60
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	6	0.06	6	0.08	4	0.15	4	0.16
Resuspension Rate	7	-0.05	8	-0.07	5	-0.14	5	-0.16
Building Exchange Rate	2	-0.38	2	-0.36	1	-0.77	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.07	9	0.06	14	0.01	14	0.00
Air fraction of 1	14	-0.01	15	-0.01	11	-0.02	12	-0.01
Release time of 1	13	0.02	10	0.05	13	0.01	11	0.01
Air fraction of 2	12	0.03	13	0.02	12	-0.02	13	-0.01
Release time of 2	15	0.00	14	0.01	9	-0.04	6	-0.05
Air fraction of 3	1	0.41	1	0.38	2	0.72	2	0.51
Release time of 3	8	0.04	4	0.11	3	0.24	3	0.36
Air fraction of 4	11	0.03	12	0.02	6	0.09	8	0.05
Release time of 4	16	0.00	16	0.01	10	0.04	7	0.05
Air fraction of 5	10	-0.03	11	-0.02	8	0.06	10	0.03
Release time of 5	9	0.03	7	0.07	16	0.00	16	0.00
Air fraction of 6	3	0.11	5	0.10	7	0.06	9	0.03
Release time of 6	5	-0.07	3	-0.16	15	0.00	15	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:42:14 Page: 40 **
Title : CR3 Sensitivity Analysis - Co60
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.02	11	0.03	6	0.08	5	0.09
Resuspension Rate	8	-0.04	9	-0.06	5	-0.12	4	-0.13
Building Exchange Rate	2	-0.32	2	-0.30	1	-0.79	1	-0.62
Receptor Ingestion Rate of receptor 1	3	0.15	4	0.14	12	0.03	15	0.02
Air fraction of 1	15	0.01	15	0.01	9	-0.06	11	-0.03
Release time of 1	6	0.05	5	0.13	15	-0.01	14	-0.02
Air fraction of 2	14	-0.01	14	-0.01	8	0.07	10	0.03
Release time of 2	13	-0.01	12	-0.03	13	0.03	8	0.04
Air fraction of 3	11	0.01	13	0.01	7	0.07	9	0.03
Release time of 3	12	-0.01	10	-0.04	16	0.01	16	0.01
Air fraction of 4	1	0.35	1	0.33	2	0.70	2	0.48
Release time of 4	5	0.07	3	0.18	3	0.26	3	0.37
Air fraction of 5	16	0.00	16	0.00	11	0.05	13	0.02
Release time of 5	9	-0.02	8	-0.06	10	-0.05	7	-0.06
Air fraction of 6	4	0.12	7	0.10	4	0.13	6	0.06
Release time of 6	7	-0.04	6	-0.11	14	0.02	12	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:42:14 Page: 41 **
Title : CR3 Sensitivity Analysis - Co60
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	16	0.00	16	0.01	5	0.12	4	0.13
Resuspension Rate	14	-0.01	14	-0.01	7	-0.10	5	-0.11
Building Exchange Rate	2	-0.31	2	-0.28	1	-0.78	1	-0.58
Receptor Ingestion Rate of receptor 1	4	0.06	9	0.06	10	0.05	13	0.02
Air fraction of 1	12	-0.02	13	-0.01	9	-0.05	12	-0.02
Release time of 1	6	0.04	3	0.10	11	0.05	7	0.07
Air fraction of 2	5	-0.04	10	-0.03	16	0.01	16	0.01
Release time of 2	13	-0.01	12	-0.02	13	0.03	11	0.04
Air fraction of 3	15	-0.01	15	-0.01	6	0.11	10	0.05
Release time of 3	10	-0.02	6	-0.06	8	-0.07	6	-0.09
Air fraction of 4	9	0.04	11	0.03	4	0.14	8	0.07
Release time of 4	11	0.02	8	0.06	12	0.05	9	0.06
Air fraction of 5	1	0.43	1	0.41	2	0.75	2	0.54
Release time of 5	8	0.04	5	0.08	3	0.23	3	0.30
Air fraction of 6	3	0.07	7	0.06	14	0.02	15	0.01
Release time of 6	7	-0.04	4	-0.09	15	-0.02	14	-0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 11:42:14 Page: 42 **
Title : CR3 Sensitivity Analysis - Co60
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.05	6	0.07	4	0.12	4	0.14
Resuspension Rate	8	-0.04	7	-0.05	5	-0.11	5	-0.13
Building Exchange Rate	2	-0.28	2	-0.26	1	-0.69	2	-0.48
Receptor Ingestion Rate of receptor 1	3	0.09	5	0.08	12	0.03	12	0.01
Air fraction of 1	9	-0.03	10	-0.02	8	-0.05	10	-0.02
Release time of 1	5	0.04	3	0.11	11	-0.03	9	-0.05
Air fraction of 2	6	-0.04	9	-0.04	15	-0.01	15	0.00
Release time of 2	10	-0.02	8	-0.05	16	0.00	16	0.00
Air fraction of 3	11	-0.02	12	-0.02	10	0.05	11	0.02
Release time of 3	14	0.01	13	0.02	7	0.06	7	0.08
Air fraction of 4	15	0.00	16	0.00	13	0.02	13	0.01
Release time of 4	16	0.00	15	0.00	6	-0.09	6	-0.12
Air fraction of 5	12	0.01	14	0.01	14	-0.02	14	-0.01
Release time of 5	13	0.01	11	0.02	9	0.05	8	0.07
Air fraction of 6	1	0.36	1	0.34	2	0.64	3	0.42
Release time of 6	7	0.04	4	0.09	3	0.38	1	0.60

Cs-137 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:39:05 Page: 37 **
Title : CR3 Sensitivity Analysis - Cs137
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	0.00	15	0.00	5	0.28	3	0.26
Resuspension Rate	13	-0.01	11	-0.01	4	-0.35	2	-0.34
Building Exchange Rate	3	-0.15	3	-0.13	2	-0.52	4	-0.24
Receptor Ingestion Rate of receptor 1	6	0.06	9	0.05	6	0.16	6	0.07
Air fraction of 1	2	0.19	2	0.15	3	0.47	5	0.21
Release time of 1	1	0.19	1	0.48	1	0.56	1	0.80
Air fraction of 2	4	0.12	4	0.09	8	0.08	9	0.03
Release time of 2	8	0.04	5	0.09	10	0.03	8	0.03
Air fraction of 3	11	0.02	12	0.01	11	0.03	12	0.01
Release time of 3	16	0.00	16	0.00	14	-0.01	14	-0.01
Air fraction of 4	12	-0.01	13	-0.01	15	0.01	15	0.00
Release time of 4	9	-0.03	6	-0.06	13	-0.01	13	-0.01
Air fraction of 5	5	-0.07	7	-0.06	7	-0.11	7	-0.04
Release time of 5	10	0.02	8	0.05	16	0.00	16	0.00
Air fraction of 6	7	-0.04	10	-0.03	9	0.05	11	0.02
Release time of 6	14	0.00	14	-0.01	12	0.02	10	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:39:05 Page: 38 **
Title : CR3 Sensitivity Analysis - Cs137
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff

BHI energy Power Services

Deposition Velocity	15	0.00	15	-0.01	5	0.38	3	0.41
Resuspension Rate	8	-0.04	7	-0.06	4	-0.45	2	-0.50
Building Exchange Rate	2	-0.13	3	-0.13	1	-0.60	4	-0.33
Receptor Ingestion Rate of receptor 1	16	0.00	16	0.00	6	0.19	6	0.08
Air fraction of 1	7	0.04	11	0.04	11	-0.03	12	-0.01
Release time of 1	13	-0.01	12	-0.02	16	0.00	16	0.01
Air fraction of 2	1	0.26	2	0.24	2	0.53	5	0.28
Release time of 2	3	0.12	1	0.30	3	0.47	1	0.67
Air fraction of 3	12	-0.01	14	-0.01	10	-0.03	11	-0.01
Release time of 3	14	0.00	13	0.01	13	-0.01	10	-0.01
Air fraction of 4	5	-0.06	8	-0.06	8	-0.06	9	-0.03
Release time of 4	10	-0.02	6	-0.06	9	0.05	7	0.06
Air fraction of 5	4	-0.09	5	-0.08	7	-0.10	8	-0.05
Release time of 5	9	0.04	4	0.09	15	0.01	14	0.01
Air fraction of 6	6	0.04	10	0.04	12	0.02	15	0.01
Release time of 6	11	-0.02	9	-0.05	14	0.01	13	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:39:05 Page: 39 **
Title : CR3 Sensitivity Analysis - Cs137
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	16	0.01	16	0.01	5	0.34	3	0.40
Resuspension Rate	11	-0.03	12	-0.04	4	-0.43	2	-0.52
Building Exchange Rate	2	-0.20	3	-0.18	1	-0.56	4	-0.33
Receptor Ingestion Rate of receptor 1	6	0.06	8	0.05	6	0.15	7	0.07
Air fraction of 1	14	0.01	15	0.01	13	0.02	14	0.01
Release time of 1	13	-0.02	11	-0.04	10	0.04	9	0.06
Air fraction of 2	4	0.09	6	0.08	11	-0.04	12	-0.02
Release time of 2	8	0.05	5	0.12	9	-0.05	8	-0.07
Air fraction of 3	1	0.23	2	0.20	2	0.53	5	0.31
Release time of 3	3	0.17	1	0.43	3	0.47	1	0.75
Air fraction of 4	9	-0.05	10	-0.04	14	0.02	16	0.01
Release time of 4	15	-0.01	13	-0.03	16	0.01	15	0.01
Air fraction of 5	10	-0.03	14	-0.02	8	-0.05	10	-0.03
Release time of 5	12	0.02	9	0.05	15	0.02	11	0.02
Air fraction of 6	5	0.08	7	0.07	12	0.03	13	0.02
Release time of 6	7	-0.05	4	-0.12	7	-0.05	6	-0.07

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:39:05 Page: 40 **
Title : CR3 Sensitivity Analysis - Cs137
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	16	0.00	16	0.00	5	0.33	3	0.39
Resuspension Rate	9	-0.02	8	-0.03	4	-0.41	2	-0.51
Building Exchange Rate	1	-0.18	2	-0.17	1	-0.59	4	-0.36
Receptor Ingestion Rate of receptor 1	4	0.10	4	0.09	6	0.24	6	0.13
Air fraction of 1	6	0.04	7	0.04	13	0.03	13	0.02
Release time of 1	13	-0.01	12	-0.02	10	0.06	7	0.08
Air fraction of 2	7	0.03	10	0.03	14	-0.02	14	-0.01
Release time of 2	10	0.02	6	0.05	9	0.06	8	0.08
Air fraction of 3	11	0.02	13	0.01	15	0.01	15	0.00
Release time of 3	12	0.01	9	0.03	11	-0.05	9	-0.08
Air fraction of 4	2	0.16	3	0.15	2	0.46	5	0.26
Release time of 4	3	0.12	1	0.30	3	0.42	1	0.65
Air fraction of 5	8	-0.03	11	-0.02	8	-0.06	12	-0.03
Release time of 5	14	0.00	14	0.01	16	0.00	16	0.00
Air fraction of 6	5	0.09	5	0.08	7	0.09	11	0.04
Release time of 6	15	0.00	15	0.01	12	-0.03	10	-0.05

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:39:05 Page: 41 **
Title : CR3 Sensitivity Analysis - Cs137
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	5	-0.03	7	-0.05	5	0.35	3	0.39
Resuspension Rate	10	0.01	9	0.02	4	-0.42	2	-0.47
Building Exchange Rate	2	-0.16	3	-0.15	1	-0.60	4	-0.34
Receptor Ingestion Rate of receptor 1	4	0.07	5	0.06	6	0.20	6	0.09
Air fraction of 1	7	-0.02	10	-0.02	11	-0.03	12	-0.02
Release time of 1	14	0.01	11	0.02	14	0.01	13	0.01
Air fraction of 2	13	0.01	15	0.01	12	0.02	14	0.01
Release time of 2	8	0.02	6	0.05	13	0.02	11	0.02
Air fraction of 3	16	0.00	16	0.00	7	0.11	9	0.05
Release time of 3	15	0.00	14	-0.01	16	0.00	16	0.00
Air fraction of 4	9	-0.02	12	-0.01	15	0.00	15	0.00
Release time of 4	11	0.01	8	0.03	9	0.05	7	0.07
Air fraction of 5	1	0.26	2	0.24	2	0.52	5	0.28
Release time of 5	3	0.15	1	0.36	3	0.49	1	0.70
Air fraction of 6	12	0.01	13	0.01	8	0.10	10	0.04
Release time of 6	6	-0.03	4	-0.07	10	-0.05	8	-0.06

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 10:39:05 Page: 42 **
Title : CR3 Sensitivity Analysis - Cs137
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	6	0.05	7	0.07	5	0.32	3	0.36
Resuspension Rate	3	-0.08	4	-0.12	4	-0.40	2	-0.47
Building Exchange Rate	2	-0.18	2	-0.16	1	-0.57	4	-0.33
Receptor Ingestion Rate of receptor 1	8	0.04	12	0.03	6	0.17	6	0.08
Air fraction of 1	13	0.02	14	0.02	15	0.00	16	0.00
Release time of 1	10	0.03	6	0.07	16	0.00	15	0.00
Air fraction of 2	9	0.03	13	0.03	12	-0.01	13	-0.01
Release time of 2	15	0.01	11	0.04	14	0.01	12	0.01
Air fraction of 3	14	-0.02	15	-0.01	7	0.07	10	0.03
Release time of 3	11	0.02	8	0.06	10	0.04	9	0.06
Air fraction of 4	5	-0.05	10	-0.05	13	0.01	14	0.01
Release time of 4	12	-0.02	9	-0.06	8	-0.06	7	-0.07
Air fraction of 5	16	0.00	16	0.00	11	-0.02	11	-0.01
Release time of 5	7	0.05	5	0.11	9	0.04	8	0.06
Air fraction of 6	1	0.25	1	0.23	2	0.48	5	0.26
Release time of 6	4	0.06	3	0.16	3	0.45	1	0.69

Eu-152 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:09:56 Page: 37 **
Title : CR3 Sensitivity Analysis - Eu152
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	8	0.03	7	0.04	5	0.10	5	0.11
Resuspension Rate	11	-0.01	12	-0.02	4	-0.10	4	-0.11
Building Exchange Rate	2	-0.33	2	-0.31	1	-0.76	1	-0.55
Receptor Ingestion Rate of receptor 1	9	0.02	13	0.02	10	-0.03	10	-0.01
Air fraction of 1	1	0.35	1	0.32	2	0.70	3	0.47
Release time of 1	3	0.09	3	0.24	3	0.35	2	0.54
Air fraction of 2	15	0.01	15	0.01	15	0.00	15	0.00
Release time of 2	5	0.03	4	0.08	14	0.01	14	0.01
Air fraction of 3	16	0.00	16	0.00	9	0.03	9	0.01
Release time of 3	10	-0.02	6	-0.04	6	-0.06	6	-0.09
Air fraction of 4	4	-0.04	8	-0.03	16	0.00	16	0.00
Release time of 4	14	-0.01	11	-0.02	13	-0.01	12	-0.01
Air fraction of 5	6	0.03	9	0.02	11	0.02	13	0.01
Release time of 5	12	0.01	10	0.02	12	0.01	11	0.01
Air fraction of 6	13	-0.01	14	-0.01	7	0.04	8	0.02
Release time of 6	7	-0.03	5	-0.06	8	0.04	7	0.05

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:09:56 Page: 38 **
Title : CR3 Sensitivity Analysis - Eu152
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.01	12	-0.02	14	0.02	11	0.02
Resuspension Rate	8	-0.04	9	-0.05	12	-0.03	9	-0.03
Building Exchange Rate	2	-0.34	2	-0.31	1	-0.82	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.08	8	0.07	5	0.09	8	0.04
Air fraction of 1	13	0.02	16	0.02	4	-0.10	7	-0.04
Release time of 1	7	0.04	5	0.10	15	-0.01	15	-0.01
Air fraction of 2	1	0.40	1	0.37	2	0.82	2	0.63
Release time of 2	6	-0.05	4	-0.12	10	0.04	6	0.05
Air fraction of 3	9	0.04	10	0.03	6	0.08	10	0.03
Release time of 3	16	0.01	14	0.02	16	0.00	16	0.01
Air fraction of 4	12	0.02	15	0.02	11	-0.04	13	-0.02
Release time of 4	11	-0.03	7	-0.07	3	-0.13	3	-0.17
Air fraction of 5	10	-0.04	11	-0.03	9	0.05	12	0.02
Release time of 5	15	0.01	13	0.02	8	0.05	5	0.07
Air fraction of 6	3	0.09	6	0.08	13	-0.03	14	-0.01
Release time of 6	5	-0.05	3	-0.12	7	0.06	4	0.08

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:09:56 Page: 39 **
Title : CR3 Sensitivity Analysis - Eu152
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff

BHI energy Power Services

Deposition Velocity	9	0.04	10	0.05	3	0.13	3	0.13
Resuspension Rate	7	-0.05	8	-0.07	4	-0.11	4	-0.11
Building Exchange Rate	2	-0.38	2	-0.35	1	-0.85	1	-0.67
Receptor Ingestion Rate of receptor 1	4	0.08	6	0.07	5	-0.10	9	-0.04
Air fraction of 1	13	0.01	14	0.01	8	-0.06	12	-0.03
Release time of 1	12	0.02	9	0.05	9	0.06	6	0.07
Air fraction of 2	16	0.00	16	0.00	16	-0.01	16	0.00
Release time of 2	14	-0.01	13	-0.01	12	-0.04	8	-0.05
Air fraction of 3	1	0.39	1	0.36	2	0.82	2	0.61
Release time of 3	6	-0.07	3	-0.17	6	-0.08	5	-0.09
Air fraction of 4	10	0.03	12	0.03	15	0.01	15	0.01
Release time of 4	15	0.00	15	0.00	11	0.05	7	0.06
Air fraction of 5	8	-0.05	11	-0.04	7	0.06	11	0.03
Release time of 5	11	0.03	7	0.07	13	-0.03	10	-0.03
Air fraction of 6	3	0.11	5	0.09	10	0.05	13	0.02
Release time of 6	5	-0.07	4	-0.16	14	0.01	14	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:09:56 Page: 40 **
Title : CR3 Sensitivity Analysis - Eu152
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	16	0.00	15	-0.01	5	0.13	4	0.13
Resuspension Rate	7	-0.04	11	-0.05	3	-0.18	3	-0.18
Building Exchange Rate	2	-0.32	2	-0.30	1	-0.83	1	-0.66
Receptor Ingestion Rate of receptor 1	3	0.16	4	0.14	14	0.01	15	0.01
Air fraction of 1	12	0.02	13	0.02	11	-0.03	13	-0.01
Release time of 1	5	0.06	3	0.17	9	-0.03	8	-0.04
Air fraction of 2	15	-0.01	16	-0.01	6	0.12	7	0.05
Release time of 2	13	-0.02	10	-0.05	7	0.05	5	0.06
Air fraction of 3	14	0.02	14	0.01	10	0.03	12	0.01
Release time of 3	9	-0.03	7	-0.07	13	-0.01	11	-0.02
Air fraction of 4	1	0.33	1	0.31	2	0.80	2	0.60
Release time of 4	8	-0.03	8	-0.07	12	0.02	9	0.02
Air fraction of 5	10	-0.03	12	-0.02	8	-0.04	10	-0.02
Release time of 5	11	-0.03	9	-0.06	15	-0.01	14	-0.01
Air fraction of 6	4	0.13	6	0.11	4	0.13	6	0.06
Release time of 6	6	-0.05	5	-0.11	16	0.00	16	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:09:56 Page: 41 **
Title : CR3 Sensitivity Analysis - Eu152
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	16	0.00	15	0.00	4	0.22	4	0.21
Resuspension Rate	14	-0.02	13	-0.02	3	-0.22	3	-0.21
Building Exchange Rate	2	-0.32	2	-0.29	1	-0.85	1	-0.66
Receptor Ingestion Rate of receptor 1	4	0.08	7	0.07	11	-0.04	12	-0.02
Air fraction of 1	13	-0.02	14	-0.02	16	0.00	16	0.00
Release time of 1	8	0.04	5	0.10	6	0.08	5	0.10
Air fraction of 2	5	-0.06	10	-0.05	9	0.04	11	0.02
Release time of 2	12	-0.02	11	-0.05	15	0.00	15	0.00
Air fraction of 3	15	0.00	16	0.00	5	0.09	7	0.04
Release time of 3	11	-0.02	9	-0.06	10	-0.04	6	-0.05
Air fraction of 4	9	0.04	12	0.03	7	0.07	8	0.03
Release time of 4	10	0.02	8	0.06	12	0.02	9	0.03
Air fraction of 5	1	0.41	1	0.39	2	0.83	2	0.62
Release time of 5	6	-0.06	3	-0.13	14	0.01	14	0.01
Air fraction of 6	3	0.10	6	0.09	8	0.06	10	0.02
Release time of 6	7	-0.05	4	-0.12	13	-0.01	13	-0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:09:56 Page: 42 **
Title : CR3 Sensitivity Analysis - Eu152
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	0.00	13	0.00	6	0.10	6	0.10
Resuspension Rate	16	0.00	16	0.00	8	-0.08	7	-0.08
Building Exchange Rate	2	-0.29	2	-0.27	1	-0.82	1	-0.64
Receptor Ingestion Rate of receptor 1	3	0.14	5	0.12	11	0.05	12	0.02
Air fraction of 1	7	-0.05	8	-0.04	12	-0.03	14	-0.01
Release time of 1	6	0.05	4	0.13	16	0.00	16	0.00
Air fraction of 2	5	-0.06	6	-0.05	9	-0.07	10	-0.03
Release time of 2	10	-0.01	9	-0.04	4	0.12	4	0.15
Air fraction of 3	13	0.00	15	0.00	15	0.01	15	0.00
Release time of 3	15	0.00	14	0.00	14	0.02	13	0.02
Air fraction of 4	8	0.02	11	0.02	5	0.11	8	0.05
Release time of 4	11	0.01	10	0.03	7	-0.08	5	-0.10
Air fraction of 5	12	0.01	12	0.01	10	-0.06	11	-0.02
Release time of 5	9	-0.02	7	-0.05	13	-0.03	9	-0.03
Air fraction of 6	1	0.36	1	0.34	2	0.78	2	0.55
Release time of 6	4	-0.08	3	-0.19	3	0.20	3	0.26

Eu-154 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:59:53 Page: 37 **
Title : CR3 Sensitivity Analysis - Eu154
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	8	0.02	7	0.03	5	0.08	5	0.09
Resuspension Rate	11	-0.01	11	-0.02	4	-0.09	4	-0.09
Building Exchange Rate	2	-0.33	2	-0.31	1	-0.78	1	-0.58
Receptor Ingestion Rate of receptor 1	10	0.02	12	0.01	11	-0.03	11	-0.01
Air fraction of 1	1	0.34	1	0.32	2	0.72	2	0.50
Release time of 1	3	0.06	3	0.16	3	0.31	3	0.46
Air fraction of 2	12	-0.01	14	-0.01	10	-0.03	10	-0.01
Release time of 2	6	0.03	4	0.07	16	0.00	16	0.00
Air fraction of 3	16	0.00	16	0.00	12	0.01	13	0.01
Release time of 3	9	-0.02	6	-0.05	7	-0.05	6	-0.06
Air fraction of 4	5	-0.03	9	-0.03	13	0.01	14	0.01
Release time of 4	14	0.00	13	-0.01	15	0.00	15	0.00
Air fraction of 5	4	0.04	8	0.03	9	0.03	9	0.01
Release time of 5	13	0.01	10	0.02	14	-0.01	12	-0.01
Air fraction of 6	15	0.00	15	0.00	6	0.06	8	0.03
Release time of 6	7	-0.02	5	-0.06	8	0.04	7	0.06

* RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:59:53 Page: 38 **
Title : CR3 Sensitivity Analysis - Eu154
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.01	14	-0.02	9	-0.02	10	-0.02
Resuspension Rate	10	-0.03	9	-0.05	13	0.01	12	0.01
Building Exchange Rate	2	-0.35	2	-0.32	2	-0.83	2	-0.63
Receptor Ingestion Rate of receptor 1	4	0.09	7	0.07	6	0.07	8	0.03
Air fraction of 1	13	0.01	15	0.01	4	-0.11	5	-0.05
Release time of 1	8	0.04	5	0.11	10	0.02	9	0.03
Air fraction of 2	1	0.41	1	0.37	1	0.84	1	0.65
Release time of 2	5	-0.07	3	-0.16	11	-0.02	11	-0.02
Air fraction of 3	7	0.05	10	0.04	5	0.09	7	0.04
Release time of 3	15	0.01	13	0.02	15	0.00	15	0.00
Air fraction of 4	9	0.04	11	0.03	12	-0.01	13	-0.01
Release time of 4	12	-0.03	8	-0.06	3	-0.11	3	-0.13
Air fraction of 5	11	-0.03	12	-0.03	14	0.01	14	0.00
Release time of 5	16	0.00	16	0.01	8	0.04	6	0.04
Air fraction of 6	3	0.09	6	0.08	16	0.00	16	0.00
Release time of 6	6	-0.05	4	-0.11	7	0.06	4	0.07

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:59:53 Page: 39 **
Title : CR3 Sensitivity Analysis - Eu154
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.04	10	0.05	3	0.10	3	0.09
Resuspension Rate	7	-0.05	7	-0.07	7	-0.06	7	-0.05
Building Exchange Rate	2	-0.38	2	-0.35	1	-0.86	1	-0.69
Receptor Ingestion Rate of receptor 1	4	0.09	6	0.08	5	-0.09	9	-0.04
Air fraction of 1	14	0.01	14	0.01	9	-0.05	13	-0.02
Release time of 1	12	0.02	9	0.05	11	0.05	5	0.06
Air fraction of 2	15	-0.01	15	-0.01	13	-0.03	15	-0.01
Release time of 2	13	-0.01	13	-0.03	12	-0.05	6	-0.05
Air fraction of 3	1	0.39	1	0.35	2	0.83	2	0.61
Release time of 3	5	-0.08	3	-0.18	6	-0.07	4	-0.08
Air fraction of 4	8	0.04	11	0.04	10	0.05	14	0.02
Release time of 4	16	0.00	16	0.00	14	0.03	10	0.03
Air fraction of 5	9	-0.04	12	-0.03	8	0.05	12	0.02
Release time of 5	11	0.03	8	0.06	15	-0.02	11	-0.03
Air fraction of 6	3	0.11	5	0.09	4	0.10	8	0.04
Release time of 6	6	-0.07	4	-0.16	16	0.01	16	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:59:53 Page: 40 **
Title : CR3 Sensitivity Analysis - Eu154
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	-0.01	15	-0.01	6	0.09	4	0.09
Resuspension Rate	8	-0.03	11	-0.05	4	-0.14	3	-0.14
Building Exchange Rate	2	-0.32	2	-0.30	1	-0.83	1	-0.65

Receptor Ingestion Rate of receptor 1	3	0.17	4	0.15	16	0.00	16	0.00
Air fraction of 1	13	0.02	13	0.02	10	-0.05	11	-0.02
Release time of 1	5	0.07	3	0.17	8	-0.06	5	-0.07
Air fraction of 2	16	-0.01	16	-0.01	5	0.11	8	0.05
Release time of 2	11	-0.02	10	-0.05	9	0.05	6	0.06
Air fraction of 3	14	0.02	14	0.01	11	0.05	12	0.02
Release time of 3	9	-0.03	8	-0.08	12	-0.02	10	-0.02
Air fraction of 4	1	0.34	1	0.31	2	0.82	2	0.62
Release time of 4	7	-0.03	7	-0.08	15	0.00	15	-0.01
Air fraction of 5	12	-0.02	12	-0.02	7	-0.06	9	-0.03
Release time of 5	10	-0.03	9	-0.07	14	-0.01	14	-0.01
Air fraction of 6	4	0.13	6	0.11	3	0.14	7	0.06
Release time of 6	6	-0.05	5	-0.12	13	0.01	13	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:59:53 Page: 41 **
Title : CR3 Sensitivity Analysis - Eu154
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	0.00	15	0.00	3	0.15	3	0.14
Resuspension Rate	14	-0.01	13	-0.01	4	-0.13	4	-0.13
Building Exchange Rate	2	-0.31	2	-0.28	1	-0.84	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.09	7	0.07	16	0.00	16	0.00
Air fraction of 1	13	-0.02	14	-0.01	13	-0.02	14	-0.01
Release time of 1	9	0.04	5	0.09	7	0.06	5	0.08
Air fraction of 2	6	-0.06	11	-0.05	8	0.06	11	0.02
Release time of 2	11	-0.02	9	-0.06	12	-0.03	9	-0.04
Air fraction of 3	16	0.00	16	0.00	5	0.11	8	0.05
Release time of 3	12	-0.02	10	-0.06	10	-0.05	7	-0.06
Air fraction of 4	8	0.04	12	0.03	6	0.07	10	0.03
Release time of 4	10	0.03	8	0.06	9	0.05	6	0.06
Air fraction of 5	1	0.41	1	0.38	2	0.83	2	0.64
Release time of 5	5	-0.06	3	-0.15	14	-0.01	13	-0.01
Air fraction of 6	3	0.10	6	0.09	11	0.05	12	0.02
Release time of 6	7	-0.05	4	-0.12	15	0.00	15	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:59:53 Page: 42 **
Title : CR3 Sensitivity Analysis - Eu154
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	0.00	14	0.00	7	0.08	6	0.08
Resuspension Rate	13	0.01	12	0.01	10	-0.04	7	-0.04
Building Exchange Rate	2	-0.29	2	-0.27	1	-0.83	1	-0.66
Receptor Ingestion Rate of receptor 1	3	0.15	4	0.13	11	0.03	13	0.02
Air fraction of 1	6	-0.05	8	-0.04	14	-0.03	15	-0.01
Release time of 1	7	0.05	5	0.13	15	0.01	14	0.01
Air fraction of 2	5	-0.06	6	-0.06	8	-0.07	11	-0.03
Release time of 2	10	-0.02	9	-0.04	4	0.12	4	0.15
Air fraction of 3	15	0.00	16	0.00	16	0.00	16	0.00
Release time of 3	16	0.00	15	0.00	13	0.03	10	0.03
Air fraction of 4	8	0.03	11	0.03	5	0.08	9	0.04
Release time of 4	11	0.01	10	0.03	6	-0.08	5	-0.10
Air fraction of 5	12	0.01	13	0.01	9	-0.05	12	-0.02
Release time of 5	9	-0.02	7	-0.06	12	-0.03	8	-0.04
Air fraction of 6	1	0.35	1	0.33	2	0.79	2	0.57
Release time of 6	4	-0.08	3	-0.20	3	0.14	3	0.18

Fe-55 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:36:23 Page: 37 **
Title : CR3 Sensitivity Analysis - Fe55
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	12	0.01	12	0.02	15	0.01	14	0.00
Resuspension Rate	13	-0.01	13	-0.01	16	0.00	16	0.00
Building Exchange Rate	2	-0.28	2	-0.27	1	-0.85	1	-0.67
Receptor Ingestion Rate of receptor 1	9	0.02	10	0.02	3	0.08	5	0.04
Air fraction of 1	1	0.30	1	0.28	2	0.83	2	0.62
Release time of 1	4	-0.04	3	-0.11	14	0.01	13	0.01
Air fraction of 2	5	-0.04	8	-0.04	4	-0.08	6	-0.03
Release time of 2	7	0.02	4	0.06	8	-0.05	3	-0.05
Air fraction of 3	15	0.00	16	0.00	13	-0.01	15	0.00
Release time of 3	10	-0.02	6	-0.05	11	0.01	11	0.02
Air fraction of 4	6	-0.03	9	-0.03	7	0.05	10	0.02
Release time of 4	14	0.00	14	0.00	10	0.03	7	0.03
Air fraction of 5	3	0.05	7	0.05	6	0.06	9	0.02
Release time of 5	16	0.00	15	0.00	12	0.01	12	0.02
Air fraction of 6	11	0.02	11	0.02	5	0.07	8	0.03
Release time of 6	8	-0.02	5	-0.06	9	0.04	4	0.05

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:36:23 Page: 38 **
Title : CR3 Sensitivity Analysis - Fe55
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	11	-0.02	11	-0.03	9	-0.06	6	-0.06
Resuspension Rate	12	-0.02	12	-0.02	8	0.06	5	0.06
Building Exchange Rate	2	-0.36	2	-0.32	2	-0.84	2	-0.64
Receptor Ingestion Rate of receptor 1	3	0.11	6	0.09	3	0.13	8	0.06
Air fraction of 1	13	0.02	14	0.01	4	-0.13	9	-0.05
Release time of 1	8	0.05	4	0.12	10	0.05	7	0.06
Air fraction of 2	1	0.42	1	0.39	1	0.84	1	0.64
Release time of 2	5	-0.06	3	-0.14	13	0.03	11	0.04
Air fraction of 3	7	0.05	9	0.05	6	0.09	10	0.04
Release time of 3	15	0.01	13	0.02	15	-0.02	13	-0.02
Air fraction of 4	6	0.05	10	0.05	11	-0.04	14	-0.02
Release time of 4	10	-0.03	7	-0.07	5	-0.13	3	-0.15
Air fraction of 5	14	-0.01	16	-0.01	12	0.03	15	0.01
Release time of 5	16	0.00	15	0.01	14	0.03	12	0.03
Air fraction of 6	4	0.08	8	0.07	16	0.00	16	0.00
Release time of 6	9	-0.04	5	-0.10	7	0.08	4	0.09

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:36:23 Page: 39 **
Title : CR3 Sensitivity Analysis - Fe55
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	9	0.03	10	0.05	16	0.00	15	0.00
Resuspension Rate	8	-0.04	9	-0.05	11	0.03	10	0.03
Building Exchange Rate	2	-0.38	2	-0.35	1	-0.86	1	-0.69
Receptor Ingestion Rate of receptor 1	3	0.11	5	0.09	13	-0.01	14	-0.01
Air fraction of 1	16	0.00	16	0.00	4	-0.08	9	-0.03
Release time of 1	12	0.02	8	0.06	7	0.04	4	0.05
Air fraction of 2	14	-0.01	15	-0.01	5	-0.07	11	-0.03
Release time of 2	13	-0.01	12	-0.03	10	-0.03	6	-0.04
Air fraction of 3	1	0.39	1	0.36	2	0.84	2	0.61
Release time of 3	5	-0.07	3	-0.17	6	-0.06	3	-0.07
Air fraction of 4	7	0.05	11	0.04	15	0.01	16	0.00
Release time of 4	15	0.00	14	0.01	12	0.03	7	0.04
Air fraction of 5	10	-0.03	13	-0.03	8	0.04	12	0.02
Release time of 5	11	0.03	7	0.06	14	-0.01	13	-0.01
Air fraction of 6	4	0.09	6	0.08	3	0.08	8	0.03
Release time of 6	6	-0.06	4	-0.14	9	0.04	5	0.04

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:36:23 Page: 40 **
Title : CR3 Sensitivity Analysis - Fe55
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	16	-0.01	14	-0.01	11	0.03	9	0.03
Resuspension Rate	10	-0.02	11	-0.03	5	-0.08	3	-0.08
Building Exchange Rate	2	-0.32	2	-0.30	1	-0.84	1	-0.66
Receptor Ingestion Rate of receptor 1	3	0.18	4	0.16	8	0.05	10	0.02
Air fraction of 1	12	0.02	13	0.01	13	-0.01	15	-0.01
Release time of 1	5	0.07	3	0.18	6	-0.06	4	-0.08
Air fraction of 2	14	-0.01	15	-0.01	4	0.10	7	0.04
Release time of 2	9	-0.03	8	-0.06	14	0.01	13	0.01
Air fraction of 3	11	0.02	12	0.01	10	0.04	12	0.02
Release time of 3	7	-0.03	7	-0.08	15	0.01	14	0.01
Air fraction of 4	1	0.35	1	0.32	2	0.82	2	0.61
Release time of 4	13	-0.02	10	-0.04	7	0.06	5	0.07
Air fraction of 5	15	-0.01	16	-0.01	9	-0.05	11	-0.02
Release time of 5	8	-0.03	9	-0.06	16	0.00	16	0.00
Air fraction of 6	4	0.11	6	0.10	3	0.13	6	0.05
Release time of 6	6	-0.05	5	-0.12	12	0.03	8	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:36:23 Page: 41 **
Title : CR3 Sensitivity Analysis - Fe55
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	15	0.00	15	0.00	5	0.11	3	0.10
Resuspension Rate	14	0.00	14	0.00	6	-0.08	5	-0.07
Building Exchange Rate	2	-0.31	2	-0.28	1	-0.85	1	-0.64

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Receptor Ingestion Rate of receptor 1	3	0.10	6	0.08	16	-0.01	16	0.00
Air fraction of 1	13	-0.01	13	-0.01	10	-0.05	14	-0.02
Release time of 1	9	0.04	5	0.10	7	0.07	4	0.08
Air fraction of 2	5	-0.06	11	-0.05	9	0.05	13	0.02
Release time of 2	11	-0.02	9	-0.06	14	-0.02	12	-0.02
Air fraction of 3	16	0.00	16	0.00	3	0.11	6	0.05
Release time of 3	12	-0.02	10	-0.05	13	-0.02	10	-0.03
Air fraction of 4	8	0.05	12	0.04	4	0.11	7	0.04
Release time of 4	10	0.03	8	0.06	11	0.04	8	0.04
Air fraction of 5	1	0.42	1	0.39	2	0.84	2	0.64
Release time of 5	6	-0.05	3	-0.12	12	0.03	9	0.03
Air fraction of 6	4	0.09	7	0.08	8	0.06	11	0.02
Release time of 6	7	-0.05	4	-0.11	15	-0.01	15	-0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 12:36:23 Page: 42 **
Title : CR3 Sensitivity Analysis - Fe55
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.02	13	-0.02	12	0.02	10	0.02
Resuspension Rate	10	0.02	11	0.04	16	0.00	16	0.00
Building Exchange Rate	2	-0.28	2	-0.26	1	-0.86	1	-0.68
Receptor Ingestion Rate of receptor 1	3	0.17	4	0.15	7	0.05	11	0.02
Air fraction of 1	6	-0.06	9	-0.05	15	0.01	15	0.00
Release time of 1	7	0.05	5	0.13	8	0.05	6	0.06
Air fraction of 2	5	-0.07	7	-0.06	13	-0.01	13	0.00
Release time of 2	11	-0.02	8	-0.06	4	0.09	3	0.10
Air fraction of 3	16	0.00	16	0.00	14	0.01	14	0.00
Release time of 3	15	-0.01	15	-0.01	9	0.04	8	0.04
Air fraction of 4	8	0.04	12	0.04	3	0.12	7	0.05
Release time of 4	13	0.02	10	0.04	6	-0.06	5	-0.07
Air fraction of 5	12	0.02	14	0.02	11	-0.03	12	-0.01
Release time of 5	9	-0.03	6	-0.07	5	-0.07	4	-0.08
Air fraction of 6	1	0.33	1	0.31	2	0.83	2	0.61
Release time of 6	4	-0.09	3	-0.23	10	0.04	9	0.04

H-3 Results:

* RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 16:36:48 Page: 37 **
Title : CR3 Sensitivity Analysis - H3
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	7	0.03	6	0.05	3	0.44	3	0.38
Resuspension Rate	5	-0.04	5	-0.06	2	-0.48	2	-0.42
Building Exchange Rate	1	-0.25	1	-0.25	1	-0.93	1	-0.90
Receptor Ingestion Rate of receptor 1	4	0.07	4	0.07	5	0.22	5	0.08
Release time of 1	2	-0.25	2	-0.24	4	-0.33	4	-0.13
Release time of 2	3	0.08	3	0.08	9	0.01	9	0.00
Release time of 3	9	-0.01	9	-0.01	7	0.11	7	0.04
Release time of 4	8	0.03	8	0.03	10	0.01	10	0.00
Release time of 5	6	0.03	7	0.03	6	0.11	6	0.04
Release time of 6	10	-0.01	10	-0.01	8	0.01	8	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 16:36:48 Page: 38 **
Title : CR3 Sensitivity Analysis - H3
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	5	0.03	5	0.04	3	0.38	3	0.33
Resuspension Rate	4	-0.05	4	-0.07	2	-0.46	2	-0.41
Building Exchange Rate	1	-0.39	1	-0.39	1	-0.93	1	-0.90
Receptor Ingestion Rate of receptor 1	3	0.08	3	0.08	5	0.22	5	0.08
Release time of 1	8	0.01	8	0.01	10	-0.01	10	0.00
Release time of 2	2	-0.21	2	-0.19	4	-0.22	4	-0.08
Release time of 3	10	0.00	10	0.00	6	0.11	6	0.04
Release time of 4	9	-0.01	9	-0.01	7	-0.09	7	-0.03
Release time of 5	7	-0.02	7	-0.02	8	0.04	8	0.02
Release time of 6	6	-0.02	6	-0.02	9	0.02	9	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 16:36:48 Page: 39 **
Title : CR3 Sensitivity Analysis - H3
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC	SRC	PRCC	SRRC
Repetition =	1	1	1	1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	8	0.02	7	0.03	3	0.38	3	0.34
Resuspension Rate	5	-0.04	3	-0.07	2	-0.45	2	-0.42
Building Exchange Rate	1	-0.22	1	-0.21	1	-0.92	1	-0.90
Receptor Ingestion Rate of receptor 1	4	0.06	5	0.06	4	0.25	4	0.10
Release time of 1	10	0.01	10	0.01	7	0.02	7	0.01
Release time of 2	6	-0.04	6	-0.04	9	0.00	9	0.00
Release time of 3	2	-0.20	2	-0.19	5	-0.17	5	-0.07
Release time of 4	9	-0.01	9	-0.01	8	-0.01	8	0.00
Release time of 5	3	-0.07	4	-0.06	6	-0.07	6	-0.03
Release time of 6	7	0.02	8	0.02	10	0.00	10	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 16:36:48 Page: 40 **
Title : CR3 Sensitivity Analysis - H3
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.00	10	0.01	3	0.43	3	0.37
Resuspension Rate	9	-0.01	9	-0.01	2	-0.49	2	-0.43
Building Exchange Rate	1	-0.22	1	-0.22	1	-0.93	1	-0.90
Receptor Ingestion Rate of receptor 1	6	0.04	6	0.04	5	0.28	5	0.10
Release time of 1	4	0.07	4	0.07	10	0.03	10	0.01
Release time of 2	5	-0.04	5	-0.04	8	-0.06	8	-0.02
Release time of 3	7	-0.04	7	-0.03	6	0.11	6	0.04
Release time of 4	2	-0.21	2	-0.21	4	-0.35	4	-0.13
Release time of 5	8	-0.02	8	-0.02	7	0.09	7	0.03
Release time of 6	3	-0.07	3	-0.07	9	0.05	9	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 16:36:48 Page: 41 **
Title : CR3 Sensitivity Analysis - H3
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	5	0.06	5	0.09	3	0.40	3	0.34
Resuspension Rate	4	-0.10	3	-0.15	2	-0.49	2	-0.43
Building Exchange Rate	1	-0.37	1	-0.36	1	-0.93	1	-0.91
Receptor Ingestion Rate of receptor 1	3	0.11	4	0.10	4	0.22	4	0.08
Release time of 1	8	-0.02	8	-0.02	6	0.05	6	0.02
Release time of 2	7	0.04	7	0.03	9	0.01	9	0.00
Release time of 3	6	-0.06	6	-0.05	8	0.01	8	0.00
Release time of 4	10	0.02	10	0.02	7	-0.01	7	0.00
Release time of 5	2	-0.25	2	-0.23	5	-0.21	5	-0.08
Release time of 6	9	-0.02	9	-0.02	10	0.00	10	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 16:36:48 Page: 42 **
Title : CR3 Sensitivity Analysis - H3
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	6	0.04	5	0.06	3	0.37	3	0.32
Resuspension Rate	4	-0.06	3	-0.09	2	-0.43	2	-0.38
Building Exchange Rate	1	-0.30	1	-0.30	1	-0.93	1	-0.91
Receptor Ingestion Rate of receptor 1	3	0.07	4	0.07	5	0.23	5	0.08
Release time of 1	10	-0.02	10	-0.02	9	-0.03	9	-0.01
Release time of 2	9	0.02	9	0.02	10	-0.01	10	-0.01
Release time of 3	8	-0.03	8	-0.03	6	0.07	6	0.02
Release time of 4	7	0.03	7	0.03	7	-0.03	7	-0.01
Release time of 5	5	0.05	6	0.05	8	0.03	8	0.01
Release time of 6	2	-0.25	2	-0.23	4	-0.29	4	-0.11

Nb-94 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:01:36 Page: 37 **
Title : CR3 Sensitivity Analysis - Nb94
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	9	-0.03	7	-0.04	7	0.09	5	0.10
Resuspension Rate	12	-0.01	11	-0.02	4	-0.24	4	-0.28
Building Exchange Rate	2	-0.31	2	-0.29	1	-0.76	1	-0.59

Receptor Ingestion Rate of receptor 1	15	0.00	15	0.00	16	0.00	16	0.00
Air fraction of 1	1	0.34	1	0.32	2	0.71	2	0.51
Release time of 1	7	-0.04	8	-0.04	3	0.51	3	0.30
Air fraction of 2	10	0.02	10	0.02	9	-0.06	9	-0.03
Release time of 2	5	0.06	5	0.05	12	-0.04	12	-0.02
Air fraction of 3	11	0.02	12	0.02	13	-0.03	13	-0.01
Release time of 3	14	-0.01	14	-0.01	15	-0.02	15	-0.01
Air fraction of 4	4	-0.06	4	-0.06	10	0.05	10	0.03
Release time of 4	3	-0.08	3	-0.07	11	0.05	11	0.02
Air fraction of 5	8	-0.03	9	-0.03	8	0.09	8	0.05
Release time of 5	16	0.00	16	0.00	14	0.02	14	0.01
Air fraction of 6	6	0.05	6	0.05	6	0.11	7	0.05
Release time of 6	13	0.01	13	0.01	5	0.13	6	0.07

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:01:36 Page: 38 **
Title : CR3 Sensitivity Analysis - Nb94
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	9	-0.06	4	-0.08	5	0.14	5	0.13
Resuspension Rate	16	-0.01	14	-0.02	4	-0.32	3	-0.31
Building Exchange Rate	2	-0.28	2	-0.26	1	-0.85	1	-0.65
Receptor Ingestion Rate of receptor 1	11	0.05	11	0.05	12	0.05	12	0.02
Air fraction of 1	12	0.04	12	0.04	7	-0.10	7	-0.04
Release time of 1	7	-0.07	8	-0.06	16	0.01	16	0.00
Air fraction of 2	1	0.29	1	0.27	2	0.83	2	0.60
Release time of 2	3	-0.25	3	-0.23	3	-0.33	4	-0.14
Air fraction of 3	5	0.07	6	0.06	8	0.09	8	0.03
Release time of 3	10	-0.06	10	-0.05	11	-0.05	11	-0.02
Air fraction of 4	13	0.04	13	0.03	13	-0.05	13	-0.02
Release time of 4	6	-0.07	7	-0.06	6	-0.13	6	-0.05
Air fraction of 5	14	-0.01	15	-0.01	10	0.06	10	0.02
Release time of 5	15	-0.01	16	-0.01	15	0.03	15	0.01
Air fraction of 6	4	0.09	5	0.08	14	0.03	14	0.01
Release time of 6	8	-0.06	9	-0.06	9	0.08	9	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:01:36 Page: 39 **
Title : CR3 Sensitivity Analysis - Nb94
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	8	0.05	7	0.06	5	0.22	4	0.20
Resuspension Rate	6	-0.08	4	-0.11	4	-0.33	3	-0.32
Building Exchange Rate	2	-0.36	2	-0.33	1	-0.86	1	-0.67
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	10	-0.06	10	-0.03
Air fraction of 1	4	0.10	5	0.09	14	-0.02	14	-0.01
Release time of 1	12	-0.02	12	-0.02	12	-0.03	12	-0.01
Air fraction of 2	9	0.04	9	0.03	6	-0.14	6	-0.06
Release time of 2	13	0.02	13	0.02	8	-0.10	8	-0.04
Air fraction of 3	1	0.37	1	0.33	2	0.81	2	0.57
Release time of 3	3	-0.30	3	-0.26	3	-0.41	5	-0.18
Air fraction of 4	14	-0.01	14	-0.01	15	0.02	15	0.01
Release time of 4	16	-0.01	16	-0.01	13	0.02	13	0.01
Air fraction of 5	10	-0.03	10	-0.03	11	0.04	11	0.02
Release time of 5	11	0.03	11	0.02	16	0.00	16	0.00
Air fraction of 6	7	0.05	8	0.04	7	0.10	7	0.04
Release time of 6	5	-0.10	6	-0.08	9	0.07	9	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:01:36 Page: 40 **
Title : CR3 Sensitivity Analysis - Nb94
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	13	-0.02	11	-0.03	5	0.23	4	0.22
Resuspension Rate	7	-0.05	6	-0.07	3	-0.39	3	-0.39
Building Exchange Rate	3	-0.32	2	-0.28	1	-0.84	1	-0.63
Receptor Ingestion Rate of receptor 1	5	0.14	5	0.12	12	0.03	12	0.01
Air fraction of 1	12	0.03	13	0.02	13	0.02	13	0.01
Release time of 1	15	0.01	15	0.01	9	-0.05	9	-0.02
Air fraction of 2	14	-0.01	14	-0.01	10	0.04	10	0.02
Release time of 2	11	0.03	12	0.02	8	0.05	8	0.02
Air fraction of 3	6	0.06	7	0.05	14	-0.02	14	-0.01
Release time of 3	8	-0.05	8	-0.04	15	0.01	15	0.00
Air fraction of 4	1	0.43	1	0.39	2	0.84	2	0.62
Release time of 4	2	-0.33	3	-0.28	4	-0.33	5	-0.14
Air fraction of 5	10	-0.04	10	-0.03	7	-0.11	7	-0.04
Release time of 5	16	0.00	16	0.00	16	0.00	16	0.00
Air fraction of 6	4	0.20	4	0.17	6	0.21	6	0.09
Release time of 6	9	-0.04	9	-0.03	11	0.03	11	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:01:36 Page: 41 **

Title : CR3 Sensitivity Analysis - Nb94
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	12	0.02	9	0.03	4	0.32	4	0.29
Resuspension Rate	7	-0.05	4	-0.07	3	-0.45	3	-0.43
Building Exchange Rate	2	-0.36	2	-0.33	1	-0.86	1	-0.64
Receptor Ingestion Rate of receptor 1	11	0.02	12	0.02	8	-0.07	8	-0.03
Air fraction of 1	16	0.01	16	0.01	16	-0.01	16	0.00
Release time of 1	4	0.07	5	0.05	11	0.05	11	0.02
Air fraction of 2	15	0.01	15	0.01	14	0.04	14	0.01
Release time of 2	6	-0.06	7	-0.05	7	-0.08	7	-0.03
Air fraction of 3	8	0.04	8	0.03	13	0.05	13	0.02
Release time of 3	9	-0.04	10	-0.03	12	-0.05	12	-0.02
Air fraction of 4	14	0.01	14	0.01	10	0.06	10	0.02
Release time of 4	13	-0.02	13	-0.01	9	-0.07	9	-0.03
Air fraction of 5	1	0.42	1	0.39	2	0.85	2	0.62
Release time of 5	3	-0.24	3	-0.20	5	-0.27	5	-0.10
Air fraction of 6	10	0.02	11	0.02	6	0.15	6	0.06
Release time of 6	5	-0.06	6	-0.05	15	0.02	15	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:01:36 Page: 42 **
Title : CR3 Sensitivity Analysis - Nb94
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	16	0.00	16	0.00	5	0.14	4	0.14
Resuspension Rate	14	-0.02	13	-0.03	3	-0.26	3	-0.27
Building Exchange Rate	3	-0.13	3	-0.13	1	-0.84	1	-0.66
Receptor Ingestion Rate of receptor 1	13	-0.02	14	-0.02	7	0.10	7	0.04
Air fraction of 1	12	0.03	12	0.03	11	0.04	11	0.02
Release time of 1	5	0.07	5	0.07	8	0.08	8	0.04
Air fraction of 2	4	0.08	4	0.08	14	-0.01	14	-0.01
Release time of 2	11	0.04	11	0.03	16	0.00	16	0.00
Air fraction of 3	8	0.04	8	0.04	13	-0.01	13	-0.01
Release time of 3	10	-0.04	10	-0.04	15	-0.01	15	0.00
Air fraction of 4	6	-0.06	6	-0.06	6	0.12	6	0.05
Release time of 4	7	-0.05	7	-0.05	12	-0.02	12	-0.01
Air fraction of 5	9	-0.04	9	-0.04	10	-0.05	10	-0.02
Release time of 5	15	0.00	15	0.00	9	-0.07	9	-0.03
Air fraction of 6	1	0.17	1	0.17	2	0.81	2	0.59
Release time of 6	2	-0.14	2	-0.13	4	0.19	5	0.08

Ni-59 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:30:46 Page: 37 **
Title : CR3 Sensitivity Analysis - Ni59
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	12	-0.01	11	-0.02	8	0.07	6	0.06
Resuspension Rate	11	-0.01	10	-0.02	4	-0.20	4	-0.15
Building Exchange Rate	3	-0.27	3	-0.25	2	-0.88	2	-0.63
Receptor Ingestion Rate of receptor 1	7	0.05	7	0.04	5	0.19	5	0.06
Air fraction of 1	2	0.30	2	0.28	1	0.89	1	0.64
Release time of 1	1	-0.31	1	-0.29	3	-0.64	3	-0.28
Air fraction of 2	10	-0.01	12	-0.01	9	-0.06	9	-0.02
Release time of 2	4	0.10	4	0.08	11	-0.03	11	-0.01
Air fraction of 3	15	0.00	15	0.00	12	0.02	12	0.01
Release time of 3	14	0.00	14	0.00	6	0.10	7	0.03
Air fraction of 4	8	-0.05	8	-0.04	15	0.02	15	0.01
Release time of 4	5	-0.05	5	-0.05	13	0.02	13	0.01
Air fraction of 5	13	0.01	13	0.01	14	-0.02	14	-0.01
Release time of 5	9	-0.04	9	-0.03	10	0.04	10	0.01
Air fraction of 6	6	0.05	6	0.04	7	0.10	8	0.03
Release time of 6	16	0.00	16	0.00	16	0.00	16	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:30:46 Page: 38 **
Title : CR3 Sensitivity Analysis - Ni59
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	13	-0.04	6	-0.06	6	0.12	5	0.08
Resuspension Rate	16	-0.01	16	-0.01	4	-0.23	4	-0.17

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Building Exchange Rate	2	-0.29	2	-0.27	1	-0.89	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.11	4	0.10	5	0.19	6	0.06
Air fraction of 1	12	0.05	13	0.04	11	-0.05	11	-0.02
Release time of 1	7	-0.07	8	-0.06	10	0.06	10	0.02
Air fraction of 2	3	0.27	3	0.25	2	0.89	2	0.62
Release time of 2	1	-0.30	1	-0.28	3	-0.69	3	-0.31
Air fraction of 3	10	0.05	11	0.05	14	0.03	14	0.01
Release time of 3	11	-0.05	12	-0.05	15	-0.03	15	-0.01
Air fraction of 4	9	0.06	10	0.05	8	-0.07	8	-0.02
Release time of 4	8	-0.06	9	-0.05	7	-0.10	7	-0.03
Air fraction of 5	15	0.03	15	0.02	16	0.02	16	0.01
Release time of 5	14	-0.03	14	-0.03	9	0.06	9	0.02
Air fraction of 6	5	0.09	5	0.08	12	0.04	12	0.01
Release time of 6	6	-0.07	7	-0.06	13	0.04	13	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:30:46 Page: 39 **
Title : CR3 Sensitivity Analysis - Ni59
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	8	0.08	5	0.10	5	0.17	5	0.14
Resuspension Rate	6	-0.08	4	-0.11	4	-0.26	4	-0.21
Building Exchange Rate	3	-0.37	2	-0.33	1	-0.89	1	-0.67
Receptor Ingestion Rate of receptor 1	5	0.09	7	0.08	10	0.05	10	0.02
Air fraction of 1	4	0.11	6	0.09	11	-0.04	11	-0.02
Release time of 1	9	-0.04	9	-0.03	14	-0.03	14	-0.01
Air fraction of 2	12	0.03	12	0.03	6	-0.16	6	-0.06
Release time of 2	10	0.04	10	0.03	7	-0.11	7	-0.04
Air fraction of 3	1	0.38	1	0.33	2	0.86	2	0.57
Release time of 3	2	-0.38	3	-0.33	3	-0.66	3	-0.30
Air fraction of 4	14	0.02	14	0.02	13	-0.03	13	-0.01
Release time of 4	13	0.02	13	0.02	16	0.00	16	0.00
Air fraction of 5	16	0.01	16	0.00	15	0.00	15	0.00
Release time of 5	11	0.03	11	0.03	12	-0.04	12	-0.01
Air fraction of 6	15	0.01	15	0.01	9	0.05	9	0.02
Release time of 6	7	-0.08	8	-0.06	8	0.07	8	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:30:46 Page: 40 **
Title : CR3 Sensitivity Analysis - Ni59
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	16	0.00	16	0.00	5	0.19	5	0.14
Resuspension Rate	7	-0.06	6	-0.08	4	-0.32	4	-0.25
Building Exchange Rate	3	-0.32	3	-0.28	1	-0.89	1	-0.63
Receptor Ingestion Rate of receptor 1	4	0.19	4	0.16	7	0.12	7	0.04
Air fraction of 1	11	0.02	11	0.01	14	-0.04	14	-0.01
Release time of 1	15	0.00	15	0.00	9	-0.06	9	-0.02
Air fraction of 2	13	-0.02	13	-0.01	16	0.00	16	0.00
Release time of 2	10	0.03	10	0.03	12	0.04	12	0.01
Air fraction of 3	8	0.05	8	0.04	13	-0.04	13	-0.01
Release time of 3	9	-0.05	9	-0.04	11	0.05	11	0.02
Air fraction of 4	1	0.43	1	0.38	2	0.89	2	0.63
Release time of 4	2	-0.35	2	-0.30	3	-0.66	3	-0.29
Air fraction of 5	12	-0.02	12	-0.01	10	-0.05	10	-0.02
Release time of 5	14	-0.01	14	-0.01	15	0.03	15	0.01
Air fraction of 6	5	0.17	5	0.14	6	0.14	6	0.05
Release time of 6	6	-0.06	7	-0.05	8	0.09	8	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:30:46 Page: 41 **
Title : CR3 Sensitivity Analysis - Ni59
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	8	0.05	5	0.07	5	0.22	5	0.16
Resuspension Rate	7	-0.06	4	-0.08	4	-0.31	4	-0.23
Building Exchange Rate	2	-0.36	2	-0.31	1	-0.90	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.06	6	0.05	7	0.12	7	0.04
Air fraction of 1	13	0.01	13	0.01	15	0.00	15	0.00
Release time of 1	5	0.06	7	0.05	11	0.04	11	0.01
Air fraction of 2	16	0.00	16	0.00	8	0.06	8	0.02
Release time of 2	6	-0.06	8	-0.05	9	-0.05	9	-0.02
Air fraction of 3	11	0.03	11	0.02	14	0.03	14	0.01
Release time of 3	9	-0.04	9	-0.04	12	-0.03	12	-0.01
Air fraction of 4	12	0.02	12	0.02	13	0.03	13	0.01
Release time of 4	15	0.00	15	0.00	16	0.00	16	0.00
Air fraction of 5	1	0.42	1	0.38	2	0.89	2	0.61
Release time of 5	3	-0.32	3	-0.27	3	-0.66	3	-0.28
Air fraction of 6	14	0.01	14	0.01	6	0.15	6	0.05
Release time of 6	10	-0.04	10	-0.03	10	0.04	10	0.01

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:30:46 Page:  42 **
 Title      : CR3 Sensitivity Analysis - Ni59
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(6) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		1		1		1		1
Repetition =		1		1		1		1
Deposition Velocity	13	-0.01	13	-0.01	7	0.10	5	0.08
Resuspension Rate	15	0.00	14	0.01	4	-0.22	4	-0.17
Building Exchange Rate	3	-0.17	3	-0.16	1	-0.89	1	-0.66
Receptor Ingestion Rate of receptor 1	16	0.00	16	0.00	5	0.21	6	0.07
Air fraction of 1	12	0.02	12	0.02	10	0.06	10	0.02
Release time of 1	5	0.07	5	0.06	9	0.06	9	0.02
Air fraction of 2	4	0.07	4	0.06	16	-0.01	16	0.00
Release time of 2	11	0.03	11	0.03	14	0.02	14	0.01
Air fraction of 3	9	0.04	9	0.04	11	0.05	11	0.02
Release time of 3	8	-0.04	8	-0.04	15	-0.02	15	-0.01
Air fraction of 4	7	-0.05	7	-0.04	6	0.13	7	0.04
Release time of 4	6	-0.05	6	-0.05	12	0.03	12	0.01
Air fraction of 5	10	-0.04	10	-0.04	13	0.03	13	0.01
Release time of 5	14	-0.01	15	-0.01	8	-0.08	8	-0.03
Air fraction of 6	1	0.21	1	0.21	2	0.87	2	0.61
Release time of 6	2	-0.20	2	-0.19	3	-0.63	3	-0.27

Ni-63 Results:

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:41:58 Page:  37 **
 Title      : CR3 Sensitivity Analysis - Ni63
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(1) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		1		1		1		1
Repetition =		1		1		1		1
Deposition Velocity	16	0.00	14	0.01	10	0.05	6	0.04
Resuspension Rate	12	-0.02	10	-0.02	5	-0.11	4	-0.08
Building Exchange Rate	3	-0.27	3	-0.25	2	-0.88	2	-0.64
Receptor Ingestion Rate of receptor 1	9	0.03	9	0.02	4	0.13	5	0.04
Air fraction of 1	2	0.29	2	0.27	1	0.88	1	0.65
Release time of 1	1	-0.29	1	-0.27	3	-0.58	3	-0.24
Air fraction of 2	11	-0.02	12	-0.02	9	-0.06	10	-0.02
Release time of 2	4	0.09	4	0.08	16	0.01	16	0.00
Air fraction of 3	14	0.00	15	0.00	13	0.03	13	0.01
Release time of 3	15	0.00	16	0.00	7	0.07	8	0.02
Air fraction of 4	7	-0.05	7	-0.04	15	0.02	15	0.01
Release time of 4	5	-0.05	5	-0.05	12	0.03	12	0.01
Air fraction of 5	10	0.02	11	0.02	11	-0.04	11	-0.01
Release time of 5	8	-0.04	8	-0.04	8	0.07	9	0.02
Air fraction of 6	6	0.05	6	0.04	6	0.08	7	0.03
Release time of 6	13	-0.01	13	-0.01	14	0.03	14	0.01

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:41:58 Page:  38 **
 Title      : CR3 Sensitivity Analysis - Ni63
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(2) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		1		1		1		1
Repetition =		1		1		1		1
Deposition Velocity	14	-0.03	12	-0.04	7	0.10	5	0.08
Resuspension Rate	16	-0.01	16	-0.02	4	-0.14	4	-0.10
Building Exchange Rate	1	-0.28	1	-0.26	1	-0.90	1	-0.65
Receptor Ingestion Rate of receptor 1	4	0.10	4	0.09	5	0.14	6	0.05
Air fraction of 1	13	0.04	14	0.04	12	-0.07	12	-0.02
Release time of 1	6	-0.08	6	-0.07	14	0.04	14	0.01
Air fraction of 2	3	0.26	3	0.24	2	0.89	2	0.64
Release time of 2	2	-0.28	2	-0.26	3	-0.63	3	-0.26
Air fraction of 3	10	0.06	10	0.05	11	0.08	11	0.02
Release time of 3	9	-0.06	9	-0.05	10	-0.08	10	-0.02
Air fraction of 4	8	0.06	8	0.06	8	-0.08	8	-0.03
Release time of 4	11	-0.05	11	-0.04	6	-0.13	7	-0.04
Air fraction of 5	15	0.03	15	0.02	15	0.04	15	0.01
Release time of 5	12	-0.05	13	-0.04	9	0.08	9	0.02
Air fraction of 6	5	0.09	5	0.08	16	0.02	16	0.01
Release time of 6	7	-0.07	7	-0.06	13	0.07	13	0.02

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:41:58 Page:  39 **
 Title      : CR3 Sensitivity Analysis - Ni63
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(3) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		1		1		1		1
Repetition =		1		1		1		1

Deposition Velocity	4	0.10	4	0.14	5	0.16	5	0.13
Resuspension Rate	5	-0.09	5	-0.13	4	-0.18	4	-0.15
Building Exchange Rate	2	-0.39	2	-0.34	1	-0.89	1	-0.68
Receptor Ingestion Rate of receptor 1	8	0.07	8	0.06	15	0.00	15	0.00
Air fraction of 1	6	0.08	6	0.07	10	-0.06	10	-0.02
Release time of 1	9	-0.04	9	-0.03	12	-0.03	12	-0.01
Air fraction of 2	16	0.01	16	0.01	6	-0.15	6	-0.05
Release time of 2	13	0.02	13	0.02	7	-0.10	7	-0.03
Air fraction of 3	1	0.40	1	0.36	2	0.86	2	0.58
Release time of 3	3	-0.38	3	-0.33	3	-0.61	3	-0.27
Air fraction of 4	10	0.03	10	0.03	13	-0.03	13	-0.01
Release time of 4	14	0.02	14	0.01	14	0.03	14	0.01
Air fraction of 5	15	0.01	15	0.01	16	0.00	16	0.00
Release time of 5	11	0.03	11	0.02	11	-0.05	11	-0.02
Air fraction of 6	12	0.02	12	0.02	9	0.07	9	0.02
Release time of 6	7	-0.07	7	-0.06	8	0.08	8	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:41:58 Page: 40 **
Title : CR3 Sensitivity Analysis - Ni63
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	12	0.02	10	0.03	5	0.16	5	0.13
Resuspension Rate	7	-0.07	6	-0.09	4	-0.24	4	-0.19
Building Exchange Rate	3	-0.32	3	-0.28	2	-0.88	2	-0.63
Receptor Ingestion Rate of receptor 1	4	0.17	4	0.14	7	0.09	7	0.03
Air fraction of 1	16	0.00	16	0.00	12	-0.04	12	-0.01
Release time of 1	14	-0.02	14	-0.02	10	-0.06	10	-0.02
Air fraction of 2	15	-0.02	15	-0.01	15	0.02	15	0.01
Release time of 2	10	0.03	11	0.02	11	0.06	11	0.02
Air fraction of 3	6	0.08	7	0.07	13	-0.04	13	-0.01
Release time of 3	9	-0.04	9	-0.03	16	0.01	16	0.00
Air fraction of 4	1	0.43	1	0.38	1	0.88	1	0.64
Release time of 4	2	-0.34	2	-0.29	3	-0.58	3	-0.25
Air fraction of 5	13	-0.02	13	-0.02	9	-0.08	9	-0.03
Release time of 5	11	-0.03	12	-0.02	14	0.03	14	0.01
Air fraction of 6	5	0.17	5	0.14	6	0.15	6	0.05
Release time of 6	8	-0.07	8	-0.05	8	0.08	8	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:41:58 Page: 41 **
Title : CR3 Sensitivity Analysis - Ni63
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.07	4	0.09	5	0.20	5	0.15
Resuspension Rate	5	-0.06	5	-0.08	4	-0.22	4	-0.16
Building Exchange Rate	2	-0.35	2	-0.31	1	-0.89	1	-0.65
Receptor Ingestion Rate of receptor 1	9	0.03	9	0.03	8	0.06	8	0.02
Air fraction of 1	13	0.01	13	0.01	15	-0.02	15	-0.01
Release time of 1	8	0.05	8	0.04	9	0.05	9	0.02
Air fraction of 2	15	0.00	15	0.00	7	0.09	7	0.03
Release time of 2	7	-0.06	7	-0.05	13	-0.02	13	-0.01
Air fraction of 3	11	0.03	11	0.03	12	0.03	12	0.01
Release time of 3	6	-0.06	6	-0.05	11	-0.04	11	-0.01
Air fraction of 4	12	0.02	12	0.02	14	0.02	14	0.01
Release time of 4	14	-0.01	14	0.00	16	0.00	16	0.00
Air fraction of 5	1	0.42	1	0.38	2	0.89	2	0.63
Release time of 5	3	-0.30	3	-0.26	3	-0.57	3	-0.23
Air fraction of 6	16	0.00	16	0.00	6	0.14	6	0.05
Release time of 6	10	-0.03	10	-0.03	10	0.04	10	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:41:58 Page: 42 **
Title : CR3 Sensitivity Analysis - Ni63
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	-0.01	14	-0.01	10	0.06	7	0.05
Resuspension Rate	14	0.01	13	0.01	6	-0.11	4	-0.09
Building Exchange Rate	3	-0.18	3	-0.17	1	-0.89	1	-0.67
Receptor Ingestion Rate of receptor 1	16	0.00	16	0.00	4	0.16	5	0.05
Air fraction of 1	12	0.02	12	0.02	14	0.03	14	0.01
Release time of 1	5	0.06	5	0.06	9	0.07	10	0.03
Air fraction of 2	4	0.07	4	0.06	16	-0.01	16	0.00
Release time of 2	11	0.03	11	0.02	11	0.05	11	0.02
Air fraction of 3	8	0.05	8	0.04	8	0.08	9	0.03
Release time of 3	7	-0.05	7	-0.04	12	-0.03	12	-0.01
Air fraction of 4	9	-0.04	9	-0.04	5	0.13	6	0.05
Release time of 4	6	-0.05	6	-0.04	13	0.03	13	0.01
Air fraction of 5	10	-0.04	10	-0.04	15	0.02	15	0.01
Release time of 5	13	-0.01	15	-0.01	7	-0.08	8	-0.03
Air fraction of 6	1	0.22	1	0.22	2	0.87	2	0.62
Release time of 6	2	-0.20	2	-0.19	3	-0.56	3	-0.23

Pu-238 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 22:32:26 Page: 37 **
Title : CR3 Sensitivity Analysis - Pu238
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	0.01	12	0.02	13	-0.01	13	-0.01
Resuspension Rate	13	-0.01	11	-0.02	12	-0.01	12	-0.01
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	9	0.03	9	0.01
Air fraction of 1	2	0.26	2	0.24	2	0.91	2	0.59
Release time of 1	1	-0.33	1	-0.31	3	-0.87	3	-0.47
Air fraction of 2	7	-0.04	7	-0.04	7	-0.04	7	-0.01
Release time of 2	4	0.09	4	0.08	14	0.01	14	0.00
Air fraction of 3	16	0.00	16	0.00	6	0.05	6	0.01
Release time of 3	12	0.02	14	0.02	5	0.08	5	0.02
Air fraction of 4	8	-0.04	8	-0.04	10	0.03	10	0.01
Release time of 4	9	-0.04	9	-0.04	11	-0.02	11	-0.01
Air fraction of 5	10	0.04	10	0.04	8	-0.04	8	-0.01
Release time of 5	5	-0.05	5	-0.04	16	0.00	16	0.00
Air fraction of 6	6	0.05	6	0.04	4	0.12	4	0.03
Release time of 6	11	-0.02	13	-0.02	15	0.00	15	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 22:32:26 Page: 38 **
Title : CR3 Sensitivity Analysis - Pu238
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	-0.02	15	-0.03	11	0.03	6	0.02
Resuspension Rate	16	-0.01	16	-0.01	12	0.03	8	0.02
Building Exchange Rate	2	-0.27	2	-0.25	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.08	5	0.02
Air fraction of 1	13	0.05	13	0.04	7	-0.05	9	-0.01
Release time of 1	6	-0.08	6	-0.07	13	0.03	13	0.01
Air fraction of 2	3	0.24	3	0.22	2	0.92	2	0.58
Release time of 2	1	-0.33	1	-0.31	3	-0.89	3	-0.50
Air fraction of 3	10	0.05	10	0.04	15	-0.01	15	0.00
Release time of 3	9	-0.06	9	-0.05	16	-0.01	16	0.00
Air fraction of 4	7	0.07	7	0.06	4	-0.14	4	-0.04
Release time of 4	12	-0.05	12	-0.04	10	-0.03	12	-0.01
Air fraction of 5	14	0.04	14	0.04	14	0.03	14	0.01
Release time of 5	11	-0.05	11	-0.04	9	0.04	11	0.01
Air fraction of 6	5	0.09	5	0.08	8	0.04	10	0.01
Release time of 6	8	-0.07	8	-0.06	6	0.06	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 22:32:26 Page: 39 **
Title : CR3 Sensitivity Analysis - Pu238
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.12	4	0.15	12	0.03	8	0.02
Resuspension Rate	5	-0.09	5	-0.12	15	-0.01	15	-0.01
Building Exchange Rate	3	-0.38	3	-0.33	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	10	0.03	10	0.02	5	-0.10	5	-0.03
Air fraction of 1	7	0.05	7	0.04	6	-0.08	6	-0.02
Release time of 1	8	-0.04	8	-0.03	10	-0.04	11	-0.01
Air fraction of 2	11	-0.02	11	-0.02	4	-0.11	4	-0.03
Release time of 2	16	0.00	16	0.00	8	-0.06	9	-0.02
Air fraction of 3	2	0.39	2	0.34	2	0.90	2	0.56
Release time of 3	1	-0.44	1	-0.39	3	-0.87	3	-0.48
Air fraction of 4	9	0.04	9	0.03	14	-0.02	14	-0.01
Release time of 4	13	0.02	13	0.02	13	0.02	13	0.01
Air fraction of 5	12	0.02	12	0.02	16	-0.01	16	0.00
Release time of 5	14	0.01	14	0.01	9	-0.04	10	-0.01
Air fraction of 6	15	0.01	15	0.00	11	-0.04	12	-0.01
Release time of 6	6	-0.06	6	-0.04	7	0.07	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 22:32:26 Page: 40 **
Title : CR3 Sensitivity Analysis - Pu238
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient = PCC SRC PRCC SRRC

Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.03	9	0.05	16	0.00	16	0.00
Resuspension Rate	7	-0.07	6	-0.10	14	-0.02	10	-0.01
Building Exchange Rate	3	-0.31	3	-0.27	1	-0.91	1	-0.61
Receptor Ingestion Rate of receptor 1	5	0.15	5	0.12	9	-0.05	9	-0.01
Air fraction of 1	16	-0.01	16	-0.01	7	-0.06	7	-0.02
Release time of 1	12	-0.03	12	-0.02	4	-0.11	4	-0.03
Air fraction of 2	14	-0.02	14	-0.02	11	0.03	12	0.01
Release time of 2	13	0.02	13	0.02	10	0.04	11	0.01
Air fraction of 3	6	0.08	7	0.06	8	-0.05	8	-0.01
Release time of 3	9	-0.05	10	-0.04	12	0.03	13	0.01
Air fraction of 4	1	0.42	1	0.37	2	0.90	2	0.58
Release time of 4	2	-0.39	2	-0.34	3	-0.87	3	-0.47
Air fraction of 5	15	-0.02	15	-0.01	13	-0.02	14	-0.01
Release time of 5	11	-0.03	11	-0.03	15	0.02	15	0.00
Air fraction of 6	4	0.16	4	0.13	6	0.08	6	0.02
Release time of 6	8	-0.06	8	-0.05	5	0.11	5	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 22:32:26 Page: 41 **
Title : CR3 Sensitivity Analysis - Pu238
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.08	4	0.11	9	0.03	5	0.02
Resuspension Rate	6	-0.06	5	-0.09	12	-0.02	9	-0.01
Building Exchange Rate	3	-0.34	3	-0.29	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	13	0.01	13	0.01	6	-0.05	7	-0.01
Air fraction of 1	11	0.02	11	0.01	15	0.00	15	0.00
Release time of 1	7	0.05	7	0.04	13	0.01	13	0.00
Air fraction of 2	15	0.00	15	0.00	5	0.06	6	0.02
Release time of 2	8	-0.05	8	-0.04	16	0.00	16	0.00
Air fraction of 3	10	0.02	10	0.02	11	0.02	12	0.00
Release time of 3	5	-0.07	6	-0.06	8	-0.04	10	-0.01
Air fraction of 4	9	0.02	9	0.02	10	0.02	11	0.00
Release time of 4	14	0.00	14	0.00	14	-0.01	14	0.00
Air fraction of 5	1	0.39	1	0.35	2	0.91	2	0.56
Release time of 5	2	-0.38	2	-0.34	3	-0.88	3	-0.47
Air fraction of 6	16	0.00	16	0.00	4	0.12	4	0.03
Release time of 6	12	-0.01	12	-0.01	7	0.05	8	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 22:32:26 Page: 42 **
Title : CR3 Sensitivity Analysis - Pu238
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.01	12	-0.02	15	0.01	14	0.00
Resuspension Rate	11	0.03	7	0.05	16	0.00	16	0.00
Building Exchange Rate	3	-0.21	3	-0.20	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	9	-0.03	9	-0.01
Air fraction of 1	16	0.01	16	0.01	4	0.12	4	0.03
Release time of 1	6	0.05	6	0.05	11	0.03	11	0.01
Air fraction of 2	5	0.05	5	0.05	14	-0.01	15	0.00
Release time of 2	13	0.02	14	0.02	8	0.05	8	0.01
Air fraction of 3	8	0.04	9	0.04	10	-0.03	10	-0.01
Release time of 3	4	-0.06	4	-0.05	7	-0.06	7	-0.02
Air fraction of 4	10	-0.03	11	-0.03	6	0.06	6	0.02
Release time of 4	7	-0.05	8	-0.04	13	0.02	13	0.00
Air fraction of 5	9	-0.04	10	-0.04	12	0.02	12	0.01
Release time of 5	12	-0.02	13	-0.02	5	-0.08	5	-0.02
Air fraction of 6	2	0.25	2	0.24	2	0.91	2	0.57
Release time of 6	1	-0.26	1	-0.24	3	-0.87	3	-0.46

Pu-239 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 07:18:35 Page: 37 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	0.01	14	0.01	13	0.01	13	0.00
Resuspension Rate	13	-0.02	11	-0.02	8	-0.04	5	-0.03
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	14	0.01	15	0.01	6	0.05	7	0.01
Air fraction of 1	2	0.26	2	0.24	2	0.91	2	0.59
Release time of 1	1	-0.33	1	-0.31	3	-0.87	3	-0.47
Air fraction of 2	9	-0.04	9	-0.04	7	-0.04	8	-0.01

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Release time of 2	4	0.09	4	0.08	15	0.00	15	0.00
Air fraction of 3	16	0.00	16	0.00	9	0.04	9	0.01
Release time of 3	12	0.02	13	0.01	5	0.08	6	0.02
Air fraction of 4	7	-0.05	7	-0.04	12	0.03	12	0.01
Release time of 4	8	-0.04	8	-0.04	11	-0.03	11	-0.01
Air fraction of 5	10	0.04	10	0.03	10	-0.04	10	-0.01
Release time of 5	6	-0.05	6	-0.04	16	0.00	16	0.00
Air fraction of 6	5	0.05	5	0.04	4	0.11	4	0.03
Release time of 6	11	-0.02	12	-0.02	14	-0.01	14	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 07:18:35 Page: 38 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	15	-0.02	15	-0.03	7	0.05	5	0.03
Resuspension Rate	16	-0.01	16	-0.01	16	-0.01	14	0.00
Building Exchange Rate	2	-0.28	2	-0.25	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.10	6	0.02
Air fraction of 1	12	0.05	12	0.04	8	-0.04	8	-0.01
Release time of 1	6	-0.08	6	-0.07	12	0.03	12	0.01
Air fraction of 2	3	0.25	3	0.22	2	0.91	2	0.58
Release time of 2	1	-0.33	1	-0.31	3	-0.89	3	-0.50
Air fraction of 3	10	0.05	10	0.05	14	-0.01	15	0.00
Release time of 3	9	-0.06	9	-0.05	15	-0.01	16	0.00
Air fraction of 4	8	0.07	8	0.06	4	-0.14	4	-0.04
Release time of 4	11	-0.05	11	-0.04	11	-0.03	11	-0.01
Air fraction of 5	14	0.04	14	0.04	13	0.03	13	0.01
Release time of 5	13	-0.05	13	-0.04	10	0.04	10	0.01
Air fraction of 6	5	0.09	5	0.08	9	0.04	9	0.01
Release time of 6	7	-0.07	7	-0.06	6	0.06	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 07:18:35 Page: 39 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.11	4	0.15	9	0.05	4	0.03
Resuspension Rate	5	-0.09	5	-0.12	10	-0.05	6	-0.03
Building Exchange Rate	3	-0.38	3	-0.33	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	9	0.03	9	0.02	5	-0.09	7	-0.02
Air fraction of 1	7	0.06	7	0.05	6	-0.07	8	-0.02
Release time of 1	8	-0.04	8	-0.03	12	-0.04	12	-0.01
Air fraction of 2	14	-0.02	14	-0.01	4	-0.11	5	-0.03
Release time of 2	16	0.00	16	0.00	8	-0.07	10	-0.02
Air fraction of 3	2	0.39	2	0.34	2	0.90	2	0.56
Release time of 3	1	-0.44	1	-0.39	3	-0.87	3	-0.48
Air fraction of 4	10	0.03	10	0.02	14	-0.03	14	-0.01
Release time of 4	11	0.02	11	0.01	15	0.02	15	0.00
Air fraction of 5	12	0.02	12	0.01	16	-0.01	16	0.00
Release time of 5	13	0.02	13	0.01	11	-0.04	11	-0.01
Air fraction of 6	15	0.01	15	0.01	13	-0.04	13	-0.01
Release time of 6	6	-0.06	6	-0.05	7	0.07	9	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 07:18:35 Page: 40 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.03	9	0.04	15	0.02	10	0.01
Resuspension Rate	7	-0.07	6	-0.10	7	-0.06	4	-0.03
Building Exchange Rate	3	-0.32	3	-0.27	1	-0.91	1	-0.61
Receptor Ingestion Rate of receptor 1	5	0.15	5	0.12	12	-0.03	13	-0.01
Air fraction of 1	16	0.00	16	0.00	9	-0.05	9	-0.01
Release time of 1	12	-0.03	12	-0.02	4	-0.11	5	-0.03
Air fraction of 2	14	-0.02	14	-0.01	11	0.04	12	0.01
Release time of 2	13	0.03	13	0.02	10	0.04	11	0.01
Air fraction of 3	6	0.08	7	0.06	8	-0.05	8	-0.01
Release time of 3	9	-0.05	10	-0.04	14	0.02	15	0.01
Air fraction of 4	1	0.42	1	0.37	2	0.90	2	0.58
Release time of 4	2	-0.39	2	-0.34	3	-0.86	3	-0.47
Air fraction of 5	15	-0.02	15	-0.01	13	-0.02	14	-0.01
Release time of 5	11	-0.03	11	-0.02	16	0.02	16	0.00
Air fraction of 6	4	0.16	4	0.13	6	0.08	7	0.02
Release time of 6	8	-0.06	8	-0.05	5	0.11	6	0.03

Page Break
** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 07:18:35 Page: 41 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	4	0.08	4	0.11	7	0.06	5	0.03
Resuspension Rate	6	-0.06	5	-0.09	6	-0.06	4	-0.04
Building Exchange Rate	3	-0.34	3	-0.29	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	13	0.01	13	0.01	10	-0.03	10	-0.01
Air fraction of 1	11	0.02	11	0.01	15	0.01	15	0.00
Release time of 1	7	0.05	7	0.04	14	0.01	14	0.00
Air fraction of 2	16	0.00	16	0.00	5	0.07	7	0.02
Release time of 2	8	-0.05	8	-0.04	16	0.00	16	0.00
Air fraction of 3	9	0.02	9	0.02	12	0.02	12	0.00
Release time of 3	5	-0.07	6	-0.06	9	-0.04	9	-0.01
Air fraction of 4	10	0.02	10	0.02	13	0.02	13	0.00
Release time of 4	14	-0.01	14	0.00	11	-0.02	11	-0.01
Air fraction of 5	1	0.40	1	0.35	2	0.91	2	0.56
Release time of 5	2	-0.38	2	-0.34	3	-0.88	3	-0.47
Air fraction of 6	15	0.00	15	0.00	4	0.13	6	0.03
Release time of 6	12	-0.01	12	-0.01	8	0.04	8	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 07:18:35 Page: 42 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	15	-0.01	13	-0.02	12	0.03	8	0.02
Resuspension Rate	12	0.02	11	0.03	9	-0.04	5	-0.02
Building Exchange Rate	3	-0.19	3	-0.18	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	16	0.00	16	0.00	16	-0.01	16	0.00
Air fraction of 1	14	0.01	15	0.01	4	0.13	4	0.03
Release time of 1	5	0.06	5	0.05	11	0.03	12	0.01
Air fraction of 2	4	0.06	4	0.06	14	-0.02	14	0.00
Release time of 2	11	0.02	12	0.02	8	0.05	10	0.01
Air fraction of 3	8	0.04	8	0.04	10	-0.03	11	-0.01
Release time of 3	6	-0.05	6	-0.05	7	-0.05	9	-0.01
Air fraction of 4	10	-0.04	10	-0.04	6	0.06	7	0.02
Release time of 4	7	-0.05	7	-0.04	15	0.01	15	0.00
Air fraction of 5	9	-0.04	9	-0.04	13	0.02	13	0.00
Release time of 5	13	-0.02	14	-0.01	5	-0.08	6	-0.02
Air fraction of 6	2	0.23	2	0.23	2	0.91	2	0.57
Release time of 6	1	-0.24	1	-0.23	3	-0.87	3	-0.46

Pu-240 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 09:36:35 Page: 37 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	14	0.01	14	0.01	13	0.01	13	0.00
Resuspension Rate	13	-0.02	11	-0.02	9	-0.04	5	-0.02
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	6	0.05	7	0.01
Air fraction of 1	2	0.26	2	0.24	2	0.91	2	0.59
Release time of 1	1	-0.33	1	-0.31	3	-0.87	3	-0.47
Air fraction of 2	9	-0.04	9	-0.04	7	-0.04	8	-0.01
Release time of 2	4	0.09	4	0.08	15	0.00	15	0.00
Air fraction of 3	16	0.00	16	0.00	8	0.04	9	0.01
Release time of 3	12	0.02	13	0.01	5	0.08	6	0.02
Air fraction of 4	7	-0.05	7	-0.04	12	0.03	12	0.01
Release time of 4	8	-0.04	8	-0.04	11	-0.03	11	-0.01
Air fraction of 5	10	0.04	10	0.03	10	-0.04	10	-0.01
Release time of 5	6	-0.05	6	-0.04	16	0.00	16	0.00
Air fraction of 6	5	0.05	5	0.04	4	0.11	4	0.03
Release time of 6	11	-0.02	12	-0.02	14	-0.01	14	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 09:36:35 Page: 38 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Coefficient =		PCC		SRC		PRCC		SRRC
Repetition =		1		1		1		1
Deposition Velocity	15	-0.02	15	-0.03	7	0.05	5	0.03
Resuspension Rate	16	-0.01	16	-0.01	16	-0.01	14	0.00

Building Exchange Rate	2	-0.28	2	-0.25	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.09	6	0.02
Air fraction of 1	12	0.05	12	0.04	8	-0.04	8	-0.01
Release time of 1	6	-0.08	6	-0.07	12	0.03	12	0.01
Air fraction of 2	3	0.25	3	0.22	2	0.92	2	0.58
Release time of 2	1	-0.33	1	-0.31	3	-0.89	3	-0.50
Air fraction of 3	10	0.05	10	0.05	15	-0.01	16	0.00
Release time of 3	9	-0.06	9	-0.05	14	-0.01	15	0.00
Air fraction of 4	8	0.07	8	0.06	4	-0.14	4	-0.04
Release time of 4	11	-0.05	11	-0.04	11	-0.03	11	-0.01
Air fraction of 5	14	0.04	14	0.04	13	0.03	13	0.01
Release time of 5	13	-0.05	13	-0.04	10	0.04	10	0.01
Air fraction of 6	5	0.09	5	0.08	9	0.04	9	0.01
Release time of 6	7	-0.07	7	-0.06	6	0.06	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 09:36:35 Page: 39 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.11	4	0.15	9	0.05	4	0.03
Resuspension Rate	5	-0.09	5	-0.12	10	-0.05	6	-0.03
Building Exchange Rate	3	-0.38	3	-0.33	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	10	0.03	9	0.02	5	-0.09	7	-0.02
Air fraction of 1	7	0.06	7	0.05	6	-0.07	8	-0.02
Release time of 1	8	-0.04	8	-0.03	12	-0.04	12	-0.01
Air fraction of 2	13	-0.02	14	-0.01	4	-0.11	5	-0.03
Release time of 2	16	0.00	16	0.00	8	-0.07	10	-0.02
Air fraction of 3	2	0.39	2	0.34	2	0.90	2	0.56
Release time of 3	1	-0.44	1	-0.39	3	-0.87	3	-0.48
Air fraction of 4	9	0.03	10	0.02	14	-0.03	14	-0.01
Release time of 4	11	0.02	11	0.01	15	0.02	15	0.00
Air fraction of 5	12	0.02	12	0.01	16	-0.01	16	0.00
Release time of 5	14	0.02	13	0.01	11	-0.04	11	-0.01
Air fraction of 6	15	0.01	15	0.01	13	-0.04	13	-0.01
Release time of 6	6	-0.06	6	-0.05	7	0.07	9	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 09:36:35 Page: 40 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.03	9	0.04	15	0.02	10	0.01
Resuspension Rate	7	-0.07	6	-0.10	7	-0.05	4	-0.03
Building Exchange Rate	3	-0.32	3	-0.27	1	-0.91	1	-0.61
Receptor Ingestion Rate of receptor 1	5	0.15	5	0.12	12	-0.03	13	-0.01
Air fraction of 1	16	0.00	16	0.00	8	-0.05	8	-0.01
Release time of 1	12	-0.03	12	-0.02	4	-0.11	5	-0.03
Air fraction of 2	14	-0.02	14	-0.01	11	0.04	12	0.01
Release time of 2	13	0.02	13	0.02	10	0.04	11	0.01
Air fraction of 3	6	0.08	7	0.06	9	-0.05	9	-0.01
Release time of 3	9	-0.05	10	-0.04	14	0.02	15	0.01
Air fraction of 4	1	0.42	1	0.37	2	0.90	2	0.58
Release time of 4	2	-0.39	2	-0.34	3	-0.86	3	-0.47
Air fraction of 5	15	-0.02	15	-0.01	13	-0.02	14	-0.01
Release time of 5	11	-0.03	11	-0.02	16	0.02	16	0.00
Air fraction of 6	4	0.16	4	0.13	6	0.08	7	0.02
Release time of 6	8	-0.06	8	-0.05	5	0.11	6	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 09:36:35 Page: 41 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.08	4	0.11	7	0.06	5	0.03
Resuspension Rate	6	-0.06	5	-0.09	6	-0.06	4	-0.04
Building Exchange Rate	3	-0.34	3	-0.29	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	13	0.01	13	0.01	10	-0.03	10	-0.01
Air fraction of 1	11	0.02	11	0.01	15	0.01	15	0.00
Release time of 1	7	0.05	7	0.04	14	0.01	14	0.00
Air fraction of 2	16	0.00	16	0.00	5	0.07	7	0.02
Release time of 2	8	-0.05	8	-0.04	16	0.00	16	0.00
Air fraction of 3	9	0.02	9	0.02	11	0.02	11	0.01
Release time of 3	5	-0.07	6	-0.06	9	-0.04	9	-0.01
Air fraction of 4	10	0.02	10	0.02	13	0.02	13	0.00
Release time of 4	14	-0.01	14	0.00	12	-0.02	12	-0.01
Air fraction of 5	1	0.40	1	0.35	2	0.91	2	0.56
Release time of 5	2	-0.38	2	-0.34	3	-0.88	3	-0.47
Air fraction of 6	15	0.00	15	0.00	4	0.13	6	0.03
Release time of 6	12	-0.01	12	-0.01	8	0.05	8	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/28/22 09:36:35 Page: 42 **
Title : CR3 Sensitivity Analysis - Pu239
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	15	-0.01	13	-0.02	12	0.03	8	0.02
Resuspension Rate	12	0.02	11	0.03	9	-0.04	5	-0.02
Building Exchange Rate	3	-0.19	3	-0.18	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	16	0.00	16	0.00	16	-0.01	16	0.00
Air fraction of 1	14	0.01	15	0.01	4	0.13	4	0.03
Release time of 1	5	0.06	5	0.05	11	0.03	12	0.01
Air fraction of 2	4	0.06	4	0.06	15	-0.01	15	0.00
Release time of 2	11	0.02	12	0.02	8	0.05	10	0.01
Air fraction of 3	8	0.04	8	0.04	10	-0.03	11	-0.01
Release time of 3	6	-0.05	6	-0.05	7	-0.05	9	-0.01
Air fraction of 4	10	-0.04	10	-0.04	6	0.06	7	0.02
Release time of 4	7	-0.05	7	-0.04	14	0.02	14	0.00
Air fraction of 5	9	-0.04	9	-0.04	13	0.02	13	0.00
Release time of 5	13	-0.02	14	-0.01	5	-0.08	6	-0.02
Air fraction of 6	2	0.24	2	0.23	2	0.91	2	0.57
Release time of 6	1	-0.24	1	-0.23	3	-0.87	3	-0.46

Pu-241 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 13:55:14 Page: 37 **
Title : CR3 Sensitivity Analysis - Pu241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	14	0.01	14	0.01	11	-0.03	6	-0.02
Resuspension Rate	13	-0.01	11	-0.02	13	0.01	12	0.01
Building Exchange Rate	3	-0.25	3	-0.23	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	10	0.03	11	0.01
Air fraction of 1	2	0.26	2	0.24	2	0.91	2	0.59
Release time of 1	1	-0.33	1	-0.31	3	-0.87	3	-0.47
Air fraction of 2	5	-0.05	5	-0.04	6	-0.05	7	-0.01
Release time of 2	4	0.09	4	0.08	15	0.01	15	0.00
Air fraction of 3	16	0.00	16	0.00	7	0.04	8	0.01
Release time of 3	11	0.02	12	0.02	5	0.08	5	0.02
Air fraction of 4	9	-0.04	9	-0.04	9	0.03	10	0.01
Release time of 4	10	-0.04	10	-0.03	12	-0.02	13	-0.01
Air fraction of 5	7	0.04	7	0.04	8	-0.04	9	-0.01
Release time of 5	6	-0.05	6	-0.04	14	0.01	14	0.00
Air fraction of 6	8	0.04	8	0.04	4	0.12	4	0.03
Release time of 6	12	-0.02	13	-0.02	16	0.00	16	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 13:55:14 Page: 38 **
Title : CR3 Sensitivity Analysis - Pu241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	15	-0.02	15	-0.03	15	0.01	14	0.00
Resuspension Rate	16	-0.01	16	-0.01	7	0.05	5	0.03
Building Exchange Rate	2	-0.27	2	-0.25	1	-0.92	1	-0.60
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.08	6	0.02
Air fraction of 1	13	0.05	13	0.04	8	-0.05	8	-0.01
Release time of 1	6	-0.08	6	-0.07	13	0.02	13	0.01
Air fraction of 2	3	0.24	3	0.22	2	0.92	2	0.58
Release time of 2	1	-0.34	1	-0.31	3	-0.89	3	-0.50
Air fraction of 3	11	0.05	10	0.04	14	-0.01	15	0.00
Release time of 3	9	-0.06	9	-0.05	16	-0.01	16	0.00
Air fraction of 4	7	0.08	7	0.07	4	-0.14	4	-0.03
Release time of 4	12	-0.05	12	-0.04	11	-0.03	11	-0.01
Air fraction of 5	14	0.05	14	0.04	12	0.03	12	0.01
Release time of 5	10	-0.05	11	-0.04	10	0.04	10	0.01
Air fraction of 6	5	0.08	5	0.07	9	0.04	9	0.01
Release time of 6	8	-0.06	8	-0.06	6	0.07	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 13:55:14 Page: 39 **
Title : CR3 Sensitivity Analysis - Pu241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.12	4	0.16	15	0.01	14	0.01
Resuspension Rate	5	-0.09	5	-0.12	13	0.02	11	0.01
Building Exchange Rate	3	-0.38	3	-0.33	1	-0.92	1	-0.62
Receptor Ingestion Rate of receptor 1	11	0.03	11	0.02	5	-0.10	5	-0.03
Air fraction of 1	8	0.05	8	0.04	6	-0.08	6	-0.02
Release time of 1	6	-0.05	6	-0.04	10	-0.04	10	-0.01
Air fraction of 2	10	-0.03	10	-0.03	4	-0.11	4	-0.03
Release time of 2	15	-0.01	15	-0.01	8	-0.06	8	-0.02
Air fraction of 3	2	0.39	2	0.34	2	0.90	2	0.56
Release time of 3	1	-0.45	1	-0.40	3	-0.87	3	-0.48
Air fraction of 4	9	0.04	9	0.03	14	-0.01	15	0.00
Release time of 4	13	0.02	13	0.02	12	0.03	13	0.01
Air fraction of 5	12	0.03	12	0.02	16	0.00	16	0.00
Release time of 5	14	0.01	14	0.01	9	-0.04	9	-0.01
Air fraction of 6	16	0.00	16	0.00	11	-0.03	12	-0.01
Release time of 6	7	-0.05	7	-0.04	7	0.07	7	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 13:55:14 Page: 40 **
Title : CR3 Sensitivity Analysis - Pu241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	10	0.03	9	0.04	12	-0.03	7	-0.02
Resuspension Rate	7	-0.07	6	-0.10	16	0.01	14	0.01
Building Exchange Rate	3	-0.31	3	-0.27	1	-0.91	1	-0.61
Receptor Ingestion Rate of receptor 1	5	0.15	5	0.12	9	-0.05	10	-0.01
Air fraction of 1	16	-0.01	16	-0.01	7	-0.06	8	-0.02
Release time of 1	12	-0.03	12	-0.02	5	-0.12	5	-0.03
Air fraction of 2	14	-0.02	14	-0.02	13	0.03	13	0.01
Release time of 2	13	0.02	13	0.02	10	0.04	11	0.01
Air fraction of 3	6	0.08	7	0.06	8	-0.05	9	-0.01
Release time of 3	9	-0.05	10	-0.04	11	0.03	12	0.01
Air fraction of 4	1	0.42	1	0.37	2	0.90	2	0.58
Release time of 4	2	-0.39	2	-0.34	3	-0.86	3	-0.47
Air fraction of 5	15	-0.01	15	-0.01	15	-0.02	16	0.00
Release time of 5	11	-0.03	11	-0.03	14	0.02	15	0.01
Air fraction of 6	4	0.16	4	0.13	6	0.08	6	0.02
Release time of 6	8	-0.06	8	-0.05	4	0.12	4	0.03

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 13:55:14 Page: 41 **
Title : CR3 Sensitivity Analysis - Pu241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.08	4	0.11	15	0.00	14	0.00
Resuspension Rate	6	-0.06	5	-0.09	12	0.01	9	0.01
Building Exchange Rate	3	-0.33	3	-0.29	1	-0.92	1	-0.61
Receptor Ingestion Rate of receptor 1	13	0.01	13	0.01	7	-0.05	7	-0.01
Air fraction of 1	11	0.02	11	0.01	13	-0.01	13	0.00
Release time of 1	7	0.05	7	0.04	11	0.01	12	0.00
Air fraction of 2	14	0.00	14	0.00	6	0.05	6	0.01
Release time of 2	8	-0.05	8	-0.04	16	0.00	16	0.00
Air fraction of 3	10	0.02	10	0.02	10	0.02	11	0.00
Release time of 3	5	-0.07	6	-0.06	8	-0.04	8	-0.01
Air fraction of 4	9	0.03	9	0.02	9	0.03	10	0.01
Release time of 4	15	0.00	15	0.00	14	-0.01	15	0.00
Air fraction of 5	1	0.40	1	0.35	2	0.91	2	0.56
Release time of 5	2	-0.38	2	-0.34	3	-0.88	3	-0.47
Air fraction of 6	16	0.00	16	0.00	4	0.12	4	0.03
Release time of 6	12	-0.01	12	-0.01	5	0.05	5	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/27/22 13:55:14 Page: 42 **
Title : CR3 Sensitivity Analysis - Pu241
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	13	-0.02	10	-0.04	16	-0.01	14	-0.01
Resuspension Rate	5	0.05	4	0.08	14	0.02	10	0.01
Building Exchange Rate	3	-0.24	3	-0.23	1	-0.92	1	-0.63
Receptor Ingestion Rate of receptor 1	12	0.03	13	0.03	9	-0.04	9	-0.01
Air fraction of 1	16	0.00	16	0.00	4	0.12	4	0.03
Release time of 1	9	0.04	9	0.04	10	0.04	11	0.01
Air fraction of 2	8	0.04	8	0.04	15	-0.01	16	0.00
Release time of 2	15	0.01	15	0.01	8	0.05	8	0.01
Air fraction of 3	6	0.04	6	0.04	11	-0.03	12	-0.01
Release time of 3	4	-0.06	5	-0.05	7	-0.06	7	-0.02
Air fraction of 4	14	-0.02	14	-0.01	6	0.06	6	0.02

Release time of 4	7	-0.04	7	-0.04	13	0.02	15	0.00
Air fraction of 5	10	-0.04	11	-0.03	12	0.02	13	0.01
Release time of 5	11	-0.03	12	-0.03	5	-0.07	5	-0.02
Air fraction of 6	2	0.29	2	0.28	2	0.91	2	0.58
Release time of 6	1	-0.30	1	-0.28	3	-0.87	3	-0.46

Sr-90 Results:

```
* RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:58:04 Page:  37 **
 Title      : CR3 Sensitivity Analysis - Sr90
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(1) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	0.01	13	0.01	12	0.04	6	0.03
Resuspension Rate	12	-0.02	11	-0.02	8	-0.07	4	-0.05
Building Exchange Rate	3	-0.27	2	-0.25	1	-0.88	1	-0.65
Receptor Ingestion Rate of receptor 1	11	0.02	12	0.02	4	0.11	5	0.04
Air fraction of 1	1	0.28	1	0.26	2	0.88	2	0.65
Release time of 1	2	-0.27	3	-0.25	3	-0.45	3	-0.18
Air fraction of 2	10	-0.03	10	-0.03	6	-0.08	8	-0.03
Release time of 2	4	0.09	4	0.08	14	0.03	14	0.01
Air fraction of 3	16	0.00	16	0.00	13	0.03	13	0.01
Release time of 3	15	0.01	15	0.00	9	0.05	10	0.02
Air fraction of 4	6	-0.04	6	-0.04	16	0.00	16	0.00
Release time of 4	5	-0.05	5	-0.04	10	0.05	11	0.02
Air fraction of 5	9	0.03	9	0.03	15	-0.02	15	-0.01
Release time of 5	7	-0.04	7	-0.04	7	0.07	9	0.03
Air fraction of 6	8	0.04	8	0.04	5	0.08	7	0.03
Release time of 6	13	-0.01	14	-0.01	11	0.05	12	0.02

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:58:04 Page:  38 **
 Title      : CR3 Sensitivity Analysis - Sr90
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(2) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.03	13	-0.04	13	0.07	5	0.06
Resuspension Rate	16	-0.01	16	-0.02	10	-0.09	4	-0.07
Building Exchange Rate	1	-0.28	1	-0.26	1	-0.88	1	-0.66
Receptor Ingestion Rate of receptor 1	4	0.10	4	0.09	7	0.10	9	0.04
Air fraction of 1	13	0.04	14	0.04	8	-0.09	10	-0.03
Release time of 1	6	-0.07	6	-0.06	15	0.01	15	0.00
Air fraction of 2	3	0.26	3	0.24	2	0.87	2	0.63
Release time of 2	2	-0.26	2	-0.24	3	-0.44	3	-0.18
Air fraction of 3	10	0.06	10	0.05	9	0.09	11	0.03
Release time of 3	9	-0.06	9	-0.05	5	-0.10	7	-0.04
Air fraction of 4	7	0.07	7	0.06	11	-0.08	12	-0.03
Release time of 4	11	-0.05	11	-0.04	4	-0.15	6	-0.05
Air fraction of 5	15	0.02	15	0.02	12	0.07	13	0.03
Release time of 5	12	-0.05	12	-0.04	14	0.05	14	0.02
Air fraction of 6	5	0.09	5	0.08	16	0.01	16	0.00
Release time of 6	8	-0.07	8	-0.06	6	0.10	8	0.04

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:58:04 Page:  39 **
 Title      : CR3 Sensitivity Analysis - Sr90
 Input File : C:\RESRAD_Family\BUILD\3.BLD
```

Coefficients for Source(3) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	4	0.12	4	0.15	4	0.13	4	0.11
Resuspension Rate	5	-0.10	5	-0.13	6	-0.13	5	-0.11
Building Exchange Rate	2	-0.39	2	-0.35	1	-0.89	1	-0.69
Receptor Ingestion Rate of receptor 1	8	0.07	8	0.05	13	-0.03	13	-0.01
Air fraction of 1	7	0.07	7	0.06	9	-0.08	9	-0.03
Release time of 1	10	-0.04	10	-0.03	15	-0.02	15	-0.01
Air fraction of 2	16	0.00	16	0.00	5	-0.13	6	-0.05
Release time of 2	15	0.01	15	0.01	7	-0.10	7	-0.04
Air fraction of 3	1	0.41	1	0.37	2	0.85	2	0.58
Release time of 3	3	-0.36	3	-0.31	3	-0.52	3	-0.22
Air fraction of 4	9	0.04	9	0.04	14	-0.02	14	-0.01
Release time of 4	14	0.02	14	0.01	11	0.06	11	0.02
Air fraction of 5	13	0.02	13	0.01	16	0.01	16	0.00
Release time of 5	11	0.03	11	0.02	12	-0.04	12	-0.01
Air fraction of 6	12	0.03	12	0.02	8	0.08	8	0.03
Release time of 6	6	-0.07	6	-0.06	10	0.08	10	0.03

```
** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:58:04 Page:  40 **
```

Title : CR3 Sensitivity Analysis - Sr90
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	11	0.03	9	0.04	6	0.15	5	0.12
Resuspension Rate	7	-0.07	6	-0.09	4	-0.21	3	-0.18
Building Exchange Rate	2	-0.31	2	-0.27	2	-0.86	2	-0.63
Receptor Ingestion Rate of receptor 1	4	0.17	4	0.14	8	0.09	8	0.03
Air fraction of 1	16	0.00	16	0.00	15	-0.01	15	0.00
Release time of 1	14	-0.02	14	-0.02	10	-0.05	10	-0.02
Air fraction of 2	15	-0.02	15	-0.02	11	0.05	11	0.02
Release time of 2	12	0.03	12	0.02	9	0.08	9	0.03
Air fraction of 3	6	0.08	7	0.07	13	-0.04	13	-0.01
Release time of 3	9	-0.04	10	-0.03	16	0.01	16	0.00
Air fraction of 4	1	0.43	1	0.38	1	0.87	1	0.66
Release time of 4	3	-0.31	3	-0.27	3	-0.43	4	-0.18
Air fraction of 5	13	-0.02	13	-0.02	7	-0.10	7	-0.04
Release time of 5	10	-0.03	11	-0.02	14	0.04	14	0.01
Air fraction of 6	5	0.16	5	0.13	5	0.18	6	0.07
Release time of 6	8	-0.07	8	-0.06	12	0.04	12	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:58:04 Page: 41 **
Title : CR3 Sensitivity Analysis - Sr90
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	4	0.07	4	0.10	4	0.19	4	0.15
Resuspension Rate	5	-0.06	5	-0.09	5	-0.18	5	-0.14
Building Exchange Rate	2	-0.35	2	-0.31	1	-0.88	1	-0.65
Receptor Ingestion Rate of receptor 1	9	0.03	9	0.03	14	0.02	14	0.01
Air fraction of 1	13	0.01	13	0.01	16	-0.01	16	0.00
Release time of 1	7	0.06	7	0.05	9	0.04	9	0.02
Air fraction of 2	16	0.00	16	0.00	7	0.10	7	0.03
Release time of 2	8	-0.05	8	-0.05	12	-0.02	12	-0.01
Air fraction of 3	11	0.03	10	0.02	15	0.01	15	0.00
Release time of 3	6	-0.06	6	-0.05	10	-0.04	10	-0.01
Air fraction of 4	12	0.03	12	0.02	13	0.02	13	0.01
Release time of 4	14	-0.01	14	-0.01	11	-0.03	11	-0.01
Air fraction of 5	1	0.42	1	0.39	2	0.88	2	0.64
Release time of 5	3	-0.27	3	-0.23	3	-0.41	3	-0.16
Air fraction of 6	15	-0.01	15	0.00	6	0.12	6	0.04
Release time of 6	10	-0.03	11	-0.02	8	0.06	8	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 17:58:04 Page: 42 **
Title : CR3 Sensitivity Analysis - Sr90
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	16	-0.01	14	-0.01	12	0.02	11	0.01
Resuspension Rate	12	0.02	11	0.03	9	-0.05	6	-0.04
Building Exchange Rate	3	-0.20	3	-0.19	1	-0.88	1	-0.67
Receptor Ingestion Rate of receptor 1	15	0.01	15	0.01	4	0.14	4	0.05
Air fraction of 1	14	0.01	16	0.01	15	0.01	15	0.00
Release time of 1	5	0.06	5	0.05	7	0.08	8	0.03
Air fraction of 2	4	0.06	4	0.06	14	-0.01	14	0.00
Release time of 2	11	0.02	12	0.02	10	0.04	10	0.01
Air fraction of 3	8	0.05	8	0.04	8	0.06	9	0.02
Release time of 3	6	-0.05	6	-0.05	13	-0.02	13	-0.01
Air fraction of 4	10	-0.04	10	-0.03	5	0.13	5	0.05
Release time of 4	7	-0.05	7	-0.04	11	0.02	12	0.01
Air fraction of 5	9	-0.04	9	-0.04	16	0.01	16	0.00
Release time of 5	13	-0.01	13	-0.01	6	-0.09	7	-0.03
Air fraction of 6	1	0.25	1	0.24	2	0.86	2	0.62
Release time of 6	2	-0.21	2	-0.20	3	-0.43	3	-0.17

Tc-99 Results:

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 18:24:26 Page: 37 **
Title : CR3 Sensitivity Analysis - Tc99
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(1) at Time: 2
Coefficient = PCC SRC PRCC SRRC
Repetition = 1 1 1 1

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	9	-0.03	7	-0.05	6	0.12	4	0.11
Resuspension Rate	15	-0.01	14	-0.01	3	-0.28	3	-0.27
Building Exchange Rate	2	-0.27	2	-0.25	1	-0.85	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.09	4	0.08	5	0.21	6	0.08
Air fraction of 1	1	0.32	1	0.30	2	0.84	2	0.63
Release time of 1	3	-0.26	3	-0.23	4	-0.23	5	-0.09
Air fraction of 2	12	0.02	12	0.02	7	-0.11	7	-0.04
Release time of 2	5	0.09	5	0.08	13	-0.01	13	-0.01
Air fraction of 3	16	0.00	16	0.00	15	0.00	15	0.00
Release time of 3	14	-0.01	15	-0.01	9	0.09	9	0.03
Air fraction of 4	7	-0.04	9	-0.04	14	0.01	14	0.00
Release time of 4	6	-0.06	6	-0.05	10	0.07	10	0.03
Air fraction of 5	10	-0.02	10	-0.02	16	0.00	16	0.00
Release time of 5	13	-0.02	13	-0.02	12	0.03	12	0.01
Air fraction of 6	8	0.04	8	0.04	8	0.10	8	0.04
Release time of 6	11	0.02	11	0.02	11	0.04	11	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 18:24:26 Page: 38 **
Title : CR3 Sensitivity Analysis - Tc99
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(2) at Time: 2
Coefficient = PCC 1, SRC 1, PRCC 1, SRRC 1
Repetition =

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	8	-0.06	5	-0.09	6	0.13	4	0.12
Resuspension Rate	16	0.00	16	-0.01	3	-0.31	3	-0.31
Building Exchange Rate	1	-0.29	1	-0.27	1	-0.84	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.13	4	0.12	5	0.21	6	0.09
Air fraction of 1	12	0.04	12	0.04	8	-0.09	8	-0.04
Release time of 1	9	-0.06	9	-0.05	16	0.01	16	0.00
Air fraction of 2	2	0.29	2	0.26	2	0.82	2	0.60
Release time of 2	3	-0.25	3	-0.22	4	-0.24	5	-0.10
Air fraction of 3	10	0.05	10	0.05	11	0.07	11	0.03
Release time of 3	11	-0.05	11	-0.04	14	-0.04	14	-0.02
Air fraction of 4	13	0.04	13	0.03	12	-0.06	12	-0.02
Release time of 4	7	-0.07	8	-0.06	7	-0.12	7	-0.05
Air fraction of 5	15	0.01	15	0.01	10	0.08	10	0.03
Release time of 5	14	-0.01	14	-0.01	15	0.03	15	0.01
Air fraction of 6	5	0.09	6	0.08	13	0.05	13	0.02
Release time of 6	6	-0.07	7	-0.06	9	0.09	9	0.04

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 18:24:26 Page: 39 **
Title : CR3 Sensitivity Analysis - Tc99
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(3) at Time: 2
Coefficient = PCC 1, SRC 1, PRCC 1, SRRC 1
Repetition =

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	12	0.03	10	0.04	5	0.22	4	0.21
Resuspension Rate	9	-0.05	6	-0.08	4	-0.34	3	-0.34
Building Exchange Rate	1	-0.32	1	-0.30	1	-0.85	1	-0.67
Receptor Ingestion Rate of receptor 1	4	0.14	4	0.12	7	0.12	7	0.05
Air fraction of 1	5	0.14	5	0.12	16	0.00	16	0.00
Release time of 1	11	-0.04	12	-0.03	11	-0.03	11	-0.01
Air fraction of 2	7	0.07	8	0.06	6	-0.17	6	-0.07
Release time of 2	8	0.07	9	0.06	8	-0.10	8	-0.04
Air fraction of 3	2	0.32	2	0.29	2	0.80	2	0.56
Release time of 3	3	-0.26	3	-0.23	3	-0.36	5	-0.16
Air fraction of 4	14	0.02	14	0.01	15	0.00	15	0.00
Release time of 4	13	0.03	13	0.02	14	0.01	14	0.00
Air fraction of 5	16	-0.01	16	-0.01	12	0.03	12	0.01
Release time of 5	10	0.04	11	0.04	13	-0.01	13	0.00
Air fraction of 6	15	0.01	15	0.01	9	0.07	9	0.03
Release time of 6	6	-0.08	7	-0.07	10	0.04	10	0.02

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 18:24:26 Page: 40 **
Title : CR3 Sensitivity Analysis - Tc99
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(4) at Time: 2
Coefficient = PCC 1, SRC 1, PRCC 1, SRRC 1
Repetition =

Description of Probabilistic Variable	PCC Sig	PCC Coeff	SRC Sig	SRC Coeff	PRCC Sig	PRCC Coeff	SRRC Sig	SRRC Coeff
Deposition Velocity	12	-0.03	7	-0.05	5	0.23	4	0.22
Resuspension Rate	10	-0.04	6	-0.05	3	-0.40	3	-0.40
Building Exchange Rate	2	-0.30	2	-0.27	1	-0.84	1	-0.62
Receptor Ingestion Rate of receptor 1	4	0.22	4	0.19	7	0.20	7	0.08
Air fraction of 1	9	0.04	11	0.03	11	0.04	11	0.01
Release time of 1	11	0.04	12	0.03	13	-0.03	13	-0.01
Air fraction of 2	16	-0.01	16	-0.01	10	0.04	10	0.02
Release time of 2	8	0.04	10	0.03	9	0.06	9	0.03
Air fraction of 3	13	0.02	13	0.01	12	-0.03	12	-0.01
Release time of 3	7	-0.04	9	-0.03	15	0.02	15	0.01
Air fraction of 4	1	0.40	1	0.36	2	0.83	2	0.62
Release time of 4	3	-0.28	3	-0.24	4	-0.25	5	-0.11
Air fraction of 5	14	-0.01	14	-0.01	8	-0.09	8	-0.04
Release time of 5	15	0.01	15	0.01	16	0.01	16	0.00

Air fraction of 6	5	0.17	5	0.14	6	0.21	6	0.09
Release time of 6	6	-0.06	8	-0.05	14	0.03	14	0.01

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 18:24:26 Page: 41 **
Title : CR3 Sensitivity Analysis - Tc99
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(5) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	12	0.01	11	0.01	4	0.35	4	0.33
Resuspension Rate	8	-0.04	8	-0.06	3	-0.47	3	-0.47
Building Exchange Rate	2	-0.36	2	-0.32	1	-0.86	1	-0.64
Receptor Ingestion Rate of receptor 1	4	0.12	4	0.10	6	0.15	6	0.06
Air fraction of 1	13	0.01	13	0.01	12	0.05	12	0.02
Release time of 1	6	0.07	6	0.06	16	0.01	16	0.00
Air fraction of 2	14	0.01	14	0.01	9	0.06	9	0.02
Release time of 2	7	-0.07	7	-0.06	8	-0.09	8	-0.04
Air fraction of 3	9	0.03	9	0.03	14	0.03	14	0.01
Release time of 3	15	-0.01	15	0.00	11	-0.05	11	-0.02
Air fraction of 4	11	0.02	12	0.01	10	0.06	10	0.02
Release time of 4	16	0.00	16	0.00	13	-0.03	13	-0.01
Air fraction of 5	1	0.43	1	0.39	2	0.85	2	0.62
Release time of 5	3	-0.21	3	-0.17	5	-0.18	5	-0.07
Air fraction of 6	10	0.02	10	0.02	7	0.11	7	0.04
Release time of 6	5	-0.08	5	-0.06	15	0.01	15	0.00

** RESRAD-BUILD Regression and Correlation output 3.50 01/26/22 18:24:26 Page: 42 **
Title : CR3 Sensitivity Analysis - Tc99
Input File : C:\RESRAD_Family\BUILD\3.BLD

Coefficients for Source(6) at Time: 2

Coefficient =	PCC		SRC		PRCC		SRRC	
Repetition =	1		1		1		1	
Description of Probabilistic Variable	Sig	Coeff	Sig	Coeff	Sig	Coeff	Sig	Coeff
Deposition Velocity	14	-0.01	14	-0.01	6	0.12	5	0.12
Resuspension Rate	13	-0.01	13	-0.01	3	-0.29	3	-0.28
Building Exchange Rate	3	-0.15	3	-0.14	1	-0.84	1	-0.65
Receptor Ingestion Rate of receptor 1	16	0.00	16	0.00	4	0.28	4	0.12
Air fraction of 1	12	0.03	12	0.03	10	0.04	10	0.02
Release time of 1	5	0.07	5	0.07	9	0.05	9	0.02
Air fraction of 2	4	0.07	4	0.07	15	0.00	15	0.00
Release time of 2	11	0.03	11	0.03	14	0.00	14	0.00
Air fraction of 3	8	0.04	8	0.04	12	0.04	12	0.02
Release time of 3	10	-0.04	10	-0.04	13	0.00	13	0.00
Air fraction of 4	6	-0.05	6	-0.05	7	0.12	7	0.05
Release time of 4	7	-0.05	7	-0.05	11	0.04	11	0.02
Air fraction of 5	9	-0.04	9	-0.04	16	0.00	16	0.00
Release time of 5	15	0.00	15	0.00	8	-0.10	8	-0.04
Air fraction of 6	1	0.19	1	0.19	2	0.82	2	0.60
Release time of 6	2	-0.17	2	-0.16	5	-0.25	6	-0.10

Enclosure 10

BHI Energy Engineering Calculation

"Derived Concentration Guideline Levels Values for Soil – Crystal River 3"

ENG-CR3-003

Revision 1

March 2022

BEGINS ON NEXT PAGE

BHI ENERGY ENGINEERING CALCULATION

Derived Concentration Guideline Levels Values for Soil – Crystal River 3

ENG-CR3-003

Revision: 1

March 2022

Prepared by:

BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA

Prepared by	Joseph Bisson
Approved by	Christopher Amato

1.0 PURPOSE

The purpose of this calculation is to develop derived concentration guideline levels (DCGLs) values for assessing soil at the Crystal River 3 (CR3) site.

2.0 APPLICABILITY

This calculation addresses only the development of DCGLs for surface soils at the CR3 site.

3.0 REFERENCES

3.1 BHI Energy Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 ANL/EAD-4, User's Manual for RESRAD Version 6, U.S. Department of Energy – Argonne National Laboratory, July, 2001

3.3 ANL/EVS/TM-18/1, RESRAD-Onsite 7.2 User's Guide, April 2018

3.4 ENG-CR3-001, *RESRAD-Onite Input Parameter Sensitivity Analysis – CR3*

3.5 NUREG/CR-5512, *Residual Radioactive Contamination from Decommissioning*

- Volume 1: *Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, Oct. 1992 (PNL-7994)
- Volume 3: *Parameter Analysis, Draft Report for Comment*, Oct. 1999 (SAND99-2148)

3.6 *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection For DCGL Development*, June 21, 2021

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Onsite 7.2 computer code was verified on each computer used for code executions in accordance with BHI Energy Engineering procedure ENG-AP-02, Verification of Software Operability [3.1]. The RESRAD code has undergone extensive review, benchmarking, verification, and validation [3.2]. The RESRAD-Onsite 7.2 User's Guide [3.3] provided instructions for code use.

RESRAD-Onsite code executions were performed for each of the radionuclides-of-concern (ROC) identified for the CR3 site. The probabilistic module of RESRAD-Onsite software was used to compute a "peak of the mean" (POM) dose. The POM dose for each ROC was used to determine the DCGL value that corresponded to the NRC dose criteria established in 10CFR20.1403 (i.e., 25 mrem/y). The DCGL value for each ROC was calculated as follows:

DCGL(pCi/g) = (25 mrem/y)/(POM dose in mrem/y per pCi/g).

5.0 SCENARIO and INPUT

5.1 The dose model behind the DCGL values is the Resident Farmer Scenario defined in NUREG/CR-5512 [3.5]. The average member of the critical group is the resident farmer that lives on the plant site, grows all or a portion of his/her diet onsite, and drinks water from a groundwater source onsite.

The pathways used to estimate human radiation exposure resulting from residual radioactivity in the soil for this scenario includes the following:

- Direct external radiation exposure pathway;
- Inhalation exposure pathway;
- Ingestion exposure pathway:
  - plant foods grown in the soil material containing residual radioactivity,
  - meat and milk from livestock fed with fodder grown in soil containing residual radioactivity and watercontaining residual radioactivity,
  - drinking water containing residual radioactivity from a well, and
  - aquatic food from a pond containing residual radioactivity;
- Inadvertent ingestion of contaminated soil

5.1.1 Conceptual Model: The conceptual hydrological model for this resident farmer scenario has three geological strata: (1) a contaminated zone (CZ), (2) an unsaturated zone (UZ), and (3) a saturated zone (SZ). The contaminated zone is assumed to be uncovered, equivalent in size to the CR3 Protected Area (PA), 64,821 m^2. The unsaturated zone is initially uncontaminated. The groundwater in the saturated zone is also assumed initially uncontaminated.

5.2 A site-specific suite of ROCs has been identified for the CR3 site [3.6]. CR3 ROCs are shown in Table 1 below.

NOTE:
RESRAD-Onsite 7.2 automatically accounts for progeny radionuclides with input for several of the CR3 ROCs (also shown in Table 1).

Table 1: Radionuclides-of-Concern for input to RESRAD-Onsite:

ROC[a]	Progeny[b]	ROC[a]	Progeny[b]
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-59	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Ni-63	---
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sr-90	---
Fe-55	---	Tc-99	---
H-3	---		

[a] ROC = radionuclide-of-concern identified for the CR3 site [3.7].
[b] Included automatically with input of parent ROC.

NOTE:
Sensitive RESRAD-Onsite input parameters have been identified for each ROC and conservative input values have been determined in ENG-CR3-001. Refer to ENG-CR3-001 [3.2] for details and supporting bases for input values

5.3 Input

5.3.1 Table 2 presents the RESRAD Onsite parameters identified as sensitive by ROC and the conservative input values (i.e., 25^{th} and 75^{th} percentile values from the parameters distributions).

5.3.2 Table 3 lists the value for each RESRAD Onsite parameter used as input for the DCGL calculations. RESRAD Onsite code executions were performed for each ROC.

6.0 RESULTS

6.1 Table 4 provides the RESRAD-Onsite results for POM dose for each ROC. POM doses from the RESRAD-Onsite 7.2 output report for each ROC are provided in Appendix A.

6.2 Table 4 also provides the DCGL corresponding to an annual dose equal to 25 mrem under the resident farmer scenario.

6.2.1 The DCGL for each ROC was calculated from POM dose using the following relationship:

DCGL(pCi/g) = (25 mrem/y)/(POM in mrem/y per pCi/g)

6.3 For practical application, the DCGL values were rounded to 2 significant digits. Table 5 presents the rounded DCGL values.

Table 2: RESRAD-Onsite Generated Percentile Values for Sensitive Input Parameters
(from ENG-CR3-001)

Sensitive Input Parameter	Affected Nuclide	RESRAD Percentile Value[a] 25th	75th
Depth of roots (m)	Am-241	1.2E+00	
	C-14	1.2E+00	
	Cm-243	1.2E+00	
	Cm-244	1.2E+00	
	Cs-137	1.2E+00	
	Fe-55	1.2E+00	
	H-3	1.2E+00	
	Ni-59	1.2E+00	
	Ni-63	1.2E+00	
	Pu-238	1.2E+00	
	Pu-239	1.2E+00	
	Pu-240	1.2E+00	
	Pu-241	1.2E+00	
	Sr-90	1.2E+00	
	Tc-99	1.2E+00	
Depth of soil mixing layer	Am-241	1.5E-01	
	Cm-243	1.5E-01	
	Cm-244	1.5E-01	
	Fe-55	1.5E-01	
	Ni-59	1.5E-01	
	Ni-63	1.5E-01	
	Pu-238	1.5E-01	
	Pu-239	1.5E-01	
	Pu-240	1.5E-01	
	Pu-241	1.5E-01	
External gamma shielding factor	Am-241		4.0E-01
	Cm-243		4.0E-01
	Co-60		4.0E-01
	Cs-137		4.0E-01
	Eu-152		4.0E-01
	Eu-154		4.0E-01
	Nb-94		4.0E-01
Well Pump Intake Depth (m)	H-3	1.1E+01	
Plant transfer factor (pCi/g plant per pCi/g soil)	Am-241 (the plant transfer factor was also found sensitive for the Am-241 as Pu-241daughter)		1.8E-03 1.8E-03
	Cm-243		1.8E-03
	Cm-244		8.0E-02
	Cs-137		1.8E-03
	Fe-55		9.1E-02
	Ni-59		9.1E-02

BHI energy | Power Services

Sensitive Input Parameter	Affected Nuclide	RESRAD Percentile Value[a] 25th	75th
	Ni-63		1.8E-03
	Pu-238		1.8E-03
	Pu-239		1.8E-03
	Pu-240		1.8E-03
	Pu-241		5.9E-01
	Sr-90		9.1E+00
	Tc-99		
Meat transfer factor (pCi/kg per pCi/d)	Cs-137		4.0E-02
	Fe-55		1.8E-02
	Pu-238		9.4E-06
Milk transfer factor (pCi/l per pCi/d)	Cs-137		7.4E-03
	Ni-59		3.2E-02
	Ni-63		3.2E-02
K_d in CZ (cm^3/g)	C-14		7.1E+01
	Co-60		3.1E+03
	Eu-152		1.4E+04
	Eu-154		1.4E+04
	Nb-94		3.8E+03
	Sr-90		1.7E+02
	Tc-99		8.8E-01
SZ hydraulic gradient	H-3	1.8E-03	
	Tc-99	1.8E-03	

[a] The 75th percentile value was selected when the value of the PRCC for a given parameter was ≥0.25 and had a positive value. The 25th percentile value was selected when the value of the PRCC value for a given parameter was ≥0.25 and had a negative value.

BHI energy | Power Services

Table 3: Summary of Values for RESRAD-Onsite Input Parameters

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (generic soil type values assigned to contaminated, unsaturated. and saturated zones) (cm^3/g)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.44	1.1	0.001	0.999	1700
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
C-14	P	1	S D	Truncated lognormal-n 7.1E+01	Distribution from NUREG/CR-7267 applied to UZ and SZ 75[th] percentile value applied to CZ	3.04	1.82	0.001	0.999	21
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Co-60	P	1	S D	Truncated lognormal-n 3.1E+03	Distribution from NUREG/CR-7267 applied to UZ and SZ 75[th] percentile value applied to CZ	6.17	2.77	0.001	0.999	480
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.09	1.95	0.001	0.999	1200
Eu-152	P	1	S D	Truncated lognormal-n 1.4E+04	Distribution from NUREG/CR-7267 applied to UZ and SZ 75[th] percentile value applied to CZ	6.86	4.01	0.001	0.999	955
Eu-154	P	1	S D	Truncated lognormal-n 1.4E+04	Distribution from NUREG/CR-7267 applied to UZ and SZ 75[th] percentile value applied to CZ	6.86	4.01	0.001	0.999	955
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.78	0.69	0.001	0.999	880
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.61	3.22	0.001	0.999	5
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.81	0.5	0.001	0.999	0.06
Nb-94	P	1	S D	Truncated lognormal-n 3.8E+03	Distribution from NUREG/CR-7267 applied to UZ and SZ 75[th] percentile value applied to CZ	7.31	1.39	0.001	0.999	1500

Input Values and Bases for DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.58	1.79	0.001	0.999	36
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.6	1.1	0.001	0.999	2000
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.65	2.30	0.001	0.999	2100
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.19	1.61	0.001	0.999	180
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Sr-90	P	1	S D	Truncated lognormal-n 1.7E+02	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	3.95	1.79	0.001	0.999	52
Tc-99	P	1	S D	Truncated lognormal-n 8.8E-01	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	-1.61	2.20	0.001	0.999	0.2
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-232	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	Ground water uncontaminated	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0		NR	NR	NR	NR	

BHI energy Power Services

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	**Type[a]**	**Priority[b]**	**Treatment[c]**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters[d]**				**Median/ Mean**
						1	**2**	**3**	**4**	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	64,821	CR3 PA= 64,821 m^2 (file "CZ_Zone_11-22-2021.dwg")	NR	NR	NR	NR	
Thickness of contaminated zone (m)	P	2	D	0.1524	Depth of soil mixing layer (6 inches) as defined for the Resident Farmer Scenario in NUREG/CR-5512	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	287	Site-specific – assumed diameter of a circle with an area = CR3 contaminated zone, 64,821 m^2	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	Consistent with resident farmer scenario - no cover assumed	NR	NR	NR	NR	
Density of contaminated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone erosion rate (m/y)	P	2	D	6E-04	NUREG/CR-7267; assumed erosion rate for site with shallow slope	NR	NR	NR	NR	
Contaminated zone total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021					
Contaminated zone hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Humidity in air (g/m^3)	P	3	D	13.8	Figure 1 in *Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations* (see figure below)	NR	NR	NR	NR	
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-7267	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	D	3.5	TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Precipitation (m/y)	P	2	D	1.5	Upper end of precipitation range is applied: "rainfall averages about 50 to 60 inches per year" TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	

Input Values and Bases for DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Irrigation (m/y)	B	3	S	Uniform	Distribution determined using methodology described in 2015 updated *Data Collection Handbook* and NUREG/CR-6697.	0	0.6	NR	NR	0.3
Irrigation mode	B	3	D	Overhead	Overhead irrigation is common practice for crops in U.S.	NR	NR	NR	NR	
Runoff coefficient	P	2	D	0.2	Value determined using methodology described in *Data Collection Handbook* and NUREG/CR-7267	NR	NR	NR	NR	
Watershed area for nearby stream or pond (m^2)	P	3	D	1.3E+07	**Crystal River** is a very short river, "just seven miles (eleven kilometers) long, and has a drainage basin of five square miles (thirteen square kilometers),…" (https://en.wikipedia.org/wiki/Crystal_River_(Florida))	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	S	Bounded Lognormal-n 1.8E-03	Distribution from NUREG/CR-7267 applied to all ROCs **except H-3 and Tc-99** 25th percentile value applied to H-3 and Tc-99	-5.11	1.77	7.0E-05	0.5	0.006
Saturated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Water table drop rate (m/y)	P	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Well pump intake depth (m below water table)	P	2	S	Triangular 1.1E+01	Distribution from NUREG/CR-7267 applied to all ROCs **except H-3** 25th percentile value applied to H-3	6	10	30		14.51
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	ND model recommended for contaminant areas >1,000 m^2	NR	NR	NR	NR	
Well pumping rate (m^3/y)	P	2	S	Uniform	Min, and max value based on site irrigation rate and information from NUREG/CR-7267.	407	1605			802.5
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	Based on suggested uniform input for RESRAD-Onsite hydrologic parameters for the UZ (H&A Technical Support Document, File No. 134300, 12/9/2021) and assignment of generic soil type for UZ	NR	NR	NR	NR	
Unsat. zone 1, thickness (m)	P	1	S	uniform	Distribution developed from depth range for site groundwater, 5 ft – 9 ft (H&A *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station*); thickness of burm area, 21ft (H&A Technical Support Document, File No. 134300, 12/9/2021), and scenario default thickness of CZ, 0.5 ft.	7.92	8.99			8.46
Unsat. zone 1, soil density (g/cm^3)	P	2	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, effective porosity	P	2	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, soil-specific b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Occupancy										
Inhalation rate (m^3/y)	B	3	D	8400	NUREG/CR-7267	NR	NR	NR	NR	
Mass loading for inhalation (g/m^3)	P	2	S	Continuous linear	NUREG/CR-7267					2.3E-5

BHI energy Power Services

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Exposure duration	B	3	D	30	RESRAD Default	NR	NR	NR	NR	
Indoor dust filtration factor	P	2	S	Uniform	NUREG/CR-7267	0.15	0.95			0.55
Shielding factor, external gamma	P	2	S D	Bounded lognormal-n 4.0E-01	Distribution from NUREG/CR-7267 applied to C-14, Cm-244, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99 75th percentile value applied to Am-241, Cm-243, Co-60, Cs-137, Eu-152, Eu-154, and Nb-94	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.6571	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Fraction of time spent outdoors	B	3	D	0.1181	NUREG/CR-5512, Vol. 3 (outdoors + gardening)	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	RESRAD Default - Circular contaminated zone assumed	NR	NR	NR	NR	
Ingestion, Dietary										
Fruits, vegetables, grain consumption (kg/y)	B	2	D	112	NUREG/CR-5512, Vol. 3 (other vegetables + fruits + grain)	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	B	3	D	21.4	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk consumption (L/y)	B	2	D	233	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	B	3	D	65.1	NUREG/CR5512, Vol. 3 (beef + poultry)	NR	NR	NR	NR	
Fish consumption (kg/y)	B	3	D	20.6	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Other seafood consumption (kg/y)	B	3	D	0.9	RESRAD Default	NR	NR	NR	NR	
Soil ingestion rate (g/yr)	B	2	D	18.26	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Drinking water intake (L/y)	B	2	D	478.5	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of drinking water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water	P	3		NA						
Contamination fraction of livestock water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of irrigation water	P	3	D	1	RESRAD Default - all water assumed contaminate	NR	NR	NR	NR	
Contamination fraction of aquatic food	P	2	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Input Values and Bases for DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Contamination fraction of plant food	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of meat	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of milk	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/d)	M	3	D	27.1	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/d)	M	3	D	63.2	NUREG/CR5512, Vol. 3, forage + grain + hay	NR	NR	NR	NR	
Livestock water intake for meat (L/d)	M	3	D	50.6	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock water intake for milk (L/d)	M	3	D	60	NUREG/CR5512, Vol. 3	NR	NR	NR	NR	
Livestock soil intake (kg/d)	M	3	D	0.5	RESRAD Default	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	4.00E-04	NUREG/CR-5512, Vol. 3, gardening	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	S	Triangular 1.5E-01	Distribution from NUREG/CR-7267 applied to C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Sr-90, and Tc-99 25th percentile value applied to Am-241, Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, and Pu-241	0	0.15	0.6		0.23
Depth of roots (m)	P	1	S D	Uniform 1.2E+00	Distribution from NUREG/CR-7267 applied to Co-60, Eu-152, Eu-154, and Nb-94 25th percentile value applied to Am-241, C-14, Cm-243, Cm-244, Cs-137, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99	0.3	4			1.85
Drinking water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Household water fraction from ground water (if used)	P	3		NA						
Livestock water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Irrigation fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	

BHI energy Power Services

Input Values and Bases for DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	Truncated lognormal-n	NUREG/CR-7267, App. C	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	2.88921	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	1.8868	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	0.246	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	0.123	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	0.082	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	0.1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Weathering Removal Constant for Vegetation (1/y)	P	2	S	Triangular	NUREG/CR-7267	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy	P	2	S	Triangular	NUREG/CR-7267	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	14	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Leafy vegetables	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry	B	3	D	20	NUREG/CR-5512, Vol. 3 (holdup period for beef)	NR	NR	NR	NR	
Fish	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Well water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Surface water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Livestock fodder	B	3	D	45	RESRAD Default	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	2.00E-05	RESRAD Default	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	3.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	2.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	9.80E-01	RESRAD Default	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	S	Triangular	NUREG/CR-7267, App. C (Ref. 4)	0.2	0.3	0.6		0.3
C-14 evasion flux rate from soil (1/s)	P	3	D	7.00E-07	RESRAD Default	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/s)	P	3	D	1.00E-10	RESRAD Default	NR	NR	NR	NR	
Fraction of grain in beef cattle feed	B	3	D	0.2500	NUREG/CR-7267	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	0.1000	NUREG/CR-7267	NR	NR	NR	NR	
Inhalation Dose Conversion Factors (mrem/pCi inhaled) from FGR11 (contained in RESRAD Dose Conversion Library)										
Ingestion Dose Conversion Factors (mrem/pCi ingested) from FGR11 (contained in RESRAD Dose Conversion Library)										
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	1.1	0.001	0.999	1.0E-03
Am-241	P	1	D	1.8E-03	75th percentile value					
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-0.4	0.9	0.001	0.999	6.7E-01
Cm-243	P	1	D	1.8E-03	75th percentile value					
Cm-244	P	1	D	1.8E-03	75th percentile value					
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.5	0.9	0.001	0.999	8.0E-02
Cs-137	P	1	D	8.0E-02	75th percentile value					
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Fe-55	P	1	D	1.8E-03	75th percentile value					
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	1.1	0.001	0.999	5.0E+00
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.0	0.001	0.999	2.0E-03

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ni-59	P	1	D	9.1E-02	75th percentile value					
Ni-63	P	1	D	9.1E-02	75th percentile value					
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.9	0.9	0.001	0.999	2.0E-02
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.1	0.001	0.999	1.0E-02
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-5.5	0.9	0.001	0.999	4.0E-04
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-238	P	1	D	1.8E-03	75th percentile value					
Pu-239	P	1	D	1.8E-03	75th percentile value					
Pu-240	P	1	D	1.8E-03	75th percentile value					
Pu-241	P	1	D	1.8E-03	75th percentile value					
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Sr-90	P	1	D	5.9E-01	75th percentile value					
Tc-99	P	1	D	9.1E+00	75th percentile value					
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.47	1.0	0.001	0.999	3.1E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.75	0.8	0.001	0.999	4.3E-04
Cs-137	P	2	D	4.0E-02	75th percentile value					

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Fe-55	P	2	D	1.8E-02	75th percentile value					
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.42	1.0	0.001	0.999	1.2E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.9	0.001	0.999	1.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	1.0	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.26	0.9	0.001	0.999	7.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.7	0.001	0.999	5.0E-03
Pu-238	P	2	S	9.4E-06	75th percentile value					
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	1.1	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.21	0.7	0.001	0.999	1.0E-04
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-232	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06

Input Values and Bases for DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.4	0.9	0.001	0.999	1.2E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.12	0.7	0.001	0.999	1.1E-04
Cs-137	P	2	D	7.4E-03	75th percentile value					
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.26	0.7	0.001	0.999	3.5E-05
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	0.9	0.001	0.999	1.0E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Ni-59	P	2	D	3.2E-02	75th percentile value					
Ni-63	P	2	D	3.2E-02	75th percentile value					
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-11.51	0.7	0.001	0.999	1.0E-05
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.11	0.9	0.001	0.999	3.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.47	0.6	0.001	0.999	2.1E-04
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	0.5	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+01
Am-241	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
Am-243	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
C-14	P	2	S	Lognormal-n	NUREG/CR-7267	13.0	1.1			4.4E+05
Cm-243	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Cm-244	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Co-60	P	2	S	Lognormal-n	NUREG/CR-7267	4.3	0.9			7.4E+01
Cs-137	P	2	S	Lognormal-n	NUREG/CR-7267	7.8	0.9			2.4E+03
Eu-152	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Eu-154	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Fe-55	P	2	S	Lognormal-n	NUREG/CR-7267	5.1	1.9			1.6E+02
Gd-152	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
H-3	P	2	S	Lognormal-n	NUREG/CR-7267	0	0.1			1.0E+00
Nb-94	P	2	S	Lognormal-n	NUREG/CR-7267	5.7	1.1			3.0E+02
Ni-59	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Ni-63	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Np-237	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Pa-231	P	2	S	Lognormal-n	NUREG/CR-7267	2.3	1.1			1.0E+01
Pb-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.4E+01
Po-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.6	1.5			3.7E+01
Pu-238	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-239	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-240	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-241	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Ra-226	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00

Input Values and Bases for DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ra-228	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Sr-90	P	2	S	Lognormal-n	NUREG/CR-7267	1.1	1.4			3.0E+00
Tc-99	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Th-228	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-229	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-230	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
U-233	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-234	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-235	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-236	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L)) RESRAD default value for each radionuclide applied										
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Notes:

[a] P = physical, B = behavioral, M = metabolic; (NUREG/CR-7267)
[b] 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter (NUREG/CR-6697)
[c] D = deterministic, S = stochastic
NR = none recommended

[d] Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum

Table 4: RESRAD Onsite Generated POM Doses and DCGL Values by ROC

ROC	POM Dose (mrem/y)	DCGL (pCi/g)
Am-241	1.23E-01	2.04E+02
C-14	3.57E-01	7.00E+01
Cm-243	3.27E-01	7.65E+01
Cm-244	9.54E-02	2.62E+02
Co-60	4.87E+00	5.13E+00
Cs-137	1.36E+00	1.84E+01
Eu-152	2.26E+00	1.11E+01
Eu-154	2.40E+00	1.04E+01
Fe-55	3.44E-04	7.27E+04
H-3	5.69E-04	4.40E+04
Nb-94	3.22E+00	7.77E+00
Ni-59	2.29E-03	1.09E+04
Ni-63	6.27E-03	3.99E+03
Pu-238	1.50E-01	1.67E+02
Pu-239	1.75E-01	1.43E+02
Pu-240	1.75E-01	1.43E+02
Pu-241	4.01E-03	6.24E+03
Sr-90	1.82E+00	1.38E+01
Tc-99	1.06E-01	2.35E+02

Table 5: Soil DCGL Values by Radionuclide

ROC	DCGL (pCi/g)
Am-241	2.0E+02
C-14	7.0E+01
Cm-243	7.6E+01
Cm-244	2.6E+02
Co-60	5.1E+00
Cs-137	1.8E+01
Eu-152	1.1E+01
Eu-154	1.0E+01
Fe-55	7.3E+04
H-3	4.4E+04
Nb-94	7.8E+00
Ni-59	1.1E+04
Ni-63	4.0E+03
Pu-238	1.7E+02
Pu-239	1.4E+02
Pu-240	1.4E+02
Pu-241	6.2E+03
Sr-90	1.4E+01
Tc-99	2.3E+02

Appendix A

RESRAD-Onsite Results

Am-241 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/11/2022  14:16  Page  20
 Probabilistic results summary : CR3_DCGL_ Am241
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\AM-241\CR3 AM241\CR3_DCGL_AM241.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              1.227E-01
```

C-14 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/11/2022  14:57  Page  20
 Probabilistic results summary : CR3_DCGL_C14
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\C-14\CR3 C14\CR3_DCGL_C14.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              3.573E-01
```

Cm-243 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/11/2022  13:46  Page  21
 Probabilistic results summary : CR3_DCGL_Cm243
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\CM-243\CR3\CR3_DCGL_CM243.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              3.270E-01
```

Cm-244 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/11/2022  15:27  Page  21
 Probabilistic results summary : CR3_DCGL_CM244
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\CM-244\CR3\CR3_DCGL_CM244.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              9.536E-02
```

Co-60 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 180 days        02/14/2022  12:45  Page  20
 Probabilistic results summary : CR3 Sensitivity Analysis - Co60
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\CO-60\CR3 CO60\CR3_DCGL_CO60.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              4.870E+00
```

Cs-137 POM:

```
Probabilistic results summary : CR3_DCGL_Cs137
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\CS-137\CR3\CR3_DCGL_CS137.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              1.356E+00
```

Eu-152 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/12/2022  06:33  Page  20
 Probabilistic results summary : CR3_DCGL_ Eu152
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\EU-152\CR3\CR3_DCGL_EU152.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose      Peak mean dose
                         Years                  mrem/yr
          1            0.000E+00              2.226E+00
```

Eu-154 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/12/2022  06:51  Page  20
 Probabilistic results summary : CR3_DCGL_Eu154
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\EU-154\CR3\CR3_DCGL_EU154.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              2.399E+00
```

Fe-55 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/12/2022  07:36  Page  20
 Probabilistic results summary : CR3_DCGL_Fe55
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\FE-55\CR3\CR3_DCGL_FE55.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              3.441E-04
```

H-3 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/13/2022  07:47  Page  20
 Probabilistic results summary : CR3_DCGL_H3
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\H-3\CR3\CR3_DCGL_H3.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              5.686E-04
```

Nb-94 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/13/2022  08:06  Page  20
 Probabilistic results summary : CR3_DCGL_Nb94
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\NB-94\CR3\CR3_DCGL_NB94.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              3.218E+00
```

Ni-59 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/14/2022  08:35  Page  20
 Probabilistic results summary : CR3_DCGL_Ni59
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\NI-59\CR3\CR3_DCGL_NI59.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              2.290E-03
```

Ni-63 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/14/2022  08:53  Page  20
 Probabilistic results summary : CR3_DCGL_Ni63
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\NI-63\CR3_DCGL_NI63.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              6.269E-03
```

Pu-238 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/14/2022  09:06  Page  21
 Probabilistic results summary : CR3_DCGL_Pu238
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\PU-238\CR3_DCGL_PU238.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                  mrem/yr
          1           0.000E+00              1.497E-01
```

Pu-239 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/14/2022  09:53  Page  20
 Probabilistic results summary : CR3_DCGL_Pu239
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\PU-239\CR3_DCGL_PU239.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                 mrem/yr
          1           0.000E+00              1.752E-01
```

Pu-240 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/14/2022  10:21  Page  20
 Probabilistic results summary : CR3_DCGL_Pu240
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\PU-240\CR3_DCGL_PU240.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                 mrem/yr
          1           0.000E+00              1.748E-01
```

Pu-241 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/14/2022  10:56  Page  21
 Probabilistic results summary : CR3_DCGL_Pu241
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\PU-241\CR3_DCGL_PU241.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                 mrem/yr
          1           1.859E+01              4.005E-03
```

Sr-90 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/15/2022  07:57  Page  20
 Probabilistic results summary : CR3_DCGL_Sr90
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\SR-90\CR3_DCGL_SR90.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                 mrem/yr
          1           0.000E+00              1.818E+00
```

Tc-99 POM:

```
1RESRAD-ONSITE, Version 7.2      T« Limit = 30 days         02/15/2022  08:18  Page  20
 Probabilistic results summary : CR3_DCGL_Tc99
 File : C:\RESRAD_FAMILY\ONSITE\7.2\USERFILES - COPY\TC-99\CR3_DCGL_TC99.RAD
                   Peak of the mean dose (averaged over observations) at graphical times
 Repetition     Time of peak mean dose     Peak mean dose
                        Years                 mrem/yr
          1           0.000E+00              1.064E-01
```

Enclosure 11

BHI Energy Engineering Calculation

"Crystal River* 3 *Building Surface DCGL Values"

ENG-CR3-004

Revision 0

March 2022

BEGINS ON NEXT PAGE

BHI ENERGY ENGINEERING CALCULATION

Crystal River 3 Building Surface DCGL Values

ENG-CR3-004

Revision: 0

March 2022

Prepared by:
BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA

Prepared by	
Approved by	

1.0 PURPOSE

The purpose of this calculation is to develop building surface derived concentration guideline levels (DCGLs) to support characterization and final status surveys at the Crystal River 3 (CR3) site.

2.0 APPLICABILITY

This calculation addresses only the development of site-specific building surface DCGLs for CR3.

3.0 REFERENCES

3.1 BHI Energy Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 *User's Manual for RESRAD-Build Version 3.0*, June 2003 (ANL/EAD/03-1)

3.3 BHI Energy Engineering Calculation ENG-CR3-002, *RESRAD-Build Input Parameter Sensitivity Analysis – Crystal River 3*

3.4 NUREG/CR-5512, *Residual Radioactive Contamination from Decommissioning*

3.4.1 Volume 1: *Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, Oct. 1992 (PNL-7994)

3.4.2 Volume 3: *Parameter Analysis, Draft Report for Comment*, Oct. 1999 (SAND99-2148)

3.5 *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection For DCGL Development*, June 21, 2021

3.6 NUREG/CR-6755, *Technical Basis for Calculating Radiation Doses for the Building Occupancy Scenario Using the Probabilistic RESRAD-Build 3.0 Code*, Feb. 2002 (ANL/EAD/TM/02-1)

3.7 NUREG/CR-7267, *Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes*, February 2020

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Build code was verified on each computer used for code executions in accordance with Engineering procedure ENG-AP-02, *Verification of Software Operability* [3.1]. The RESRAD-Build user's manual [3.2] provided guidance for code operation.

BHI Energy Engineering Calculation ENG-CR3-002 [3.3] documents the probabilistic (sensitivity) analyses performed for the numerous RESRAD-Build input parameters; this calculation incorporates those results. Six input parameters are identified in ENG-CR3-002 as sensitive (i.e., parameters that have a significant impact on the calculated dose with a change in input value): deposition velocity, resuspension rate, room air exchange rate, indirect ingestion rate, air release fraction, and time for source removal.

In addition, BHI Energy Engineering Calculation ENG-CR3-002 provides recommendations for reasonably conservative values for the sensitive parameters: 25th and 75th percentiles of the input parameter distributions. Use of 25th and 75th percentiles values provides assurance that the DCGL calculations take into account the uncertainties associated with input parameters identified as sensitive. The input values used in this calculation are consistent with both the selected scenario and the results of the sensitivity analyses.

RESRAD-Build version 3.5 code runs were performed for each of the radionuclides-of-concern (ROCs) for the CR3 site. The RESRAD-Build results (i.e., mrem/y per 1.0 pCi/m^2) were used as a conversion factor (CF) to obtain DCGL values that corresponded to 25 mrem/y (the dose criterion for unrestricted release established in 10CFR20.1402:). This was accomplished as follows:

(25 mrem/y)/(RESRAD-Build CF (mrem/y per pCi/m^2)) = $DCGL_{25}$ (pCi/m^2).

$DCGL_{25}$ (pCi/m^2) x (2.22dpm/1pCi) x (1m^2/10000cm^2) x 100 = $DCGL_{25}$ (dpm/100cm^2)

5.0 ASSUMPTIONS AND INPUT

5.1 Assumptions

- Exposure Scenario: The the building occupancy scenario defined in NUREG/CR-5512, volume 1 [3.4.1], including the following exposure pathways:
    - direct external exposure from the source (i.e., residual radioactive material on the floor, walls, and ceiling),
    - external exposure from deposited airborne material,
    - external exposure due to air submersion,
    - exposure due to inhalation of airborne radioactive material,
    - indirect ingestion of radioactive material on the sources and material deposited on the surfaces.
- The ROCs identified for the CR3 site are shown in Table 1 below.

  NOTE: RESRAD-Build automatically accounts for progeny radionuclides with input for several of the CR3 ROCs (also shown in Table 1).

Table 1. Radionuclide Input for RESRAD-Build

ROC[a]	Progeny[b]	ROC[a]	Progeny[b]
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-59	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Ni-63	---
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sr-90	---
Fe-55	---	Tc-99	---
H-3	---		

[a] ROC identified for the CR3 site [3.5].

[b] Progeny radionuclides automatically included in RESRAD-Build with ROC input.

- The hypothetical individual occupies a room and performs work-related activities inside the building for a full occupational year.
- The scenario room defined in NUREG/CR-5512 Volume 1, NUREG/CR-6755 [3.6], and NUREG/CR-6772 [3.7] is modeled in these calculations. The dimensions for the scenario-

defined room are: $64m^2$ in area with 3m walls (8m by 8m by 3m). The room contains 6 area sources: floor, 4 walls, and ceiling.

5.2 Input

- Values from NUREG/CR-5512, volume 3 [3.4.2], NUREG/CR-6755, and NUREG/CR-7267 were assigned for the following parameters:
    - Exposure duration: 365.25 d
    - Indoor fraction: 0.267
    - Breathing rate: 33.6 m^3/d
    - Receptor location (center of room): 4.0m, 4.0m,1.0m
    - Air release fraction for H-3: 1.0
    - Removable fraction: 0.1
    - Room area: $64m^2$ (8m by 8m)
    - Room height: 3m
    - Receptor location: center
    - Location of center of source: center point of floor, walls, and ceiling

- Direct ingestion rate, 4.91E-7 h^{-1}, was taken from NUREG/CR-6755.

- BHI Energy Engineering Calculation ENG-CR3-002 identifies sensitive RESRAD-Build parameters for each ROC. The RESRAD-Build parameters identified as sensitive for one or more of the CR3 ROCs are:
    - deposition velocity
    - resuspension rate
    - room air exchange rate
    - indirect ingestion rate
    - air release fraction
    - time for source removal

- 25^{th} or 75^{th} percentile values (determined in BHI Energy Engineering Calculation ENG-CR3-002) were used as input values for ROCs for which one of the above-listed parameters was identified as sensitive. The 50^{th} percentile value was used as input if a parameter was not identified as sensitive. Table 2 summarizes the 25^{th}, 50^{th}, and 75^{th} percentile values and identifies the ROC to which each percentile value was assigned.

- Table 3 summaries the input values for all the RESRAD-Build parameters, including the application of the $25^{th}/50^{th}/75^{th}$ percentile values by ROC.

Table 2: Percentile Values for Sensitive RESRAD-Build Parameters
(Source: Table 4 in ENG-CR3-002)

Sensitive Parameter[a]	Percentile Value		
	25th	50th	75th
LAMBDAT	8.4E-01	1.5E+00	2.7E+00
UD	1.5E-05	8.5E-05	4.8E-04
DKSUS	6.6E-10	1.8E-08	4.7E-07
INGE	5.0E-05	9.0E-05	1.6E-04
AIRFR(1)	1.6E-01	3.2E-01	5.2E-01
AIRFR(2)	1.6E-01	3.2E-01	5.2E-01
AIRFR(3)	1.6E-01	3.2E-01	5.2E-01
AIRFR(4)	1.6E-01	3.2E-01	5.2E-01
AIRFR(5)	1.6E-01	3.2E-01	5.2E-01
AIRFR(6)	1.6E-01	3.2E-01	5.2E-01
RFO(1)	1.8E+04	3.3E+04	5.3E+04
RFO(2)	1.8E+04	3.3E+04	5.3E+04
RFO(3)	1.8E+04	3.3E+04	5.3E+04
RFO(4)	1.8E+04	3.3E+04	5.3E+04
RFO(5)	1.8E+04	3.3E+04	5.3E+04
RFO(6)	1.8E+04	3.3E+04	5.3E+04

[a] LAMBDAT = building air exchange rate, UD = deposition velocity, DKSUS = resuspension rate, INGE = ingestion rate, AIRFR(#) = air release fraction (for source number), and RFO(#) = source removal time (for source number).

6.0 CALCULATIONS AND RESULTS

6.1 Location of the center of source: The center of each source was determined based on the dimensions for the scenario-defined room. The locations were determined as the mid-point of the dimension values for the X, Y, and Z-axes.

Source No.	Source Description	Location of Center of Source (m)		
		X-axis	Y-axis	Z-axis
1	Floor	4	4	0
2	Wall 1	4	0	1.5
3	Wall 2	0	4	1.5
4	Wall 3	4	8	1.5
5	Wall 4	8	4	1.5
6	Ceiling	4	4	3

6.2 Table 3 summarizes the input used in each RESRAD-Build code execution.

6.2.1 Each of the ROCs listed in Table 1 was evaluated using an initial concentration of 1.0 pCi/m^2 in separate code executions.

6.2.2 For all ROCs except Pu-241, the maximum dose occurred in the first time interval (see selected pages of the RESRAD-Build reports in Appendix A). For Pu-241, the maximum dose may occur at a later time. Multiple time intervals were used for Pu-241 to assure that the maximum dose was used to develop the DCGL value. RESRAD-Build results at the various time intervals are summarized in Table 4.

6.3 The maximum doses shown in **bold** font in Table 4 were used to as the radionuclide-specific CF with units of mrem per pCi/m^2 for developing the DCGL values, which are presented in Table 5.

6.3.1 Column 2 in Table 5 presents the annual dose associated with a concentration of 1.0 pCi/m^2 as calculated using the RESRAD-Build code. For each radionuclide, DCGL values corresponding to the 10CFR20.1402 radiological criterion, 25 mrem/y (designated as $DCGL_{25}$), were calculated as follows:

(25 mrem/y)/radionuclide-specific CF = $DCGL_{25}$ (pCi/m^2)

The resulting $DCGL_{25}$ values are shown in column 3 of Table 5.

Column 4 of Table 5 presents the conversions of the $DCGL_{25}$ values to values with units of dpm/100cm^2 (designated in Table 4 as $DCGL_w$).

$DCGL_{25}$ (pCi/m^2) • 2.22 dpm/1pCi • 1m^2/10000cm^2 • 100 = $DCGL_w$ (dpm/100cm^2)

6.4 For practical application, the $DCGL_w$ values were rounded to 2 significant digits. The rounded $DCGL_w$ values will support decommissioning and final status surveys at the CR3 site. Table 6 presents the rounded $DCGL_w$ values.

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Exposure Duration (d)	B	All ROCs	D	365.25	NUREG/CR-5512; NUREG/CR-7267
Indoor Fraction	B	All ROCs	D	0.267	NUREG/CR-5512; NUREG/CR-7267
Evaluation Time (y)	P	All ROCs	D	1 (1, 5, 10, 25, 50 for Pu-241)	T=1 corresponds to dose over the 1st year; multiple input applied to Pu241 verify time of peak dose
Number of Rooms	P	All ROCs	D	1	NUREG/CR-5512 building occupancy scenario assumpyion
Deposition Velocity (m/s)	P	Am-241, Cm-243, Cm-244, Pu-238, Pu-239, Pu-240, Pu-241	D	8.5E-05	50th percentile value
		C-14, Co-60, Cs-137, Eu-152, Eu-154, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	D	4.8E-04	75th percentile value
Resuspension Rate (s^{-1})	P	C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	D	6.6E-10	25th percentile value
		Am-241, Cm-243, Cm-244, Fe-55, Pu-238, Pu-239, Pu-240, Pu-241	D	1.8E-08	50th percentile value
Air Exchange Rate for Room (h^{-1})	P	All ROCs	D	8.41E-01	25th percentile value
Room Area (m^2)	P	All ROCs	D	64	NURGEG/CR-6755
Room Height (m)	P	All ROCs	D	3	NURGEG/CR-6755
Time Fraction	B	All ROCs	D	1	NUREG/CR-7267
Inhalation Rate (m^3/d)	M	All ROCs	D	33.6	NUREG/CR-5512, vol. 3

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Indirect Ingestion Rate (m^2/h)	B	AM-241, Cm-243, Cm-244, Eu-152, Pu-238, Pu-241	D	5.0E-05	25th percentile value
		Co-60, Eu-154, Pu-240	D	9.0E-05	50th percentile value
		C-14, Cs-137, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Pu-239, Sr-90, Tc-99	D	1.6E-04	75th percentile value
Receptor Location	B	All ROCs	D	4, 4,1	NUREG/CR-5512; center of room based on scenario room dimensions from NUREG/CR-5512 and NUREG/CR-7267
Shielding Thickness (cm)	P	All ROCs	D	0	no shielding assumed
Shielding Density (g/cm^3)	P	All ROCs	D	1	Input value required for code execution – input has no impact due to shield thickness input
Shielding Material	P	All ROCs	D	water	Input value required for code execution – input has no impact due to shield thickness input
Number of Sources	P	All ROCs		6	Includes floor, ceiling and 4 walls consistent to scenario assumptions in NUREG/CR-6755 and NUREG/CR-7267
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Inhalation Dose Conversion Factor, (mrem/pCi)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Ingestionl Dose Conversion Factor, (mrem/pCi)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Source 1: Floor					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 4, 0	Center of floor based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Area (m^2)	P	All ROCs	D	---	Source length input used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-5512 and NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Fe-55 C-14, Co-60, Cs-137, Eu-152, Eu-154, Nb-94	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 2: Wall 1					
Type	P	All ROCs		Area	NUREG/CR-5512

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Direction	P	All ROCs		Y	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 0, 1.5	Center of wall based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source dimension used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Eu-152, Eu-154, Fe-55 C-14, Co-60, Cs-137	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 3: Wall 2					
Type	P	All ROCs		Area	NUREG/CR-5512
Direction	P	All ROCs		X	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	0.0, 4, 1.5	center of wall based on dimensions for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Area (m^2)	P	All ROCs	D	---	Source dimension used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Eu-152, Eu-154, Fe-55 C-14, Co-60, Cs-137	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 4: Wall 3					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		Y	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 8, 1.5	center of wall based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source dimension used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99	D	1.8E+04	25th percentile value
		Eu-152, Eu-154, Fe-55	D	3.3E+04	50th percentile value
		C-14, Co-60, Cs-137	D	5.3E+04	75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 5: Wall 4					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		x	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	8, 4, 1.5	center of wall based on dimensions for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source length inputs used
Air Release Fraction	B	H-3	D	1.0	NUREG/CR-7267
		All other ROCs	D	5.2E-01	75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99	D	1.8E+04	25th percentile value
		Eu-152, Eu-154, Fe-55	D	3.3E+04	50th percentile value
		C-14, Co-60, Cs-137	D	5.3E+04	75Th percentile value
Radionuclide Concentration (pCi/m²)	P	All ROCs	D	1.0	-
Source 6: Ceiling					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 4, 3	center of ceiling based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m²) for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m²) for defined room
Area (m²)	P	All ROCs	D	---	Source length inputs used
Air Release Fraction	B	H-3	D	1.0	NUREG/CR-7267
		All other ROCs	D	5.2E-01	75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755

Table 3: RESRAD-Build Input Parameter Values for DCGLs					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99	D	1.8E+04	25th percentile value
		Fe-55, Nb-94	D	3.3E+04	50th percentile value
		C-14, Co-60, Cs-137, Eu-152, Eu-154, Nb-94	D	5.3E+04	75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-

[a] P = physical, B = behavioral, M = metabolic
[b] D = deterministic.

Table 4: Dose at Various Evaluation Times

ROC	Maximum dose (mrem) at evaluation time:					
	0y	1y	5y	10y	25y	50y
Am-241	**3.36E-04**	3.34E-04	---	---	---	---
C-14	**8.64E-08**	8.60E-08	---	---	---	---
Cm-243	**2.31E-04**	2.24E-04	---	---	---	---
Cm-244	**1.83E-04**	1.75E-04	---	---	---	---
Co-60	**4.11E-05**	3.60E-05	---	---	---	---
Cs-137	**1.18E-05**	1.15E-05	---	---	---	---
Eu-152	**2.05E-05**	1.94E-05	---	---	---	---
Eu-154	**2.17E-05**	2.00E-05				
Fe-55	**1.46E-08**	1.12E-08	---	---	---	---
H-3	**2.64E-09**	2.46E-09	---	---	---	---
Nb-94	**2.16E-05**	2.16E-05	---	---	---	---
Ni-59	**1.64E-08**	1.63E-08	---	---	---	---
Ni-63	**3.41E-08**	3.35E-08	---	---	---	---
Pu-238	**2.95E-04**	2.91E-04				
Pu-239	**3.26E-04**	3.24E-04	---	---	---	---
Pu-240	**3.26E-04**	3.24E-04	---	---	---	---
Pu-241	6.34E-06	6.53E-06	7.16E-06	7.70E-06	**8.21E-06**	1.94E-08
Sr-90	**6.82E-06**	6.58E-06	---	---	---	---
Tc-99	**1.10E-07**	1.09E-07	---	---	---	---

Table 5. Radionuclide-Specific DCGL Values

	DCGL Value Development:		
Nuclide	CF (mrem/y per 1pCi/m^2)	$DCGL_{25}$ (pCi/m^2)	$DCGL_w$ (dpm/100cm^2)
Am-241	3.36E-04	7.44E+04	1.65E+03
C-14	8.64E-08	2.89E+08	6.42E+06
Cm-243	2.31E-04	1.08E+05	2.40E+03
Cm-244	1.83E-04	1.37E+05	3.03E+03
Co-60	4.11E-05	6.08E+05	1.35E+04
Cs-137	1.18E-05	2.12E+06	4.70E+04
Eu-152	2.05E-05	1.22E+06	2.71E+04
Eu-154	2.17E-05	1.15E+06	2.56E+04
Fe-55	1.46E-08	1.71E+09	3.80E+07
H-3	2.64E-09	9.47E+09	2.10E+08
Nb-94	2.16E-05	1.16E+06	2.57E+04
Ni-59	1.64E-08	1.52E+09	3.38E+07
Ni-63	3.41E-08	7.33E+08	1.63E+07
Pu-238	2.95E-04	8.47E+04	1.88E+03
Pu-239	3.26E-04	7.67E+04	1.70E+03
Pu-240	3.26E-04	7.67E+04	1.70E+03
Pu-241	8.21E-06	3.05E+06	6.76E+04
Sr-90	6.82E-06	3.67E+06	8.14E+04
Tc-99	1.10E-07	2.27E+08	5.05E+06

Table 6: Building Surface $DCGL_w$ Values by Radionuclide

Nuclide	Building Surface $DCGL_w$ ($dpm/100cm^2$)
Am-241	1.7E+03
C-14	6.4E+06
Cm-243	2.4E+03
Cm-244	3.0E+03
Co-60	1.4E+04
Cs-137	4.7E+04
Eu-152	2.7E+04
Eu-154	2.6E+04
Fe-55	3.8E+07
H-3	2.1E+08
Nb-94	2.6E+04
Ni-59	3.4E+07
Ni-63	1.6E+07
Pu-238	1.9E+03
Pu-239	1.7E+03
Pu-240	1.7E+03
Pu-241	6.8E+04
Sr-90	8.1E+04
Tc-99	5.0E+06

Appendix A
Selected Pages from RESRAD-Build Reports

Am-241 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/11/22 17:01:16  Page:  10 **
 Title : CR3 DCGL-Am241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Am241.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    9.63E-05 3.60E-05 3.60E-05 3.60E-05 3.60E-05 9.61E-05 3.36E-04
 Total          9.63E-05 3.60E-05 3.60E-05 3.60E-05 3.60E-05 9.61E-05 3.36E-04

** RESRAD-BUILD Dose Program Output, Version 3.50 02/11/22 17:01:16  Page:  17 **
 Title : CR3 DCGL-Am241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Am241.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    9.56E-05 3.57E-05 3.57E-05 3.57E-05 3.57E-05 9.54E-05 3.34E-04
 Total          9.56E-05 3.57E-05 3.57E-05 3.57E-05 3.57E-05 9.54E-05 3.34E-04
```

C-14 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 12:24:07  Page:  10 **
 Title : CR3 DCGL_C14
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_C14.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    2.48E-08 9.24E-09 9.24E-09 9.24E-09 9.24E-09 2.47E-08 8.64E-08
 Total          2.48E-08 9.24E-09 9.24E-09 9.24E-09 9.24E-09 2.47E-08 8.64E-08


** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 12:24:07  Page:  17 **
 Title : CR3 DCGL_C14
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_C14.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
```

```
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

               Source    Source    Source    Source    Source    Source    Total
                  1         2         3         4         5         6
 Receptor  1   2.47E-08 9.20E-09 9.20E-09 9.20E-09 9.20E-09 2.46E-08 8.60E-08
 Total         2.47E-08 9.20E-09 9.20E-09 9.20E-09 9.20E-09 2.46E-08 8.60E-08
```

Cm-243 Results

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:44:57  Page:  11 **
 Title : CR3 DCGL-Cm243
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Cm243.bld
 Evaluation Time:  0.00000000E+00  years

              íííííííííííííííííííííííííííííííííííííííííííííííí
              íííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              íííííííííííííííííííííííííííííííííííííííííííííííí
              íííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

               Source    Source    Source    Source    Source    Source    Total
                  1         2         3         4         5         6
 Receptor  1   6.64E-05 2.46E-05 2.46E-05 2.46E-05 2.46E-05 6.60E-05 2.31E-04
 Total         6.64E-05 2.46E-05 2.46E-05 2.46E-05 2.46E-05 6.60E-05 2.31E-04

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:44:57  Page:  18 **
 Title : CR3 DCGL-Cm243
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Cm243.bld
 Evaluation Time:  1.00000000   years

              íííííííííííííííííííííííííííííííííííííííííííííííí
              íííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              íííííííííííííííííííííííííííííííííííííííííííííííí
              íííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

               Source    Source    Source    Source    Source    Source    Total
                  1         2         3         4         5         6
 Receptor  1   6.45E-05 2.39E-05 2.39E-05 2.39E-05 2.39E-05 6.40E-05 2.24E-04
 Total         6.45E-05 2.39E-05 2.39E-05 2.39E-05 2.39E-05 6.40E-05 2.24E-04
```

Cm-244 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:53:05  Page:  11 **
 Title : CR3 DCGL-Cm244
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Cm244.bld
 Evaluation Time:  0.00000000E+00  years

              íííííííííííííííííííííííííííííííííííííííííííííííí
              íííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              íííííííííííííííííííííííííííííííííííííííííííííííí
              íííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

               Source    Source    Source    Source    Source    Source    Total
                  1         2         3         4         5         6
 Receptor  1   5.22E-05 1.96E-05 1.96E-05 1.96E-05 1.96E-05 5.22E-05 1.83E-04
 Total         5.22E-05 1.96E-05 1.96E-05 1.96E-05 1.96E-05 5.22E-05 1.83E-04

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:53:05  Page:  18 **
 Title : CR3 DCGL-Cm244
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Cm244.bld
 Evaluation Time:  1.00000000   years

              íííííííííííííííííííííííííííííííííííííííííííííííí
```

```
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    5.00E-05 1.87E-05 1.87E-05 1.87E-05 1.87E-05 5.00E-05 1.75E-04
 Total          5.00E-05 1.87E-05 1.87E-05 1.87E-05 1.87E-05 5.00E-05 1.75E-04
```

Co-60 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 12:01:58  Page:  10 **
 Title : CR3 DCGL_Co60
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Co60.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    1.98E-05 2.38E-06 2.38E-06 2.38E-06 2.38E-06 1.18E-05 4.11E-05
 Total          1.98E-05 2.38E-06 2.38E-06 2.38E-06 2.38E-06 1.18E-05 4.11E-05

* RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 12:01:58  Page:  17 **
 Title : CR3 DCGL_Co60
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Co60.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    1.74E-05 2.08E-06 2.08E-06 2.08E-06 2.08E-06 1.03E-05 3.60E-05
 Total          1.74E-05 2.08E-06 2.08E-06 2.08E-06 2.08E-06 1.03E-05 3.60E-05
```

Cs-137 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 12:38:41  Page:  10 **
 Title : CR3 DCGL_Cs137
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Cs137.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    5.40E-06 7.51E-07 7.51E-07 7.51E-07 7.51E-07 3.36E-06 1.18E-05
 Total          5.40E-06 7.51E-07 7.51E-07 7.51E-07 7.51E-07 3.36E-06 1.18E-05
```

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 12:38:41  Page:  17 **
 Title : CR3 DCGL_Cs137
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Cs137.bld
 Evaluation Time:  1.00000000  years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    5.27E-06 7.32E-07 7.32E-07 7.32E-07 7.32E-07 3.28E-06 1.15E-05
 Total          5.27E-06 7.32E-07 7.32E-07 7.32E-07 7.32E-07 3.28E-06 1.15E-05
```

Eu-152 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:35:17  Page:  10 **
 Title : CR3 DCGL_Eu152
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Eu152.bld
 Evaluation Time:  0.00000000E+00  years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    9.88E-06 1.19E-06 1.19E-06 1.19E-06 1.19E-06 5.85E-06 2.05E-05
 Total          9.88E-06 1.19E-06 1.19E-06 1.19E-06 1.19E-06 5.85E-06 2.05E-0
```

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:35:17  Page:  17 **
 Title : CR3 DCGL_Eu152
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Eu152.bld
 Evaluation Time:  1.00000000  years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    9.37E-06 1.13E-06 1.13E-06 1.13E-06 1.13E-06 5.55E-06 1.94E-05
 Total          9.37E-06 1.13E-06 1.13E-06 1.13E-06 1.13E-06 5.55E-06 1.94E-05
```

Eu-154 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:45:43  Page:  10 **
 Title : CR3 DCGL_Eu154
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Eu154.bld
 Evaluation Time:  0.00000000E+00  years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                          ííí
              ííí        RESRAD-BUILD Dose Tables          ííí
              ííí                                          ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
```

```
                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    1.05E-05 1.26E-06 1.26E-06 1.26E-06 1.26E-06 6.19E-06 2.17E-05
 Total          1.05E-05 1.26E-06 1.26E-06 1.26E-06 1.26E-06 6.19E-06 2.17E-05


** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:45:43  Page:  17 **
 Title : CR3 DCGL_Eu154
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Eu154.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    9.66E-06 1.16E-06 1.16E-06 1.16E-06 1.16E-06 5.72E-06 2.00E-05
 Total          9.66E-06 1.16E-06 1.16E-06 1.16E-06 1.16E-06 5.72E-06 2.00E-05
```

Fe-55 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 16:05:43  Page:  10 **
 Title : CR3 DCGL_Fe55
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Fe55.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    4.16E-09 1.56E-09 1.56E-09 1.56E-09 1.56E-09 4.16E-09 1.46E-08
 Total          4.16E-09 1.56E-09 1.56E-09 1.56E-09 1.56E-09 4.16E-09 1.46E-08
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 16:05:43  Page:  17 **
 Title : CR3 DCGL_Fe55
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Fe55.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    3.19E-09 1.19E-09 1.19E-09 1.19E-09 1.19E-09 3.19E-09 1.12E-08
 Total          3.19E-09 1.19E-09 1.19E-09 1.19E-09 1.19E-09 3.19E-09 1.12E-08
```

H-3 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 16:34:09  Page:  10 **
 Title : CR3 DCGL_H3
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_H3.bld
```

```
Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
Receptor  1     7.54E-10 2.83E-10 2.83E-10 2.83E-10 2.83E-10 7.54E-10 2.64E-09
Total           7.54E-10 2.83E-10 2.83E-10 2.83E-10 2.83E-10 7.54E-10 2.64E-09


** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 16:34:09  Page:  17 **
 Title : CR3 DCGL_H3
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_H3.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
Receptor  1     7.04E-10 2.64E-10 2.64E-10 2.64E-10 2.64E-10 7.04E-10 2.46E-09
Total           7.04E-10 2.64E-10 2.64E-10 2.64E-10 2.64E-10 7.04E-10 2.46E-09
```

Nb-94 Results:

```
  ** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 16:18:37  Page:  10 **
 Title : CR3 DCGL_Nb94
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Nb94.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
Receptor  1     1.41E-05 1.88E-06 1.88E-06 1.88E-06 1.88E-06 4.11E-09 2.16E-05
Total           1.41E-05 1.88E-06 1.88E-06 1.88E-06 1.88E-06 4.11E-09 2.16E-05


** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 16:18:37  Page:  17 **
 Title : CR3 DCGL_Nb94
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Nb94.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
Receptor  1     1.41E-05 1.87E-06 1.87E-06 1.87E-06 1.87E-06 3.16E-09 2.16E-05
Total           1.41E-05 1.87E-06 1.87E-06 1.87E-06 1.87E-06 3.16E-09 2.16E-05
```

Ni-59 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:21:09  Page:  10 **
 Title : CR3 DCGL_Ni59
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Ni59.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    4.68E-09 1.75E-09 1.75E-09 1.75E-09 1.75E-09 4.68E-09 1.64E-08
 Total          4.68E-09 1.75E-09 1.75E-09 1.75E-09 1.75E-09 4.68E-09 1.64E-08

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:21:09  Page:  17 **
 Title : CR3 DCGL_Ni59
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Ni59.bld
 Evaluation Time:  1.00000000   years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    4.65E-09 1.74E-09 1.74E-09 1.74E-09 1.74E-09 4.65E-09 1.63E-08
 Total          4.65E-09 1.74E-09 1.74E-09 1.74E-09 1.74E-09 4.65E-09 1.63E-08
```

Ni-63 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:32:24  Page:  10 **
 Title : CR3 DCGL_Ni63
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Ni63.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source    Source    Source    Source    Source    Source    Total
                   1         2         3         4         5         6
 Receptor  1    9.73E-09 3.65E-09 3.65E-09 3.65E-09 3.65E-09 9.73E-09 3.41E-08
 Total          9.73E-09 3.65E-09 3.65E-09 3.65E-09 3.65E-09 9.73E-09 3.41E-08

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 13:32:24  Page:  17 **
 Title : CR3 DCGL_Ni63
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Ni63.bld
 Evaluation Time:  1.00000000   years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
```

```
                  Source Contributions to Receptor Doses
                  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                  [mrem]

              Source   Source   Source   Source   Source   Source   Total
                 1        2        3        4        5        6
Receptor  1   9.58E-09 3.59E-09 3.59E-09 3.59E-09 3.59E-09 9.58E-09 3.35E-08
Total         9.58E-09 3.59E-09 3.59E-09 3.59E-09 3.59E-09 9.58E-09 3.35E-08
```

Pu-238 Results:

```
 ** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:04:59  Page:  11 **
Title : CR3 DCGL-Pu238
Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu238.bld
Evaluation Time:  0.00000000E+00   years

            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍ                                         ÍÍÍ
            ÍÍÍ        RESRAD-BUILD Dose Tables         ÍÍÍ
            ÍÍÍ                                         ÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                  Source Contributions to Receptor Doses
                  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                  [mrem]

              Source   Source   Source   Source   Source   Source   Total
                 1        2        3        4        5        6
Receptor  1   8.42E-05 3.16E-05 3.16E-05 3.16E-05 3.16E-05 8.42E-05 2.95E-04
Total         8.42E-05 3.16E-05 3.16E-05 3.16E-05 3.16E-05 8.42E-05 2.95E-04

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:04:59  Page:  18 **
Title : CR3 DCGL-Pu238
Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu238.bld
Evaluation Time:  1.00000000   years

            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍ                                         ÍÍÍ
            ÍÍÍ        RESRAD-BUILD Dose Tables         ÍÍÍ
            ÍÍÍ                                         ÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                  Source Contributions to Receptor Doses
                  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                  [mrem]

              Source   Source   Source   Source   Source   Source   Total
                 1        2        3        4        5        6
Receptor  1   8.31E-05 3.12E-05 3.12E-05 3.12E-05 3.12E-05 8.31E-05 2.91E-04
Total         8.31E-05 3.12E-05 3.12E-05 3.12E-05 3.12E-05 8.31E-05 2.91E-04
```

Pu-239 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:16:16  Page:  10 **
Title : CR3 DCGL-Pu239
Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu239.bld
Evaluation Time:  0.00000000E+00   years

            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍ                                         ÍÍÍ
            ÍÍÍ        RESRAD-BUILD Dose Tables         ÍÍÍ
            ÍÍÍ                                         ÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
            ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                  Source Contributions to Receptor Doses
                  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                  [mrem]

              Source   Source   Source   Source   Source   Source   Total
                 1        2        3        4        5        6
Receptor  1   9.31E-05 3.49E-05 3.49E-05 3.49E-05 3.49E-05 9.31E-05 3.26E-04
Total         9.31E-05 3.49E-05 3.49E-05 3.49E-05 3.49E-05 9.31E-05 3.26E-04

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:16:16  Page:  17 **
Title : CR3 DCGL-Pu239
Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu239.bld
Evaluation Time:  1.00000000   years
```

```
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                            ííí
              ííí        RESRAD-BUILD Dose Tables            ííí
              ííí                                            ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    9.26E-05 3.47E-05 3.47E-05 3.47E-05 3.47E-05 9.26E-05 3.24E-04
 Total          9.26E-05 3.47E-05 3.47E-05 3.47E-05 3.47E-05 9.26E-05 3.24E-04
```

Pu-240 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:29:25  Page:  11 **
 Title : CR3 DCGL-Pu240
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu240.bld
 Evaluation Time:  0.00000000E+00  years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                            ííí
              ííí        RESRAD-BUILD Dose Tables            ííí
              ííí                                            ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    9.30E-05 3.49E-05 3.49E-05 3.49E-05 3.49E-05 9.30E-05 3.26E-04
 Total          9.30E-05 3.49E-05 3.49E-05 3.49E-05 3.49E-05 9.30E-05 3.26E-04

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:29:25  Page:  18 **
 Title : CR3 DCGL-Pu240
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu240.bld
 Evaluation Time:  1.00000000   years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                            ííí
              ííí        RESRAD-BUILD Dose Tables            ííí
              ííí                                            ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    9.25E-05 3.47E-05 3.47E-05 3.47E-05 3.47E-05 9.25E-05 3.24E-04
 Total          9.25E-05 3.47E-05 3.47E-05 3.47E-05 3.47E-05 9.25E-05 3.24E-04
```

Pu-241 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:41:00  Page:  11 **
 Title : CR3 DCGL-Pu241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu241.bld
 Evaluation Time:  0.00000000E+00  years

              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííí                                            ííí
              ííí        RESRAD-BUILD Dose Tables            ííí
              ííí                                            ííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí
              ííííííííííííííííííííííííííííííííííííííííííííííííí


                    Source Contributions to Receptor Doses
                    ííííííííííííííííííííííííííííííííííííííí
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    1.81E-06 6.79E-07 6.79E-07 6.79E-07 6.79E-07 1.81E-06 6.34E-06
 Total          1.81E-06 6.79E-07 6.79E-07 6.79E-07 6.79E-07 1.81E-06 6.34E-06
```

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:41:00  Page:  18 **
 Title : CR3 DCGL-Pu241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu241.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                  1        2        3        4        5        6
 Receptor  1    1.87E-06 7.00E-07 7.00E-07 7.00E-07 7.00E-07 1.87E-06 6.53E-06
 Total          1.87E-06 7.00E-07 7.00E-07 7.00E-07 7.00E-07 1.87E-06 6.53E-06

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:41:00  Page:  25 **
 Title : CR3 DCGL-Pu241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu241.bld
 Evaluation Time:  5.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                  1        2        3        4        5        6
 Receptor  1    2.05E-06 7.67E-07 7.67E-07 7.67E-07 7.67E-07 2.05E-06 7.16E-06
 Total          2.05E-06 7.67E-07 7.67E-07 7.67E-07 7.67E-07 2.05E-06 7.16E-06


** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:41:00  Page:  32 **
 Title : CR3 DCGL-Pu241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu241.bld
 Evaluation Time:  10.0000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                  1        2        3        4        5        6
 Receptor  1    2.20E-06 8.24E-07 8.24E-07 8.24E-07 8.24E-07 2.20E-06 7.70E-06
 Total          2.20E-06 8.24E-07 8.24E-07 8.24E-07 8.24E-07 2.20E-06 7.70E-06

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:41:00  Page:  39 **
 Title : CR3 DCGL-Pu241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu241.bld
 Evaluation Time:  25.0000019  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                  1        2        3        4        5        6
 Receptor  1    2.35E-06 8.79E-07 8.79E-07 8.79E-07 8.79E-07 2.35E-06 8.21E-06
 Total          2.35E-06 8.79E-07 8.79E-07 8.79E-07 8.79E-07 2.35E-06 8.21E-06
```

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 14:41:00  Page:  46 **
 Title : CR3 DCGL-Pu241
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Pu241.bld
 Evaluation Time:  50.0000038  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    9.52E-09 1.09E-09 1.09E-09 1.09E-09 1.09E-09 5.55E-09 1.94E-08
 Total          9.52E-09 1.09E-09 1.09E-09 1.09E-09 1.09E-09 5.55E-09 1.94E-08
```

Sr-90 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:13:16  Page:  10 **
 Title : CR3 DCGL_Sr90
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Sr90.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    1.97E-06 7.25E-07 7.25E-07 7.25E-07 7.25E-07 1.95E-06 6.82E-06
 Total          1.97E-06 7.25E-07 7.25E-07 7.25E-07 7.25E-07 1.95E-06 6.82E-06

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:13:16  Page:  17 **
 Title : CR3 DCGL_Sr90
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Sr90.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    1.90E-06 7.00E-07 7.00E-07 7.00E-07 7.00E-07 1.88E-06 6.58E-06
 Total          1.90E-06 7.00E-07 7.00E-07 7.00E-07 7.00E-07 1.88E-06 6.58E-06
```

Tc-99 Results:

```
** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:22:47  Page:  10 **
 Title : CR3 DCGL_Tc99
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Tc99.bld
 Evaluation Time:  0.00000000E+00  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
```

```
                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    3.16E-08 1.17E-08 1.17E-08 1.17E-08 1.17E-08 3.13E-08 1.10E-07
 Total          3.16E-08 1.17E-08 1.17E-08 1.17E-08 1.17E-08 3.13E-08 1.10E-07

** RESRAD-BUILD Dose Program Output, Version 3.50 02/12/22 15:22:47  Page:  17 **
 Title : CR3 DCGL_Tc99
 Input File : C:\RESRAD_Family\BUILD\3.5\CR3_DCGL_Tc99.bld
 Evaluation Time:  1.00000000  years

              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍ        RESRAD-BUILD Dose Tables          ÍÍÍ
              ÍÍÍ                                          ÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ


                    Source Contributions to Receptor Doses
                    ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
                                    [mrem]

                Source   Source   Source   Source   Source   Source   Total
                   1        2        3        4        5        6
 Receptor  1    3.14E-08 1.16E-08 1.16E-08 1.16E-08 1.16E-08 3.11E-08 1.09E-07
 Total          3.14E-08 1.16E-08 1.16E-08 1.16E-08 1.16E-08 3.11E-08 1.09E-07
```

Enclosure 12

BHI Energy Engineering Calculation

"Area Factors for Use with Crystal River DCGL Values for Soil"

ENG-CR3-005

Revision 0

April 2022

BEGINS ON NEXT PAGE

BHI Power Services
energy

BHI ENERGY ENGINEERING CALCULATION

Area Factors for Use with Crystal River DCGL Values for Soil

ENG-CR3-005

Revision: 0

April 13, 2022

Prepared by:
BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA

Prepared by	Joseph Bisson
Approved by	Christopher Messina

1.0 PURPOSE

The purpose of this calculation is to develop area factors (AFs) for use with derived concentration guideline levels (DCGLs) for assessing soil at the Crystal River 3 (CR3) site.

2.0 APPLICABILITY

This calculation addresses only the development of AF values for use with soil DCGLs for the CR3 site.

3.0 REFERENCES

3.1 BHI Energy Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 ANL/EVS/TM-18/1, *RESRAD-Onsite 7.2 User's Guide*, April 2018

3.3 ENG-CR3-003, *Derived Concentration Guideline Levels for Soil-Crystal River 3*

3.4 NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual -MARSSIM*, August 2000

3.5 *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection For DCGL Development*, June 21, 2021

3.6 NUREG/CR-5512, Volume 1, *Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, Final Report, U.S. Nuclear Regulatory Commission, October 1992.

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Onsite 7.2 code was verified on each computer used for code executions in accordance with BHI Energy Engineering procedure ENG-AP-02, *Verification of Software Operability* [3.1]. The *RESRAD-Onsite 7.2 User's Guide* [3.2] provided guidance for code operation and execution.

The method applied in the calculation of area factors is the same as that applied in BHI Energy Engineering calculation ENG-CR3-003 [3.3] for developing the soil DCGL values, including the same active exposure pathways. However, adjustments were made to certain RESRAD-Onsite input parameters (i.e., the size of the contaminated zone, the length of parallel to aquifer flow, and contaminated fractions for plant, meat, and milk) to account for a reduced size of the assumed contaminated zone. Area factors were not determined for areas greater than 2,000 m^2 because that is the maximum size for a MARSSIM Class 1 land survey unit [3.4]. Accordingly, a contaminated area equal to 2000 m^2 was selected as the base case.

AF values are calculated from the RESRAD-Onsite generated "peak of the mean" (POM) doses using the following equation:

$$AF = (POM_{2000}/POM_i)$$

Where:

AF = the area factor (unitless)

POM_{2000} = peak of the mean dose for the base case (mrem/y), and

POM_i = peak of the mean dose for the reduced area i (mrem/y), where "i" is set at various sized areas

The above equation shows that the AF is the ratio of the base case POM_{2000} to the POM_i for the smaller area.

5.0 ASSUMPTIONS AND INPUT

5.1 Assumptions

5.1.1 Radionuclides-of-concern (ROCs) identified for the CR3 site [3.5] are shown in Table 1 below.

Table 1: Radionuclides-of-Concern for input to RESRAD-Onsite:

ROC[a]	Progeny[b]	ROC[a]	Progeny[b]
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-59	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Ni-63	---
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sr-90	---
Fe-55	---	Tc-99	---
H-3	---		

[a] ROC = radionuclide-of-concern identified for the CR3 site.
[b] Included automatically with input of parent ROC.

5.1.2 Resident Farmer Scenario: The scenario used to develop the soil DCGL values was the Resident Farmer Scenario as defined in NUREG/CR-5512 Volume 1 [3.6]. That same scenario is applied in the calculations of AFs. The pathways used to estimate human radiation exposure resulting from residual radioactivity in the soil for this scenario includes the following:

- Direct external radiation exposure pathway;
- Inhalation exposure pathway;
- Ingestion exposure pathway:
  - plant foods grown in the soil material containing residual radioactivity,
  - meat and milk from livestock fed with fodder grown in soil containing residual radioactivity and watercontaining residual radioactivity,
  - drinking water containing residual radioactivity from a well, and
  - aquatic food from a pond containing residual radioactivity;
- Inadvertent ingestion of contaminated soil

5.1.3 Eight sizes for the contaminated area were assumed: 2000 m^2 (base case), 1000 m^2, 500 m^2, 100 m^2, 50 m^2, 10 m^2, 5 m^2, and 1m^2.

5.1.4 As the area of the contaminated zone decreases, the value for the length parallel to aquifer flow (LCZPAQ) also decreases. The contaminated zone is assumed to be circular, so the value for LCZPAQ is equal to the diameter of the circle:

$$\text{LCZPAQ (m)} = 2 \sqrt{(A/\pi)}$$

5.1.5 As the area of the contaminated zone decreases from the base case (2,000 m^2, the suggested limit for a MARSSIM Class 1 open land), it is assumed that the values for the contaminated fractions of plant food, meat, and milk originating from the site also decrease.

Input for the contaminated fraction of plants (F_{plant}) with decreasing size of the contaminated area (A) was assumed as follows:

F_{plant} = A/1,000, when the value for A is <1,000 m^2
F_{plant} = 1.0, when the value for A is >1,000 m^2

Input for the contaminated fraction of meat (F_{meat}) and milk (F_{milk}) with decreasing size of the contaminated area was assumed as follows:

$F_{meat} = F_{milk}$ = A/20,000 when A < 20,000 m^2
F_{meat} & F_{milk} = 1.0 when A ≥ 20,000 m^2

Table 2 shows the values for LCZPAQ, FPLANT, FMEAT, and FMILK as a function of the area of the contaminated zone.

Table 2: RESRAD-Onsite Input Parameters Vs. Size of Contaminated Zone

RESRAD Parameter	Input Value				
Contaminated Zone (m^2)	38,185[a]	2,000	1,000	500	100
LCZPAQ (m)	220.5[a]	50	36	25	11
FPLANT	1.0[a]	1.0	1.0	0.5	0.10
FMEAT	1.0[a]	0.1	0.05	0.025	0.005
FMILK	1.0[a]	0.1	0.05	0.025	0.005
Contaminated Zone (m^2)	50	10	5	1	
LCZPAQ (m)	8.0	3.6	2.5	1.1	
FPLANT	0.05	0.01	0.005	0.001	
FMEAT	0.0025	0.0005	0.00025	0.00005	
FMILK	0.0025	0.0005	0.00025	0.00005	

[a] Parameter value for DCGL modeling.

5.1.6 The contaminated fractions for drinking water, livestock water, irrigation water, and aquatic food are assumed not to decrease as the size of the contaminated zone decreases and input for these parameters was maintain equal to 1.0, consistent with the calculations of DCGL values [3.3].

5.2 Input

5.2.1 Except for the 5 parameters listed in Table 2, input parameter values used in AF calculations were the same values as those used to calculate DCGLs.

5.3 Results:

5.3.1 The POM doses for reduced contaminated zone sizes are presented by ROC in Table 3.

5.3.2 AF values were generated from the POM doses using the following equation:

$$AF = (POM_{2000}/POM_i)$$

Where:

AF = the area factor (unitless)

POM_{2000} = peak of the mean dose for the base case (mrem/y), and

POM_i = peak of the mean dose for the reduced area i (mrem/y), where "i" is set at various sized areas

The AF values for each ROC are presented in Table 4.

Table 3: RESRAD-Onsite Dose Results for Reduced Sizes of Contaminated Zone

	POM Dose (mrem/y) for Contaminated Zone Size (m²)							
ROC	2000	1000	500	100	50	10	5	1
Am-241	1.29E-01	1.28E-01	7.17E-02	2.52E-02	1.85E-02	1.01E-02	7.05E-03	3.21E-03
C-14	3.05E-02	2.04E-02	7.26E-03	6.75E-04	2.45E-04	2.47E-05	9.49E-06	1.18E-06
Cm-243	3.15E-01	3.13E-01	2.53E-01	1.87E-01	1.65E-01	1.01E-01	6.74E-02	2.22E-02
Cm-244	9.16E-02	9.12E-02	4.66E-02	1.07E-02	6.12E-03	2.29E-03	6.74E-02	2.22E-02
Co-60	4.67E+00	4.62E+00	4.46E+00	3.86E+00	3.44E+00	2.02E+00	1.33E+00	4.06E-01
Cs-137	1.17E+00	1.15E+00	1.08E+00	9.17E-01	8.18E-01	4.86E-01	3.21E-01	9.96E-02
Eu-152	2.14E+00	2.11E+00	2.05E+00	1.79E+00	1.60E+00	9.46E-01	6.23E-01	1.92E-01
Eu-154	2.30E+00	2.27E+00	2.21E+00	1.92E+00	1.71E+00	1.01E+00	6.64E-01	2.04E-01
Fe-55	5.60E-05	4.00E-05	2.00E-05	4.01E-06	2.01E-06	4.13E-07	2.12E-07	5.03E-08
H-3	2.46E-04	2.28E-04	1.15E-04	2.39E-05	1.23E-05	3.58E-06	2.49E-06	1.09E-06
Nb-94	3.09E+00	3.06E+00	2.97E+00	2.60E+00	2.32E+00	1.37E+00	9.06E-01	2.80E-01
Ni59	5.17E-04	4.18E-04	2.09E-04	4.18E-05	2.09E-05	4.20E-06	2.10E-06	4.30E-07
Ni63	1.41E-03	1.15E-03	5.72E-04	1.15E-04	5.73E-05	1.15E-05	5.75E-06	1.17E-06
Pu-238	1.46E-01	1.46E-01	7.46E-02	1.71E-02	9.77E-03	3.65E-03	2.77E-03	1.86E-03
Pu-239	1.64E-01	1.63E-01	8.30E-02	1.90E-02	1.09E-02	4.05E-03	3.07E-03	2.05E-03
Pu-240	1.63E-01	1.63E-01	8.30E-02	1.90E-02	1.08E-02	4.03E-03	3.05E-03	2.04E-03
Pu241	3.76E-03	3.74E-03	2.03E-03	6.58E-04	4.69E-04	2.52E-04	1.78E-04	8.53E-05
Sr-90	1.54E+00	1.52E+00	7.63E-01	1.57E-01	8.09E-02	1.82E-02	9.60E-03	2.14E-03
Tc-99	9.28E-02	9.20E-02	4.60E-02	9.21E-03	4.61E-03	9.28E-04	4.65E-04	9.37E-05

Table 4: Area Factors for Soil DCGLs by ROC

ROC	Area Factor for Area Contaminated Zone (m^2)							
	2000	1000	500	100	50	10	5	1
Am-241	1	1	2	5	7	13	18	40
C-14	1	1	4	45	124	1235	3211	25923
Cm-243	1	1	1	2	2	3	5	14
Cm-244	1	1	2	9	15	40	53	79
Co-60	1	1	1	1	1	2	4	11
Cs-137	1	1	1	1	1	2	4	12
Eu-152	1	1	1	1	1	2	3	11
Eu-154	1	1	1	1	1	2	3	11
Fe-55	1	1	3	14	28	136	264	1113
H-3	1	1	2	10	20	69	99	225
Nb-94	1	1	1	1	1	2	3	11
Ni59	1	1	2	12	25	123	246	1203
Ni63	1	1	2	12	25	123	246	1208
Pu-238	1	1	2	9	15	40	53	79
Pu-239	1	1	2	9	15	40	53	80
Pu-240	1	1	2	9	15	41	54	80
Pu241	1	1	2	6	8	15	21	44
Sr-90	1	1	2	10	19	84	160	716
Tc-99	1	1	2	10	20	100	199	990

Enclosure 13

BHI Energy Engineering Calculation

"*Area Factors for Use with CR3 DCGL Values for Buildings/Structures*"

ENG-CR3-006

Revision 0

April 2022

BEGINS ON NEXT PAGE

BHI ENERGY ENGINEERING CALCULATION

Area Factors for Use with CR3 DCGL Values for Buildings/Structures

ENG-CR3-006

Revision: 0

April 13, 2022

Prepared by:
BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA

Prepared by	Joseph Bisson
Approved by	Christopher Mecomo

1.0 PURPOSE

The purpose of this calculation is to develop area factors (AFs) for use with derived concentration guideline levels (DCGLs) for assessing building/structure surfaces at the Crystal River 3 (CR3) site.

2.0 APPLICABILITY

This calculation addresses only the development of AF values for use with building/structure surface DCGLs for the CR3 site.

3.0 REFERENCES

3.1 BHI Energy Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 *User's Manual for RESRAD-Build Version 3.0*, June 2003 (ANL/EAD/03-1)

3.3 BHI Energy Engineering Calculation ENG-CR3-002, *RESRAD-Build Input Parameter Sensitivity Analysis- Crystal River 3*

3.4 BHI Energy Engineering Calculation ENG-CR3-004, *Crystal River 3 Building Surface DCGL Values*

3.5 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Rev.1, August 2000

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Build code was verified on each computer used for code executions in accordance with BHI Energy Engineering procedure ENG-AP-02, *Verification of Software Operability* [3.1]. The RESRAD-Build user's manual [3.2] provided guidance for code operation.

Version 3.5 of the RESRAD-Build code was used to perform a parameter sensitivity analysis [3.3] and to calculate building surface DCGL values [3.4]. To maintain consistency with the approached used in those calculations, RESRAD-Build version 3.5 was also used in the development of area factors for use with the building surface DCGLS.

Area factors permit assessments of small areas of elevated activity. An AF is the magnitude by which the residual radioactivity in a small area of elevated activity can exceed the DCGL value while maintaining compliance with the release criterion [3.5]. Typically, a DCGL value is adjusted by an area factor that is appropriate for the identified area of elevated contamination. The resulting adjusted DCGL value is referred to as $DCGL_{EMC}$, where EMC stands for elevated measurement comparison. $DCGL_{EMC}$ values are obtained from the following relationship:

$$DCGL * AF = DCGL_{EMC}$$

where the AF value is specific for the area of the elevated contamination.

The model used for AFs is the same as that used in the development of building surface $DCGL_w$ values. However, only one source is modeled instead of the six sources considered in calculating the building surface $DCGL_w$ values. The receptor is located 1 meter away from the source midpoint. All other input parameters and assumed active exposure pathways are the same as those in the building surface DCGL calculation.

The base case for AF values is a single area source (i.e., a 64 m^2 floor). Doses for the following area sizes smaller than the base case are evaluated in this calculation: 50 m^2, 10 m^2, 5 m^2, 2.5 m^2, and 1 m^2.

RESRAD-Build version 3.5 code runs were performed for each area size and each radionuclides-of-concern (ROC) for the CR3 site. The development of AFs followed the steps:

1. RESRAD-Build calculations of the doses associated with each area size for each ROC.
2. Calculation of the AF value by determining the ratio of the dose associated with an area of 64m^2 (dose$_{64}$) to the doses for the various area sizes (dose$_i$): dose$_{64}$/dose$_i$.
3. Generation of a table to present AF values.

5.0 ASSUMPTIONS AND INPUT

5.1 Assumptions

5.1.1 Except for the number of sources and area size input, all assumptions regarding input parameters and active exposure pathways are the same as those used in the DCGL calculations.

5.1.2 The ROCs identified for the CR3 site are shown in Table 1 below. RESRAD-Build automatically accounts for progeny radionuclides with input for several of the CR3 ROCs (also shown in Table 1).

Table 1. Radionuclide Input for RESRAD-Build

ROC[a]	Progeny[b]	ROC[a]	Progeny[b]
Am-241	Np-237, Th-229, U-233	Nb-94	---
C-14	---	Ni-59	---
Cm-243	Ac-227, Am-243, Pa-231, Pu-239, U-235	Ni-63	---
Cm-244	Pu-240, Ra-228, Th-228, Th-232, U-236	Pu-238	Pb-210, Po-210, Ra-226, Th-230, U-234
Cs-137	---	Pu-239	Ac-227, Pa-231, U-235
Co-60	---	Pu-240	Ra-228, Th-228, Th-232, U-236
Eu-152	Gd-152	Pu-241	Am-241, Np-237, Th-229, U-233
Eu-154	---	Sr-90	---
Fe-55	---	Tc-99	---
H-3	---		

[a] ROC identified for the CR3 site.
[b] Progeny radionuclides automatically included in RESRAD-Build with ROC input.

5.1.3 Area sizes assumed in this calculation are 64 m^2 (base case), 50 m^2, 10 m^2, 5 m^2, 2.5 m^2, and 1 m^2.

5.1.4 The receptor dose point is assumed at 1m away from the center of the various area sources.

5.2 Input

5.2.1 Table 2 summarizes the input values for all input parameters.

6.0 CALCULATIONS AND RESULTS

6.1 The source dimensions for the X- and Y-axes for the base case and smaller areas are assumed equal to the square root of the size of the area source.

Area Source (m^2)	Length of X- and Y-axes (m)
64	8.00
50	7.07
10	3.16
5.0	2.24
2.5	1.58
1.0	1.00

6.2 Table 3 summarizes the RESRAD-Build dose results for the various area sizes by ROC.

6.3 Table 4 shows the AF values for each area size by ROC. The AF values were calculated as follows:

$AF = dose_{64}/dose_i$

where, $dose_{64}$ = dose associated with 64 m^2, and $dose_i$ = dose associated with area size of interest, i, where i = 50m^2, 10m^2, 5m^2, 2.5m^2, and 1m^2.

Table 2: RESRAD-Build Input Parameter Values for DCGLs			
Parameter	**Nuclide**	**Value/Distribution**	**Value Reference Source**
Exposure Duration (d)	All ROCs	365.25	NUREG/CR-5512; NUREG/CR-7267
Indoor Fraction	All ROCs	0.267	NUREG/CR-5512; NUREG/CR-7267
Evaluation Time (y)	All ROCs	1 (1, 5, 10, 25, 50 for Pu-241)	T=1 corresponds to dose over the 1st year; multiple input applied to Pu241 verify time of peak dose
Number of Rooms	All ROCs	1	NUREG/CR-5512 building occupancy scenario assumption
Deposition Velocity (m/s)	Am-241, Cm-243, Cm-244, Pu-238, Pu-239, Pu-240, Pu-241	D	8.5E-05
	C-14, Co-60, Cs-137, Eu-152, Eu-154, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	D	4.8E-04
Resuspension Rate (s^{-1})	C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	D	6.6E-10
	Am-241, Cm-243, Cm-244, Fe-55, Pu-238, Pu-239, Pu-240, Pu-241	D	1.8E-08
Air Exchange Rate for Room (h^{-1})	All ROCs	8.41E-01	25th percentile value
Room Area (m^2)	All ROCs	64	NURGEG/CR-6755
Room Height (m)	All ROCs	3	NURGEG/CR-6755
Time Fraction	All ROCs	1	NUREG/CR-7267
Inhalation Rate (m^3/d)	All ROCs	33.6	NUREG/CR-5512, vol. 3
Indirect Ingestion Rate (m^2/h)	AM-241, Cm-243, Cm-244, Eu-152, Pu-238, Pu-241	5.0E-05	25th percentile value
	Co-60, Eu-154, Pu-240	9.0E-05	50th percentile value
	C-14, Cs-137, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Pu-239, Sr-90, Tc-99	1.6E-04	75th percentile value
Receptor Location	All ROCs	4, 4,1	NUREG/CR-5512; center of room based on scenario room dimensions from NUREG/CR-5512; NUREG/CR-7267
Shielding Thickness (cm)	All ROCs	0	no shielding assumed
Shielding Density (g/cm^3)	All ROCs	1	Input value required for code execution – input has no impact due to shield thickness input

Table 2: RESRAD-Build Input Parameter Values for DCGLs

Parameter	Nuclide	Value/Distribution	Value Reference Source
Shielding Material	All ROCs	water	Input value required for code execution – input has no impact due to shield thickness input
Number of Sources	All ROCs	1	Floor in scenario is assumed as source
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Inhalation Dose Conversion Factor, (mrem/pCi)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Ingestionl Dose Conversion Factor, (mrem/pCi)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Source: scenario room floor			
Type	All ROCs	area	NUREG/CR-5512
Direction	All ROCs	Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	All ROCs	4, 4, 0	Center of 8m x 8m floor
Source length X-axis (m)	All ROCs	Square root of assumed source size	Input values provided in step 6.1
Source length Y-axis (m)	All ROCs	Square root of assumed source size	Input values provided in step 6.1
Area (m^2)	All ROCs	---	Source length input used
Air Release Fraction	H-3 All others	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	All ROCs	4.91E-7	NUREG/CR6755
Removable Fraction	All ROCs	0.1	NUREG/CR-5512 and NUREG/CR-6755
Time for Source Removal (d)	Am-241, Cm-243, Cm-244, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Fe-55 C-14, Co-60, Cs-137, Eu-152, Eu-154, Nb-94	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	All ROCs	1.0	-

Table 3: RESRAD-Build Dose Results

Area (m^2)	Annual Dose (mrem) from 1 pCi/m^2:									
	Am-241	C-14	Cm-243	Cm-244	Co-60	Cs-137	Eu-152	Eu-154	Fe-55	H-3
64	9.63E-05	2.48E-08	6.64E-05	5.22E-05	1.98E-05	5.40E-06	9.88E-06	1.05E-05	4.16E-09	7.54E-10
50	7.52E-05	1.94E-08	5.20E-05	4.08E-05	1.82E-05	4.90E-06	9.07E-06	9.60E-06	3.25E-09	5.89E-10
10	1.51E-05	3.92E-09	1.07E-05	8.15E-06	9.19E-06	2.38E-06	4.58E-06	4.85E-06	6.49E-10	1.18E-10
5	7.64E-06	1.99E-09	5.47E-06	4.10E-06	6.13E-06	1.58E-06	3.06E-06	3.23E-06	3.26E-10	5.91E-11
2.5	3.81E-06	9.95E-10	2.76E-06	2.04E-06	3.76E-06	9.64E-07	1.87E-06	1.98E-06	1.62E-10	2.94E-11
1	1.53E-06	4.01E-10	1.12E-06	8.17E-07	1.78E-06	4.55E-07	8.88E-07	9.40E-07	6.50E-11	1.18E-11
Area (m^2)	Annual Dose (mrem) from 1 pCi/m^2:									
	Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90	Tc-99	
64	1.41E-05	4.68E-09	9.73E-09	8.42E-05	9.31E-05	9.30E-05	1.81E-06	1.97E-06	3.16E-08	
50	1.29E-05	3.65E-09	7.60E-09	6.58E-05	7.27E-05	7.26E-05	1.41E-06	1.54E-06	2.48E-08	
10	6.54E-06	7.30E-10	1.52E-09	1.31E-05	1.45E-05	1.45E-05	2.83E-07	3.23E-07	5.15E-09	
5	4.37E-06	3.67E-10	7.63E-10	6.61E-06	7.31E-06	7.30E-06	1.42E-07	1.66E-07	2.64E-09	
2.5	2.68E-06	1.82E-10	3.80E-10	3.29E-06	3.64E-06	3.63E-06	7.07E-08	8.45E-08	1.34E-09	
1	1.27E-06	7.31E-11	1.52E-10	1.32E-06	1.46E-06	1.46E-06	2.83E-08	3.45E-08	5.47E-10	

Table 3: Building Surface Area Factors by Radionuclide and Area Size

Area (m^2)	Area Factor Values: Am-241	C-14	Cm-243	Cm-244	Co-60	Cs-137	Eu-152	Eu-154	Fe-55	H-3
64	1	1	1	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1	1	1
10	6	6	6	6	2	2	2	2	6	6
5	13	12	12	13	3	3	3	3	13	13
2.5	25	25	24	26	5	6	5	5	26	26
1	63	62	59	64	11	12	11	11	64	64
Area (m^2)	Area Factor Values: Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90	Tc-99	
64	1	1	1	1	1	1	1	1	1	
50	1	1	1	1	1	1	1	1	1	
10	2	6	6	6	6	6	6	6	6	
5	3	13	13	13	13	13	13	12	12	
2.5	5	26	26	26	26	26	26	23	24	
1	11	64	64	64	64	64	64	57	58	

Enclosure 14

"10 CFR 50.75(g) Table 2.2 List of Events/Issues Affecting ADP-CR3 Areas"

BEGINS ON NEXT PAGE

10 CFR 50.75(g) Table 2.2 List of Events/Issues Affecting ADP-CR3 Areas

Date	Location	CR#	Comments
12/6/2006	Settling Ponds	215535	NRC inspector commented that the settling ponds were not in the 10 CFR50.75(g) decommissioning file database. The location was added.
4/3/2007	West of PA	228274	Trace levels of tritium detected in groundwater monitoring wells CR3-5, CR3-7 and CR3-8 on the west perimeter of the protected area fencing. Typical values around 1000 pCi/liter or less.
10/8/2008	SW. Berm	300365	Trace amounts of Cs-137 (0.45 Pci/g) found in excavated soil during demolition of Outage support Building. Survey 08-10-0026.
12/10/2015	143 AB	310478	SFDM-1 effluent sample valve SFV-177: Overflow of funnel while sampling by Chemistry. This contaminated floor in clean area on 143' AB. Floor was cleaned up. Amount of spill likely less then one liter.
9/22/2009	West Settling Ponds	336767	Review of Chemistry REMP data shows small amounts of licensed activity in the Settling Ponds. Highest soil sample showed 27 pCi/kg of Cs-137 and 299 pCi/kg of Co-60. Source of activity is SDT-1 releases. The Cs-137 concentration is at and near background.
10/1/2009	Satellite RCA's	none	Pre-outage baseline surveys performed in the following four satellite RCA areas: No licensed contamination found. Shipping Area (Survey 09-06-0266), EPU Area (Survey 09-05-0193), SGR Area (Survey 09-05-0193), and Storage Area (Survey 09-05-0244).
2/19/2009	East of Berm	320618	Trace amounts of licensed material found in soil in "swamp" area east of Maintenance building adjacent to berm. Soil was created during leveling activities in preparation of installing temporary trailers for upcoming outage. The soil was not removed. Reference survey 09-02-0109
3/24/2009	SW berm to Laydown area near Fitness building	none	Several cubic yards of excavated soil from near equipment hatch was brought outside the PA near the fitness building. Soil was sampled prior to movement and showed no licensed activity above background.

Date	Location	CR#	Comments
			Highest Cs137 activity was 0.12 pCi/g which is consistent with background. No other licensed activity found. Survey number is 09-03-0185
1/28/2009	SW berm	316860	Hot particle of Co-60 (9,000 dpm) found during dismantlement of old Outage support Building. Remediation successful.
7/20/2010	NE Berm	411245	Old contaminated nitrogen line was cut during excavation of soil in front of Turbine Building rollup door. Small amount of contaminated water released onto soil below. All soil remediated and shipped as radwaste. Contamination levels in the soil were just above environmental LLD limits for Co-60 and Cs-137. See Apex spectrum 20-Jul-2010-0006. Co-60 was 1.56E-7 uCi/g and Cs-137 was 7.72E-5 uCi/g. No other nuclides identified via gamma spec.
7/16/2010	Aux Build 95'	410612	Contaminated water leaked from WDV-287 located above WDP-5A. Area was posted as CA and then remediated.
1/19/2011	"A" Decay Heat Vault	448181	Water seeping through concrete wall showed evelavated tritium of 50,000 pCi/liter and trace amounts of Cs-137. The area is inside a posted contamination area in the Aux Building. Also see CR 443392
9/11/2012	South Berm	560532	Trace amounts of Cs-137 under wood cribbing removed in front of equipment hatch. Cribbage and loose debris sent as radwaste
8/14/2012	West Berm	555078	Excavated soil next to SDT-1 showed 3 pCi/g Cs-137. Soil was taken just under a pipe weld with minor degradation. All soil shipped as radwaste.
4/29/2013	South Berm	603660	Trace amounts of Cs-137 and Co-60 in storm drain about one foot from OSSI-7 in front of green room. Gamma spectrum# 25-Apr-2013-0004. Activities: 2.35E-8 uCi/g of Co-60, 2.0E-6 uCi/g of Cs-137. No other licensed material identified. Survey Numbers 13-04-0209 and 13-04-0210. Also see NTM 229460 assignment 74 for followup info.

Date	Location	CR#	Comments
1/27/2016	Back Berm	1995427	ISFSI - Hydraulic leak on Pump Skid At 1700hrs on 1/26/16, Contractor Supervision discovered hydraulic fluid in the pump skid catch basin. Contractor Supervision contacted ISFSI Oversight Lead and Project HP tech and the Project personnel made notification to the Control Room. Approximately 8 to 10 gallons of fluid had been released from the pump into built in drip pan/catch basin. Fluid had sprayed onto the inside of a tarp that, as part of the spill prevention plan, had been covering the pump. The tarp allowed all sprayed fluid to be funneled in the catch basin. There was no fluid spilled into the Berm. Spill containment kits stationed in the area and pumps were used to clean up and dispose of fluid. HP free released material waste generated by clean up and the remaining fluid is being stored in staged FHCR-5 fluid/oil waste drums for later disposal by Project. Leak is under investigation. Konecrane will issue a PCAR in their system to track investigation. ==> Immediate Actions Taken: Yes. Spilled fluid was cleaned up and waste material was disposed of. (Also see NCR 1995990 for additional info.)
2/2/2017	Back Berm	1998132	At approximately 1400hrs on 2/3/16, Contractor Supervision notified Duke that they had discovered Hydraulic Fluid in the pump skid catch basin. Approximately 3 to 4 gallons of fluid had been released from the pump into built in drip pan/catch basin. This release was from the same O-ring as the 1/26/16 incident. There was no fluid spilled into the Berm. The Control Room, ISFSI Oversight lead, and HP were notified. Spill Containment Kits stationed in the area were used to clean up and dispose of the fluid, HP worked to free release the 6 bags of generated oil cloth and rags. Konecrane will issue a PCAR in their system to track investigation. ==> Immediate Actions Taken: Yes. Work was stopped. The Control Room, ISFSI Oversight lead, environmental and HP were notified All fluid was cleaned and handled properly. ==> Other Actions Needed: Yes. Investigation into O-ring failure. Contractor engineering review of design and operation.

Date	Location	CR#	Comments
5/6/2016	East Berm	2026952	During demolition of the ready warehouse approximately 1 to 2 gallons of hydraulic fluid was spilled on the ground. Contractor was removing the ready warehouse elevator hydraulic piston when a weld on the piston broke. T his allowed fluid to spill onto the ground instead of being contained in the elevator pit as planned. ==> Immediate Actions Taken: Yes. Work was stopped, the Control room, Environmental, Management and Safety where notified. After evaluation of the area the piston was removed and the spilled fluid was cleaned up and properly disposed of.
5/24/2016	Rail Spur	2032141	The 'B' Steam Generator (OTSG) was moved from the storage mausoleum to the rail spur area to finish preparing the component for shipment. The transporter supporting the OTSG was covered in grifflon as a proactive measure to capture any contamination that could become loose during the roll process. The rolling process positions the OTSG for transport. On 5/23/2016, the OTSG the roll process started. During the end of the roll process, approximately 20 gallons of water came out of the feed water flange area which was awaiting permanent blind flange installation and was not water tight. All water was captured with the exception of <1 gallon which seeped through the grifflon to an area below the transporter. All smears on the grifflon showed no contamination but an isotopic of the water captured indicated low levels of Cs-137 (6.2E-7 uCi/cc). All individuals cleared the contamination monitors. Follow up smears and dirt samples below the transporter have been taken. Smears are clean (non-detectable) and dirt samples #5 through #8 are awaiting isotopic results. Dirt sample #1 was taken directly below the feed water flange and shows very low levels of Cs-137 activity (5.6E-8 uCi/g). Dirt samples #2 through #4 taken around sample #1 show no detectable activity. ==> Immediate Actions Taken: Yes. Upon noticing water coming out of the feed water flange, a 5 gallon bucket was placed under leak. A small kiddie pool was then placed under leak in conjunction with bucket. All the water on the grifflon and was mopped up and collected. All water collected was transferred to a 55 gallon drum. ==> Other Actions Needed: Yes. Follow up dirt/soil samples under

Date	Location	CR#	Comments
			area of leak. Complete, taken on 5/24/2016. ==> Present Elsewhere: Yes. This process and lessons learned need to be applied to the 'A' OTSG which is located in the storage mausoleum.
8/13/2017	ISFSI Pad	2143281	On 8/10/17 a sample of sand was obtained from inside the ISFSI Pad drainage system as a follow up to NCR 2141449. This sample was sent to Chemistry for isotopic analysis. The isotopic results showed the presence of radioactive material (Cs-137, 2.05E-7 uCi/grams). Since the ISFSI drainage system, downstream of where this sample was obtained, is outside of the ISFSI RCA it is recommended that access into those parts of the drainage system be controlled until an evaluation can be made to determine the type and quantity of any radioactive material that might be present. ==> Present Elsewhere: Yes. Radioactive material might be downstream of where this sample was obtained.
8/25/2017	ISFSI Pad	2146348	At approximately 0440 the fuel return line that attaches to a barbed fitting became dislodged on the light plant located at the northeast corner of the ISFSI pad. Although there existed a catchment under the light plant, approximately one gallon of diesel fuel exited the catchment. There was a rain event ending approximately 6 hours earlier and it is believed that this was a contributing factor in the diesel fuel exiting the catchment. The diesel fuel was contained to the ISFSI Apron and sidewalk that runs the periphery of the ISFSI Apron. No diesel fuel entered any waterways or drainage system. ==> Immediate Actions Taken: Yes. TN personnel shut down light plant. TN personnel secured the diesel fuel leak. TN personnel utilized spill kits to contain and clean up fuel spill. TN Project Coordinator notified Duke Oversight. Duke Oversight notified CR3 Control Room. Duke Oversight contacted ISFSI Project Safety CR3 Control room to contact Duke Environmental ==> Other Actions Needed: Yes. TN clean up diesel fuel spill.

Date	Location	CR#	Comments
7/28/2019	CC/Aux Building/TB	None	On July 28th, 2019, it was observed via the Hot Shop cameras that the Aux Building (AB) sump, Turbine Building (TB) sump, Tendon Gallery and "B" Decay Heat area had elevated water levels. It was later determined that about 15,000 gallons of domestic water had entered the AB and TB buildings from the 95 Control Complex (CC) due to a faulty valve lineup associated with final "cold and dark" preparations for SAFSTOR2. No condition report was generated. Much of this water, determined to be Domestic Water (DO), backed up through toilets on the 95' CC and then entered the AB and TB. Various floor drain levels were also observed to be elevated but no floor drains were identified above the flange level – thus no spread of contamination out of the floor drains. Operations is planning to divert some of the AB water to the MWST. TB sump water will be evaporated with the help of surface blowers. As of August 14th, it does not appear that any significant spread of contamination has occurred due to this domestic water intrusion.

Enclosure 15

"*CR3 SeaLand Reclassification Position Paper*"

September 2022

BEGINS ON NEXT PAGE

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

CR3 SeaLand Reclassification Position Paper

September 12, 2022

Marshall H Blake

Reviewed By: Marty Erickson *Marty Erickson*
CR3/VY FSS/LTP Consultant

Approved By: Bryant Akins *Bryant Akins*
Radiation Protection Manager

Approved By: Gordon Madison *Gordon Madison*
Gordon Madison (Sep 26, 2022 05:41 EDT)
CR3/VY Special Projects Lead LTP/FSS Manager

Contents

THIS SPACE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

This position paper is for the reclassification of the Crystal River Nuclear Generating Plant (CR3) area known in the HSA as the SeaLand storge area and for FSS it is the SEAL Survey Area. This area contains ~ 2,712 m^2 of open land area that was fenced off and used during Refuel Outage #16 as storage area for outage containers of radioactive equipment. The area was classified as an MARSSIM Class 3 area based on the RSCS HSA because the containers were stored in this area. We are reclassifying this area as MARSSIM non-impacted based upon the following discussion in this position paper.

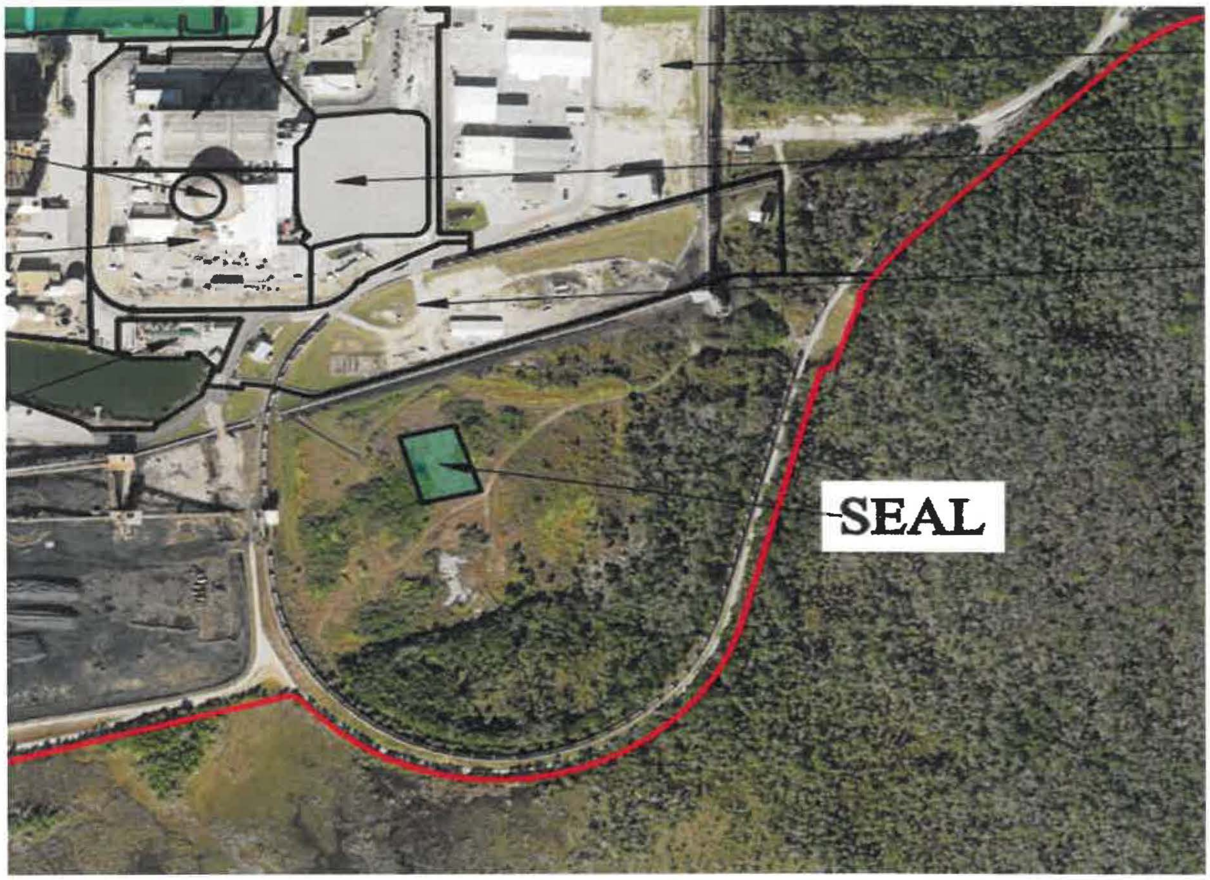
II. BODY

Historical Assessment:

The SeaLand Container Storage Area is located outside of the Protected Area (PA), outside the restricted area, and inside of the railroad loop (Figure II-1). Radioactive material was stored inside the containers, but they have all been removed from the area. The containers remained closed and were not opened in this area.

This space intentionally left blank

Figure II-1 SeaLand Survey Area



This area was used as a sealand container storage area during Refuel Outage #16. A release survey (RS10-07-0090, Attachment A) was performed in July 2010, which consisted of a gamma walkover survey and seven (7) soil samples. The soil samples were isotopically analyzed to environmental LLDs and did not identify any plant derived activity. The dose rates in the area were higher, but consistent with background levels, than the values obtained during a baseline survey (RS09-05-0244, Attachment B), conducted in May of 2009, prior to use of the area. Soil samples taken as part of the release survey following use of the area, failed to identify plant derived material when counted to environmental LLDs.

Site Characterization:

In March of 2022, a Site Characterization was done. It included Survey Areas: EOCZ, EORB, NORB, R16Y, SEAL, SOCZ, SORB, and WOCZ. SEAL being the SeaLand container storage area for Refuel Outage #16. The survey for the SEAL Survey Area (Attachment C) consisted of six (6) soil samples. The soil samples were isotopically analyzed to the MDC requirements as stated in the "CHAR-01 CR3 Site Characterization Project Open Land Area Survey Plan". The 10%-50% MDC requirement was based on the specific CR3 DCGLs. The soil samples taken as part of the survey following use of the area, did not identify any radioactive plant derived activity when counted to the MDC requirements as stated in the survey plan. Additionally, sample SEAL-CHAR-01-001-S (Attachment D) was a split sample and sent to the off-site laboratory (GEL) for a full suite analysis and did not identify any radioactive plant derived activity.

Personnel Interviews:

A discussion was held with the CR3 RPM and the resident CHP of the SeaLand Survey Unit in order to classify the area more properly for the upcoming LTP. Both the CR3 RPM and the resident CHP stated that the area was solely used as a staging area for the Refuel Outage #16 containers, no containers were opened in the SeaLand Survey Area, and once a container came inside the PA it was surveyed for contamination prior to leaving the PA and transferred back to the SeaLand Survey Area.

III. CONCLUSION

Based on the information above to include the attached data the SeaLand Survey Area is being reclassified as a non-impacted area.

ATTACHMENT A

RS10-07-0090

Progress Energy

HEALTH PHYSICS SURVEY RECORD

Page 1 of 2

SURVEY DATE 07-09-10 (MM DD YY) TIME 1000 (HHMM) SURVEY NUMBER 10-07-0070 (YY MM ####)

RWP No. N/A	BUILDING Outside	ELEVATION N/A	POWER LEVEL 0%	COMPONENT ID N/A

LOCATION South Storage Yard

Health Physics Tech. Dose received (mrem) 0

JOB EVOLUTION South Storage Yard Free release survey

REMARKS

ALPHA/BETA,GAMMA-DAC FRACTION RATIO: N/A ALPHA RATIO: N/A

SMEARS N/A thru N/A < ___ dpm/100cm² βγ, ☐ ND/100cm² ☐ βγ ☐α, ☐ <MDA/100cm² ☐βγ ☐α unless noted below

LAS N/A thru N/A < ___ dpm/AUP or ☐ ND/AUP βγ unless noted

SMEAR NO.	βγ ACTIVITY ☐ (dpm/100cm²) ☐ (dpm/aup)	SMEAR NO.	βγ ACTIVITY ☐ (dpm/100cm²) ☐ (dpm/aup)	SMEAR NO.	α ACTIVITY (dpm/100cm²)
◯		◯		◯	
◯		◯		◯	
◯		◯		◯	
◯		◯	N	◯	
◯		◯		◯	
◯		◯		◯	
◯		◯		◯	
◯		◯	A	◯	
◯		◯		◯	
◯		◯		◯	
◯		◯		◯	
◯		◯		◯	
◯		◯		◯	

METERS/AIR SAMPLERS

Model No.	Serial No.	Cal Due (MM/DD/YY)
LUD-19	51871	10/10/10
LUD-19	138427	02/17/11
LUD-19	214333	02/15/11
N		A

COUNTING EQUIPMENT USED

MODEL NO.				
SERIAL NO.				
CAL DUE (MM/DD/YY)				
BKG. CPM		N		
LLD			A	
MDA				
DET. EFF.				

A/S NO.	LOCATION or WORK IN PROGRESS	P or C	FLOW RATE (CFM)	TIME ON	TIME OFF	VOLUME (cc)	NCPM	FCE	DET. EFF.	ACTIVITY (µCi/cc)	ISOTOPIC Y/N
△											
△											
△				N							
△							A				
△											
△											

SURVEY PERFORMED BY, (Print Last, First Name) HIRSCH, JACOB / Simmons, Roger INITIALS JH/RDS

REVIEWED BY (CHPT) Bartlett, David INITIALS DB DATE 7/9/10 SRC Initials [illegible]

QA RECORD

L:\Environmental & Rad Control\Health Physics\FORMS\HPOFFICE\Survey\Survxmit.docx HPP-202A 03/10

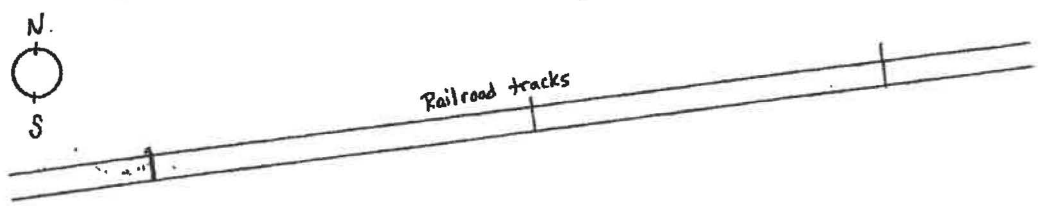
ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Progress Energy

Survey # 10-07-0090
Page 2 of 2

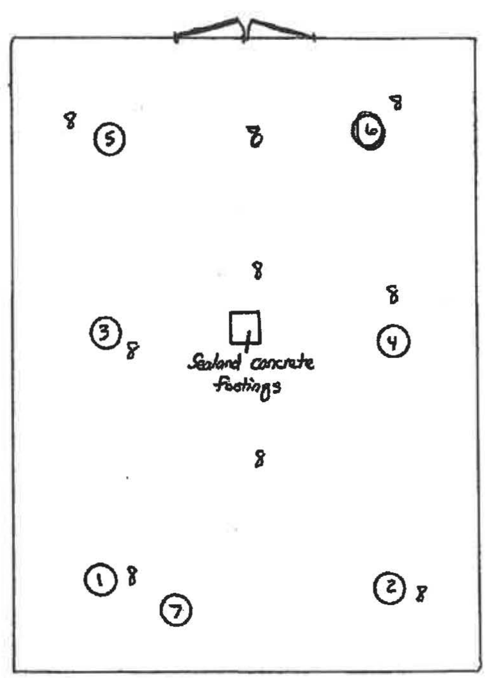
MISCELLANEOUS SURVEY SHEET

AREA OR ITEM BEING SURVEYED: South Storage Yard



- All dose rates inside South Storage yard in µR/hr.

-Background dose rate equals 6 – 8 µR/hr



(#) = Soil sample location

UNLESS OTHERWISE NOTED:
- ALL DOSE RATES IN MREM/HR
- NO BETA RADIATION DETECTED

* DENOTES CONTACT READING

RA = RADIATION AREA
HRA = HIGH RADIATION AREA
LHRA = LOCKED HIGH RADIATION AREA
CA = CONTAMINATED AREA
RMA = RADIOACTIVE MATERIAL AREA

Progress Energy Apex

6/17/2010 14:14:20 Page 1 of 6

Analysis Report for 17-Jun-2010-0008

Sample Identification	: 17-Jun-2010-0008		
Sample Description	: Unconditional release of solid material FR-10-103		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.1 seconds
Acquisition Started	: 17-Jun-2010 14:07:27	Dead Time	: 0.02 %
Decay Time	: 0 07:07:27		
Sample Size	: 1.197E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Mar-2010 13:22:52	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 15-Mar-2010 13:15:33		
Energy Calibration Date	: 30-Dec-2009 11:26:47	Peak Area Range	: 77 - 4096 channels
Energy Slope	: 0.5000 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.275 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 5.715E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error	Nuclide
1	76.42	40	35	1.25	153.39	7	29.3	Pb-212
2	86.31	35	17	1.03	173.16	7	25.9	Pb-212
3	185.21	31	32	1.59	370.93	9	37.6	
4	237.83	36	16	0.66	476.16	9	26.2	Pb-212
5	241.45	31	11	1.15	483.40	6	24.4	
6	294.65	74	8	1.46	589.76	11	13.9	
7	351.46	133	0	1.35	703.36	13	8.7	
8	608.98	103	2	1.23	1218.27	9	10.2	
9	1119.87	24	5	0.78	2239.58	10	27.1	
10	1237.43	11	2	1.22	2474.57	9	37.6	
11	1764.58	16	0	1.12	3528.06	11	25.0	

% Error in counts/sec recorded at 1.00 sigma

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCi/grams)		Activity Uncertainty
Nuclide Type: AP								
Pb-212	0.71	10.64 hrs	74.81	10.70	1.461E+00			
			77.11	18.00	1.542E+00	1.306E-06		3.832E-07
			87.30	8.00	1.992E+00	1.982E-06		5.141E-07
			238.63	44.60	2.391E+00	3.000E-07		7.856E-08
			300.09	3.41	2.042E+00			
		Pb-212 Interference Corrected Final Weighted Mean				3.765E-07	+/-	7.612E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Na-22	1274.54	2.00	5.722E-08
Na-24	1368.53	1.00	5.961E-08
Cl-38	1642.42	1.00	4.607E-04
Ar-41		0.00	0.000E+00
Sc-46	889.25	5.00	6.738E-08
Cr-51	320.08	15.00	5.350E-07
Mn-54	834.83	4.00	5.711E-08
Mn-56	1810.69	1.00	1.325E-06
Ni-56	158.38	22.00	4.493E-08
Co-57	122.06	35.00	6.443E-08
Co-58	810.76	2.00	3.974E-08
Fe-59	1099.22	2.00	9.007E-08
Co-60	1173.22	1.00	3.779E-08
Cu-64	1345.90	1.00	1.275E-05
Ni-65	1115.52	1.00	1.765E-06
Zn-65	1115.52	1.00	7.150E-08
Zn-69	438.63	7.00	6.845E-08
Zn-72	144.70	25.00	6.068E-08
Se-75	136.00	25.00	7.673E-08
Br-82	554.32	1.00	3.347E-08
Br-84	881.50	3.00	1.471E-03
Kr-85	513.99	7.00	1.207E-05
Kr-85m	151.18	30.00	2.006E-07
Sr-85	513.99	7.00	5.171E-08
Kr-87	402.58	13.00	5.838E-06
Kr-88	196.32	19.00	9.540E-07
Rb-88	898.02	2.00	5.889E+00
Y-88	898.02	2.00	4.596E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1031.88	1.00	1.464E+01
Mo-90	257.34	17.00	1.470E-07
Y-90m	202.51	26.00	2.517E-07
Sr-91	1024.30	1.00	1.755E-07
Y-91	1204.90	4.00	2.584E-05
Y-91m	557.57	6.00	2.157E-05
Sr-92	1383.94	1.00	3.009E-07
Y-92	934.46	6.00	2.251E-06
Y-93	266.90	19.00	1.225E-06
Nb-94	871.10	3.00	5.117E-08
Nb-95	765.79	8.00	7.578E-08
Nb-95m	235.69	38.00	2.853E-07
Zr-95	756.72	4.00	9.552E-08
Nb-97	657.90	5.00	7.195E-08

Analysis Report for 17-Jun-2010-0008 6/17/2010 14:14:20 Page 4 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Zr-97	743.36	3.00	6.159E-08
Mo-99	739.58	6.00	5.332E-07
Tc-99m	140.51	32.00	6.197E-08
Tc-101	306.81	13.00	7.233E+01
Ru-103	497.08	3.00	3.686E-08
Rh-105	318.90	13.00	2.905E-07
Ru-105	724.50	6.00	3.897E-07
Ru-106	511.85	9.00	2.809E-07
Cd-109	88.03	44.00	2.274E-06
Ag-110m	884.67	1.00	4.125E-08
In-113m	391.69	10.00	1.531E-06
Sn-113	391.69	10.00	7.652E-08
Sb-122	563.93	6.00	7.793E-08
Sb-124	602.71	4.00	4.496E-08
Sb-125	427.89	8.00	1.618E-07
Xe-127	202.84	26.00	7.551E-08
Te-129	459.60	5.00	4.074E-05
Te-129m	459.60	5.00	5.617E-07
I-131	364.48	9.00	5.628E-08
Xe-131m	163.93	24.00	2.345E-06
I-132	667.69	4.00	4.196E-07
Te-132	228.16	18.00	5.502E-08
Ba-133	356.01	8.00	6.875E-08
Ba-133m	276.09	21.00	3.508E-07
I-133	529.87	3.00	5.049E-08
Te-133	912.58	6.00	1.894E-05
Xe-133	80.99	34.00	2.479E-07
Xe-133m	233.22	24.00	5.674E-07
Cs-134	604.70	1.00	2.253E-08
I-134	884.09	3.00	2.316E-05
Te-134	210.47	21.00	2.707E-04
I-135	1260.41	1.00	2.974E-07
Xe-135	249.79	18.00	9.237E-08
Xe-135m	526.56	1.00	6.720E+00
Cs-136	818.50	6.00	7.006E-08
Cs-137	661.65	14.00	1.038E-07
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	1435.86	3.00	1.073E-03
Xe-138	258.31	15.00	2.136E+02
Ba-139	165.85	22.00	9.274E-06
Ce-139	165.85	22.00	5.406E-08
Ba-140	537.32	3.00	1.410E-07
La-140	1596.49	3.00	8.859E-08
Ba-141	190.22	26.00	1.265E+00
Ce-141	145.44	30.00	1.031E-07
La-142	641.17	4.00	2.007E-06
Ce-143	293.26	78.00	3.093E-07
Ce-144	133.54	33.00	4.838E-07

Analysis Report for 17-Jun-2010-0008 6/17/2010 14:14:20 Page 5 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	4.00	1.060E+02
Nd-147	91.11	34.00	2.563E-07
Pm-148m	550.27	5.00	4.831E-08
Eu-152	344.27	8.00	1.518E-07
Eu-156	646.29	1.00	3.310E-07
Sm-156	208.83	16.00	3.006E-07
W-187	685.81	2.00	1.417E-07
Re-188	155.03	42.00	5.277E-07
Hg-203	279.19	9.00	4.764E-08
Bi-207	1063.62	1.00	4.654E-08
Pb-212	238.63	15.50	1.984E-07
Np-239	103.76	26.00	2.427E-07
Am-241	59.54	26.00	5.594E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0008		
Sample Description	: Unconditional release of solid material FR-10-103		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET01
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 14:07:27	Live Time	: 400.0 seconds
Decay Time	: 0 07:07:27	Real Time	: 400.1 seconds
Sample Size	: 1.197E+03 grams	Dead Time	: 0.02 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments
Pb-212	AP	10.64 hrs	0.71	3.765E-07	7.612E-08	
		Total Gamma Activity		3.765E-07		

Errors quoted at 1.000 sigma

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
185.21	31	1.59	37.6	U	Ra-226	NP	1.937E-06
				U	Pa-234	NP	6.676E-06
				U	U-235	NP	1.176E-07
241.45	31	1.15	24.4	R	Sr-92	FP	1.555E-05
				U	Te-131m	FP	1.157E-06
				R	Xe-138	FG	3.185E+03
				U	Ra-224	NP	2.018E-06
294.65	74	1.46	13.9	R	Ce-143	FP	5.565E-07
				U	Pb-214	NP	7.215E-02
				U	Pa-234	NP	1.056E-05
351.46	133	1.35	8.7	R	Ce-143	FP	1.412E-05
				U	Pb-214	NP	7.670E-02
608.98	103	1.23	10.2	R	Ru-103	FP	8.775E-06
				R	Xe-135	FG	2.921E-05
				U	Bi-214	NP	3.477E+00
1119.87	24	0.78	27.1	R	Sc-46	AP	1.865E-07
				U	Bi-214	NP	4.055E+00
1237.43	11	1.22	37.6	U	Co-56	AP	1.435E-07
				R	I-133	HFP	8.178E-06
				U	Bi-214	NP	5.313E+00
1764.58	16	1.12	25.0	U	Bi-214	NP	3.644E+00

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

Progress Energy Apex

6/17/2010 14:14:40 Page 1 of 6

Analysis Report for 17-Jun-2010-0005

Sample Identification	: 17-Jun-2010-0005		
Sample Description	: Unconditional release of solid material FR-10-104		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET02
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.1 seconds
Acquisition Started	: 17-Jun-2010 14:07:30	Dead Time	: 0.02 %
Decay Time	: 0 07:07:30		
Sample Size	: 2.394E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 18-Mar-2010 11:21:54	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 22-Mar-2010 12:56:12		
Energy Calibration Date	: 12-Mar-2010 11:30:09	Peak Area Range	: 86 - 4096 channels
Energy Slope	: 0.5004 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.301 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 7.570E-09	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error	Nuclide
	1	77.15	35	61	0.88	154.78	8	43.3	
	2	186.55	33	39	1.03	373.43	11	41.0	
M	3	238.90	40	18	1.67	478.05	19	25.7	
m	4	241.99	35	13	1.29	484.22	19	25.7	
	5	295.16	79	6	1.10	590.48	8	12.5	
	6	352.05	132	15	1.00	704.18	9	10.2	
	7	609.59	100	9	1.22	1218.87	12	11.6	
	8	1120.43	28	0	1.49	2239.75	11	18.9	
	9	1765.04	22	0	1.61	3527.91	11	21.3	

M = First peak in a multiplet region
m = Other peak in a multiplet region
% Error in counts/sec recorded at 1.00 sigma

Analysis Report for 17-Jun-2010-0005 6/17/2010 14:14:40 Page 2 of 6

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCi/grams)	Activity Uncertainty

No Nuclides were Identified

Analysis Report for 17-Jun-2010-0005 6/17/2010 14:14:40 Page 3 of 6

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Na-22		0.00	0.000E+00
Na-24	1368.53	1.00	3.893E-08
Cl-38		0.00	0.000E+00
Ar-41	1293.64	2.00	5.800E-07
Sc-46	889.25	3.00	3.372E-08
Cr-51	320.08	9.00	2.543E-07
Mn-54	834.83	1.00	1.842E-08
Mn-56	846.75	3.00	2.248E-07
Ni-56	811.85	1.00	2.162E-08
Co-57	122.06	31.00	3.492E-08
Co-58	810.76	1.00	1.811E-08
Fe-59	1099.22	3.00	7.166E-08
Co-60	1173.22	1.00	2.459E-08
Cu-64		0.00	0.000E+00
Ni-65	1481.84	1.00	9.130E-07
Zn-65	1115.52	1.00	4.646E-08
Zn-69	438.63	5.00	3.625E-08
Zn-72	144.70	39.00	4.399E-08
Se-75	264.65	16.00	4.775E-08
Br-82	776.49	2.00	3.382E-08
Br-84	881.50	2.00	7.769E-04
Kr-85	513.99	5.00	6.449E-06
Kr-85m	151.18	28.00	1.128E-07
Sr-85	513.99	5.00	2.763E-08
Kr-87	402.58	7.00	2.671E-06
Kr-88	196.32	26.00	6.607E-07
Rb-88	898.02	2.00	3.813E+00
Y-88	898.02	2.00	2.971E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1248.10	6.00	3.779E+01
Mo-90	257.34	19.00	9.382E-08
Y-90m	479.53	4.00	1.207E-07
Sr-91	749.80	3.00	2.136E-07
Y-91	1204.90	1.00	8.410E-06
Y-91m	557.57	9.00	1.678E-05
Sr-92	1383.94	1.00	1.966E-07
Y-92	934.46	15.00	2.303E-06
Y-93	266.90	21.00	7.797E-07
Nb-94	702.63	6.00	3.894E-08
Nb-95	765.79	11.00	5.716E-08
Nb-95m	235.69	18.00	1.178E-07
Zr-95	724.18	2.00	5.295E-08
Nb-97	657.90	7.00	5.446E-08

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCilgrams)
Zr-97	743.36	3.00	3.958E-08
Mo-99	739.58	4.00	2.797E-07
Tc-99m	140.51	36.00	3.810E-08
Tc-101	306.81	11.00	4.079E+01
Ru-103	497.08	5.00	3.003E-08
Rh-105	318.90	7.00	1.308E-07
Ru-105	724.50	2.00	1.445E-07
Ru-106	511.85	14.00	2.215E-07
Cd-109	88.03	56.00	1.468E-06
Ag-110m	657.75	7.00	4.218E-08
In-113m	391.69	10.00	9.529E-07
Sn-113	391.69	10.00	4.761E-08
Sb-122	563.93	2.00	2.858E-08
Sb-124	602.71	1.00	1.433E-08
Sb-125	427.89	6.00	8.767E-08
Xe-127	202.84	26.00	4.479E-08
Te-129	459.60	8.00	3.240E-05
Te-129m	459.60	8.00	4.465E-07
I-131	364.48	13.00	4.188E-08
Xe-131m	163.93	33.00	1.608E-06
I-132	667.69	3.00	2.327E-07
Te-132	228.16	22.00	3.640E-08
Ba-133	356.01	9.00	4.508E-08
Ba-133m	276.09	18.00	1.971E-07
I-133	529.87	6.00	4.523E-08
Te-133	912.58	10.00	1.582E-05
Xe-133	80.99	43.00	1.596E-07
Xe-133m	233.22	24.00	3.401E-07
Cs-134	604.70	4.00	2.872E-08
I-134	847.03	3.00	9.860E-06
Te-134	180.89	24.00	1.931E-04
I-135	1260.41	1.00	1.938E-07
Xe-135	249.79	13.00	4.729E-08
Xe-135m	526.56	2.00	6.030E+00
Cs-136	818.50	2.00	2.607E-08
Cs-137	661.65	4.00	3.551E-08
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	1435.86	4.00	8.108E-04
Xe-138	258.31	15.00	1.293E+02
Ba-139	165.85	33.00	6.649E-06
Ce-139	165.85	33.00	3.875E-08
Ba-140	537.32	4.00	1.032E-07
La-140	1596.49	1.00	3.355E-08
Ba-141	190.22	23.00	7.037E-01
Ce-141	145.44	35.00	6.465E-08
La-142	641.17	6.00	1.571E-06
Ce-143	293.26	45.00	1.432E-07
Ce-144	133.54	46.00	3.302E-07

Analysis Report for 17-Jun-2010-0005 6/17/2010 14:14:40 Page 5 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	2.00	4.816E+01
Nd-147	91.11	58.00	1.915E-07
Pm-148m	550.27	6.00	3.358E-08
Eu-152	344.27	8.00	9.363E-08
Eu-156	811.77	1.00	1.751E-07
Sm-156	208.83	31.00	2.488E-07
W-187	685.81	2.00	9.079E-08
Re-188	155.03	30.00	2.599E-07
Hg-203	279.19	12.00	3.341E-08
Bi-207	1063.62	1.00	3.021E-08
Pb-212	238.63	18.44	2.223E-07
Np-239	103.76	34.00	1.590E-07
Am-241	59.54	24.00	3.117E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0005		
Sample Description	: Unconditional release of solid material FR-10-104		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET02
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 14:07:30	Live Time	: 400.0 seconds
Decay Time	: 0 07:07:30	Real Time	: 400.1 seconds
Sample Size	: 2.394E+03 grams	Dead Time	: 0.02 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments
		Total Gamma Activity		0.000E+00		

Errors quoted at 1.000 sigma

Analysis Report for 17-Jun-2010-0005 6/17/2010 14:14:40 Page 6 of 6

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
77.15	35	0.88	43.3	U	Ba-142	FP	9.767E+05
				R	Pb-212	NP	6.341E-07
				U	Bi-214	NP	6.708E+01
				U	Pb-214	NP	4.611E-02
186.55	33	1.03	41.0	U	Ac-225	NP	7.537E-06
				U	Ra-226	NP	1.238E-06
				U	Pa-234	NP	4.267E-06
				U	U-235	NP	7.519E-08
238.90	40	1.67	25.7	R	Pb-212	NP	2.017E-07
241.99	35	1.29	25.7	R	Sr-92	FP	1.038E-05
				U	Te-131m	FP	7.718E-07
				R	Xe-138	FG	2.131E+03
				U	Ra-224	NP	1.347E-06
295.16	79	1.10	12.5	U	Sb-126	AP	2.968E-06
				U	Pb-214	NP	4.720E-02
				U	Pa-234	NP	6.901E-06
352.05	132	1.00	10.2	R	Ce-143	FP	8.699E-06
				U	Pb-214	NP	4.731E-02
609.59	100	1.22	11.6	R	Ru-103	FP	5.448E-06
				R	Xe-135	FG	1.814E-05
				U	Bi-214	NP	2.163E+00
1120.43	28	1.49	18.9	R	Sc-46	AP	1.427E-07
				U	Bi-214	NP	3.107E+00
1765.04	22	1.61	21.3	U	Bi-214	NP	3.304E+00

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Progress Energy Apex

6/17/2010 14:15:01 Page 1 of 6

Analysis Report for 17-Jun-2010-0007

Sample Identification	: 17-Jun-2010-0007		
Sample Description	: Unconditional release of solid material FR-10-105		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET03
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.3 seconds
Acquisition Started	: 17-Jun-2010 14:07:35	Dead Time	: 0.08 %
Decay Time	: 0 07:07:35		
Sample Size	: 1.071E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 22-Mar-2010 10:22:28	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 24-Mar-2010 15:41:25		
Energy Calibration Date	: 21-Sep-2009 13:46:14	Peak Area Range	: 85 - 4096 channels
Energy Slope	: 0.5001 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.296 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: -3.951E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error	Nuclide
M	1	74.26	43	27	1.18	149.08	15	25.1	Pb-212
m	2	75.93	31	26	1.18	152.41	15	38.2	Pb-212
	3	186.04	59	32	1.18	372.59	14	24.8	
M	4	237.77	37	18	1.29	476.05	17	26.3	Pb-212
m	5	241.13	45	14	1.30	482.76	17	21.0	
	6	294.69	71	7	0.92	589.87	10	13.8	
	7	351.39	114	13	1.01	703.25	10	11.3	
	8	477.18	16	0	1.02	954.81	8	25.0	
	9	608.67	96	5	1.03	1217.78	10	11.1	
	10	910.38	10	0	1.16	1821.20	8	31.6	
	11	1119.42	15	0	0.68	2239.33	10	25.8	
	12	1763.40	29	0	1.93	3527.59	11	18.6	

M = First peak in a multiplet region
m = Other peak in a multiplet region
% Error in counts/sec recorded at 1.00 sigma

Analysis Report for 17-Jun-2010-0007 6/17/2010 14:15:01 Page 2 of 6

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCi/grams)		Activity Uncertainty
Nuclide Type: AP								
Pb-212	0.71	10.64 hrs	74.81	10.70	1.583E+00	2.544E-06		6.373E-07
			77.11	18.00	1.670E+00	1.038E-06		3.963E-07
			87.30	8.00	2.188E+00			
			238.63	44.60	2.429E+00	3.406E-07		8.963E-08
			300.09	3.41	2.073E+00			
		Pb-212 Interference Corrected Final Weighted Mean				4.146E-07	+/-	8.661E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Na-22	1274.54	1.00	4.452E-08
Na-24	1368.53	2.00	9.277E-08
Cl-38		0.00	0.000E+00
Ar-41	1293.64	1.00	6.924E-07
Sc-46	1120.51	15.00	1.555E-07
Cr-51	320.08	9.00	4.562E-07
Mn-54	834.83	5.00	7.022E-08
Mn-56	846.75	1.00	2.213E-07
Ni-56	158.38	29.00	5.623E-08
Co-57	122.06	23.00	5.612E-08
Co-58	810.76	3.00	5.353E-08
Fe-59	1099.22	2.00	9.911E-08
Co-60	1173.22	3.00	7.204E-08
Cu-64		0.00	0.000E+00
Ni-65	1115.52	1.00	1.944E-06
Zn-65	1115.52	1.00	7.868E-08
Zn-69	438.63	1.00	2.846E-08
Zn-72	144.70	32.00	7.453E-08
Se-75	264.65	16.00	8.686E-08
Br-82	619.07	1.00	6.579E-08
Br-84	881.50	1.00	9.370E-04
Kr-85	513.99	3.00	8.688E-06
Kr-85m	151.18	25.00	1.993E-07
Sr-85	513.99	3.00	3.722E-08
Kr-87	402.58	7.00	4.719E-06
Kr-88	196.32	16.00	9.608E-07
Rb-88	1836.01	1.00	5.229E+00
Y-88	1836.01	1.00	5.834E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1031.88	1.00	1.620E+01
Mo-90	122.37	23.00	1.801E-07
Y-90m	479.53	6.00	2.583E-07
Sr-91	1024.30	1.00	1.932E-07
Y-91	1204.90	2.00	2.011E-05
Y-91m	557.57	8.00	2.743E-05
Sr-92	1383.94	5.00	7.406E-07
Y-92	934.46	5.00	2.261E-06
Y-93	266.90	19.00	1.348E-06
Nb-94	871.10	3.00	5.629E-08
Nb-95	765.79	7.00	7.795E-08
Nb-95m	235.69	47.00	3.489E-07
Zr-95	756.72	3.00	9.097E-08
Nb-97	657.90	3.00	6.128E-08

Analysis Report for 17-Jun-2010-0007 6/17/2010 14:15:01 Page 4 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Zr-97	743.36	5.00	8.744E-08
Mo-99	739.58	6.00	5.863E-07
Tc-99m	140.51	23.00	5.696E-08
Tc-101	306.81	10.00	7.027E+01
Ru-103	497.08	4.00	4.681E-08
Rh-105	318.90	9.00	2.662E-07
Ru-105	724.50	8.00	4.949E-07
Ru-106	511.85	3.00	1.783E-07
Cd-109	88.03	34.00	2.076E-06
Ag-110m	657.75	3.00	4.746E-08
In-113m	391.69	4.00	1.067E-06
Sn-113	391.69	4.00	5.326E-08
Sb-122	563.93	5.00	7.822E-08
Sb-124	602.71	8.00	6.991E-08
Sb-125	427.89	9.00	1.888E-07
Xe-127	202.84	28.00	8.600E-08
Te-129	459.60	2.00	2.838E-05
Te-129m	459.60	2.00	3.908E-07
I-131	364.48	11.00	6.848E-08
Xe-131m	163.93	26.00	2.664E-06
I-132	667.69	2.00	3.265E-07
Te-132	228.16	24.00	6.985E-08
Ba-133	356.01	7.00	7.079E-08
Ba-133m	276.09	17.00	3.475E-07
I-133	529.87	6.00	7.853E-08
Te-133	912.58	9.00	2.556E-05
Xe-133	80.99	27.00	2.267E-07
Xe-133m	233.22	25.00	6.368E-07
Cs-134	604.70	4.00	4.954E-08
I-134	847.03	2.00	1.376E-05
Te-134	565.99	1.00	1.539E-04
I-135	1260.41	2.00	4.630E-07
Xe-135	249.79	20.00	1.071E-07
Xe-135m	526.56	3.00	1.287E+01
Cs-136	818.50	1.00	3.146E-08
Cs-137	661.65	14.00	1.142E-07
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	1435.86	2.00	9.663E-04
Xe-138	258.31	22.00	2.864E+02
Ba-139	165.85	21.00	9.904E-06
Ce-139	165.85	21.00	5.768E-08
Ba-140	537.32	4.00	1.790E-07
La-140	1596.49	3.00	9.738E-08
Ba-141	190.22	21.00	1.252E+00
Ce-141	145.44	27.00	1.062E-07
La-142	641.17	1.00	1.104E-06
Ce-143	293.26	80.00	3.449E-07
Ce-144	133.54	31.00	5.069E-07

Analysis Report for 17-Jun-2010-0007 6/17/2010 14:15:01 Page 5 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	3.00	1.015E+02
Nd-147	91.11	38.00	2.827E-07
Pm-148m	629.97	2.00	3.988E-08
Eu-152	121.78	19.00	1.536E-07
Eu-156	723.47	1.00	4.716E-07
Sm-156	208.83	17.00	3.404E-07
W-187	685.81	3.00	1.908E-07
Re-188	155.03	28.00	4.693E-07
Hg-203	279.19	22.00	8.199E-08
Bi-207	569.67	6.00	5.779E-08
Pb-212	238.63	17.59	3.893E-07
Np-239	103.76	26.00	2.571E-07
Am-241	59.54	35.00	6.260E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0007		
Sample Description	: Unconditional release of solid material FR-10-105		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET03
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 14:07:35	Live Time	: 400.0 seconds
Decay Time	: 0 07:07:35	Real Time	: 400.3 seconds
Sample Size	: 1.071E+03 grams	Dead Time	: 0.08 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments
Pb-212	AP	10.64 hrs	0.71	4.146E-07	8.661E-08	
		Total Gamma Activity		4.146E-07		

Errors quoted at 1.000 sigma

Analysis Report for 17-Jun-2010-0007 6/17/2010 14:15:01 Page 6 of 6

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
186.04	59	1.18	24.8	U	Ra-226	NP	4.076E-06
				U	Pa-234	NP	1.405E-05
				U	U-235	NP	2.476E-07
241.13	45	1.30	21.0	R	Sr-92	FP	2.492E-05
				U	Te-131m	FP	1.852E-06
				R	Xe-138	FG	5.133E+03
				U	Ra-224	NP	3.232E-06
294.69	71	0.92	13.8	R	Ce-143	FP	5.912E-07
				U	Pb-214	NP	7.690E-02
				U	Pa-234	NP	1.122E-05
351.39	114	1.01	11.3	R	Ce-143	FP	1.329E-05
				U	Pb-214	NP	7.243E-02
477.18	16	1.02	25.0	U	Be-7	NP	6.650E-07
608.67	96	1.03	11.1	R	Xe-135	FG	2.996E-05
				U	Bi-214	NP	3.582E+00
910.38	10	1.16	31.6	U	Te-131m	FP	2.599E-06
				U	I-132	HFP	6.858E-05
				U	I-133	HFP	4.341E-05
				U	Tl-210	NP	Halflife to short
				U	Ac-228	NP	5.612E-07
1119.42	15	0.68	25.8	R	Sc-46	AP	1.293E-07
				U	Bi-214	NP	2.825E+00
1763.40	29	1.93	18.6	U	Bi-214	NP	7.279E+00

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

Progress Energy Apex

6/17/2010 13:54:35 Page 1 of 6

Analysis Report for 17-Jun-2010-0009

Sample Identification	: 17-Jun-2010-0009		
Sample Description	: Unconditional release of solid material FR-10-101		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET02
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.1 seconds
Acquisition Started	: 17-Jun-2010 13:47:24	Dead Time	: 0.01 %
Decay Time	: 0 06:47:24		
Sample Size	: 1.088E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 18-Mar-2010 11:21:54	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 22-Mar-2010 12:56:12		
Energy Calibration Date	: 12-Mar-2010 11:30:09	Peak Area Range	: 86 - 4096 channels
Energy Slope	: 0.5004 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.301 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 7.570E-09	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error	Nuclide
	1	77.08	28	54	0.89	154.64	8	51.3	
M	2	185.99	41	6	1.32	372.31	12	19.4	
m	3	187.67	11	5	1.33	375.66	12	70.4	
	4	241.94	22	18	0.58	484.12	7	39.6	
	5	295.12	71	11	1.26	590.41	11	14.9	
	6	352.08	89	9	0.83	704.23	9	12.2	
	7	609.16	76	2	1.27	1218.01	12	12.4	
	8	1120.50	16	0	1.55	2239.88	9	25.0	

M = First peak in a multiplet region
m = Other peak in a multiplet region
% Error in counts/sec recorded at 1.00 sigma

Analysis Report for 17-Jun-2010-0009 6/17/2010 13:54:35 Page 2 of 6

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCi/grams)	Activity Uncertainty

No Nuclides were Identified

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCilgrams)
Na-22	1274.54	1.00	5.800E-08
Na-24		0.00	0.000E+00
Cl-38	1642.42	1.00	4.579E-04
Ar-41	1293.64	1.00	7.943E-07
Sc-46	889.25	2.00	6.055E-08
Cr-51	320.08	6.00	4.564E-07
Mn-54		0.00	0.000E+00
Mn-56	846.75	1.00	2.608E-07
Ni-56	158.38	14.00	4.592E-08
Co-57	122.06	19.00	6.012E-08
Co-58	810.76	1.00	3.982E-08
Fe-59	1099.22	1.00	9.097E-08
Co-60		0.00	0.000E+00
Cu-64	1345.90	1.00	1.797E-05
Ni-65	366.27	8.00	8.185E-06
Zn-65		0.00	0.000E+00
Zn-69	438.63	5.00	7.839E-08
Zn-72	144.70	23.00	7.393E-08
Se-75	264.65	4.00	5.251E-08
Br-82	554.32	2.00	6.564E-08
Br-84	881.50	6.00	1.910E-03
Kr-85	513.99	3.00	1.099E-05
Kr-85m	151.18	18.00	1.888E-07
Sr-85	513.99	3.00	4.707E-08
Kr-87	402.58	9.00	5.550E-06
Kr-88	196.32	20.00	1.174E-06
Rb-88	898.02	1.00	2.712E+00
Y-88	898.02	1.00	4.619E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1031.88	2.00	1.200E+01
Mo-90	257.34	6.00	1.113E-07
Y-90m	202.51	11.00	1.986E-07
Sr-91	1024.30	2.00	3.455E-07
Y-91		0.00	0.000E+00
Y-91m	557.57	6.00	2.277E-05
Sr-92	1383.94	2.00	5.611E-07
Y-92	934.46	5.00	2.738E-06
Y-93	266.90	9.00	1.097E-06
Nb-94		0.00	0.000E+00
Nb-95	765.79	4.00	7.578E-08
Nb-95m	235.69	15.00	2.358E-07
Zr-95	724.18	1.00	8.233E-08
Nb-97	657.90	2.00	6.315E-08

Analysis Report for 17-Jun-2010-0009 6/17/2010 13:54:35 Page 4 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Zr-97	355.39	1.00	1.155E-06
Mo-99	181.06	12.00	7.400E-07
Tc-99m	140.51	17.00	5.737E-08
Tc-101	306.81	10.00	3.208E+01
Ru-103	497.08	1.00	2.953E-08
Rh-105	318.90	8.00	3.055E-07
Ru-105	724.50	2.00	3.015E-07
Ru-106	511.85	3.00	2.255E-07
Cd-109	88.03	42.00	2.795E-06
Ag-110m	657.75	2.00	4.958E-08
In-113m	391.69	7.00	1.525E-06
Sn-113	391.69	7.00	8.760E-08
Sb-122	563.93	3.00	7.672E-08
Sb-124	602.71	5.00	7.044E-08
Sb-125	427.89	9.00	2.361E-07
Xe-127	202.84	14.00	7.227E-08
Te-129	459.60	6.00	5.051E-05
Te-129m	459.60	6.00	8.502E-07
I-131	364.48	8.00	7.217E-08
Xe-131m	163.93	32.00	3.479E-06
I-132	772.61	1.00	3.913E-07
Te-132	228.16	14.00	6.366E-08
Ba-133	302.84	3.00	1.693E-07
Ba-133m	276.09	13.00	3.663E-07
I-133	529.87	4.00	8.031E-08
Te-133	647.40	2.00	2.686E-05
Xe-133	80.99	18.00	2.267E-07
Xe-133m	233.22	11.00	5.041E-07
Cs-134	795.95	3.00	7.884E-08
I-134	847.03	1.00	9.626E-06
Te-134	210.47	15.00	2.147E-04
I-135	1131.51	2.00	6.757E-07
Xe-135	249.79	15.00	1.089E-07
Xe-135m	526.56	5.00	8.467E+00
Cs-136	818.50	1.00	4.052E-08
Cs-137	661.65	8.00	1.104E-07
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	462.79	10.00	1.754E-03
Xe-138	258.31	8.00	7.750E+01
Ba-139	165.85	28.00	1.139E-05
Ce-139	165.85	28.00	7.849E-08
Ba-140	537.32	3.00	1.964E-07
La-140	487.03	2.00	8.116E-08
Ba-141	190.22	16.00	6.023E-01
Ce-141	145.44	24.00	1.177E-07
La-142	641.17	1.00	1.219E-06
Ce-143	293.26	41.00	2.986E-07
Ce-144	133.54	18.00	4.543E-07

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
77.08	28	0.89	51.3	U	Ba-142	FP	4.656E+05
				R	Pb-212	NP	1.087E-06
				U	Bi-214	NP	5.837E+01
				U	Pb-214	NP	4.804E-02
185.99	41	1.32	19.4	U	Ra-226	NP	3.351E-06
				U	Pa-234	NP	1.116E-05
				U	U-235	NP	2.036E-07
187.67	11	1.33	70.4	U	I-134	HFP	9.579E-04
				U	Ac-225	NP	5.547E-06
				U	Ra-226	NP	3.351E-06
241.94	22	0.58	39.6	R	Sr-92	FP	1.313E-05
				U	Te-131m	FP	1.056E-06
				R	Xe-138	FG	1.096E+03
				U	Ra-224	NP	1.851E-06
295.12	71	1.26	14.9	U	Sb-126	AP	5.874E-06
				U	Pb-214	NP	5.560E-02
				U	Pa-234	NP	1.320E-05
352.08	89	0.83	12.2	R	Ce-143	FP	1.281E-05
				U	Pb-214	NP	4.174E-02
609.16	76	1.27	12.4	R	Ru-103	FP	9.032E-06
				R	Xe-135	FG	2.932E-05
				U	Bi-214	NP	1.781E+00
1120.50	16	1.55	25.0	R	Sc-46	AP	1.793E-07
				U	Bi-214	NP	1.939E+00

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

Analysis Report for 17-Jun-2010-0009 6/17/2010 13:54:35 Page 5 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	4.00	6.690E+01
Nd-147	531.02	2.00	3.038E-07
Pm-148m	629.97	2.00	5.092E-08
Eu-152	344.27	4.00	1.456E-07
Eu-156	811.77	2.00	5.444E-07
Sm-156	208.83	14.00	3.587E-07
W-187	685.81	6.00	3.425E-07
Re-188	155.03	25.00	5.148E-07
Hg-203	279.19	12.00	7.347E-08
Bi-207	569.67	2.00	4.242E-08
Pb-212	238.63	28.00	2.694E-07
Np-239	103.76	19.00	2.604E-07
Am-241	59.54	21.00	6.412E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0009		
Sample Description	: Unconditional release of solid material FR-10-101		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET02
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 13:47:24	Live Time	: 400.0 seconds
Decay Time	: 0 06:47:24	Real Time	: 400.1 seconds
Sample Size	: 1.088E+03 grams	Dead Time	: 0.01 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments
		Total Gamma Activity		0.000E+00		

Errors quoted at 1.000 sigma

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Progress Energy Apex

6/17/2010 13:54:14 Page 1 of 6

Analysis Report for 17-Jun-2010-0010

Sample Identification	: 17-Jun-2010-0010		
Sample Description	: Unconditional release of solid material FR-10-100		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.1 seconds
Acquisition Started	: 17-Jun-2010 13:47:20	Dead Time	: 0.03 %
Decay Time	: 0 06:47:20		
Sample Size	: 1.000E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Mar-2010 13:22:52	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 15-Mar-2010 13:15:33		
Energy Calibration Date	: 30-Dec-2009 11:26:47	Peak Area Range	: 77 - 4096 channels
Energy Slope	: 0.5000 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.275 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 5.715E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

Peak No.	*Energy (keV)*	*Net Peak Area*	*Continuum Counts*	*FWHM (keV)*	*Peak Centroid*	*Peak Width*	*% Error*	*Nuclide*
1	74.03	38	60	1.23	148.60	10	41.4	
2	76.75	36	60	1.02	154.03	7	39.5	
3	185.34	50	40	1.16	371.20	12	28.6	
4	294.62	104	9	1.01	589.71	11	11.2	
5	351.47	164	11	1.24	703.40	12	8.9	
6	608.85	115	0	1.44	1218.00	11	9.3	
7	767.79	14	2	0.74	1535.77	8	31.5	
8	1119.79	31	0	1.85	2239.42	11	18.0	
9	1763.96	11	4	1.27	3526.82	10	47.7	

% Error in counts/sec recorded at 1.00 sigma

Analysis Report for 17-Jun-2010-0010 6/17/2010 13:54:14 Page 2 of 6

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCi/grams)	Activity Uncertainty

No Nuclides were Identified

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Na-22	1274.54	1.00	4.843E-08
Na-24	1368.53	2.00	9.937E-08
Cl-38		0.00	0.000E+00
Ar-41	1293.64	2.00	9.373E-07
Sc-46	889.25	1.00	3.606E-08
Cr-51	320.08	10.00	5.227E-07
Mn-54	834.83	5.00	7.643E-08
Mn-56	846.75	5.00	4.918E-07
Ni-56	158.38	32.00	6.476E-08
Co-57	122.06	25.00	6.518E-08
Co-58	810.76	7.00	8.899E-08
Fe-59	1291.56	2.00	1.608E-07
Co-60	1332.49	1.00	5.015E-08
Cu-64		0.00	0.000E+00
Ni-65	1115.52	3.00	3.337E-06
Zn-65	1115.52	3.00	1.482E-07
Zn-69	438.63	8.00	8.612E-08
Zn-72	144.70	35.00	8.551E-08
Se-75	264.65	19.00	1.029E-07
Br-82	776.49	2.00	6.249E-08
Br-84	881.50	4.00	1.312E-03
Kr-85	513.99	7.00	1.445E-05
Kr-85m	151.18	31.00	2.317E-07
Sr-85	513.99	7.00	6.188E-08
Kr-87	402.58	11.00	5.355E-06
Kr-88	196.32	25.00	1.207E-06
Rb-88	1836.01	2.00	3.668E+00
Y-88	898.02	3.00	6.738E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1248.10	1.00	1.147E+01
Mo-90	122.37	25.00	2.007E-07
Y-90m	479.53	4.00	2.133E-07
Sr-91	1024.30	1.00	2.050E-07
Y-91	1204.90	3.00	2.678E-05
Y-91m	557.57	6.00	1.950E-05
Sr-92	1383.94	3.00	5.725E-07
Y-92	934.46	12.00	3.568E-06
Y-93	266.90	24.00	1.610E-06
Nb-94	702.63	5.00	6.635E-08
Nb-95	765.79	18.00	1.360E-07
Nb-95m	235.69	40.00	3.494E-07
Zr-95	756.72	6.00	1.400E-07
Nb-97	657.90	5.00	8.495E-08

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Zr-97	743.36	2.00	5.937E-08
Mo-99	739.58	3.00	4.497E-07
Tc-99m	140.51	32.00	7.392E-08
Tc-101	306.81	16.00	3.599E+01
Ru-103	497.08	5.00	5.694E-08
Rh-105	318.90	13.00	3.455E-07
Ru-105	724.50	6.00	4.427E-07
Ru-106	511.85	7.00	2.965E-07
Cd-109	88.03	40.00	2.596E-06
Ag-110m	657.75	5.00	6.671E-08
In-113m	391.69	6.00	1.234E-06
Sn-113	391.69	6.00	7.095E-08
Sb-122	563.93	6.00	9.295E-08
Sb-124	602.71	5.00	6.016E-08
Sb-125	427.89	7.00	1.812E-07
Xe-127	202.84	18.00	7.518E-08
Te-129	459.60	7.00	4.723E-05
Te-129m	459.60	7.00	7.953E-07
I-131	364.48	11.00	7.438E-08
Xe-131m	163.93	30.00	3.136E-06
I-132	667.69	5.00	5.076E-07
Te-132	228.16	20.00	6.921E-08
Ba-133	356.01	9.00	8.729E-08
Ba-133m	276.09	24.00	4.463E-07
I-133	529.87	3.00	5.977E-08
Te-133	912.58	11.00	2.387E-05
Xe-133	80.99	39.00	3.172E-07
Xe-133m	233.22	20.00	6.173E-07
Cs-134	795.95	1.00	3.846E-08
I-134	847.03	5.00	1.814E-05
Te-134	210.47	26.00	2.583E-04
I-135	1260.41	4.00	6.874E-07
Xe-135	249.79	17.00	1.047E-07
Xe-135m	526.56	8.00	9.180E+00
Cs-136	1048.07	1.00	5.256E-08
Cs-137	661.65	12.00	1.151E-07
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	462.79	5.00	1.072E-03
Xe-138	258.31	29.00	1.326E+02
Ba-139	165.85	34.00	1.167E-05
Ce-139	165.85	34.00	8.044E-08
Ba-140	537.32	4.00	1.947E-07
La-140	487.03	7.00	1.311E-07
Ba-141	190.22	27.00	7.193E-01
Ce-141	145.44	39.00	1.407E-07
La-142	894.85	1.00	7.602E-06
Ce-143	293.26	103.00	4.225E-07
Ce-144	133.54	38.00	6.215E-07

Analysis Report for 17-Jun-2010-0010 6/17/2010 13:54:14 Page 5 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	2.00	4.006E+01
Nd-147	531.02	1.00	1.846E-07
Pm-148m	550.27	3.00	4.479E-08
Eu-152	121.78	23.00	1.883E-07
Eu-156	1230.71	2.00	7.572E-07
Sm-156	208.83	26.00	4.475E-07
W-187	685.81	1.00	1.188E-07
Re-188	155.03	24.00	4.710E-07
Hg-203	279.19	19.00	8.283E-08
Bi-207	569.67	7.00	6.795E-08
Pb-212	238.63	56.00	3.453E-07
Np-239	103.76	29.00	3.055E-07
Am-241	59.54	41.00	8.408E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0010		
Sample Description	: Unconditional release of solid material FR-10-100		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET01
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 13:47:20	Live Time	: 400.0 seconds
Decay Time	: 0 06:47:20	Real Time	: 400.1 seconds
Sample Size	: 1.000E+03 grams	Dead Time	: 0.03 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments

Total Gamma Activity 0.000E+00

Errors quoted at 1.000 sigma

Analysis Report for 17-Jun-2010-0010 6/17/2010 13:54:14 Page 6 of 6

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
74.03	38	1.23	41.4	R	Pb-212	NP	2.638E-06
				U	Pb-214	NP	1.169E-01
				U	Ac-225	NP	3.686E-05
76.75	36	1.02	39.5	U	Ba-142	FP	5.836E+05
				R	Pb-212	NP	1.368E-06
				U	Bi-214	NP	7.331E+01
				U	Pb-214	NP	6.037E-02
185.34	50	1.16	28.6	U	Ra-226	NP	3.796E-06
				U	Pa-234	NP	1.264E-05
				U	U-235	NP	2.306E-07
294.62	104	1.01	11.2	R	Ce-143	FP	9.322E-07
				U	Pb-214	NP	7.235E-02
				U	Pa-234	NP	1.721E-05
351.47	164	1.24	8.9	R	Ce-143	FP	2.065E-05
				U	Pb-214	NP	6.715E-02
608.85	115	1.44	9.3	R	Ru-103	FP	1.174E-05
				R	Xe-135	FG	3.809E-05
				U	Bi-214	NP	2.309E+00
767.79	14	0.74	31.5	R	I-134	HFP	5.312E-04
				U	Bi-214	NP	3.243E+00
				U	Pa-234m	NP	Halflife to short
1119.79	31	1.85	18.0	R	Sc-46	AP	2.907E-07
				U	Bi-214	NP	3.136E+00
1763.96	11	1.27	47.7	U	Bi-214	NP	1.488E+00

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

Progress Energy Apex™ 6/17/2010 13:54:57 Page 1 of 6

Analysis Report for 17-Jun-2010-0011

Sample Identification	: 17-Jun-2010-0011		
Sample Description	: Unconditional release of solid material FR-10-102		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET03
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.3 seconds
Acquisition Started	: 17-Jun-2010 13:47:28	Dead Time	: 0.08 %
Decay Time	: 0 06:47:28		
Sample Size	: 1.200E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 22-Mar-2010 10:22:28	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 24-Mar-2010 15:41:25		
Energy Calibration Date	: 21-Sep-2009 13:46:14	Peak Area Range	: 85 - 4096 channels
Energy Slope	: 0.5001 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.296 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: -3.951E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error	Nuclide
M	1	74.03	45	49	1.18	148.61	17	30.1	Pb-212
m	2	76.59	77	40	1.19	153.74	17	18.8	Pb-212
	3	86.62	56	52	0.94	173.80	8	26.0	Pb-212
	4	185.37	75	26	1.31	371.26	9	16.9	
	5	237.88	48	62	0.98	476.27	9	33.4	Pb-212
	6	241.28	59	31	0.96	483.07	8	21.1	
	7	294.60	139	18	1.28	589.68	11	10.2	
	8	351.33	229	26	1.16	703.13	10	7.7	
	9	509.40	17	2	1.15	1019.24	9	28.6	
	10	582.38	27	2	1.76	1165.19	11	22.7	
	11	608.69	178	0	1.28	1217.82	10	7.5	
	12	726.40	13	0	0.79	1453.23	8	27.7	
	13	910.26	17	5	1.53	1820.97	9	33.8	
	14	967.99	17	5	0.86	1936.44	10	34.6	
	15	1119.56	45	3	2.34	2239.60	11	16.4	
	16	1237.03	17	0	0.79	2474.59	10	24.3	
	17	1460.08	30	2	0.92	2920.77	9	20.4	
	18	1763.99	35	0	1.70	3528.77	13	16.9	

ADP CR3, LLC

CR3 Decommissioning

15760 West Power Line Street | Crystal River, FL 34428

Analysis Report for 17-Jun-2010-0011 6/17/2010 13:54:57 Page 2 of 6

M = First peak in a multiplet region
m = Other peak in a multiplet region
% Error in counts/sec recorded at 1.00 sigma

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCilgrams)	Activity Uncertainty
Nuclide Type: AP							
Pb-212	0.89	10.64 hrs	74.81	10.70	1.571E+00	2.374E-06	7.151E-07
			77.11	18.00	1.704E+00	2.203E-06	4.134E-07
			87.30	8.00	2.161E+00	2.850E-06	7.411E-07
			238.63	44.60	2.429E+00	3.860E-07	1.289E-07
			300.09	3.41	2.073E+00		
		Pb-212 Interference Corrected Final Weighted Mean				6.583E-07	+/- 1.197E-07

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCilgrams)
Na-22	1274.54	4.00	7.952E-08
Na-24	1368.53	3.00	9.992E-08
Cl-38	1642.42	3.00	5.397E-04
Ar-41	1293.64	3.00	9.432E-07
Sc-46	889.25	11.00	9.817E-08
Cr-51	320.08	24.00	6.651E-07
Mn-54	834.83	8.00	7.933E-08
Mn-56	1810.69	1.00	1.187E-06
Ni-56	158.38	41.00	5.962E-08
Co-57	122.06	53.00	7.608E-08
Co-58	810.76	5.00	6.171E-08
Fe-59	1099.22	3.00	1.084E-07
Co-60	1332.49	1.00	4.117E-08
Cu-64	1345.90	1.00	1.230E-05
Ni-65	1481.84	1.00	1.250E-06
Zn-65	1115.52	7.00	1.859E-07
Zn-69	438.63	8.00	7.070E-08
Zn-72	144.70	47.00	8.027E-08
Se-75	136.00	48.00	1.027E-07
Br-82	776.49	1.00	3.626E-08
Br-84	881.50	6.00	1.322E-03
Kr-85	513.99	4.00	8.960E-06
Kr-85m	151.18	55.00	2.506E-07
Sr-85	513.99	4.00	3.838E-08
Kr-87	402.58	19.00	5.785E-06
Kr-88	196.32	37.00	1.202E-06
Rb-88	1836.01	1.00	2.134E+00
Y-88	1836.01	1.00	5.210E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1031.88	1.00	5.864E+00
Mo-90	257.34	38.00	2.074E-07
Y-90m	202.51	40.00	2.846E-07
Sr-91	749.80	3.00	3.185E-07
Y-91	1204.90	4.00	2.539E-05
Y-91m	557.57	5.00	1.463E-05
Sr-92	1383.94	4.00	5.430E-07
Y-92	934.46	13.00	3.049E-06
Y-93	266.90	35.00	1.597E-06
Nb-94	871.10	3.00	5.027E-08
Nb-95	765.79	17.00	1.085E-07
Nb-95m	235.69	89.00	4.277E-07
Zr-95	756.72	8.00	1.327E-07
Nb-97	657.90	4.00	6.234E-08

Nuclide Name	*Energy (keV)*	*Background Sum*	*Nuclide MDA (uCi/grams)*
Zr-97	743.36	9.00	1.033E-07
Mo-99	739.58	3.00	3.690E-07
Tc-99m	140.51	50.00	7.474E-08
Tc-101	306.81	22.00	3.488E+01
Ru-103	497.08	11.00	6.931E-08
Rh-105	318.90	20.00	3.520E-07
Ru-105	724.50	13.00	5.348E-07
Ru-106	511.85	16.00	3.678E-07
Cd-109	88.03	87.00	2.966E-06
Ag-110m	657.75	4.00	4.895E-08
In-113m	391.69	15.00	1.604E-06
Sn-113	391.69	15.00	9.211E-08
Sb-122	563.93	13.00	1.122E-07
Sb-124	602.71	6.00	5.406E-08
Sb-125	427.89	12.00	1.947E-07
Xe-127	202.84	40.00	9.178E-08
Te-129	459.60	8.00	4.149E-05
Te-129m	459.60	8.00	6.978E-07
I-131	364.48	20.00	8.237E-08
Xe-131m	163.93	45.00	3.128E-06
I-132	667.69	3.00	3.228E-07
Te-132	228.16	43.00	8.325E-08
Ba-133	356.01	10.00	7.557E-08
Ba-133m	276.09	31.00	4.166E-07
I-133	529.87	13.00	1.021E-07
Te-133	912.58	17.00	2.439E-05
Xe-133	80.99	57.00	2.936E-07
Xe-133m	233.22	46.00	7.681E-07
Cs-134	604.70	4.00	4.425E-08
I-134	884.09	6.00	2.473E-05
Te-134	435.06	6.00	1.997E-04
I-135	1260.41	4.00	5.645E-07
Xe-135	249.79	31.00	1.161E-07
Xe-135m	526.56	10.00	8.469E+00
Cs-136	818.50	8.00	7.940E-08
Cs-137	661.65	6.00	6.675E-08
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	1435.86	1.00	3.958E-04
Xe-138	258.31	38.00	1.254E+02
Ba-139	165.85	45.00	1.095E-05
Ce-139	165.85	45.00	7.540E-08
Ba-140	537.32	10.00	2.526E-07
La-140	1596.49	2.00	7.096E-08
Ba-141	190.22	46.00	7.715E-01
Ce-141	145.44	43.00	1.197E-07
La-142	641.17	7.00	2.255E-06
Ce-143	293.26	149.00	4.174E-07
Ce-144	133.54	36.00	4.878E-07

Analysis Report for 17-Jun-2010-0011 6/17/2010 13:54:57 Page 5 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	10.00	7.385E+01
Nd-147	91.11	69.00	3.399E-07
Pm-148m	629.97	2.00	3.561E-08
Eu-152	121.78	53.00	2.291E-07
Eu-156	811.77	5.00	5.965E-07
Sm-156	208.83	35.00	4.255E-07
W-187	685.81	5.00	2.179E-07
Re-188	155.03	53.00	5.689E-07
Hg-203	279.19	39.00	9.747E-08
Bi-207	569.67	4.00	4.214E-08
Pb-212	238.63	62.48	3.820E-07
Np-239	103.76	45.00	3.008E-07
Am-241	59.54	58.00	7.197E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0011		
Sample Description	: Unconditional release of solid material FR-10-102		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET03
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 13:47:28	Live Time	: 400.0 seconds
Decay Time	: 0 06:47:28	Real Time	: 400.3 seconds
Sample Size	: 1.200E+03 grams	Dead Time	: 0.08 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments
Pb-212	AP	10.64 hrs	0.89	6.583E-07	1.197E-07	
		Total Gamma Activity		6.583E-07		

Errors quoted at 1.000 sigma

Analysis Report for 17-Jun-2010-0011 6/17/2010 13:54:57 Page 6 of 6

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
185.37	75	1.31	16.9	U	Ra-226	NP	4.646E-06
				U	Pa-234	NP	1.547E-05
				U	U-235	NP	2.822E-07
241.28	59	0.96	21.1	R	Sr-92	FP	2.642E-05
				U	Te-131m	FP	2.123E-06
				R	Xe-138	FG	2.210E+03
				U	Ra-224	NP	3.723E-06
294.60	139	1.28	10.2	R	Ce-143	FP	1.028E-06
				U	Pb-214	NP	8.007E-02
				U	Pa-234	NP	1.899E-05
351.33	229	1.16	7.7	R	Ce-143	FP	2.375E-05
				U	Pb-214	NP	7.749E-02
509.40	17	1.15	28.6	U	I-133	HFP	4.813E-06
				U	Tl-208	NP	Halflife to short
				U	Ac-228	NP	3.066E-05
582.38	27	1.76	22.7	U	Tl-208	NP	Halflife to short
608.69	178	1.28	7.5	R	Xe-135	FG	4.836E-05
				U	Bi-214	NP	2.944E+00
726.40	13	0.79	27.7	R	I-132	HFP	1.719E-05
				U	Bi-212	NP	6.527E-05
				U	Ac-228	NP	1.890E-05
910.26	17	1.53	33.8	U	Te-131m	FP	3.801E-06
				U	I-132	HFP	9.134E-05
				U	I-133	HFP	6.326E-05
				U	Tl-210	NP	Halflife to short
				U	Ac-228	NP	7.963E-07
967.99	17	0.86	34.6	R	Sb-124	AP	6.048E-06
				U	I-130	HFP	1.937E-05
				U	Ac-228	NP	1.434E-06
1119.56	45	2.34	16.4	R	Sc-46	AP	3.490E-07
				U	Bi-214	NP	3.784E+00
1237.03	17	0.79	24.3	U	Co-56	AP	2.120E-07
				R	I-133	HFP	1.195E-05
				U	Bi-214	NP	3.912E+00
1460.08	30	0.92	20.4	U	K-40	NP	2.662E-06
				U	Ac-228	NP	5.909E-05
1763.99	35	1.70	16.9	U	Bi-214	NP	3.895E+00

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Progress Energy Apex™

6/17/2010 14:48:15 Page 1 of 6

Analysis Report for 17-Jun-2010-0012

Sample Identification	: 17-Jun-2010-0012		
Sample Description	: Unconditional release of solid material FR-10-106		
Procedure	: Free Release Solid		
Sample Type	: Free Release	Detector Name	: DET03
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	: 3	Nuclide Library	: UNNATURAL
Sample Point	: Free Release Solid	Activity Multiplier	: 1.00
		Live Time	: 400.0 seconds
Sample Taken On	: 17-Jun-2010 07:00:00	Real Time	: 400.2 seconds
Acquisition Started	: 17-Jun-2010 14:41:23	Dead Time	: 0.05 %
Decay Time	: 0 07:41:23		
Sample Size	: 9.164E+02 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 22-Mar-2010 10:22:28	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 24-Mar-2010 15:41:25		
Energy Calibration Date	: 21-Sep-2009 13:46:14	Peak Area Range	: 85 - 4096 channels
Energy Slope	: 0.5001 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.296 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: -3.951E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error	Nuclide
1	77.04	48	18	1.13	154.64	10	23.7	
2	185.85	30	28	1.20	372.21	11	39.0	
3	237.98	21	13	0.95	476.46	8	35.6	
4	241.32	32	5	0.95	483.15	7	21.5	
5	294.59	78	7	1.36	589.66	13	13.2	
6	351.38	122	7	0.99	703.23	9	9.8	
7	582.60	11	0	0.54	1165.64	8	30.2	
8	608.82	97	0	1.28	1218.07	9	10.2	
9	1763.50	19	0	0.62	3527.79	10	22.9	

% Error in counts/sec recorded at 1.00 sigma

Analysis Report for 17-Jun-2010-0012 6/17/2010 14:48:15 Page 2 of 6

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (uCi/grams)	Activity Uncertainty

No Nuclides were identified

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCilgrams)
Na-22	1274.54	1.00	5.205E-08
Na-24	1368.53	1.00	7.871E-08
Cl-38		0.00	0.000E+00
Ar-41		0.00	0.000E+00
Sc-46	889.25	4.00	7.751E-08
Cr-51	320.08	10.00	5.625E-07
Mn-54	834.83	6.00	8.993E-08
Mn-56	846.75	3.00	5.213E-07
Ni-56	158.38	23.00	5.869E-08
Co-57	122.06	19.00	5.963E-08
Co-58	810.76	2.00	5.111E-08
Fe-59	194.34	22.00	1.908E-06
Co-60	1173.22	2.00	6.876E-08
Cu-64	1345.90	1.00	1.691E-05
Ni-65	1481.84	1.00	2.095E-06
Zn-65	1115.52	1.00	9.199E-08
Zn-69	438.63	4.00	6.846E-08
Zn-72	144.70	26.00	7.920E-08
Se-75	264.65	11.00	8.421E-08
Br-82	776.49	1.00	4.830E-08
Br-84	881.50	4.00	4.577E-03
Kr-85	513.99	5.00	1.311E-05
Kr-85m	151.18	25.00	2.542E-07
Sr-85	513.99	5.00	5.619E-08
Kr-87	402.58	9.00	8.504E-06
Kr-88	196.32	32.00	1.823E-06
Rb-88	1836.01	1.00	2.280E+01
Y-88	1836.01	1.00	6.821E-08
Kr-89	No MDA calculated. Half life of 3.16 minutes is to short.		
Rb-89	1031.88	5.00	1.931E+02
Mo-90	257.34	15.00	1.903E-07
Y-90m	479.53	5.00	3.115E-07
Sr-91	1024.30	2.00	3.327E-07
Y-91		0.00	0.000E+00
Y-91m	557.57	3.00	3.146E-05
Sr-92	1383.94	3.00	7.745E-07
Y-92	934.46	4.00	2.640E-06
Y-93	266.90	11.00	1.247E-06
Nb-94	702.63	1.00	3.187E-08
Nb-95	765.79	10.00	1.090E-07
Nb-95m	235.69	28.00	3.162E-07
Zr-95	756.72	5.00	1.373E-07
Nb-97	657.90	5.00	9.465E-08

Analysis Report for 17-Jun-2010-0012 6/17/2010 14:48:15 Page 4 of 6

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Zr-97	743.36	2.00	6.616E-08
Mo-99	739.58	3.00	4.876E-07
Tc-99m	140.51	13.00	5.035E-08
Tc-101	306.81	12.00	4.686E+02
Ru-103	497.08	4.00	5.474E-08
Rh-105	318.90	15.00	4.061E-07
Ru-105	724.50	5.00	4.995E-07
Ru-106	511.85	3.00	2.085E-07
Cd-109	88.03	34.00	2.427E-06
Ag-110m	657.75	5.00	7.164E-08
In-113m	391.69	4.00	1.578E-06
Sn-113	391.69	4.00	6.227E-08
Sb-122	563.93	4.00	8.228E-08
Sb-124	602.71	2.00	4.087E-08
Sb-125	600.56	1.00	1.579E-07
Xe-127	202.84	26.00	9.693E-08
Te-129	459.60	10.00	1.039E-04
Te-129m	459.60	10.00	1.022E-06
I-131	364.48	10.00	7.648E-08
Xe-131m	163.93	15.00	2.369E-06
I-132	772.61	1.00	4.662E-07
Te-132	228.16	18.00	7.107E-08
Ba-133	356.01	10.00	9.891E-08
Ba-133m	276.09	9.00	2.985E-07
I-133	529.87	8.00	1.080E-07
Te-133	912.58	6.00	3.724E-05
Xe-133	80.99	24.00	2.506E-07
Xe-133m	233.22	19.00	6.539E-07
Cs-134	604.70	4.00	5.792E-08
I-134	847.03	3.00	3.077E-05
Te-134	277.95	8.00	4.624E-04
I-135	1131.51	2.00	6.682E-07
Xe-135	249.79	15.00	1.132E-07
Xe-135m	526.56	5.00	8.930E+01
Cs-136	818.50	4.00	7.364E-08
Cs-137	661.65	19.00	1.555E-07
Xe-137	No MDA calculated. Half life of 3.83 minutes is to short.		
Cs-138	1435.86	2.00	2.338E-03
Xe-138	258.31	16.00	1.499E+03
Ba-139	165.85	18.00	1.421E-05
Ce-139	165.85	18.00	6.243E-08
Ba-140	537.32	2.00	1.482E-07
La-140	487.03	4.00	1.066E-07
Ba-141	190.22	24.00	5.641E+00
Ce-141	145.44	23.00	1.146E-07
La-142	641.17	1.00	1.650E-06
Ce-143	293.26	75.00	3.950E-07
Ce-144	133.54	13.00	3.837E-07

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (uCi/grams)
Pr-144	696.49	4.00	5.315E+02
Nd-147	91.11	48.00	3.720E-07
Pm-148m	550.27	4.00	5.557E-08
Eu-152	344.27	7.00	1.827E-07
Eu-156	811.77	2.00	4.947E-07
Sm-156	208.83	23.00	4.824E-07
W-187	685.81	2.00	1.851E-07
Re-188	155.03	15.00	4.109E-07
Hg-203	279.19	6.00	5.007E-08
Bi-207	569.67	3.00	4.777E-08
Pb-212	238.63	12.59	2.244E-07
Np-239	103.76	23.00	2.846E-07
Am-241	59.54	25.00	6.185E-07

NID SUMMARY REPORT

Sample Identification	: 17-Jun-2010-0012		
Sample Description	: Unconditional release of solid material FR-10-106		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	: 3	Detector Name	: DET03
Sample Point	: Free Release Solid	Geometry	: LSB0
Sample Taken On	: 17-Jun-2010 07:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Jun-2010 14:41:23	Live Time	: 400.0 seconds
Decay Time	: 0 07:41:23	Real Time	: 400.2 seconds
Sample Size	: 9.164E+02 grams	Dead Time	: 0.05 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt Mean Activity (uCi/grams)	Wt Mean Activity Uncertainty	Comments
		Total Gamma Activity		0.000E+00		

Errors quoted at 1.000 sigma

Analysis Report for 17-Jun-2010-0012 6/17/2010 14:48:15 Page 6 of 6

UNIDENTIFIED PEAK REPORT

Energy (keV)	Net Area	FWHM	Peak Area % Error	Flag	Nuclide	Nuclide Type	Activity
77.04	48	1.13	23.7	U	Ba-142	FP	2.503E+07
				R	Pb-212	NP	1.877E-06
				U	Bi-214	NP	6.232E+02
				U	Pb-214	NP	3.161E-01
185.85	30	1.20	39.0	U	Ra-226	NP	2.395E-06
				U	Pa-234	NP	8.754E-06
				U	U-235	NP	1.455E-07
237.98	21	0.95	35.6	R	Pb-212	NP	2.415E-07
241.32	32	0.95	21.5	R	Sr-92	FP	2.341E-05
				U	Te-131m	FP	1.527E-06
				R	Xe-138	FG	2.192E+04
				U	Ra-224	NP	2.641E-06
294.59	78	1.36	13.2	R	Ce-143	FP	7.622E-07
				U	Pb-214	NP	2.349E-01
				U	Pa-234	NP	1.516E-05
351.38	122	0.99	9.8	R	Ce-143	FP	1.685E-05
				U	Pb-214	NP	2.176E-01
582.60	11	0.54	30.2	U	Tl-208	NP	Halflife to short
608.82	97	1.28	10.2	R	Xe-135	FG	3.694E-05
				U	Bi-214	NP	1.374E+01
1763.50	19	0.62	22.9	U	Bi-214	NP	1.810E+01

U: Unknown Line (Line Not Present in Analysis Library).
R: Rejected During Analysis.
P: Positively Identified (Line Not Present in Analysis Library, Nuclide Identified by Analysis Library).

ATTACHMENT B

RS22-09-0061

ADP CR3, LLC

CR3 Decommissioning

15760 West Power Line Street | Crystal River, FL 34428

Survey Plan Number: CHAR-01	Survey Area: SEAL	Survey Date: 03/10/2022	GPS Controller: CS20 LTE	Page 6 of 9
Survey Instrument (type(s)): N/A	Pre-Survey Check: SAT: ☐ UNSAT: ☐ N/A: ☒		GPS Antenna: 3620490	Survey Number: 22-09-0061
Instrument Serial Number(s): N/A	Post-Survey Check: SAT: ☐ UNSAT: ☐ N/A: ☒		Instrument Cal Due Date(s):	N/A

Comments:
All samples are Bias sample locations however only the first six were used for the DQA process.

All samples taken at a max depth of 6"

Sample Location	Northing X-Coord	Easting Y-Coord	Elevation Z-Coord
SEAL-CHAR-01-001	433377.21	1680731.29	6.89
SEAL-CHAR-01-002	433336.63	1680709.22	6.71
SEAL-CHAR-01-003	433369.66	1680640.43	6.96
SEAL-CHAR-01-004	433445.29	1680595.39	6.65
SEAL-CHAR-01-006	433422.64	1680647.48	7.03
SEAL-CHAR-01-006	433424.99	1680716.39	6.66

Surveyor: (print/sign) Connie Beluscak *Connie Beluscak*	Surveyor: (print/sign) Mike Mennella *[signature]*
Reviewed By: (print/sign) *MHBLAKE / MHBlake* Date: *6-15-2022*	File Location: (optional) *N/A*

ADP CR3, LLC

CR3 Decommissioning

15760 West Power Line Street | Crystal River, FL 34428

Apex

3/17/2022 12:33:39 Page 1 of 4

Analysis Report for 17-Mar-2022-200008

Sample Identification	: 17-Mar-2022-200008
Sample Description	: Unconditional release of solid material SEAL-CHAR-01-001
Procedure	: Free Release Solid

Sample Type	: Checks for Contamination	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	:	Nuclide Library	: UNNATURAL
Sample Point	:	Activity Multiplier	: 1.00
		Live Time	: 1000.0 seconds
Sample Taken On	: 10-Mar-2022 10:20:00	Real Time	: 1000.5 seconds
Acquisition Started	: 17-Mar-2022 12:16:18	Dead Time	: 0.05 %
Decay Time	: 7 01:56:18		
Sample Size	: 1.124E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Jun-2019 11:02:41	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 10-Jun-2019 11:04:06		
Energy Calibration Date	: 25-Jan-2022 09:51:24	Peak Area Range	: 60 - 4096 channels
Energy Slope	: 0.4996 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.340 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 6.535E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
M	1	74.95	101	73	0.86	150.71	14	16.5	
m	2	77.12	122	67	0.83	155.04	14	13.6	
M	3	87.07	71	58	0.96	174.97	18	21.1	Cd-109
m	4	89.83	34	48	0.98	180.49	18	39.5	U-235
	5	186.14	78	52	0.95	373.26	7	19.0	U-235
M	6	238.76	81	48	1.14	478.57	16	18.1	
m	7	241.97	82	40	1.25	485.01	16	18.3	Ra-224
	8	295.18	189	76	1.02	591.51	12	11.7	
	9	351.94	377	36	0.99	705.10	12	6.1	
	10	582.97	19	20	0.96	1167.45	11	51.2	
	11	609.32	271	10	1.20	1220.18	12	6.6	
	12	768.32	25	3	1.33	1538.35	9	22.6	
	13	934.02	22	2	1.53	1869.88	10	25.4	
	14	1120.20	69	3	1.74	2242.35	11	12.9	
	15	1764.57	45	0	1.48	3531.24	11	14.9	

M = First peak in a multiplet region
m = Other peak in a multiplet region

Analysis Report for 17-Mar-2022-200008 3/17/2022 12:33:39 Page 2 of 4

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (µCi/grams)		Activity Uncertainty
Nuclide Type:	AP							
Cd-109	0.91	464.00 days	88.03	3.72	2.446E+00	1.887E-06		4.092E-07
		Cd-109 Interference Corrected Final Weighted Mean				1.887E-06	+/-	4.092E-07
Nuclide Type:	NP							
Ra-224	0.89	3.62 days	240.98	3.95	2.118E+00	9.116E-06		1.703E-06
		Ra-224 Interference Corrected Final Weighted Mean				9.116E-06	+/-	1.703E-06
U-235	0.53	7.04E+08 yrs	89.95	2.70	2.513E+00	1.197E-06		4.763E-07
			93.35	4.50	2.587E+00			
			105.00	2.10	2.747E+00			
			109.14	1.50	2.780E+00			
			143.76	10.50	2.759E+00			
			163.35	4.70	2.641E+00			
			185.72	54.00	2.483E+00	1.397E-07		2.705E-08
			202.12	1.00	2.371E+00			
			205.31	4.70	2.350E+00			
		U-235 Interference Corrected Final Weighted Mean				1.431E-07	+/-	2.700E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Analysis Report for 17-Mar-2022-200008 3/17/2022 12:33:39 Page 3 of 4

NUCLIDE MDA REPORT

Nuclide Name	*Energy (keV)*	*Background Sum*	*Nuclide MDA (µCi/grams)*
Na-22	1274.54	1.00	1.972E-08
Cr-51	320.08	21.00	3.583E-07
Mn-54	834.83	7.00	3.695E-08
Co-57	122.06	59.00	3.630E-08
Co-58	810.76	11.00	4.797E-08
Fe-59	1099.22	4.00	6.854E-08
Co-60	1332.49	5.00	4.555E-08
Zn-65	1115.52	5.00	7.894E-08
Se-75	264.65	29.00	5.269E-08
Kr-85	513.99	19.00	9.517E-06
Y-88	1836.01	2.00	3.800E-08
Nb-94	702.63	12.00	4.124E-08
Nb-95	765.79	10.00	4.660E-08
Zr-95	724.18	6.00	7.387E-08
Tc-99m	140.51	62.00	2.126E-07
Cd-109	88.03	58.29	2.590E-06
Ag-110m	657.75	5.00	2.724E-08
Sn-113	391.69	23.00	5.774E-08
Sb-124	602.71	10.00	3.682E-08
Sb-125	427.89	16.00	1.098E-07
I-131	364.48	27.00	8.358E-08
Ba-133	356.01	21.00	5.327E-08
Cs-134	604.70	10.00	3.434E-08
Cs-137	661.65	15.00	5.157E-08
Ce-139	165.85	80.00	4.918E-08
Ce-144	133.54	60.00	2.915E-07
Eu-152	121.78	66.00	1.136E-07
Bi-207	569.67	15.00	3.979E-08
Pb-212	238.63	140.00	9.005E-03
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	39.59	7.561E-06
Ra-226	186.21	52.13	1.153E-06
Ra-228	911.07	15.00	2.074E-07
Th-228	84.37	104.00	4.005E-06
Th-232	59.00	66.00	3.923E-05
Th-234	92.38	91.00	1.874E-06
U-235	185.72	52.13	7.006E-08
Am-241	59.54	72.00	2.114E-07

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

NID SUMMARY REPORT

Sample Identification	: 17-Mar-2022-200008		
Sample Description	: Unconditional release of solid material SEAL-CHAR-01-001		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET01
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 10:20:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 17-Mar-2022 12:16:18	Live Time	: 1000.0 seconds
Decay Time	: 7 01:56:18	Real Time	: 1000.5 seconds
Sample Size	: 1.124E+03 grams	Dead Time	: 0.05 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt mean Activity (µCi/grams)	Wt mean Activity Uncertainty 1 Sigma	Comments
Cd-109	AP	464.00 days	0.91	1.887E-06	4.092E-07	
Ra-224	NP	3.62 days	0.89	9.116E-06	1.703E-06	
U-235	NP	7.04E+08 yrs	0.53	1.431E-07	2.700E-08	
		Total Gamma Activity		1.115E-05		

Errors quoted at 1.000 sigma

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Apex™

3/14/2022 12:06:21 Page 1 of 4

Analysis Report for 14-Mar-2022-200009

Sample Identification	: 14-Mar-2022-200009
Sample Description	: Unconditional release of solid material Seal-Char-01-001-R
Procedure	: Free Release Solid

Sample Type	: Checks for Contamination	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	:	Nuclide Library	: UNNATURAL
Sample Point	:	Activity Multiplier	: 1.00
		Live Time	: 1000.0 seconds
Sample Taken On	: 10-Mar-2022 10:20:00	Real Time	: 1000.4 seconds
Acquisition Started	: 14-Mar-2022 11:49:00	Dead Time	: 0.04 %
Decay Time	: 4 01:29:00		
Sample Size	: 1.124E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Jun-2019 11:02:41	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 10-Jun-2019 11:04:06		
Energy Calibration Date	: 25-Jan-2022 09:51:24	Peak Area Range	: 60 - 4096 channels
Energy Slope	: 0.4996 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.340 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 6.535E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
M	1	74.84	93	108	1.04	150.48	12	20.0	Pb-212
m	2	77.13	138	95	0.96	155.07	12	14.3	Pb-212
	3	186.24	99	72	1.08	373.47	10	18.9	Ra-226 U-235
M	4	238.70	77	32	1.11	478.47	19	16.8	Pb-212
m	5	241.82	78	39	1.40	484.72	19	18.2	Ra-224
	6	295.18	185	49	1.03	591.51	11	10.4	
	7	351.91	338	42	1.00	705.04	11	6.6	
	8	583.29	39	2	1.32	1168.09	10	17.8	
	9	609.29	215	3	1.28	1220.11	10	7.0	
	10	767.97	16	5	0.95	1537.65	10	36.0	
	11	1120.48	49	5	1.13	2242.91	12	17.3	
	12	1238.01	18	2	1.73	2478.03	10	29.2	
	13	1764.44	25	11	1.85	3530.98	12	33.8	

M = First peak in a multiplet region
m = Other peak in a multiplet region

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (µCi/grams)		Activity Uncertainty
Nuclide Type: natural								
Pb-212	0.55	10.64 hrs	74.81	10.70	2.033E+00	5.962E-04		1.218E-04
			77.11	18.00	2.126E+00	5.031E-04		7.515E-05
			87.30	8.00	2.452E+00			
			238.63	44.60	2.137E+00	1.119E-04		1.926E-05
			300.09	3.41	1.822E+00			
		Pb-212 Interference Corrected Final Weighted Mean				1.466E-04	+/-	1.844E-05
Nuclide Type: NP								
Ra-224	0.92	3.62 days	240.98	3.95	2.119E+00	4.859E-06		9.063E-07
		Ra-224 Interference Corrected Final Weighted Mean				4.859E-06	+/-	9.063E-07
Ra-226	1.00	1.60E+03 yrs	186.21	3.28	2.482E+00	2.935E-06		5.653E-07
		Ra-226 Interference Corrected Final Weighted Mean				2.935E-06	+/-	5.653E-07
U-235	0.98	7.04E+08 yrs	89.95	2.70	2.516E+00			
			93.35	4.50	2.587E+00			
			105.00	2.10	2.747E+00			
			109.14	1.50	2.780E+00			
			143.76	10.50	2.759E+00			
			163.35	4.70	2.641E+00			
			185.72	54.00	2.482E+00	1.783E-07		3.434E-08
			202.12	1.00	2.371E+00			
			205.31	4.70	2.350E+00			
		U-235 Interference Corrected Final Weighted Mean				1.783E-07	+/-	3.434E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Analysis Report for 14-Mar-2022-200009 3/14/2022 12:06:21 Page 3 of 4

NUCLIDE MDA REPORT

Nuclide Name	*Energy (keV)*	*Background Sum*	*Nuclide MDA (µCi/grams)*
Na-22	1274.54	3.00	3.408E-08
Cr-51	320.08	31.00	4.036E-07
Mn-54	834.83	9.00	4.162E-08
Co-57	122.06	58.00	3.572E-08
Co-58	810.76	6.00	3.439E-08
Fe-59	1099.22	5.00	7.312E-08
Co-60	1332.49	2.00	2.878E-08
Zn-65	1115.52	5.00	7.826E-08
Se-75	136.00	64.00	5.543E-08
Kr-85	513.99	17.00	8.998E-06
Y-88	1836.01	2.00	3.726E-08
Nb-94	871.10	8.00	4.030E-08
Nb-95	765.79	14.00	5.195E-08
Zr-95	724.18	5.00	6.527E-08
Tc-99m	140.51	63.00	1.002E-07
Cd-109	88.03	91.00	1.169E-06
Ag-110m	657.75	7.00	3.196E-08
Sn-113	391.69	18.00	5.016E-08
Sb-124	602.71	8.00	3.180E-08
Sb-125	427.89	19.00	1.194E-07
I-131	364.48	19.00	5.405E-08
Ba-133	356.01	25.00	5.809E-08
Cs-134	604.70	11.00	3.592E-08
Cs-137	661.65	11.00	4.416E-08
Ce-139	165.85	52.00	3.905E-08
Ce-144	133.54	57.00	2.820E-07
Eu-152	121.78	58.00	1.065E-07
Bi-207	569.67	13.00	3.704E-08
Pb-212	238.63	32.42	1.030E-04
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	38.81	4.454E-06
Ra-226	186.21	71.65	1.545E-06
Ra-228	911.07	16.00	2.140E-07
Th-228	84.37	90.00	3.715E-06
Th-232	59.00	60.00	3.740E-05
Th-234	92.38	85.00	1.660E-06
U-235	185.72	71.65	9.387E-08
Am-241	59.54	64.00	1.993E-07

Analysis Report for 14-Mar-2022-200009 3/14/2022 12:06:21 Page 4 of 4

NID SUMMARY REPORT

Sample Identification	: 14-Mar-2022-200009		
Sample Description	: Unconditional release of solid material Seal-Char-01-001-R		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET01
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 10:20:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 14-Mar-2022 11:49:00	Live Time	: 1000.0 seconds
Decay Time	: 4 01:29:00	Real Time	: 1000.4 seconds
Sample Size	: 1.124E+03 grams	Dead Time	: 0.04 %

	Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt mean Activity (µCi/grams)	Wt mean Activity Uncertainty 1 Sigma	Comments
	Pb-212	natural	10.64 hrs	0.55	1.466E-04	1.844E-05	
	Ra-224	NP	3.62 days	0.92	4.859E-06	9.063E-07	
?	Ra-226	NP	1.60E+03 yrs	1.00	2.935E-06	5.653E-07	
?	U-235	NP	7.04E+08 yrs	0.98	1.783E-07	3.434E-08	
			Total Gamma Activity		1.545E-04		

Errors quoted at 1.000 sigma
? = nuclide is part of an undetermined solution

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

Apex™ 3/14/2022 07:49:07 Page 1 of 4

Analysis Report for 14-Mar-2022-200001

Sample Identification	: 14-Mar-2022-200001		
Sample Description	: Unconditional release of solid material Seal-Char-01-002		
Procedure	: Free Release Solid		
Sample Type	: Checks for Contamination	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	:	Nuclide Library	: UNNATURAL
Sample Point	:	Activity Multiplier	: 1.00
		Live Time	: 1000.0 seconds
Sample Taken On	: 10-Mar-2022 10:36:00	Real Time	: 1000.4 seconds
Acquisition Started	: 14-Mar-2022 07:31:46	Dead Time	: 0.04 %
Decay Time	: 3 20:55:46		
Sample Size	: 1.163E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Jun-2019 11:02:41	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 10-Jun-2019 11:04:06		
Energy Calibration Date	: 25-Jan-2022 09:51:24	Peak Area Range	: 60 - 4096 channels
Energy Slope	: 0.4996 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.340 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 6.535E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
M	1	74.82	97	72	1.04	150.45	20	17.3	Pb-212
m	2	77.07	153	54	0.82	154.95	20	10.9	Pb-212
M	3	87.33	36	65	0.98	175.49	12	40.9	Pb-212
m	4	89.82	29	64	0.98	180.47	12	50.0	U-235
	5	92.84	45	65	1.65	186.51	7	33.4	Th-234 U-235
M	6	186.19	77	41	1.18	373.36	14	19.4	U-235
m	7	187.60	24	27	0.98	376.18	14	54.9	
M	8	238.69	64	50	1.68	478.44	19	24.6	Pb-212
m	9	241.95	101	35	1.22	484.98	19	14.3	Ra-224
	10	295.22	213	32	1.08	591.58	11	8.6	
	11	351.90	345	36	1.04	705.02	12	6.4	
	12	536.62	7	4	0.54	1074.70	6	63.5	
	13	609.15	264	11	1.48	1219.83	15	6.7	
	14	768.19	27	5	0.82	1538.08	10	24.4	
	15	785.99	20	3	1.13	1573.70	12	28.6	
	16	911.46	19	0	1.62	1824.74	11	22.9	
	17	1120.21	65	2	1.77	2242.38	9	13.1	
	18	1154.78	13	0	1.14	2311.54	9	27.7	
	19	1237.81	16	2	0.77	2477.64	10	31.0	
	20	1508.95	13	0	1.32	3020.00	7	27.7	
	21	1764.47	40	0	1.01	3531.05	11	15.8	

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

M = First peak in a multiplet region
m = Other peak in a multiplet region

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	*Id Confid*	*Halflife*	*Energy (keV)*	*Yield (%)*	*Efficiency (%)*	*Activity (µCi/grams)*		*Activity Uncertainty*
Nuclide Type:	*natural*							
Pb-212	0.64	10.64 hrs	74.81	10.70	2.033E+00	4.434E-04		7.921E-05
			77.11	18.00	2.123E+00	3.995E-04		4.686E-05
			87.30	8.00	2.452E+00	1.826E-04		7.526E-05
			238.63	44.60	2.137E+00	6.688E-05		1.667E-05
			300.09	3.41	1.822E+00			
		Pb-212 Interference Corrected Final Weighted Mean				1.197E-04	+/-	1.509E-05
Nuclide Type:	*NP*							
Ra-224	0.90	3.62 days	240.98	3.95	2.118E+00	5.902E-06		8.781E-07
		Ra-224 Interference Corrected Final Weighted Mean				5.902E-06	+/-	8.781E-07
Th-234	0.99	24.10 days	63.29	3.80	1.465E+00			
			92.38	2.72	2.577E+00	1.670E-06		5.631E-07
		Th-234 Interference Corrected Final Weighted Mean				1.420E-06	+/-	5.652E-07
U-235	0.61	7.04E+08 yrs	89.95	2.70	2.513E+00	9.973E-07		5.007E-07
			93.35	4.50	2.577E+00	9.030E-07		3.044E-07
			105.00	2.10	2.747E+00			
			109.14	1.50	2.780E+00			
			143.76	10.50	2.759E+00			
			163.35	4.70	2.641E+00			
			185.72	54.00	2.482E+00	1.332E-07		2.634E-08
			202.12	1.00	2.371E+00			
			205.31	4.70	2.350E+00			
		U-235 Interference Corrected Final Weighted Mean				1.355E-07	+/-	2.630E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Analysis Report for 14-Mar-2022-200001 3/14/2022 07:49:07 Page 3 of 4

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (µCi/grams)
Na-22	1274.54	3.00	3.292E-08
Cr-51	320.08	16.00	2.788E-07
Mn-54	834.83	18.00	5.685E-08
Co-57	122.06	46.00	3.072E-08
Co-58	810.76	7.00	3.583E-08
Fe-59	1099.22	5.00	7.044E-08
Co-60	1332.49	4.00	3.932E-08
Zn-65	1115.52	6.00	8.279E-08
Se-75	136.00	47.00	4.585E-08
Kr-85	513.99	16.00	8.434E-06
Y-88	898.02	7.00	4.103E-08
Nb-94	871.10	5.00	3.078E-08
Nb-95	765.79	14.00	5.001E-08
Zr-95	756.72	5.00	5.158E-08
Tc-99m	140.51	56.00	8.699E-08
Cd-109	88.03	64.95	1.792E-06
Ag-110m	657.75	2.00	1.650E-08
Sn-113	391.69	14.00	4.270E-08
Sb-124	602.71	16.00	4.336E-08
Sb-125	427.89	19.00	1.154E-07
I-131	364.48	26.00	6.010E-08
Ba-133	356.01	19.00	4.893E-08
Cs-134	795.95	2.00	2.121E-08
Cs-137	661.65	11.00	4.267E-08
Ce-139	165.85	57.00	3.947E-08
Ce-144	133.54	65.00	2.909E-07
Eu-152	121.78	51.00	9.648E-08
Bi-207	569.67	14.00	3.713E-08
Pb-212	238.63	50.00	7.715E-05
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	35.00	4.234E-06
Ra-226	186.21	41.12	1.719E-06
Ra-228	911.07	18.00	2.193E-07
Th-228	84.37	71.00	3.187E-06
Th-232	59.00	65.00	3.762E-05
Th-234	92.38	64.94	1.642E-06
U-235	185.72	41.12	1.044E-07
Am-241	59.54	64.00	1.926E-07

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

NID SUMMARY REPORT

Sample Identification	: 14-Mar-2022-200001		
Sample Description	: Unconditional release of solid material Seal-Char-01-002		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET01
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 10:36:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 14-Mar-2022 07:31:46	Live Time	: 1000.0 seconds
Decay Time	: 3 20:55:46	Real Time	: 1000.4 seconds
Sample Size	: 1.163E+03 grams	Dead Time	: 0.04 %

Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt mean Activity (µCi/grams)	Wt mean Activity Uncertainty 1 Sigma	Comments
Pb-212	natural	10.64 hrs	0.64	1.197E-04	1.509E-05	
Ra-224	NP	3.62 days	0.90	5.902E-06	8.781E-07	
Th-234	NP	24.10 days	0.99	1.420E-06	5.652E-07	
U-235	NP	7.04E+08 yrs	0.61	1.355E-07	2.630E-08	
		Total Gamma Activity		1.272E-04		

Errors quoted at 1.000 sigma

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Apex

3/14/2022 12:26:26 Page 1 of 4

Analysis Report for 14-Mar-2022-200011

Sample Identification	: 14-Mar-2022-200011		
Sample Description	: Unconditional release of solid material Seal-Char-01-003		
Procedure	: Free Release Solid		
Sample Type	: Checks for Contamination	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	:	Nuclide Library	: UNNATURAL
Sample Point	:	Activity Multiplier	: 1.00
		Live Time	: 1000.0 seconds
Sample Taken On	: 10-Mar-2022 10:49:00	Real Time	: 1000.5 seconds
Acquisition Started	: 14-Mar-2022 12:09:08	Dead Time	: 0.05 %
Decay Time	: 4 01:20:08		
Sample Size	: 1.132E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Jun-2019 11:02:41	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 10-Jun-2019 11:04:06		
Energy Calibration Date	: 25-Jan-2022 09:51:24	Peak Area Range	: 60 - 4096 channels
Energy Slope	: 0.4996 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.340 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 6.535E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
M	1	74.77	67	94	1.26	150.34	12	29.9	Pb-212
m	2	77.05	121	62	0.91	154.91	12	13.5	Pb-212
	3	87.02	52	98	1.21	174.87	8	35.7	Cd-109
									Pb-212
	4	92.87	45	79	1.13	186.58	8	36.8	Th-234
									U-235
	5	186.18	72	79	1.01	373.35	9	25.0	U-235
M	6	238.56	54	11	1.04	478.19	14	15.8	Pb-212
m	7	241.87	90	19	1.03	484.81	14	13.3	Ra-224
	8	295.17	174	39	1.12	591.48	12	10.4	
	9	351.94	307	28	1.29	705.10	12	6.7	
	10	510.68	32	5	2.02	1022.79	10	22.0	
	11	609.24	181	9	1.39	1220.01	9	8.0	
	12	768.12	24	11	1.59	1537.95	15	36.4	
	13	1120.12	46	2	1.07	2242.20	10	16.1	
	14	1377.05	12	0	0.95	2756.17	7	28.9	
	15	1460.43	17	0	1.26	2922.94	11	24.3	
	16	1764.25	33	0	1.85	3530.61	12	17.4	

M = First peak in a multiplet region
m = Other peak in a multiplet region

Analysis Report for 14-Mar-2022-200011 3/14/2022 12:26:26 Page 2 of 4

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (µCi/grams)		Activity Uncertainty
Nuclide Type:	*AP*							
Cd-109	0.90	464.00 days	88.03	3.72	2.444E+00	1.385E-06		4.988E-07
		Cd-109 Interference Corrected Final Weighted Mean				1.028E-06	+/-	5.009E-07
Nuclide Type:	*natural*							
Pb-212	0.66	10.64 hrs	74.81	10.70	2.030E+00	4.223E-04		1.274E-04
			77.11	18.00	2.123E+00	4.324E-04		6.141E-05
			87.30	8.00	2.444E+00	3.664E-04		1.320E-04
			238.63	44.60	2.138E+00	7.697E-05		1.254E-05
			300.09	3.41	1.822E+00			
		Pb-212 Interference Corrected Final Weighted Mean				9.425E-05	+/-	1.223E-05
Nuclide Type:	*NP*							
Ra-224	0.92	3.62 days	240.98	3.95	2.118E+00	5.608E-06		7.780E-07
		Ra-224 Interference Corrected Final Weighted Mean				5.608E-06	+/-	7.780E-07
Th-234	0.99	24.10 days	63.29	3.80	1.465E+00			
			92.38	2.72	2.577E+00	1.741E-06		6.458E-07
		Th-234 Interference Corrected Final Weighted Mean				1.501E-06	+/-	6.486E-07
U-235	0.61	7.04E+08 yrs	89.95	2.70	2.516E+00			
			93.35	4.50	2.577E+00	9.365E-07		3.473E-07
			105.00	2.10	2.747E+00			
			109.14	1.50	2.780E+00			
			143.76	10.50	2.759E+00			
			163.35	4.70	2.641E+00			
			185.72	54.00	2.482E+00	1.291E-07		3.264E-08
			202.12	1.00	2.371E+00			
			205.31	4.70	2.350E+00			
		U-235 Interference Corrected Final Weighted Mean				1.291E-07	+/-	3.264E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (µCi/grams)
Na-22	1274.54	2.00	2.763E-08
Cr-51	320.08	22.00	3.376E-07
Mn-54	834.83	8.00	3.897E-08
Co-57	122.06	42.00	3.018E-08
Co-58	810.76	8.00	3.944E-08
Fe-59	1099.22	2.00	4.592E-08
Co-60	1332.49	1.00	2.021E-08
Zn-65	1115.52	5.00	7.772E-08
Se-75	136.00	41.00	4.406E-08
Kr-85	513.99	11.00	7.188E-06
Y-88	1836.01	1.00	2.617E-08
Nb-94	702.63	5.00	2.644E-08
Nb-95	765.79	20.00	6.165E-08
Zr-95	756.72	2.00	3.360E-08
Tc-99m	140.51	53.00	9.110E-08
Cd-109	88.03	97.60	1.500E-06
Ag-110m	657.75	7.00	3.174E-08
Sn-113	391.69	18.00	4.981E-08
Sb-124	602.71	10.00	3.531E-08
Sb-125	427.89	9.00	8.162E-08
I-131	364.48	11.00	4.082E-08
Ba-133	356.01	15.00	4.469E-08
Cs-134	795.95	4.00	3.083E-08
Cs-137	661.65	13.00	4.767E-08
Ce-139	165.85	59.00	4.131E-08
Ce-144	133.54	49.00	2.597E-07
Eu-152	121.78	48.00	9.620E-08
Bi-207	569.67	9.00	3.060E-08
Pb-212	238.63	10.59	5.922E-05
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	19.16	2.634E-06
Ra-226	186.21	78.55	1.543E-06
Ra-228	911.07	20.00	2.376E-07
Th-228	84.37	80.00	3.478E-06
Th-232	59.00	45.00	3.217E-05
Th-234	63.29	68.00	1.849E-06
U-235	185.72	78.55	9.373E-08
Am-241	59.54	45.00	1.660E-07

NID SUMMARY REPORT

Sample Identification	: 14-Mar-2022-200011		
Sample Description	: Unconditional release of solid material Seal-Char-01-003		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET01
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 10:49:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 14-Mar-2022 12:09:08	Live Time	: 1000.0 seconds
Decay Time	: 4 01:20:08	Real Time	: 1000.5 seconds
Sample Size	: 1.132E+03 grams	Dead Time	: 0.05 %

Nuclide Name	*Nuclide Type*	*Halflife*	*Nuclide Id Confidence*	*Wt mean Activity (µCi/grams)*	*Wt mean Activity Uncertainty 1 Sigma*	*Comments*
Cd-109	AP	464.00 days	0.90	1.028E-06	5.009E-07	
Pb-212	natural	10.64 hrs	0.66	9.425E-05	1.223E-05	
Ra-224	NP	3.62 days	0.92	5.608E-06	7.780E-07	
Th-234	NP	24.10 days	0.99	1.501E-06	6.486E-07	
U-235	NP	7.04E+08 yrs	0.61	1.291E-07	3.264E-08	
		Total Gamma Activity		1.025E-04		

Errors quoted at 1.000 sigma

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

Apex
3/14/2022 08:26:45 Page 1 of 4

Analysis Report for 14-Mar-2022-200003

Sample Identification	: 14-Mar-2022-200003		
Sample Description	: Unconditional release of solid material Seal-Char-01-004		
Procedure	: Free Release Solid		
Sample Type	: Checks for Contamination	Detector Name	: DET01
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	:	Nuclide Library	: UNNATURAL
Sample Point	:	Activity Multiplier	: 1.00
		Live Time	: 1000.0 seconds
Sample Taken On	: 10-Mar-2022 11:00:00	Real Time	: 1000.4 seconds
Acquisition Started	: 14-Mar-2022 08:09:25	Dead Time	: 0.04 %
Decay Time	: 3 21:09:25		
Sample Size	: 1.262E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Jun-2019 11:02:41	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 10-Jun-2019 11:04:06		
Energy Calibration Date	: 25-Jan-2022 09:51:24	Peak Area Range	: 60 - 4096 channels
Energy Slope	: 0.4996 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: -0.340 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 6.535E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
M	1	75.04	65	84	0.78	150.89	11	25.0	Pb-212
m	2	77.06	128	76	0.79	154.94	11	13.6	Pb-212
	3	87.29	31	105	0.88	175.40	7	57.5	Pb-212
	4	186.10	104	87	1.11	373.19	10	19.5	Ra-226 U-235
M	5	238.86	55	26	1.39	478.77	18	21.2	Pb-212
m	6	242.03	97	50	1.25	485.12	18	16.3	Ra-224
	7	295.16	211	32	1.10	591.47	11	8.6	
	8	351.91	360	33	1.07	705.05	11	6.1	
	9	510.65	22	29	0.72	1022.74	13	54.2	
	10	609.28	250	10	1.15	1220.11	10	6.8	
	11	768.08	28	7	2.08	1537.86	10	26.5	
	12	933.72	21	5	0.88	1869.27	9	28.3	
	13	1120.29	42	6	1.08	2242.54	11	19.0	
	14	1238.17	23	2	1.65	2478.36	8	23.6	

M = First peak in a multiplet region
m = Other peak in a multiplet region

Analysis Report for 14-Mar-2022-200003 3/14/2022 08:26:45 Page 2 of 4

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (µCi/grams)		Activity Uncertainty
Nuclide Type:	natural							
Pb-212	0.68	10.64 hrs	74.81	10.70	2.042E+00	2.785E-04		7.064E-05
			77.11	18.00	2.123E+00	3.138E-04		4.489E-05
			87.30	8.00	2.451E+00	1.466E-04		8.462E-05
			238.63	44.60	2.136E+00	5.437E-05		1.174E-05
			300.09	3.41	1.822E+00			
		Pb-212 Interference Corrected Final Weighted Mean				7.744E-05	+/-	1.112E-05
Nuclide Type:	NP							
Ra-224	0.89	3.62 days	240.98	3.95	2.117E+00	5.254E-06		8.805E-07
		Ra-224 Interference Corrected Final Weighted Mean				5.254E-06	+/-	8.805E-07
Ra-226	1.00	1.60E+03 yrs	186.21	3.28	2.483E+00	2.730E-06		5.420E-07
		Ra-226 Interference Corrected Final Weighted Mean				2.730E-06	+/-	5.420E-07
U-235	0.99	7.04E+08 yrs	89.95	2.70	2.516E+00			
			93.35	4.50	2.587E+00			
			105.00	2.10	2.747E+00			
			109.14	1.50	2.780E+00			
			143.76	10.50	2.759E+00			
			163.35	4.70	2.641E+00			
			185.72	54.00	2.483E+00	1.658E-07		3.292E-08
			202.12	1.00	2.371E+00			
			205.31	4.70	2.350E+00			
		U-235 Interference Corrected Final Weighted Mean				1.658E-07	+/-	3.292E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

NUCLIDE MDA REPORT

Nuclide Name	*Energy (keV)*	*Background Sum*	*Nuclide MDA (µCi/grams)*
Na-22	1274.54	3.00	3.034E-08
Cr-51	320.08	23.00	3.082E-07
Mn-54	834.83	8.00	3.492E-08
Co-57	122.06	51.00	2.981E-08
Co-58	810.76	11.00	4.139E-08
Fe-59	1099.22	3.00	5.028E-08
Co-60	1332.49	3.00	3.138E-08
Zn-65	1115.52	4.00	6.229E-08
Se-75	136.00	37.00	3.749E-08
Kr-85	513.99	20.00	8.689E-06
Y-88	1836.01	2.00	3.314E-08
Nb-94	702.63	8.00	2.998E-08
Nb-95	765.79	23.00	5.907E-08
Zr-95	756.72	6.00	5.207E-08
Tc-99m	140.51	60.00	8.317E-08
Cd-109	88.03	105.21	1.307E-06
Ag-110m	657.75	5.00	2.404E-08
Sn-113	391.69	16.00	4.206E-08
Sb-124	602.71	4.00	1.998E-08
Sb-125	427.89	16.00	9.755E-08
I-131	364.48	22.00	5.098E-08
Ba-133	356.01	20.00	4.626E-08
Cs-134	604.70	8.00	2.727E-08
Cs-137	661.65	20.00	5.301E-08
Ce-139	165.85	71.00	4.059E-08
Ce-144	133.54	39.00	2.076E-07
Eu-152	121.78	46.00	8.443E-08
Bi-207	569.67	11.00	3.033E-08
Pb-212	238.63	25.96	7.150E-05
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	49.82	4.026E-06
Ra-226	186.21	87.16	1.513E-06
Ra-228	911.07	16.00	1.905E-07
Th-228	84.37	93.00	3.361E-06
Th-232	59.00	60.00	3.330E-05
Th-234	92.38	94.00	1.547E-06
U-235	185.72	87.16	9.189E-08
Am-241	59.54	58.00	1.689E-07

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

NID SUMMARY REPORT

Sample Identification	: 14-Mar-2022-200003		
Sample Description	: Unconditional release of solid material Seal-Char-01-004		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET01
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 11:00:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 14-Mar-2022 08:09:25	Live Time	: 1000.0 seconds
Decay Time	: 3 21:09:25	Real Time	: 1000.4 seconds
Sample Size	: 1.262E+03 grams	Dead Time	: 0.04 %

	Nuclide Name	Nuclide Type	Halflife	Nuclide Id Confidence	Wt mean Activity (µCi/grams)	Wt mean Activity Uncertainty 1 Sigma	Comments
	Pb-212	natural	10.64 hrs	0.68	7.744E-05	1.112E-05	
	Ra-224	NP	3.62 days	0.89	5.254E-06	8.805E-07	
?	Ra-226	NP	1.60E+03 yrs	1.00	2.730E-06	5.420E-07	
?	U-235	NP	7.04E+08 yrs	0.99	1.658E-07	3.292E-08	

Total Gamma Activity 8.559E-05

Errors quoted at 1.000 sigma
? = nuclide is part of an undetermined solution

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

Analysis Report for 14-Mar-2022-200010

Sample Identification	: 14-Mar-2022-200010		
Sample Description	: Unconditional release of solid material Seal-Char-01-005		
Procedure	: Free Release Solid		
Sample Type	: Checks for Contamination	Detector Name	: DET03
Facility	: CR3_Radiochemistry	Geometry	: LSB0
Unit	:	Nuclide Library	: UNNATURAL
Sample Point	:	Activity Multiplier	: 1.00
		Live Time	: 1000.0 seconds
Sample Taken On	: 10-Mar-2022 11:11:00	Real Time	: 1000.4 seconds
Acquisition Started	: 14-Mar-2022 11:52:00	Dead Time	: 0.04 %
Decay Time	: 4 00:41:00		
Sample Size	: 1.090E+03 grams	Peak Locate Threshold	: 4.66
		Energy Tolerance	: 1.250 keV
Efficiency Calibration Date	: 10-Jun-2019 11:39:51	Nuclide Confidence ID	: 0.30
Efficiency Approval Date	: 10-Jun-2019 11:41:11		
Energy Calibration Date	: 30-Aug-2021 12:50:05	Peak Area Range	: 60 - 4096 channels
Energy Slope	: 0.4993 keV/channel	Peak Search Version	: PEAK V16.10
Offset	: 1.378 keV	Peak Analysis Version	: PEAK V16.10
Quad Coefficient	: 9.988E-08	MDA Version	: Std MDA v2.4
		NID Version	: NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
	1	46.24	51	73	0.67	89.85	8	31.8	
M	2	74.73	174	123	1.14	146.91	16	12.5	Pb-212
m	3	77.17	252	125	1.14	151.79	16	9.6	Pb-212
M	4	87.30	68	102	1.31	172.08	21	25.1	Cd-109 Pb-212
m	5	89.69	55	117	1.40	176.87	21	37.2	U-235
m	6	92.60	80	99	1.41	182.70	21	25.6	U-235
	7	186.01	127	104	0.77	369.76	10	17.5	U-235
M	8	238.46	142	68	1.13	474.79	17	12.0	Pb-212
m	9	241.86	123	66	1.43	481.59	17	15.5	Ra-224
	10	295.05	262	36	1.00	588.09	10	7.6	
	11	351.73	384	50	1.08	701.60	12	6.3	
	12	582.87	45	26	1.28	1164.34	9	25.7	
	13	609.08	283	9	1.25	1216.82	13	6.4	
	14	767.86	35	11	1.16	1534.65	11	24.9	
	15	785.25	18	4	1.39	1569.46	9	31.7	
	16	835.19	11	2	0.75	1669.40	7	35.2	Mn-54
	17	910.97	31	5	1.34	1821.08	9	21.8	
	18	933.82	29	3	1.50	1866.81	10	21.2	
	19	1120.16	58	3	1.78	2239.70	11	14.2	
	20	1238.28	13	7	1.92	2476.05	9	45.0	
	21	1460.67	52	0	1.51	2920.98	13	13.9	
	22	1729.98	12	0	1.66	3459.67	8	28.9	

Analysis Report for 14-Mar-2022-200010 3/14/2022 12:09:18 Page 2 of 5

Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
23	1764.61	64	0	1.69	3528.92	15	12.5	

M = First peak in a multiplet region
m = Other peak in a multiplet region

Analysis Report for 14-Mar-2022-200010 3/14/2022 12:09:18 Page 3 of 5

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (µCi/grams)		Activity Uncertainty
Nuclide Type:	*AP*							
Mn-54	0.99	312.70 days	834.83	99.97	9.131E-01	3.120E-08		1.106E-08
		Mn-54 Interference Corrected Final Weighted Mean				3.120E-08	+/-	1.106E-08
Cd-109	0.95	464.00 days	88.03	3.72	2.545E+00	1.782E-06		4.554E-07
		Cd-109 Interference Corrected Final Weighted Mean				8.434E-07	+/-	4.633E-07
Nuclide Type:	*natural*							
Pb-212	0.62	10.64 hrs	74.81	10.70	2.056E+00	1.078E-03		1.427E-04
			77.11	18.00	2.167E+00	8.772E-04		9.226E-05
			87.30	8.00	2.545E+00	4.519E-04		1.155E-04
			238.63	44.60	2.411E+00	1.791E-04		2.252E-05
			300.09	3.41	2.057E+00			
		Pb-212 Interference Corrected Final Weighted Mean				2.380E-04	+/-	2.162E-05
Nuclide Type:	*NP*							
Ra-224	0.92	3.62 days	240.98	3.95	2.389E+00	7.020E-06		1.124E-06
		Ra-224 Interference Corrected Final Weighted Mean				7.020E-06	+/-	1.124E-06
U-235	0.61	7.04E+08 yrs	89.95	2.70	2.616E+00	1.938E-06		7.270E-07
			93.35	4.50	2.693E+00	1.634E-06		4.256E-07
			105.00	2.10	2.926E+00			
			109.14	1.50	2.975E+00			
			143.76	10.50	3.038E+00			
			163.35	4.70	2.936E+00			
			185.72	54.00	2.780E+00	2.102E-07		3.765E-08
			202.12	1.00	2.663E+00			
			205.31	4.70	2.640E+00			
		U-235 Interference Corrected Final Weighted Mean				2.258E-07	+/-	3.746E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (µCi/grams)
Na-22	1274.54	6.00	4.398E-08
Cr-51	320.08	40.00	4.185E-07
Mn-54	834.83	1.62	1.950E-08
Co-57	122.06	87.00	4.159E-08
Co-58	810.76	13.00	4.651E-08
Fe-59	1099.22	4.00	5.979E-08
Co-60	1332.49	3.00	3.214E-08
Zn-65	1115.52	3.00	5.544E-08
Se-75	136.00	81.00	5.865E-08
Kr-85	513.99	28.00	1.061E-05
Y-88	1836.01	4.00	4.816E-08
Nb-94	871.10	9.00	3.925E-08
Nb-95	765.79	46.00	8.652E-08
Zr-95	756.72	9.00	6.597E-08
Tc-99m	140.51	85.00	1.082E-07
Cd-109	88.03	101.85	3.545E-06
Ag-110m	657.75	17.00	4.581E-08
Sn-113	391.69	23.00	5.190E-08
Sb-124	602.71	18.00	4.386E-08
Sb-125	427.89	23.00	1.204E-07
I-131	364.48	33.00	6.496E-08
Ba-133	356.01	22.00	4.983E-08
Cs-134	604.70	15.00	3.857E-08
Cs-137	661.65	19.00	5.339E-08
Ce-139	165.85	98.00	4.967E-08
Ce-144	133.54	80.00	3.148E-07
Eu-152	344.27	21.00	1.074E-07
Bi-207	569.67	14.00	3.534E-08
Pb-212	238.63	67.93	1.087E-04
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	65.55	4.878E-06
Ra-226	186.21	103.70	1.712E-06
Ra-228	911.07	37.00	2.986E-07
Th-228	84.37	154.00	4.850E-06
Th-232	59.00	79.00	4.533E-05
Th-234	92.38	166.00	2.283E-06
U-235	185.72	103.70	1.040E-07
Am-241	59.54	86.00	2.436E-07

ADP CR3, LLC

CR3 Decommissioning

15760 West Power Line Street | Crystal River, FL 34428

NID SUMMARY REPORT

Sample Identification	: 14-Mar-2022-200010		
Sample Description	: Unconditional release of solid material Seal-Char-01-005		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET03
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 11:11:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 14-Mar-2022 11:52:00	Live Time	: 1000.0 seconds
Decay Time	: 4 00:41:00	Real Time	: 1000.4 seconds
Sample Size	: 1.090E+03 grams	Dead Time	: 0.04 %

Nuclide Name	*Nuclide Type*	*Halflife*	*Nuclide Id Confidence*	*Wt mean Activity (µCi/grams)*	*Wt mean Activity Uncertainty 1 Sigma*	*Comments*
Mn-54	AP	312.70 days	0.99	3.120E-08	1.106E-08	
Cd-109	AP	464.00 days	0.95	8.434E-07	4.633E-07	
Pb-212	natural	10.64 hrs	0.62	2.380E-04	2.162E-05	
Ra-224	NP	3.62 days	0.92	7.020E-06	1.124E-06	
U-235	NP	7.04E+08 yrs	0.61	2.258E-07	3.746E-08	
		Total Gamma Activity		2.462E-04		

Errors quoted at 1.000 sigma

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

3/14/2022 07:49:58 Page 1 of 4

Apex

Analysis Report for 14-Mar-2022-200002

Sample Identification : 14-Mar-2022-200002
Sample Description : Unconditional release of solid material Seal-Char-01-006
Procedure : Free Release Solid

Sample Type : Checks for Contamination
Facility : CR3_Radiochemistry
Unit :
Sample Point :

Sample Taken On : 10-Mar-2022 11:14:00
Acquisition Started : 14-Mar-2022 07:32:39
Decay Time : 3 20:18:39
Sample Size : 1.304E+03 grams

Efficiency Calibration Date : 10-Jun-2019 11:39:51
Efficiency Approval Date : 10-Jun-2019 11:41:11
Energy Calibration Date : 30-Aug-2021 12:50:05
Energy Slope : 0.4993 keV/channel
Offset : 1.378 keV
Quad Coefficient : 9.988E-08

Detector Name : DET03
Geometry : LSB0
Nuclide Library : UNNATURAL
Activity Multiplier : 1.00
Live Time : 1000.0 seconds
Real Time : 1000.4 seconds
Dead Time : 0.04 %

Peak Locate Threshold : 4.66
Energy Tolerance : 1.250 keV
Nuclide Confidence ID : 0.30

Peak Area Range : 60 - 4096 channels
Peak Search Version : PEAK V16.10
Peak Analysis Version : PEAK V16.10
MDA Version : Std MDA v2.4
NID Version : NID+Interf v2.6

PEAK ANALYSIS REPORT

	Peak No.	Energy (keV)	Net Peak Area	Continuum Counts	FWHM (keV)	Peak Centroid	Peak Width	% Error 1 Sigma	Nuclide
M	1	74.68	128	141	1.00	146.81	15	16.1	
m	2	77.11	228	119	0.92	151.68	15	10.0	
	3	87.15	47	135	0.63	171.78	7	42.8	Cd-109
	4	92.73	55	94	1.01	182.96	7	32.6	Th-234 U-235
	5	185.94	107	86	1.05	369.62	7	17.2	U-235
M	6	237.07	30	37	1.21	472.00	19	44.6	
m	7	241.87	176	45	1.21	481.62	19	9.4	Ra-224
	8	295.10	258	69	0.86	588.20	9	8.5	
	9	351.69	490	54	1.14	701.51	12	5.4	
	10	582.42	26	15	1.09	1163.45	12	35.9	
	11	609.05	361	18	1.19	1216.76	12	5.7	
	12	767.95	50	3	1.51	1534.82	12	15.8	
	13	786.12	20	6	0.90	1571.20	12	32.5	
	14	1120.09	71	12	1.10	2239.56	12	15.4	
	15	1154.85	18	0	0.70	2309.11	9	23.6	
	16	1237.68	31	2	1.78	2474.85	10	20.5	
	17	1377.68	20	2	0.74	2754.95	9	26.0	
	18	1407.24	14	6	1.31	2814.09	12	42.7	
	19	1764.53	65	0	1.90	3528.77	12	12.4	

Analysis Report for 14-Mar-2022-200002 3/14/2022 07:49:58 Page 2 of 4

M = First peak in a multiplet region
m = Other peak in a multiplet region

NUCLIDE LINE IDENTIFICATION REPORT

Nuclide Name	Id Confid	Halflife	Energy (keV)	Yield (%)	Efficiency (%)	Activity (µCi/grams)		Activity Uncertainty
Nuclide Type: AP								
Cd-109	0.92	464.00 days	88.03	3.72	2.540E+00	1.045E-06		4.505E-07
		Cd-109 Interference Corrected Final Weighted Mean				1.045E-06	+/-	4.505E-07
Nuclide Type: NP								
Ra-224	0.92	3.62 days	240.98	3.95	2.389E+00	8.085E-06		8.194E-07
		Ra-224 Interference Corrected Final Weighted Mean				8.085E-06	+/-	8.194E-07
Th-234	0.99	24.10 days	63.29	3.80	1.446E+00			
			92.38	2.72	2.696E+00	1.723E-06		5.683E-07
		Th-234 Interference Corrected Final Weighted Mean				1.449E-06	+/-	5.704E-07
U-235	0.62	7.04E+08 yrs	89.95	2.70	2.623E+00			
			93.35	4.50	2.696E+00	9.324E-07		3.075E-07
			105.00	2.10	2.926E+00			
			109.14	1.50	2.975E+00			
			143.76	10.50	3.038E+00			
			163.35	4.70	2.936E+00			
			185.72	54.00	2.781E+00	1.482E-07		2.626E-08
			202.12	1.00	2.663E+00			
			205.31	4.70	2.640E+00			
		U-235 Interference Corrected Final Weighted Mean				1.482E-07	+/-	2.626E-08

Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Analysis Report for 14-Mar-2022-200002 3/14/2022 07:49:58 Page 3 of 4

NUCLIDE MDA REPORT

Nuclide Name	Energy (keV)	Background Sum	Nuclide MDA (µCi/grams)
Na-22	1274.54	6.00	3.677E-08
Cr-51	320.08	43.00	3.611E-07
Mn-54	834.83	13.00	3.841E-08
Co-57	122.06	91.00	3.555E-08
Co-58	810.76	11.00	3.571E-08
Fe-59	1099.22	5.00	5.574E-08
Co-60	1332.49	4.00	3.103E-08
Zn-65	1115.52	11.00	8.872E-08
Se-75	264.65	51.00	5.237E-08
Kr-85	513.99	24.00	8.211E-06
Y-88	1836.01	1.00	2.011E-08
Nb-94	702.63	10.00	2.895E-08
Nb-95	765.79	45.00	7.130E-08
Zr-95	756.72	9.00	5.505E-08
Tc-99m	140.51	91.00	8.943E-08
Cd-109	88.03	134.64	1.386E-06
Ag-110m	657.75	15.00	3.597E-08
Sn-113	391.69	26.00	4.609E-08
Sb-124	602.71	15.00	3.341E-08
Sb-125	427.89	36.00	1.260E-07
I-131	364.48	25.00	4.654E-08
Ba-133	356.01	30.00	4.865E-08
Cs-134	604.70	15.00	3.225E-08
Cs-137	661.65	9.00	3.072E-08
Ce-139	165.85	103.00	4.254E-08
Ce-144	133.54	102.00	2.971E-07
Eu-152	121.78	100.00	1.112E-07
Bi-207	569.67	14.00	2.955E-08
Pb-212	238.63	156.00	4.625E-05
Bi-214	No MDA calculated. Half life of 19.90 minutes is to short.		
Pb-214	No MDA calculated. Half life of 26.80 minutes is to short.		
Ra-224	240.98	45.24	3.660E-06
Ra-226	186.21	85.61	1.148E-06
Ra-228	911.07	21.00	1.881E-07
Th-228	84.37	152.00	4.029E-06
Th-232	59.00	115.00	4.573E-05
Th-234	92.38	94.43	1.684E-06
U-235	185.72	85.61	6.973E-08
Am-241	59.54	112.00	2.325E-07

Analysis Report for 14-Mar-2022-200002 3/14/2022 07:49:58 Page 4 of 4

NID SUMMARY REPORT

Sample Identification	: 14-Mar-2022-200002		
Sample Description	: Unconditional release of solid material Seal-Char-01-006		
Procedure	: Free Release Solid		
Facility	: CR3_Radiochemistry		
Unit	:	Detector Name	: DET03
Sample Point	:	Geometry	: LSB0
Sample Taken On	: 10-Mar-2022 11:14:00	Nuclide Library	: UNNATURAL
Acquisition Started	: 14-Mar-2022 07:32:39	Live Time	: 1000.0 seconds
Decay Time	: 3 20:18:39	Real Time	: 1000.4 seconds
Sample Size	: 1.304E+03 grams	Dead Time	: 0.04 %

Nuclide Name	*Nuclide Type*	*Halflife*	*Nuclide Id Confidence*	*Wt mean Activity (µCi/grams)*	*Wt mean Activity Uncertainty 1 Sigma*	*Comments*
Cd-109	AP	464.00 days	0.92	1.045E-06	4.505E-07	
Ra-224	NP	3.62 days	0.92	8.085E-06	8.194E-07	
Th-234	NP	24.10 days	0.99	1.449E-06	5.704E-07	
U-235	NP	7.04E+08 yrs	0.62	1.482E-07	2.626E-08	
		Total Gamma Activity		1.073E-05		

Errors quoted at 1.000 sigma

UNIDENTIFIED PEAK REPORT

No Unidentified Peaks Present

ATTACHMENT C

GEL-SEAL-CHAR-01-001-S

GEL Laboratories LLC
a member of The GEL Group INC

PO Box 30712 · Charleston SC 29417
2040 Savage Road · Charleston SC 29407
P 843.556.8171
F 843.766.1178

gel.com

April 07, 2022

Chuck Burtoff
Progress Energy - Crystal River NPP
15760 W. Powerline Street
CR3 Nuclear Plant, Mail Code NA2B
Crystal River, Florida 34428

Re: Part 61 CR3 Nuclear Plant
Work Order: 573893

Dear Chuck Burtoff:

GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on March 21, 2022. This original data report has been prepared and reviewed in accordance with GEL's standard operating procedures.

Test results for NELAP or ISO 17025 accredited tests are verified to meet the requirements of those standards, with any exceptions noted. The results reported relate only to the items tested and to the sample as received by the laboratory. These results may not be reproduced except as full reports without approval by the laboratory. Copies of GEL's accreditations and certifications can be found on our website at www.gel.com.

Our policy is to provide high quality, personalized analytical services to enable you to meet your analytical needs on time every time. We trust that you will find everything in order and to your satisfaction. If you have any questions, please do not hesitate to call me at (843) 556-8171, ext. 1648.

Sincerely,

Meredith Boddiford

Meredith Boddiford
Project Manager

Purchase Order: GEL-CR0001
Enclosures

22-03-0133 pg 3 of 35

573843

Chain of Custody and Analytical Request

Page: 1 of 1 Project # CR-3/ FSS GEL Quote #: COC Number [1]: PO Number: GEL-CR0001	GEL Work Order Number: GEL Project Manager:	GEL Laboratories, LLC 2040 Savage Road Charleston, SC 29407 Phone: (843) 556-8171 Fax: (843) 766-1178

Client Name: NorthStar — Phone # (352) 224-1200

Project/Site Name: CR3 — Fax # N/A

Address: 15760 WEST POWER LINE STREET CRYSTAL RIVER FL. 34428

Collected By: M. Mennella/C. Beluscak — Send Results To : Chuck Burtoff

Sample Analysis Requested [5] (Fill in the number of containers for each test) — <-- Preservative Type (6)

Sample ID * For composites - indicate start and stop date/time	*Date Collected (mm-dd-yy)	*Time Collected (Military) (hhmm)	QC Code [2]	Field Filtered [3]	Sample Matrix [4]	Should this sample be considered: Radioactive (If yes, please supply isotopic info.)	(7) Known or possible Hazards	Total number of containers	see attached										Comments Note: extra sample is required for sample specific QC
EOCZ-Char-01-002-S	3/4/2022	1024	N	N	SO	N	N												
R16Y-Char-01-001-S	3/8/2022	0955	N	N	SO	N	N												
WOCZ-Char-01-005-S	3/14/2022	0935	N	N	SO	N	N												
SEAL-Char-01-001-S	3/10/2022	1020	N	N	SO	N	N												
SOCZ-Char-01-005-S	3/9/2022	1011	N	N	SO	N	N												
EORB-CHAR-01-004-S	3/16/2022	1534	N	N	SO	N	N												

Chain of Custody Signatures

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1			1 Thyasia Sahue	2/1/22	1310
2			2		
3			3		

TAT Requested: Normal: X Rush: ___ Specify: ___ (Subject to Surcharge)

Fax Results: [ ] Yes [X] No

Select Deliverable: [ ] C of A [ ] QC Summary [ ] level 1 [ ] Level 2 [ ] Level 3 [ ] Level 4

Additional Remarks:

For Lab Receiving Use Only: Custody Seal Intact? [ ] Yes [ ] No *Cooler Temp:* ____ °C

> For sample shipping and delivery details, see Sample Receipt & Review form (SRR.)

Sample Collection Time Zone: [ ] Eastern [ ] Pacific [ ] Central [ ] Mountain [ ] Other:

1.) Chain of Custody Number = Client Determined

2.) QC Codes: N = Normal Sample, TB = Trip Blank, FD = Field Duplicate, EB = Equipment Blank, MS = Matrix Spike Sample, MSD = Matrix Spike Duplicate Sample, G = Grab, C = Composite

3.) Field Filtered: For liquid matrices, indicate with a - Y - for yes the sample was field filtered or - N - for sample was not field filtered.

4.) Matrix Codes: DW=Drinking Water, GW=Groundwater, SW=Surface Water, WW=Waste Water, W=Water, ML=Misc Liquid, SO=Soil, SD=Sediment, SL=Sludge, SS=Solid Waste, O=Oil, F=Filter, P=Wipe, U=Urine, F=Fecal, N=Nasal

5.) Sample Analysis Requested: Analytical method requested (i.e. 8260B, 6010B/7470A) and number of containers provided for each (i.e. *8260B* - 3, *6010B/7470A* - 1).

6.) Preservative Type: HA = Hydrochloric Acid, NI = Nitric Acid, SH = Sodium Hydroxide, SA = Sulfuric Acid, AA = Ascorbic Acid, HX = Hexane, ST = Sodium Thiosulfate, If no preservative is added = leave field blank

7.) KNOWN OR POSSIBLE HAZARDS

RCRA Metals
As = Arsenic — Hg = Mercury
Ba = Barium — Se = Selenium
Cd = Cadmium — Ag = Silver
Cr = Chromium — MR = Misc. RCRA metals
Pb = Lead

Characteristic Hazards
FL = Flammable/Ignitable
CO = Corrosive
RE = Reactive

TSCA Regulated
PCB = Polychlorinated biphenyls

Listed Waste
LW = Listed Waste
(F,K,P and U-listed wastes.)
Waste code(s):

Other
OT = Other / Unknown
(i.e.: High/low pH, asbestos, beryllium, irritants, other misc. health hazards, etc.)
Description:

Please provide any additional details below regarding handling and/or disposal concerns. (i.e.: Origin of sample(s), type of site collected from, odd matrices, etc.)

ADP CR3, LLC
CR3 Decommissioning
15760 West Power Line Street | Crystal River, FL 34428

GEL Laboratories LLC

SAMPLE RECEIPT & REVIEW FORM

Client: CR4S	SDG/AR/COC/Work Order: 573893 M.B
Received By: TYE	Date Received: 3/21/22
Carrier and Tracking Number	Circle Applicable: FedEx Express FedEx Ground UPS Field Services Courier Other 7763 2600 3593

Suspected Hazard Information	Yes	No	*If Net Counts > 100cpm on samples not marked "radioactive", contact the Radiation Safety Group for further investigation.
A) Shipped as a DOT Hazardous?		✓	Hazard Class Shipped: UN#: If UN2910, Is the Radioactive Shipment Survey Compliant? Yes___ No___
B) Did the client designate the samples are to be received as radioactive?		✓	COC notation or radioactive stickers on containers equal client designation.
C) Did the RSO classify the samples as radioactive?	✓		Maximum Net Counts Observed* (Observed Counts - Area Background Counts): φ CPM / mR/Hr Classified as: Rad 1 Rad 2 Rad 3
D) Did the client designate samples are hazardous?		✓	COC notation or hazard labels on containers equal client designation.
E) Did the RSO identify possible hazards?		✓	If D or E is yes, select Hazards below. PCB's Flammable Foreign Soil RCRA Asbestos Beryllium Other:

	Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1	Shipping containers received intact and sealed?	✓			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
2	Chain of custody documents included with shipment?	✓			Circle Applicable: Client contacted and provided COC COC created upon receipt
3	Samples requiring cold preservation within (0 ≤ 6 deg. C)?*			✓	Preservation Method: Wet Ice Ice Packs Dry ice None Other: *all temperatures are recorded in Celsius TEMP: 16°C
4	Daily check performed and passed on IR temperature gun?	✓			Temperature Device Serial #: IR2-20 Secondary Temperature Device Serial # (If Applicable):
5	Sample containers intact and sealed?	✓			Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
6	Samples requiring chemical preservation at proper pH?		✓		Sample ID's and Containers Affected: If Preservation added, Lot#:
7	Do any samples require Volatile Analysis?			✓	If Yes, are Encores or Soil Kits present for solids? Yes___ No___ NA___(If yes, take to VOA Freezer) Do liquid VOA vials contain acid preservation? Yes___ No___ NA___(If unknown, select No) Are liquid VOA vials free of headspace? Yes___ No___ NA___ Sample ID's and containers affected:
8	Samples received within holding time?	✓			ID's and tests affected:
9	Sample ID's on COC match ID's on bottles?	✓			ID's and containers affected:
10	Date & time on COC match date & time on bottles?		✓		Circle Applicable: No dates on containers No times on containers COC missing info Other (describe)
11	Number of containers received match number indicated on COC?	✓			Circle Applicable: No container count on COC Other (describe)
12	Are sample containers identifiable as GEL provided by use of GEL labels?			✓	
13	COC form is properly signed in relinquished/received sections?	✓			Circle Applicable: Not relinquished Other (describe)

Comments (Use Continuation Form if needed):

ID: EORB-CHAR-01-004-S (RAD1)

All Other's NON-RAD.

PM (or PMA) review: Initials AM Date 3/24/22 Page 1 of 1

GL-CHL-SR-001 Rev 7

Page 3 of 77 SDG: 573893

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis Report
for

CRYS002 Crystal River Nuclear Plant, NorthStar(GEL-CR0001)
Client SDG: 573893 GEL Work Order: 573893

The Qualifiers in this report are defined as follows:

* A quality control analyte recovery is outside of specified acceptance criteria
** Analyte is a Tracer compound
** Analyte is a surrogate compound
U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
UI Gamma Spectroscopy--Uncertain identification

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Meredith Boddiford.

Reviewed by Meredith Boddiford

GEL LABORATORIES LLC
2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: April 7, 2022

Company :	Progress Energy - Crystal River NPP
Address :	15760 W. Powerline Street CR3 Nuclear Plant, Mail Code NA2B Crystal River, Florida 34428
Contact:	Chuck Burtoff
Project:	Part 61 CR3 Nuclear Plant

Client Sample ID:	SEAL-Char-01-001-S	Project:	CRYS00212
Sample ID:	573893004	Client ID:	CRYS002
Matrix:	Solid		
Collect Date:	10-MAR-22 10:20		
Receive Date:	21-MAR-22		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Alpha Spec Analysis													
Alphaspec Am241 Cm, Solid "Dry Weight Corrected"													
Americium-241	U	0.0877	+/-0.241	0.419	20.0	pCi/g			BV1	04/01/22	0904	2246439	1
Curium-242	U	0.0564	+/-0.212	0.356	1.00	pCi/g							
Curium-243/244	U	-0.179	+/-0.172	0.606	7.60	pCi/g							
Curium-245/246	U	0.000	+/-0.158	0.235	1.00	pCi/g							
Alphaspec Pu242, Solid "Dry Weight Corrected"													
Plutonium-238	U	0.0871	+/-0.300	0.481	0.0170	pCi/g			BV1	04/01/22	0904	2245650	2
Plutonium-239/240	U	0.0172	+/-0.306	0.664	0.0140	pCi/g							
Plutonium-242	U	-0.0771	+/-0.220	0.638	1.00E-04	pCi/g							
Liquid Scint Pu241, Solid "Dry Weight Corrected"													
Plutonium-241	U	-3.15	+/-53.6	94.8	0.00620	pCi/g			BV1	04/04/22	1309	2245651	3
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "As Received"													
Actinium-228	U	-0.0128	+/-0.190	0.353		pCi/g			MXR1	03/23/22	0928	2244545	4
Americium-241	U	0.0227	+/-0.0539	0.0887		pCi/g							
Antimony-124	U	0.00311	+/-0.0846	0.177		pCi/g							
Antimony-125	U	-0.0141	+/-0.0894	0.159		pCi/g							
Barium-133	U	-0.0161	+/-0.0458	0.0706		pCi/g							
Barium-140	U	-0.00772	+/-0.242	0.438		pCi/g							
Beryllium-7	U	0.113	+/-0.347	0.646		pCi/g							
Bismuth-212	U	-0.0959	+/-0.603	1.02		pCi/g							
Bismuth-214		1.35	+/-0.205	0.133		pCi/g							
Cerium-139	U	0.000304	+/-0.0240	0.0440		pCi/g							
Cerium-141	U	0.00829	+/-0.0487	0.0819		pCi/g							
Cerium-144	U	0.0432	+/-0.140	0.264		pCi/g							
Cesium-134	U	-0.00866	+/-0.0388	0.0734		pCi/g							
Cesium-136	U	-0.0605	+/-0.104	0.182		pCi/g							
Cesium-137	U	0.0196	+/-0.0762	0.0660	0.100	pCi/g							
Chromium-51	U	0.202	+/-0.316	0.610		pCi/g							
Cobalt-56	U	-0.0167	+/-0.0358	0.0653		pCi/g							
Cobalt-57	U	-0.0137	+/-0.0177	0.0310		pCi/g							
Cobalt-58	U	-0.0190	+/-0.0374	0.0676		pCi/g							
Cobalt-60	U	0.0174	+/-0.0397	0.0847		pCi/g							
Europium-152	U	-0.0199	+/-0.0865	0.154		pCi/g							
Europium-154	U	-0.00414	+/-0.114	0.223		pCi/g							
Europium-155	U	0.0257	+/-0.0725	0.125		pCi/g							

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: April 7, 2022

Company :	Progress Energy - Crystal River NPP
Address :	15760 W. Powerline Street CR3 Nuclear Plant, Mail Code NA2B Crystal River, Florida 34428
Contact:	Chuck Burtoff
Project:	Part 61 CR3 Nuclear Plant

Client Sample ID:	SEAL-Char-01-001-S	Project:	CRYS00212
Sample ID:	573893004	Client ID:	CRYS002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "As Received"													
Iridium-192	U	-0.0266	+/-0.0310	0.0515		pCi/g							
Iron-59	U	0.0721	+/-0.0858	0.188		pCi/g							
Lead-210	U	0.443	+/-0.852	0.782		pCi/g							
Lead-212		0.127	+/-0.0834	0.0840		pCi/g							
Lead-214		1.58	+/-0.230	0.402		pCi/g							
Manganese-54	U	0.0362	+/-0.0433	0.0899		pCi/g							
Mercury-203	U	-0.0109	+/-0.0382	0.0600		pCi/g							
Neodymium-147	U	-0.0699	+/-0.545	0.965		pCi/g							
Neptunium-239	U	0.0619	+/-0.189	0.356		pCi/g							
Niobium-94	U	0.0364	+/-0.0445	0.0577		pCi/g							
Niobium-95	U	0.00536	+/-0.0408	0.0723		pCi/g							
Potassium-40	U	-0.0569	+/-0.535	1.07		pCi/g							
Promethium-144	U	0.00366	+/-0.0453	0.0726		pCi/g							
Promethium-146	U	-0.000580	+/-0.0429	0.0775		pCi/g							
Radium-228	U	-0.0128	+/-0.190	0.353		pCi/g							
Ruthenium-106	U	0.0206	+/-0.334	0.610		pCi/g							
Silver-110m	U	0.00814	+/-0.0478	0.0874		pCi/g							
Sodium-22	U	0.000383	+/-0.0407	0.0798		pCi/g							
Thallium-208	U	0.0676	+/-0.0497	0.0974		pCi/g							
Thorium-234	U	0.418	+/-0.734	0.840		pCi/g							
Tin-113	U	0.00242	+/-0.0417	0.0762		pCi/g							
Uranium-235	U	0.160	+/-0.238	0.264		pCi/g							
Uranium-238	U	0.418	+/-0.734	0.840		pCi/g							
Yttrium-88	U	0.0188	+/-0.0364	0.0880		pCi/g							
Zinc-65	U	-0.0522	+/-0.115	0.173		pCi/g							
Zirconium-95	U	-0.0341	+/-0.0675	0.122		pCi/g							
Gamma Ni59, Solid "Dry Weight Corrected"													
Nickel-59	U	-8.96	+/-27.4	53.4	0.220	pCi/g			TXJ1	04/01/22	1122	2245447	5
Rad Gas Flow Proportional Counting													
GFPC,Sr89&Sr90, Solid "Dry Weight Corrected"													
Strontium-89	U	0.179	+/-0.867	1.60	2.00	pCi/g			KP1	03/29/22	1333	2246336	6
Strontium-90	U	1.04	+/-0.736	1.72	2.00	pCi/g							
Rad Liquid Scintillation Analysis													
LSC, Tritium Distillation, Solid "As Received"													
Tritium	U	1.10	+/-2.06	3.67	6.00	pCi/g			KXA1	03/29/22	2114	2245325	7

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: April 7, 2022

Company :	Progress Energy - Crystal River NPP
Address :	15760 W. Powerline Street CR3 Nuclear Plant, Mail Code NA2B Crystal River, Florida 34428
Contact:	Chuck Burtoff
Project:	Part 61 CR3 Nuclear Plant

Client Sample ID:	SEAL-Char-01-001-S	Project:	CRYS00212
Sample ID:	573893004	Client ID:	CRYS002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis													
Liquid Scint C14, Solid "As Received"													
Carbon-14	U	1.42	+/-1.16	1.93	2.00	pCi/g			KXA1	03/28/22	1834	2245377	8
Liquid Scint Tc99, Solid "As Received"													
Technetium-99	U	-26.3	+/-38.5	69.2	0.00230	pCi/g			AG2	03/29/22	1431	2244490	9
Liquid Scint Fe55, Solid "Dry Weight Corrected"													
Iron-55	U	-5.73	+/-52.4	84.5	0.700	pCi/g			TXJ1	04/01/22	1543	2245428	10
Liquid Scint Ni63, Solid "Dry Weight Corrected"													
Nickel-63	U	18.5	+/-28.2	47.9	0.00350	pCi/g			TXJ1	04/01/22	1812	2245434	11

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXB7	03/22/22	1925	2244459

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE EML HASL-300, Am-05-RC Modified	
2	DOE EML HASL-300, Pu-11-RC Modified	
3	DOE EML HASL-300, Pu-11-RC Modified	
4	DOE HASL 300, 4.5.2.3/Ga-01-R	
5	DOE RESL Ni-1	
6	EPA 905.0 Modified/DOE RP501 Rev. 1 Modified	
7	EPA 906.0 Modified	
8	EPA EERF C-01 Modified	
9	DOE EML HASL-300, Tc-02-RC Modified	
10	DOE RESL Fe-1, Modified	
11	DOE RESL Ni-1, Modified	

Surrogate/Tracer Recovery	Test	Result	Nominal	Recovery%	Acceptable Limits
Americium-243 Tracer	Alphaspec Am241 Cm, Solid "Dry Weight Corrected"			64.9	(15%-125%)
Plutonium-236 Tracer	Alphaspec Pu242, Solid "Dry Weight Corrected"			82.3	(15%-125%)
Plutonium-236 Tracer	Liquid Scint Pu241, Solid "Dry Weight Corrected"			82.3	(15%-125%)
Nickel Carrier	Gamma Ni59, Solid "Dry Weight Corrected"			96.6	(25%-125%)
Strontium Carrier	GFPC,Sr89&Sr90, Solid "Dry Weight Corrected"			89.7	(25%-125%)
Yttrium Carrier	GFPC,Sr89&Sr90, Solid "Dry Weight Corrected"			89	(25%-125%)
Technetium-99m Tracer	Liquid Scint Tc99, Solid "As Received"			51.9	(15%-125%)

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: April 7, 2022

Company :	Progress Energy - Crystal River NPP
Address :	15760 W. Powerline Street CR3 Nuclear Plant, Mail Code NA2B Crystal River, Florida 34428
Contact:	Chuck Burtoff
Project:	Part 61 CR3 Nuclear Plant

Client Sample ID:	SEAL-Char-01-001-S	Project:	CRYS00212
Sample ID:	573893004	Client ID:	CRYS002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst Date	Time Batch	Method
Iron-59 Tracer	Liquid Scint Fe55, Solid "Dry Weight Corrected"								91.6	(15%-125%)	
Nickel Carrier	Liquid Scint Ni63, Solid "Dry Weight Corrected"								70	(25%-125%)	

Notes:
Counting Uncertainty is calculated at the 68% confidence level (1-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

Enclosure 16

"*Crystal River Unit 3 DCGL Development Summary Report*"

Revision 0

May 2022

BEGINS ON NEXT PAGE

Crystal River Unit 3
DCGL Development Summary Report

Revision 0
May 02, 2022

Prepared by:
BHI Energy | Power Services
97 Libbey Industrial Pkwy
Weymouth, MA 02189
(800) 225-0385

BHI energy | Power Services

PREFACE

This document provides a summary of the Derived Concentration Guideline Level (DCGL) project conducted for the Crystal River Unit 3 (CR3) site. It provides information regarding the method, assumptions, input value selection, and results for the probabilistic analyses, DCGL calculations, and area factor calculations, which were developed using two exposure scenarios: the resident farmer and the building occupancy. This report provides information to support the development of Chapter 6, *Demonstration of Compliance with Release Criteria*, of the CR3 License Termination Plan (LTP).

RADIOLOGICAL CRITERIA FOR UNRESTRICTED USE

The U.S. Nuclear Regulatory Commission (NRC) has established radiological criteria for the unrestricted established by 10 CFR 20.1402 [1]:

> *A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25mSv) per year, including that from groundwater sources, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially results from decontamination and waste disposal*.

The site-specific derived concentration guideline (DCGL) values developed for the Crystal River Unit 3 (CR3) site correspond to the dose criterion in 10 CFR 20.1402; that is, a total effective dose equivalent (TEDE) equal to 25 mrem per year. They are tools to demonstrate compliance that "residual radioactivity that is distinguishable from background radiation" at the CR3 site meets the 10 CFR 1402 dose criterion. The NRC's definition of background radioactivity in 10 CFR 20.1003 [2] can assist licensees with identifying residual radioactivity from plant operations:

> *Background radiation means radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission*.

The CR3 DCGL values to support assessments of residual plant-related radioactive contamination in site soil and on building structures have been determined for each radionuclide-of-concern (ROC) that may be present at the time of license termination for CR3 and release of the site. The use of the CR3 DCGL values provides a regulatory-acceptable means for demonstrating compliance with the site release criteria in 10 CFR 20.1402.

Conditions Satisfying the Site Release Criteria

For NRC licensees, compliance with 10 CFR 20.1402 is demonstrated when the following conditions are met:

- The concentration of residual radioactivity distinguishable from background is less than the applied DCGL value. For contamination with a mixture of radionuclides, the sum of the fractions of the contaminant's concentration over the contaminant's DCGL value must be less one.
- An individual survey measurement representing a small area of residual contamination within a survey area that exceeds the DCGL value but does not exceed the elevated measurement comparison DCGL ($DCGL_{EMC}$) and the average concentration of residual radioactivity passes statistical testing (i.e., either the Wilcoxon Rank Sum Test or the Sign Test recommended in NUREG/CR-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* [2]).

- Remediation activities are performed in contaminated areas where ALARA considerations require reductions of the levels of residual radioactive contamination.

DOSE MODELING APPROACH

Dose models allow the translation of residual radioactive contamination levels into potential radiation doses to the public. For the CR3 site, dose modeling for soil and building structures follows the guidance in NUREG/CR-5512, *Residual Radioactivity from Contamination*, Volumes 1, 2, and 3 [4]. The dose modeling approach for the CR3 site is consistent with the information for site-specific modeling provided in NUREG-1757, *Consolidated NMSS Decommissioning Guidance* [5], including source term identification, exposure scenarios, exposure pathways, and critical groups.

The three defining factors for a dose model are the scenario, the critical group, and the exposure pathways. The scenarios described in NUREG/CR-5512, Volume 1, address the major exposure pathways: (i) direct exposure to residual plant-related radioactive material, (ii) inhalation of residual plant-related radioactive material, and (iii) ingestion of residual plant-related radioactive material. The scenarios also identify the critical receptors as individuals expected to receive the greatest exposure to residual plant-related radioactivity within the assumptions of the scenario. The scenarios and the site-specific modeling provide reasonably conservative estimates of the potential doses associated with residual radioactivity.

The scenario selected for development of the DCGL values for assessing residual plant-related radioactive material in site soil is the resident farmer scenario and the scenario selected for developing the DCGL values for assessments of residual plant-related radioactive material on building structures is the building occupancy scenario.

Development of DCGL values by modeling the resident farmer scenario and building occupancy scenario provide a conservative method for (i) assessing potential annual doses associated with residual plant-related contamination in soil and on building structures remaining in-place at license termination and (ii) demonstrating compliance with 10 CFR 20.1402 radiological criteria for unrestricted use of the CR3 site.

Potential Radionuclides-of-Concern

The identification of radionuclides expected to be present at the time of the final status survey and license termination for the CR3 site supports a focused development process for site-specific DCGLs. The radionuclide selection method applied to the CR3 site consisted of a systematic approach to identify all potential radionuclides and a deselection protocol for excluding radionuclides unlikely to be present at the time of the final survey of the CR3 site. The deselection protocol included evaluations of the half-life values, potential activity concentrations, and assessments of contributions to total dose at the CR3 site. Radionuclides surviving the deselection process form a site-specific suite of potential radionuclides-of-concern (ROCs) for the CR3 site. The ROC selection process is documented in *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection for DCGL Development* [6]. The site-specific suite of ROCs for the CR3 site is provided in Table 1.

Modeling for Soil DCGLs: Scenario Selection

The resident farmer scenario, described as the "Residential Scenario" in NUREG/CR-5512, provides a conservative estimate for human radiation exposure resulting from residual radioactive contamination in soil at the CR3 site. The use of the resident farmer scenario is assumed bounding for the calculation of soil DCGL values because it is unlikely that another set of plausible human activities could result in a radiation dose exceeding that calculated for the hypothetical resident farmer on the CR3 site.

The critical dose receptor is a hypothetical resident farmer who receives a radiation dose (TEDE) resulting from occupying the CR3 site following decommissioning, growing crops and raising livestock for consumption, and using the water from an onsite groundwater source for drinking and irrigation.

NUREG/CR-5512, Volume 1, identifies the following potential exposure pathways that are assumed active in the resident farmer scenario:

- Direct exposure to external radiation from residual radioactivity
- Internal dose from inhalation of airborne radionuclides
- Internal dose from ingestion of
    - Plant foods grown in media containing residual radioactivity and irrigated with water containing residual radioactivity
    - Meat and milk from livestock fed with fodder grown in soil containing residual radioactivity and water containing residual radioactivity
    - Drinking water (containing residual radioactivity) from an onsite well
    - Fish from a nearby pond receiving residual radioactivity
    - Soil containing residual radioactivity.

Modeling for Building Structure DCGLs: Scenario Selection

Modeling of the Building Occupancy scenario described in NUREG/CR-5512 provides a conservative estimate of radiation exposure to humans from residual radioactive contamination on building structures at the CR3 site. It is a regulatory-accepted basis for developing ROC-specific DCGL values for building structures.

The critical receptor is a hypothetical adult individual who receives a dose (TEDE) from exposure to residual radioactive contamination on the floor, walls, and ceiling within a scenario-defined room while performing work activities for a full year of employment following decommissioning of the site.

The hypothetical worker receives a radiation dose via the following potential exposure pathways:

- Direct exposure to external radiation from
    - Material deposited on the surfaces (i.e., walls, floor, and ceiling)
    - Submersion in airborne dust
- Internal dose from inhalation of airborne radionuclides
- Internal dose from ingestion of radionuclides

Computer Code Selection

The RESRAD Family of Codes has been selected for use in determining DCGL values at the CR3 site. The RESRAD computer codes are pathway-analysis models developed at Argonne National Laboratory (ANL). This family of computer codes includes RESRAD-Onsite 7.2 and RESRAD-Build 3.5. Both codes were developed by ANL as multifunctional tools to assist in developing radiological criteria for unrestricted release and assessing the dose associated with residual radioactive material. The NRC has approved the use of the RESRAD codes for development of DCGL values.

The RESRAD-Onsite 7.2 code is designed to support evaluations of the potential radiological dose associated with residual radioactive material in soil whereas the RESRAD-Build 3.5 computer code supports evaluations of the potential radiological dose associated with radioactive contamination on the surfaces of building structures. Both RESRAD-Onsite 7.2 and RESRAD-Build 3.5 incorporate probabilistic modules that permit the user to evaluate dose as a function of parameter distributions and identify "sensitive" parameters; that is, parameters that have a significant impact on dose with changes in input value. The results from probabilistic analyses are used to determine input that increases confidence that the uncertainty associated with input values for "sensitive" parameters is considered in DCGL calculations.

Information on the use of these codes and their applications are outlined in NUREG/CR-6676, *Probabilistic Dose Analysis Using Parameter Descriptions Developed for RESRAD and RESRAD-BUILD Codes* [7], NUREG/CR-6755, *Technical Basis for Calculating Radiation Doses for the Building Occupancy Scenario Using the Probabilistic RESRAD-Build 3.0 Code* [8], NUREG/CR-7267, *Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes* [9], ANL/EVS/TM-18/1, *RESRAD-Onsite 7.2 User's Guide* [10], ANL/EVS/TM-14/4, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil and Building Structures* [11], and NUREG/CR-6697, *Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes* [12].

PROBABILISTIC ANALYSES FOR INPUT PARAMETERS

The input parameters for RESRAD-Onsite 7.2 and RESRAD-Build 3.5 are classified as behavioral, metabolic, or physical in NUREG/CR-7267.

- Behavioral parameters depend on the behavior of the receptor and the scenario definition. For the same group of receptors, a parameter value could change if the scenario changes.
- Metabolic parameters represent the metabolic characteristics of the receptor and are independent of the scenario definition. Parameters that represent metabolic characteristics are defined by average values for the general population. These values are not expected to be modified for a site-specific analysis because the parameter values would not depend on site conditions.
- Physical parameters are those parameters that do not change with changes to the receptor. Physical parameters are determined by the source, its location, and the geological characteristics of the site.

The parameter classifications in NUREG/CR-7267 were retained in the CR3 probabilistic analyses and DCGL calculations.

The prioritization of parameters in order of importance is provided with discussion in NUREG/CR-6697. Prioritization was based on four criteria:

- The relevance of the parameter in dose calculations
- The variability of the dose because of changes in the parameter value
- The parameter type

- The availability of parameter-specific data

Priority 1 parameters are considered high priority; priority 2 parameters are considered medium priority; and priority 3 parameters are considered low priority. The final priority ranking of each parameter was assigned based on its total numeric score for the four ranking criteria. The final parameter priority rankings provided in NUREG/CR-6697 were applied in the probabilistic analyses and development of DCGL values for the CR3 site.

Selection Process for Model Parameter Input Values

The conceptual models are developed through the input values for RESRAD-Onsite 7.2 and RESRAD-Build 3.5 parameters. The behavioral and metabolic parameters were assigned deterministic values from NUREG/CR-5512, Volume 3, the applicable code's default library, or were assigned distributions from NUREG/CR-7267. The priority 3 physical parameters are treated as deterministic and are assigned values from NUREG/CR-5512, Volume 3, NUREG/CR-7267, ANL/EVS/TM-14/4, or available site data.

Physical parameters for which site-specific data are available were also treated as deterministic. Priority 1 and 2 parameters for which no site-specific data are available are treated as stochastic and are assigned a parameter value distribution from NUREG/CR-7267 or ANL/EVS/TM-14/4.

Identification Criteria for Sensitive Parameters

Probabilistic (sensitivity) analyses were performed (i) to determine which code parameters have a significant influence on the resulting dose with changes in input values and (ii) to determine reasonably conservative input values that address the uncertainty associated with the input for sensitive parameters.

The distribution types and corresponding distribution statistical parameters from NUREG/CR-7267 or ANL/EVS/TM-14/4 were used as input for RESRAD-Onsite 7.2 and RESRAD-Build 3.5. The following information was applied in the sensitivity analyses:

- Sample Specifications: The analyses were run using 2000 observations for resident farmer scenario and 300 observations for building occupancy, and 1 repetition for both scenarios. The Latin Hypercube Sampling technique was used to sample the parameter value distributions for each of the stochastic input parameters.
- Sensitivity Indicator: The Partial Rank Correlation Coefficient (PRCC) was used as a measure of the sensitivity of each parameter.
- Sensitivity Thresholds: For the resident farmer scenario, a parameter was identified as sensitive if the absolute value of its PRCC (|PRCC|) was greater than or equal to 0.25 and non-sensitive if the |PRCC| value was less than 0.25. For the building occupancy scenario, a parameter was identified as sensitive if the |PRCC| was greater than or equal to 0.10 and non-sensitive if the |PRCC| value was less than 0.10. These sensitivity thresholds were selected based on the guidance included in NUREG/CR-6676 and NUREG/CR-6692.

The probabilistic analysis for RESRAD-Onsite 7.2 parameters modeled the scenario description in NUREG/CR-5512 using available site-specific data, parameter value distributions from NUREG/CR-7267 and ANL/EVS/TM-14/4, and information provided in NUREG/CR-5512 as input for the RESRAD-Onsite parameters. As an example of site-specific data, the contaminated zone (CZ) for the CR3 site is assumed equal to the area of the CR3 protected area (PA) and underlain by an unsaturated zone (UZ) and a saturated zone (SZ). Site documents identify a variety of soil type descriptions, which led to the use of the generic soil type in ANL/EVS/TM-14/4 for the three zones because "data for that soil type includes all soil types combined including sand, loam, clay, organic, and the "unspecified" soil type." The UZ is modeled as extending from the CZ to groundwater using groundwater depths provided in CR3 documents. Additional site-specific input included hydro-geologic data (e.g., soil density, porosity, field capacity, and hydraulic conductivity), site topography, and meteorological data. As a modeling assumption, site ground water is assumed initially uncontaminated.

The probabilistic analysis for RESRAD-Build 3.5 parameters modeled the room described in NUREG/CR-5512: a room with an 8m by 8m (64 m^2) floor and ceiling and 3m tall walls. The modeled room included 6 area sources (i.e., floor, four walls, and ceiling). Values from NUREG/CR-5512, volume 3, NUREG/CR-7267, and NUREG/CR-6755 were assigned for receptor exposure duration, inhalation rate, removable fraction of the contamination, and fraction of time spent in the building. Parameter value distributions from NUREG/CR-7267 and NUREG/CR-6755 were used as input for deposition velocity, room air exchange rate, re-suspension rate, indirect ingestion, air release fraction, and time for source removal.

To address the uncertainties associated with the input parameters identified as "sensitive," the 25th percentile value of the parameter's distribution was selected as input for sensitive parameters that had a negative PRCC value, and the 75th percentile value of the parameter's distribution was selected as input for sensitive parameters that had a positive PRCC value. The approach of assigning 25th and 75th percentile values of a sensitive parameter's distribution has been accepted by the U.S. NRC as a reasonably conservative approach for addressing uncertainty associated with input for "sensitive" parameters.

Appendix A provides the development of site-specific input for probabilistic analysis for RESRAD-Onsite 7.2 parameters. Table B-1 in Appendix B provides a summary with justification of all input for probabilistic analysis for RESRAD-Onsite 7.2 parameters.

Appendix C provides the development of input for probabilistic analysis for RESRAD-Build 3.5 parameters. Table D-1 in Appendix D provides a summary with justification of all input for probabilistic analysis for RESRAD-Build 3.5 parameters.

Probabilistic Analysis Results

Probabilistic analysis for RESRAD-Onsite 7.2 parameters was performed using a CR3-specific site model that consisted of three hydro-geological strata: a contaminated zone (CZ), an unsaturated zone (UZ), and a saturated zone (SZ). The CZ is assumed to be an uncovered area equivalent in size to the CR3 Protected Area (64,821 m^2) with a thickness of 0.5 foot, which is consistent with the depth of the soil mixing layer as defined for the Resident Farmer Scenario. The UZ is initially uncontaminated with a minimum thickness equal to 26 ft and a maximum thickness 29.5 ft, which supports the development of a site-specific distribution for UZ thickness. The SZ begins at site groundwater. Site-specific data were used as input for soil density, porosity, field capacity, and hydraulic conductivity. In addition, site-specific input included site topography and meteorological data. The groundwater in the SZ is assumed initially uncontaminated.

The probabilistic analyses for RESRAD-Onsite 7.2 parameters, documented in ENG- CR3-001, *RESRAD-Onsite Input Parameter Sensitivity Analysis – Crystal River 3* [13], identified several parameters as sensitive for some of the CR3 ROCs:

- Plant transfer factor (Am-241, Cm-243, Cm 244, Cs-137, Fe-55, Ni-59, Ni-63, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99)
- Meat transfer factor (Cs-137, Fe-55, Pu-238)
- Milk transfer factor (Cs-137, Ni-59, and Ni-63)
- Depth of roots (Am-241, C-14, Cm-243, Cm-244, Cs-137, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90 and Tc-99)
- Depth of soil mixing layer (Am-241, Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, and Pu-241)
- External gamma shielding factor (Am-241, Cm-243, Co-60, Cs-137, Eu-152, Eu-154, and Nb-94)
- Distribution coefficient in the contaminated zone (C-14, Co-60, Eu-152, Eu-154, Nb-94, Sr-90, and Tc-99)
- Saturated zone hydraulic gradient (H-3 and Tc-99)
- Well pump intake depth (H-3)

Input values to address the uncertainty associated with input for the sensitive parameters (i.e., the 25th and 75th percentile values of a parameter's distribution) were determined from the results of the probabilistic analyses. These conservative input values were used in the subsequent DCGL calculations.

The RESRAD-Onsite 7.2 parameters identified as sensitive based on the results of the probabilistic analyses are summarized in Table E-1 in Appendix E. The 25th and 75th percentile values determined from the probabilistic analysis results for sensitive parameters are summarized in Table E-2 in Appendix E.

Probabilistic analysis for RESRAD-Build 3.5 parameters was performed by modeling the scenario room described in NUREG/CR-5512 with the assumption of uniform contamination on the surfaces of six area sources (i.e., the floor, four walls, and the ceiling). Probabilistic analyses for RESRAD-Build 3.5 parameters are documented in ENG-CR3-002, *RESRAD-Build Input Parameter Sensitivity Analysis – Crystal River 3* [14].

The following RESRAD-Build 3.5 parameters were identified as sensitive for all CR3 ROCs:

- Building air exchange rate
- Source removal time
- Deposition velocity
- Resuspension rate
- Air fraction
- Indirect ingestion rate

As done for RESRAD-Onsite 7.2 parameters, conservative input to address the uncertainty associated with input values for the sensitive RESRAD-Build 3.5 parameters (i.e., the 25th and 75th percentile values of a parameter's distribution) were determined from the results of the probabilistic analyses.

The results of the probabilistic analyses identifying sensitive RESRAD-Build 3.5 parameters are summarized in Table F-1 in Appendix F. The 25th and 75th percentile values for sensitive parameters are summarized in Table F-2 in Appendix F.

CALCULATION OF DERIVED CONCENTRATION GUIDELINES

With the exceptions for the 25th and 75th percentile values, input for DCGL calculations was the same as that used in the probabilistic analyses. Table G-1 in Appendix G provides a summary of all RESRAD-Onsite 7.2 input used to calculate DCGL values for soil at the CR3 site. Table I-1 in Appendix I provides a summary of all RESRAD-Build 3.5 input used to calculate DCGL values for building structures.

The RESRAD-Onsite 7.2 code calculates a peak mean dose in mrem/y, whereas the RESRAD-Build 3.5 code calculates an annual dose in mrem/y. Unit radionuclide concentrations (i.e., 1 pCi/g in RESRAD-Onsite 7.2 or 1 pCi/m^2 in RESRAD-Build 3.5) and the parameters values determined by the process described previously were used as input for the RESRAD code executions. The resulting doses are used as dose conversion factors (DCFs) in DCGL calculations. The DCF from RESRAD-Onsite 7.2 is in units of mrem/y per pCi/g and the DCF from RESRAD-Build 3.5 is in units of mrem/y per pCi/m^2.

The CR3 DCGL values correspond to the site release criterion, 25 mrem/y, and were calculated using the following equations:

For soil:

$$DCGL(pCi/g) = \frac{25mrem/y}{DCFmrem/y/pCi/g} \qquad \text{(Equation 1)}$$

For building structures:

$$DCGL(pCi/m^2) = \frac{25mrem/y}{DCF\,mrem/yr/pCi/m^2} \qquad \text{(Equation 2)}$$

$$DCGL(dpm/cm^2) = DCGL(pCi/m^2) \times 2.22dpm/pCi \times (1m/100cm)^2 \qquad \text{(Equation 3)}$$

$$DCGL(dpm/100cm^2) = DCGL(dpm/cm^2) \times 100 \qquad \text{(Equation 4)}$$

Soil DCGL Values

Development of DCGL values to support assessments of site soil is documented in ENG- CR3-003, *Derived Concentration Guideline Levels Values for Soil – Crystal River 3* [15]. The conceptual model for CR3 DCGL calculations was the same as that used in the probabilistic analyses. With the exception for input assigned to sensitive parameters, all input was consistent with that used in the probabilistic analyses. The conceptual model for the CR3 site consists of a contaminated zone underlain by an unsaturated zone and a saturated zone. The size of the CZ was assumed equal to the area of the CR3 PA (64,821 m^2) with a thickness equal to six inches, which is consistent with the scenario described in NUREG/CR-5512. The UZ is modeled as extending from the CZ to groundwater using groundwater depths provided in CR3 documents. Additional site-specific input included hydro-geologic data (e.g., soil density, porosity, field capacity, and hydraulic conductivity), site topography, and meteorological data.

The DCFs based upon the peak mean doses from RESRAD-Onsite 7.2 and the DCGL values corresponding 25 mrem/y are shown in Table H-1 in Appendix H.

Building Structure DCGL Values

Development of DCGL values for building structures at the CR3 site is documented in ENG-CR3-004, *Crystal River 3 Building Surface DCGL Values* [16]. The exposure scenario used to calculate the building surface DCGLs is the building occupancy scenario as defined in NUREG/CR-5512, Volumes 1, 2, and 3 and NUREG-1757.

The conceptual model was consisted of a scenario-defined room with six contaminated surfaces. The four walls, floor, and ceiling of the room are assumed to be uniformly contaminated at 1 pCi/m^2. This is a conservative assumption as normally the amount of contamination on room walls and ceiling is less than that on the floor and would be expected to decrease as the distance from the floor increases.

The DCFs based upon the annual doses from RESRAD-Build 3.5 and the DCGL values corresponding to 25 mrem/y are shown in Table J-1 in Appendix J.

CALCULATION OF AREA FACTORS

Area factors (AFs) for use with DCGL values for soil and building structures may be required during final status survey activities. AF values for the CR3 site were calculated in a 2-step process. First, the RESRAD codes were used to calculate the total doses from all pathways for each ROC for a base case and assumed reduced sizes of contaminated areas. Then, the AF values are determined from the ratio of the dose for a base case to the dose for each assumed smaller contaminated area.

Area Factors for the Soils

Except for five parameters, the calculations of AFs used the same input as that used to calculate the soil DCGL values. The five parameters are the size of the contaminated zone, length parallel to aquifer flow, and the contaminated fractions of dietary intake of plant, meat, and milk obtained from the contaminated zone.

The recommended limit to the size of a MARSSIM Class 1 open land survey unit (2,000 m^2) was established as the base case for contaminated zone sizes. The calculation of AFs assumed seven smaller contaminated zone sizes: 1000 m^2, 500 m^2, 100 m^2, 50 m^2, 10 m^2, 5 m^2, and 1m^2.

Development of DCGL values for soil assumed that the contaminated zone was a circular area equal to the area of the CR3 PA; therefore, the adjusted values for "length parallel to aquifer flow" parameter were assumed equal to the diameters of the circles equal to the reduced areas for the contaminated zone.

Area factors for use with soil DCGL values assume that, as the contaminated area decreases in size, the fractions of the person's total diet from plants, meat, and milk obtained from the contaminated area would also decrease.

Calculation of the CR3 AF for soil is documented in ENG-CR3-005, *Area Factors for Use with Crystal River DCGL Values for Soil* [17]. RESRAD-Onsite 7.2 parameters values for the area factor calculations are provided in Tables K-1 and K-2 in Appendix K. Table L-1 in Appendix L provides the soil AF values by radionuclide and contaminated zone area.

Area Factors for the Building Structures

Area factors for building structures permit assessments of small areas of elevated activity. Except for the number of sources and source size, all input is the same as that used in the building structure DCGL calculations. Only one source is modeled instead of the six sources considered in calculating the building surface DCGL values. The base case for AF values is a single area source (i.e., a 64 m^2 floor). Five smaller area sources were assumed with the receptor located 1 meter away from the source midpoint: 50 m^2, 10 m^2, 5 m^2, 2.5 m^2, and 1 m^2.

Calculation of the CR3 AF for building structures is documented in ENG-CR3-006, *Area Factors for Use with CR3 DCGL Values for Buildings/Structures* [18]. Values for the RESRAD-Build parameters are summarized in Tables M-1 and M-2 in Appendix M. Table N-1 in Appendix N presents the radionuclide-specific area factors for CR3 building structures.

REFERENCES

1 Code of Federal Regulations, Title 10, Section 20.1402, *Radiological Criteria for Unrestricted Uses*

2 Code of Federal Regulations, Title 10, Section 20.1003, *Definitions*

3 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Revision 1, August 2000

4 NUREG/CR-5512, *Residual Radioactivity from Contamination*

Volume 1: *Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*, dated October 1992

Volume 2: *User's Manual DandD Version 2.1*, April 2001

Volume 3: *Parameter Analysis, Draft Report for Comment*, October 1999

5 NUREG-1757, *Consolidated NMSS Decommissioning Guidance*, September 2003

6 *Crystal River 3 Nuclear Power Plant Radiological Nuclide Selection For DCGL Development*, June 21, 2021

7 NUREG/CR-6676, *Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes*, May 2000

8 NUREG/CR-6755, *Technical Basis for Calculating Radiation Doses for the Building Occupancy Scenario Using the Probabilistic RESRAD-Build 3.0 Code*

9 NUREG/CR-7267, *Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes*, February

10 ANL/EVS/TM-18/1, *RESRAD-Onsite 7.2 User's Guide*, April 2018

11 ANL/EVS/TM-14/4, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil and Building Structures*, Yu, C. et al., Argonne National Laboratory-Environmental Science Division, September 2015

12 NUREG/CR-6697, *Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes*

13 BHI Energy Engineering Calculation ENG-CR3-001, *RESRAD-Onsite Input Parameter Sensitivity Analysis – Crystal River 3*

14 BHI Energy Engineering Calculation ENG-CR3-002, *RESRAD-Build Input Parameter Sensitivity Analysis – Crystal River 3*

15 BHI Energy Engineering Calculation ENG-CR3-003, *Derived Concentration Guideline Levels for Soil – Crystal River 3*

16 BHI Energy Engineering Calculation ENG-CR3-004, *Crystal River 3 Building Surface DCGL Values*

17 BHI Energy Engineering Calculation ENG-CR3-005, *Area Factors for Use with Crystal River DCGL Values for Soil*

18 BHI Energy Engineering Calculation ENG-CR3-006, *Area Factors for Use with CR3 DCGL Values for Buildings/Structures*

Table 1: *CR3 Site-Specific Suite of ROCs*

ROC	Half-Life (y)
Am-241	4.32E+02
C-14	5.73E+03
Cm-243	2.91E+01
Cm-244	1.81E+01
Co-60	5.27E+00
Cs-137	3.02E+01
Eu-152	1.36E+01
Eu-154	8.80E+00
Fe-55	2.70E+00
H-3	1.23E+01
Nb-94	2.03E+04
Ni-59	7.50E+04
Ni-63	1.00E+02
Pu-238	8.77E+01
Pu-239	2.4E+04
Pu-240	6.50E+03
Pu-241	1.44E+01
Sr-90	2. 86E+01
Tc-99	2.13E+05

Table 2: *DCGL Values by Radionuclide and Medium Type*

ROC	Soil DCGL (pCi/g)	Building Structure DCGL (dpm/100cm^2)
Am-241	2.04E+02	1.65E+03
C-14	7.00E+01	6.42E+06
Cm-243	7.65E+01	2.40E+03
Cm-244	2.62E+02	3.03E+03
Co-60	5.13E+00	1.35E+04
Cs-137	1.84E+01	4.70E+04
Eu-152	1.11E+01	2.71E+04
Eu-154	1.04E+01	2.56E+04
Fe-55	7.27E+04	3.80E+07
H-3	4.40E+04	2.10E+08
Nb-94	7.77E+00	2.57E+04
Ni-59	1.09E+04	3.38E+07
Ni-63	3.99E+03	1.63E+07
Pu-238	1.67E+02	1.88E+03
Pu-239	1.43E+02	1.70E+03
Pu-240	1.43E+02	1.70E+03
Pu-241	6.24E+03	6.76E+04
Sr-90	1.38E+01	8.14E+04
Tc-99	2.35E+02	5.05E+06

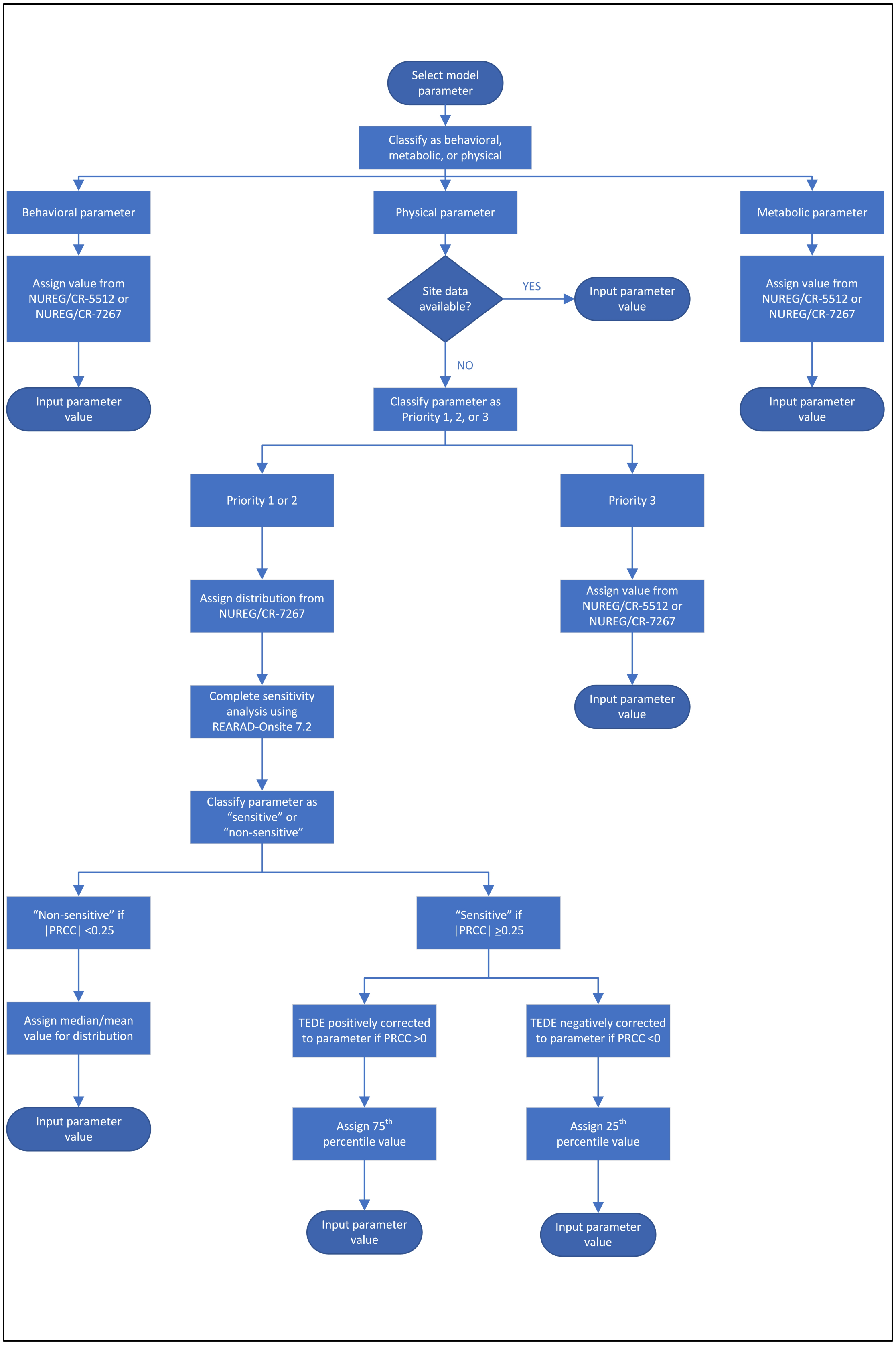


Figure 1: Parameter Selection Process

Appendix A

Development of Site-Specific Input Values for Probabilistic Analysis of RESRAD-Onsite 7.2 Parameters

(Summarized from ENG-CR3-001 [13])

Contaminated zone: The CR3 contaminated zone (CZ) is estimated to be 64,821 m^2. The thickness of the CZ is assumed equal to 6-inches, which is consistent with the depth of the soil mixing layer as defined for the Resident Farmer Scenario and supported by CR3 sub-surface soil data.

Soil in and around the area of the CR3 site identified as the CZ is described in site documents as "heterogeneous mix of sands and finer materials (loam and clay loam)," "crushed limestone," and "loam and clay," "sandy soils underlain by limestone," and undefined "surface fill" with underlying soil consisting of "thinly laminated, organic sandy silts and clays." Due to variations in the soil descriptions, input for distribution coefficient (kd) values is based on the generic soil type in ANL/EVS/TM-14/4 because "data for that soil type includes all soil types combined including sand, loam, clay, organic, and the "unspecified" soil type."

Unsaturated zone: A distribution was developed from depth range for site groundwater (5 ft – 9 ft), thickness of burm area (21ft), and scenario default thickness of CZ (0.5 ft). The minimum thickness of the UZ extends from the bottom of the CZ through the berm thickness to site GW at 5.5 ft, or a total minimum thickness = 26 ft (7.92 m), and the maximum thickness of the UZ extends from the bottom of the CZ through the berm thickness to site GW at 9 ft, or a total minimum thickness = 29.5 ft (8.99 m). This allows a uniform distribution with a minimum value = 7.92 m, a maximum value = 8.99 m, and a mean value = 8.46 m as RESRAD-Onsite 7.2 input for thickness of the UZ.

Due to variations in the soil descriptions, selected input for distribution coefficient (kd) values for the UZ is based on the generic soil type for the reason stated the CZ.

Saturated zone: Due to variations in the soil descriptions, selected input for distribution coefficient (kd) values for the SZ is based on the generic soil type for the reason stated in step 2.2.1.c.

Input for hydrogeologic parameters was obtained from H&A Technical Support Document, File No. 134300.

- Soil density = 1.5 g/cm^2
- Total porosity for CZ, UZ, and SZ = 0.4
- Effective porosity for UZ and SZ = 0.2
- Field capacity for CZ, UZ, and SZ = 0.2
- Hydraulic conductivity in CZ, UZ, and SZ = 100,000 m/y

Input for the RESRAD parameter watershed area for nearby stream or pond was determined from the following information found on https://en.wikipedia.org/wiki/Crystal_River_(Florida): Crystal River is a very short river, "just seven miles (eleven kilometers) long, and has a drainage basin of five square miles (thirteen square kilometers),…" The watershed area is approximately 13 km^2 X 10^6 m^2/1 km^2 = 1.3E+07 m^2.

For the CR3 site, rainfall averages about 50 to 60 inches per year. The upper end of that range, 60 in/y (1.5 m/y), was assigned as the input value for annual precipitation.

Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations provides a figure of absolute humidity by geographical regions within the U.S. The value of 13.8 g/m^3 was selected for the RESRAD humidity parameter.

The parameter "length parallel to the aquifer flow" is defined as is the maximum horizontal distance measured in the CZ, from its up-gradient edge to the down-gradient edge, along the direction of the groundwater flow in the underlying aquifer. The area of the CZ was be approximated by a circle with an area of 64,821 m^2 (the area of the CR3 PA). The diameter of the circle was used as input for the length parallel to the aquifer parameter: 287 m.

An erosion rate equal to 6.0×10^{-4} m/y is selected for the CR3 site because, based on information provided in NUREG/CR-7267 and the shallow slope of the PA at the site, the erosion rate is suitable for the farmer scenario and the erosion rate for the site would not be expected to exceed 6.0×10^{-4} m/y.

Runoff Coefficient (Cr) was calculated based on information in ANL/EVS/TM-14/4. For the CR3 site, Cr = 0.2.

Input for Fraction of Time Spent Indoors, Fraction of Time Spent Outdoor, Soil Ingestion Rate, and Drinking Water Intake was obtained from NUREG/CR-5512.

Input for Inhalation Rate was obtained from NUREG/CR-6697.

Irrigation Rate: The Irrigation Rate can be expressed as:

IRr = (ETr/Ce)-(1-Cr)(Pr)

ETr = estimated Evapotranspiration Rate (m/y) = 0.9 (ANL/EVS/TM-14/4)
Pr = the Precipitation Rate (m/y) = 1.5
Ce = Evapotranspiration Coefficient (ANL/EVS/TM-14/4), min value = 0.5, max value = 0.75
Cr = the Runoff Coefficient = 0.2

The input values for the variables in the equation above follow:

Variable	Use of Min Ce Value	Use of Max Ce Value
ETr (m/y)	0.9	0.9
Pr (m/y)	1.5	1.5
Cr	0.2	0.2
Ce	0.5	0.75
IRr (m/y)	0.6	0.0

The irrigation rate equation yields a minimum IRr value equal to 0.0 m/y and a maximum IRr value equal to 0.6 m/y. A uniform distribution with minimum and maximum value equal to 0.0 and 0.6, respectively, and a mean equal to 0.3 m/y was assigned as input for this parameter.

Well Pumping Rate: Information from NUREG/CR-7267 was used.

Water Use Component (general case)	**Minimum Water Use, m^3/y**	**Maximum Water Use, m^3/y**
Household (family of 4), m^3/y	328.7	328.7
Livestock, m^3/y	76.7	76.7
Irrigation Water, $m^3/y = f_p \times I_r \times 2000$	0	1200
Contaminated fraction (fp)	1	1
Irrigation Rate (I_r), m/y	0.0	0.6
Drinking Water[a] (family of 4), m^3/y	1.64	1.64
Total, m^3/y	407	1605

[a] From NUREG/CR-7267.

A uniform distribution with a minimum value equal to 407 m^3/y, a maximum value equal to 1605 m^3/y, and a mean value equal to 802.5 m^3/y was assigned as input for the Well Pump Rate parameter.

Wind speed: The average wind speed for the on-site 33-foot has been reported as 7.9 mph; unit conversion yields a wind speed = 3.5 m/s.

Appendix B

Summary of Input Parameter Values for Probabilistic Analysis of RESRAD-Onsite 7.2 Parameters

(Extracted from Reference 13)

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (generic soil type values assigned to contaminated, unsaturated. and saturated zones) (cm^3/g)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.44	1.1	0.001	0.999	1700
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.04	1.82	0.001	0.999	21
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.17	2.77	0.001	0.999	480
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.09	1.95	0.001	0.999	1200
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.86	4.01	0.001	0.999	955
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.86	4.01	0.001	0.999	955
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.78	0.69	0.001	0.999	880
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.61	3.22	0.001	0.999	5
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.81	0.5	0.001	0.999	0.06
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.31	1.39	0.001	0.999	1500
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.58	1.79	0.001	0.999	36
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.6	1.1	0.001	0.999	2000
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.65	2.30	0.001	0.999	2100
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.19	1.61	0.001	0.999	180
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Sr-90	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.95	1.79	0.001	0.999	52
Tc-99	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-1.61	2.20	0.001	0.999	0.2
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-232	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	Ground water uncontaminated	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0		NR	NR	NR	NR	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	64,821	CR3 PA= 64,821 m^2	NR	NR	NR	NR	
Thickness of contaminated zone (m)	P	2	D	0.1524	Depth of soil mixing layer (6 inches) as defined for the Resident Farmer Scenario in NUREG/CR-5512	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	287	Assumed diameter of a circle with an area = CR3 contaminated zone, 64,821 m^2	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	Consistent with resident farmer scenario - no cover assumed	NR	NR	NR	NR	
Density of contaminated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone erosion rate (m/y)	P	2	D	6E-04	NUREG/CR-7267; assumed erosion rate for site with shallow slope	NR	NR	NR	NR	

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Contaminated zone total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021					
Contaminated zone hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Humidity in air (g/m^3)	P	3	D	13.8	*Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations*	NR	NR	NR	NR	
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-7267	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	D	3.5	TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Precipitation (m/y)	P	2	D	1.5	Upper end of precipitation range is applied: "rainfall averages about 50 to 60 inches per year" TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Irrigation (m/y)	B	3	S	Uniform	Distribution determined using methodology described in 2015 updated *Data Collection Handbook* and NUREG/CR-6697.	0	0.6	NR	NR	0.3
Irrigation mode	B	3	D	Overhead	Overhead irrigation is common practice for crops in U.S.	NR	NR	NR	NR	
Runoff coefficient	P	2	D	0.2	Value determined using methodology described in *Data Collection Handbook* and NUREG/CR-7267	NR	NR	NR	NR	
Watershed area for nearby stream or pond (m^2)	P	3	D	1.3E+07	https://en.wikipedia.org/wiki/Crystal_River_(Florida)	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Saturated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	S	Bounded Lognormal-n	NUREG/CR-7267	-5.11	1.77	7.0E-05	0.5	0.006
Saturated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Water table drop rate (m/y)	P	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Well pump intake depth (m below water table)	P	2	S	Triangular	NUREG/CR-7267	6	10	30		14.51
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	ND model recommended for contaminant areas >1,000 m^2	NR	NR	NR	NR	
Well pumping rate (m^3/y)	P	2	S	Uniform	Min, and max value based on site irrigation rate and information from NUREG/CR-7267.	407	1605			802.5
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	Based on suggested uniform input for RESRAD-Onsite hydrologic parameters for the UZ (H&A Technical Support Document, File No. 134300, 12/9/2021) and assignment of generic soil type for UZ	NR	NR	NR	NR	
Unsat. zone 1, thickness (m)	P	1	S	uniform	Distribution developed from depth range for site groundwater, 5 ft – 9 ft (H&A *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station*); thickness of burm area, 21ft (H&A Technical Support Document, File No. 134300, 12/9/2021), and scenario default thickness of CZ, 0.5 ft.	7.92	8.99			8.46
Unsat. zone 1, soil density (g/cm^3)	P	2	D	1.5	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, effective porosity	P	2	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	
Unsat. zone 1, hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300, 12/9/2021	NR	NR	NR	NR	

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Unsat. zone 1, soil-specific b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Occupancy										
Inhalation rate (m^3/y)	B	3	D	8400	NUREG/CR-7267	NR	NR	NR	NR	
Mass loading for inhalation (g/m^3)	P	2	S	Continuous linear	NUREG/CR-7267					2.3E-5
Exposure duration	B	3	D	30	RESRAD Default	NR	NR	NR	NR	
Indoor dust filtration factor	P	2	S	Uniform	NUREG/CR-7267	0.15	0.95			0.55
Shielding factor, external gamma	P	2	S	Bounded lognormal-n	NUREG/CR-7267	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.6571	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Fraction of time spent outdoors	B	3	D	0.1181	NUREG/CR-5512, Vol. 3 (outdoors + gardening)	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	RESRAD Default - Circular contaminated zone assumed	NR	NR	NR	NR	
Ingestion, Dietary										
Fruits, vegetables, grain consumption (kg/y)	B	2	D	112	NUREG/CR-5512, Vol. 3 (other vegetables + fruits + grain)	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	B	3	D	21.4	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk consumption (L/y)	B	2	D	233	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	B	3	D	65.1	NUREG/CR5512, Vol. 3 (beef + poultry)	NR	NR	NR	NR	
Fish consumption (kg/y)	B	3	D	20.6	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Other seafood consumption (kg/y)	B	3	D	0.9	RESRAD Default	NR	NR	NR	NR	
Soil ingestion rate (g/yr)	B	2	D	18.26	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Drinking water intake (L/y)	B	2	D	478.5	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of drinking water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water	P	3		NA						
Contamination fraction of livestock water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of irrigation water	P	3	D	1	RESRAD Default - all water assumed contaminate	NR	NR	NR	NR	
Contamination fraction of aquatic food	P	2	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of plant food	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Contamination fraction of meat	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of milk	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/d)	M	3	D	27.1	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/d)	M	3	D	63.2	NUREG/CR5512, Vol. 3 , forage + grain + hay	NR	NR	NR	NR	
Livestock water intake for meat (L/d)	M	3	D	50.6	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock water intake for milk (L/d)	M	3	D	60	NUREG/CR5512, Vol. 3	NR	NR	NR	NR	
Livestock soil intake (kg/d)	M	3	D	0.5	RESRAD Default	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	4.00E-04	NUREG/CR-5512, Vol. 3, gardening	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	S	Triangular	NUREG/CR-7267	0	0.15	0.6		0.23
Depth of roots (m)	P	1	S	Uniform	NUREG/CR-7267	0.3	4			1.85
Drinking water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Household water fraction from ground water (if used)	P	3		NA						
Livestock water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Irrigation fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	Truncated lognormal-n	NUREG/CR-7267	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	2.88921	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	1.8868	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	0.246	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	0.123	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	0.082	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	0.1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Weathering Removal Constant for Vegetation (1/y)	P	2	S	Triangular	NUREG/CR-7267	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy	P	2	S	Triangular	NUREG/CR-7267	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	14	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Leafy vegetables	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry	B	3	D	20	NUREG/CR-5512, Vol. 3 (holdup period for beef)	NR	NR	NR	NR	
Fish	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Well water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Surface water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Livestock fodder	B	3	D	45	RESRAD Default	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	2.00E-05	RESRAD Default	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	3.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	2.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	9.80E-01	RESRAD Default	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	S	Triangular	NUREG/CR-7267	0.2	0.3	0.6		0.3
C-14 evasion flux rate from soil (1/s)	P	3	D	7.00E-07	RESRAD Default	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/s)	P	3	D	1.00E-10	RESRAD Default	NR	NR	NR	NR	

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Fraction of grain in beef cattle feed	B	3	D	0.2500	NUREG/CR-7267	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	0.1000	NUREG/CR-7267	NR	NR	NR	NR	
Inhalation Dose Conversion Factors (mrem/pCi inhaled) from FGR11 (contained in RESRAD Dose Conversion Library)										
Ingestion Dose Conversion Factors (mrem/pCi ingested) from FGR11 (contained in RESRAD Dose Conversion Library)										
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	1.1	0.001	0.999	1.0E-03
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-0.4	0.9	0.001	0.999	6.7E-01
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.5	0.9	0.001	0.999	8.0E-02
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	1.0	0.001	0.999	4.0E-02
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	1.1	0.001	0.999	5.0E+00
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.0	0.001	0.999	2.0E-03
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.0	0.9	0.001	0.999	5.0E-02
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.0	0.9	0.001	0.999	5.0E-02
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.9	0.9	0.001	0.999	2.0E-02
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.1	0.001	0.999	1.0E-02
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-5.5	0.9	0.001	0.999	4.0E-04
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Sr-90	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-1.2	1.0	0.001	0.999	3.0E-01
Tc-99	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	0.9	0.001	0.999	5.0E+00
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.47	1.0	0.001	0.999	3.1E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.75	0.8	0.001	0.999	4.3E-04
Cs-137	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.82	0.9	0.001	0.999	2.2E-02
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.27	0.4	0.001	0.999	1.4E-02
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.42	1.0	0.001	0.999	1.2E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.9	0.001	0.999	1.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	1.0	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.26	0.9	0.001	0.999	7.0E-04

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.7	0.001	0.999	5.0E-03
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	1.1	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.21	0.7	0.001	0.999	1.0E-04
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-232	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.4	0.9	0.001	0.999	1.2E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.12	0.7	0.001	0.999	1.1E-04
Cs-137	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.38	0.7	0.001	0.999	4.6E-03
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.26	0.7	0.001	0.999	3.5E-05
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	0.9	0.001	0.999	1.0E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.91	0.7	0.001	0.999	2.0E-02
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.91	0.7	0.001	0.999	2.0E-02
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-11.51	0.7	0.001	0.999	1.0E-05
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.11	0.9	0.001	0.999	3.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.47	0.6	0.001	0.999	2.1E-04
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	0.5	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+01
Am-241	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
Am-243	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
C-14	P	2	S	Lognormal-n	NUREG/CR-7267	13.0	1.1			4.4E+05
Cm-243	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Cm-244	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Co-60	P	2	S	Lognormal-n	NUREG/CR-7267	4.3	0.9			7.4E+01
Cs-137	P	2	S	Lognormal-n	NUREG/CR-7267	7.8	0.9			2.4E+03
Eu-152	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Eu-154	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Fe-55	P	2	S	Lognormal-n	NUREG/CR-7267	5.1	1.9			1.6E+02
Gd-152	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
H-3	P	2	S	Lognormal-n	NUREG/CR-7267	0	0.1			1.0E+00
Nb-94	P	2	S	Lognormal-n	NUREG/CR-7267	5.7	1.1			3.0E+02
Ni-59	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Ni-63	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Np-237	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Pa-231	P	2	S	Lognormal-n	NUREG/CR-7267	2.3	1.1			1.0E+01
Pb-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.4E+01
Po-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.6	1.5			3.7E+01
Pu-238	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-239	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-240	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-241	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Ra-226	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Ra-228	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Sr-90	P	2	S	Lognormal-n	NUREG/CR-7267	1.1	1.4			3.0E+00
Tc-99	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Th-228	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-229	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-230	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
U-233	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-234	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-235	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-236	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
Bioaccumulation Factors for Crustacea/ Mollusks **((pCi/kg)/(pCi/L)) RESRAD default value for each radionuclide applied**										

Table B-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for CR3 Probabilistic Analysis Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Table B-1 Notes:

[a] P = physical, B = behavioral, M = metabolic
[b] 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter
[c] D = deterministic, S = stochastic, NR = none recommended
[d] Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum

Appendix C

Development of Input Values for Probabilistic Analysis of RESRAD-Build 3.5 Parameters

Values from NUREG/CR-5512, volume 3, and NUREG/CR-7267, NUREG/CR-6755, were assigned for the following scenario-defined parameters:

- Exposure duration: 365.25 d
- Indoor fraction: 0.267
- Inhalation rate: 33.6 m^3/d
- Receptor location (center of room, x, y, z coordinates): 4m, 4m, 1.0m
- Air fraction: 1.0 for H-3 (triangular distribution used for all other nuclides)
- Removable fraction: 0.1 (all ROCs)
- Room area: 64 m^2
- Room height: 3 m
- Receptor location: center
- Location of center of source: center point of floor, walls, and ceiling

Statistical distributions from NUREG/CR-7267 and NUREG/CR-6755 provided input for:

- deposition velocity
- air exchange rate for room
- re-suspension rate
- indirect ingestion rate
- air release fraction
- time for source removal

An input correlation of 0.9 between the deposition velocity and the resuspension rate was applied based on guidance in NUREG/CR-6676. In addition, because the sources are assumed constructed of the same material and subject to the same environment, an input correlation of 0.9 was applied for the time for source removal between sources.

Room dimensions: dimensions of a representative room are 8m by 8m by 3m.

Direct ingestion rate (h^{-1}) is based on the direct ingestion rate given in NUREG/CR-6755: 4.91E-07 h^{-1}.

Using the dimensions for the modelled room, the locations of the centers of the sources were determined as the mid-point on the X, Y, and Z-axes.

Source No.	Source Description	Location of Center of Source (m) X-axis	Y-axis	Z-axis
1	Floor	4	4	0
2	Wall 1	4	0	1.5
3	Wall 2	0	4	1.5
4	Wall 3	4	8	1.5
5	Wall 4	8	4	1.5
6	Ceiling	4	4	3

Appendix D

Summary of Input Parameter Values for Probabilistic Analysis for RESRAD-Build 3.5 Parameters

(Extracted from Reference 14)

Table D-1: Input Values for RESRAD-BUILD 3.5 Parameter Probabilistic Analysis
Building Occupancy Scenario

Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Exposure Duration (d)	B	3	D	365.25	NUREG/CR-5512, NUREG/CR-7267				
Indoor Fraction	B	2	D	0.267	NUREG/CR-5512, NUREG/CR-7267				
Evaluation Time (y)	P	3	D	1 or multiple (e.g., 1,10, 50, 100)	T=1 corresponds to dose over the 1st year				
Number of Rooms	P	3	D	1	one contaminated room assumed				
Deposition Velocity (m/s)	P	2	S	Loguniform	NUREG/CR-6755, NUREG/CR-7267	2.7E-06	2.7E-03	-	-
Resuspension Rate (s^{-1})	P	1	S	Loguniform	NUREG/CR-6755, NUREG/CR-7267	2.5E-11	1.3E-5	-	-
Air Exchange Rate for Room (h^{-1})	B	2	S	Truncated Lognormal	NUREG/CR-6755	0.4187	0.88	0.001	0.999
Room Area (m^2)	P	2	S	64	NUREG/CR-6755				
Room Height (m)	P	2	D	3	NUREG/CR-6755				
Time Fraction	B	3	D	1	NUREG/CR-7267				
Inhalation Rate (m^3/d)	M	2	D	33.6	NUREG/CR-5512				
Indirect Ingestion Rate (m^2/h)	B	2	S	Loguniform	NUREG/CR-6755, NUREG/CR-7267	2.8E-5	2.9E-4	-	-
Receptor Location x, y, z (m)	B	3	D	4, 4,1	Center of room based on scenario room dimensions defined in NUREG/CR-5512 and NUREG/CR-7267				
Shielding Thickness (cm)	P	2	D	0	No shielding assumed				
Shielding Density (g/cm^3)	P	1	D	1	Input value required by code execution – input has no impact due to shielding thickness input				

Table D-1: Input Values for RESRAD-BUILD 3.5 Parameter Probabilistic Analysis
Building Occupancy Scenario

Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Shielding Material	P	3	D	water	Input value required by code execution – input has no impact due to shielding thickness input				
Number of Sources	P	3	D	6	Includes floor, ceiling, and 4 walls consistent to scenario assumptions stated in NUREG/CR-7267				
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.12 (FGR-12).				
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.12 (FGR-12).				
Inhalation Dose Conversion Factor, (mrem/pCi)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.11 (FGR-11).				
Ingestion Dose Conversion Factor, (mrem/pCi)	M	3	D	RESRAD-Build Dose Conversion Factor Library	Values were from Federal Guidance Report No.11 (FGR-11).				
Source 1: Floor									
Type	P	3	D	area	NUREG/CR-5512				
Direction	P	3	D	Z	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 4, 0	Center of floor based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				

Table D-1: Input Values for RESRAD-BUILD 3.5 Parameter Probabilistic Analysis Building Occupancy Scenario									
Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755, NUREG/CR-5512				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 2: Wall 1									
Type	P	3	D	Area	NUREG/CR-5512				
Direction	P	3	D	Y	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 0, 1.5	Center of wall based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 3: Wall 2									
Type	P	3	D	Area	NUREG/CR-5512				
Direction	P	3	D	X	NUREG/CR-5512				

Table D-1: Input Values for RESRAD-BUILD 3.5 Parameter Probabilistic Analysis Building Occupancy Scenario									
Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Location of Center of Source: x,y,z (m)	P	3	D	0, 4, 1.5	center of wall based on dimensions for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 4: Wall 3									
Type	P	3	D	area	NUREG/CR-5512				
Direction	P	3	D	Y	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 8, 1.5	center of wall based on dimensions for scenario-defined room				
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				

Table D-1: Input Values for RESRAD-BUILD 3.5 Parameter Probabilistic Analysis Building Occupancy Scenario

Parameter	Type	Priority	Treatment	Value or Distribution	Value/Distribution Reference Source	Distribution's Statistical Parameters[a]			
						1	2	3	4
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 5: Wall 4									
Type	P	3	D	area	NUREG/CR-5512				
Direction	P	3	D	X	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	8, 4, 1.5	center of wall based on dimensions for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Z-axis (m)	P	2	D	3	Based on height (3 m) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-
Source 6: Ceiling									
Type	P	3	D	Area	NUREG/CR-5512				
Direction	P	3	D	Z	NUREG/CR-5512				
Location of Center of Source: x,y,z (m)	P	3	D	4, 4, 3	center of ceiling based on dimensions for scenario-defined room				

Table D-1: Input Values for RESRAD-BUILD 3.5 Parameter Probabilistic Analysis Building Occupancy Scenario									
Parameter	**Type**	**Priority**	**Treatment**	**Value or Distribution**	**Value/Distribution Reference Source**	**Distribution's Statistical Parameters[a]**			
						1	**2**	**3**	**4**
Source length X-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Source length Y-axis (m)	P	2	D	8	Based on area dimensions (64 m^2) for scenario-defined room				
Area (m^2)	P	2	D	NA	Room dimensions used				
Air Release Fraction for H-3	B	2	D	1.0	NUREG/CR-7267				
Air Release Fraction (all nuclides other than H-3)	B	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1E-06	1.0	0.07	
Direct Ingestion (h^{-1})	B	2	D	4.91E-7	NUREG/CR-6755				
Removable Fraction	P	1	D	0.1	NUREG/CR-5512, NUREG/CR-6755				
Time for Source Removal (d)	P	2	S	Triangular	NUREG/CR-6755, NUREG/CR-7267	1,000	100,000	10,000	-
Radionuclide Concentration (pCi/m^2)	P	2	D	1.0	ROCs identified for CR3 site	-	-	-	-

Table D-1 notes:

[a] Distribution Statistical Parameters:

Loguniform: 1= minimum, 2 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Triangular: 1 = minimum, 2 = maximum, 3 = most likely

Appendix E

RESRAD-Onsite 7.2 Probabilistic Analysis Results

(Extracted from Reference 13)

Table E-1: RESRAD-Onsite 7.2 Parameters Identified as Sensitive by Radionuclide

Radionuclide	Sensitive Parameter	PRCC Value
Am-241	Plant transfer factor for Am	0.90
	External gamma shielding factor	0.27
	Depth of soil mixing layer	-0.73
	Depth of roots	-0.82
C-14	Depth of roots	-0.45
	K_d of C14 in CZ	0.88
Cm-243	External gamma shielding factor	0.90
	Depth of soil mixing layer	-0.39
	Depth of roots	-0.65
	Plant Transfer Factor for Cm	0.75
Cm-244	Depth of soil mixing layer	-0.72
	Depth of roots	-0.82
	Plant Transfer Factor for Cm	0.90
Co-60	External gamma shielding factor	0.95
	K_d of Co-60 in CZ	0.47
Cs-137	External gamma shielding factor	0.96
	Depth of roots	-0.46
	Plant transfer factor for Cs	0.58
	Meat Transfer Factor for Cs	0.39
	Milk transfer factor for Cs	0.31
Eu-152	External gamma shielding factor	0.91
	K_d of Eu-152 in CZ	0.53
Eu-154	External gamma shielding factor	0.90
	K_d of Eu-154 in CZ	0.53
Fe-55	Depth of soil mixing layer	-0.93
	Depth of roots	-0.32
	Plant transfer factor for Fe	0.38
	Meat transfer factor for Fe	0.92
H-3	SZ hydraulic gradient	-0.69
	Well pump intake depth	-0.27
	Depth of roots	-0.75
Nb-94	External gamma shielding factor	1.00
	K_d of Nb-94 in CZ	0.48
Ni-59	Depth of soil mixing later	-0.55
	Depth of roots	-0.76
	Plant Transfer Factor for Ni	0.84
	Milk Transfer Factor for Ni	0.88
Ni-63	Depth of soil mixing later	-0.55
	Depth of roots	-0.76
	Plant Transfer Factor for Ni	0.84
	Milk Transfer Factor for Ni	0.88
Pu-238	Depth of soil mixing layer	-0.65
	Depth of roots	-0.77
	Plant transfer factor for Pu	0.85

Radionuclide	Sensitive Parameter	PRCC Value
Pu-239	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu	-0.62 -0.74 0.84
Pu-240	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu	-0.56 -0.71 0.82
Pu-241	Depth of soil mixing layer Depth of roots Plant transfer factor for Pu Plant transfer factor for Am	-0.56 -0.75 0.50 0.68
Sr-90	Depth of roots K_d of Sr-90 in CZ Plant Transfer Factor for Sr	-0.89 0.30 0.95
Tc-99	SZ hydraulic gradient Depth of roots K_d of Tc-99 in CZ Plant transfer factor for Tc	-0.39 -0.57 0.70 0.71

Table E-2: 25th and 75th Percentile Values for Sensitive RESRAD-Onsite 7.2 Parameters

Sensitive Input Parameter	Affected Nuclide	RESRAD Percentile Value[a] 25th	75th
Depth of roots (m)	Am-241	1.2E+00	
	C-14	1.2E+00	
	Cm-243	1.2E+00	
	Cm-244	1.2E+00	
	Cs-137	1.2E+00	
	Fe-55	1.2E+00	
	H-3	1.2E+00	
	Ni-59	1.2E+00	
	Ni-63	1.2E+00	
	Pu-238	1.2E+00	
	Pu-239	1.2E+00	
	Pu-240	1.2E+00	
	Pu-241	1.2E+00	
	Sr-90	1.2E+00	
	Tc-99	1.2E+00	
Depth of soil mixing layer	Am-241	1.5E-01	
	Cm-243	1.5E-01	
	Cm-244	1.5E-01	
	Fe-55	1.5E-01	
	Ni-59	1.5E-01	
	Ni-63	1.5E-01	
	Pu-238	1.5E-01	
	Pu-239	1.5E-01	
	Pu-240	1.5E-01	
	Pu-241	1.5E-01	
External gamma shielding factor	Am-241		4.0E-01
	Cm-243		4.0E-01
	Co-60		4.0E-01
	Cs-137		4.0E-01
	Eu-152		4.0E-01
	Eu-154		4.0E-01
	Nb-94		4.0E-01
Well Pump Intake Depth (m)	H-3	1.1E+01	

Sensitive Input Parameter	Affected Nuclide	RESRAD Percentile Value[a]	
		25th	75th
Plant transfer factor (pCi/g plant per pCi/g soil)	Am-241 (the plant transfer factor was also found sensitive for the Am-241 as Pu-241daughter)		1.8E-03
	Cm-243		1.8E-03
	Cm-244		1.8E-03
	Cs-137		8.0E-02
	Fe-55		1.8E-03
	Ni-59		9.1E-02
	Ni-63		9.1E-02
	Pu-238		1.8E-03
	Pu-239		1.8E-03
	Pu-240		1.8E-03
	Pu-241		1.8E-03
	Sr-90		5.9E-01
	Tc-99		9.1E+00
Meat transfer factor (pCi/kg per pCi/d)	Cs-137		4.0E-02
	Fe-55		1.8E-02
	Pu-238		9.4E-06
Milk transfer factor (pCi/l per pCi/d)	Cs-137		7.4E-03
	Ni-59		3.2E-02
	Ni-63		3.2E-02
K_d in CZ (cm^3/g)	C-14		7.1E+01
	Co-60		3.1E+03
	Eu-152		1.4E+04
	Eu-154		1.4E+04
	Nb-94		3.8E+03
	Sr-90		1.7E+02
	Tc-99		8.8E-01
SZ hydraulic gradient	H-3	1.8E-03	
	Tc-99	1.8E-03	

[a] The 75th percentile value was selected when the absolute value of the PRCC for a given parameter was ≥0.25 and PRCC had a positive value. The 25th percentile value was selected when the absolute value of the PRCC value for a given parameter was ≥0.25 and the PRCC had a negative value.

Appendix F

RESRAD-Build 3.5 Probabilistic Analysis Results

(Extracted from Reference 14)

Table F-1: RESRAD-Build 3.5 Parameters Identified as Sensitive by Radionuclide

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	**DKSUS** (resuspension rate)	**LAMBDAT** (building air exchange rate)	**INGE** (ingestion rate)	**AIRFR**[a] (air fraction)	**RFO** (source Release time)
Am-241	1	NS[b]	NS	-0.92	NS	0.91	-0.53
	2	NS	NS	-0.94	NS	0.92	-0.58
	3	NS	NS	-0.92	-0.11	0.91	-0.55
	4	NS	NS	-0.92	NS	0.91	-0.53
	5	NS	NS	-0.92	NS	0.90	-0.50
	6	NS	NS	-0.91	NS	0.90	-0.48
C-14	1	0.23	-0.45	-0.66	0.24	0.59	0.30
	2	0.28	-0.51	-0.67	0.26	0.58	0.22
	3	0.31	-0.50	-0.63	0.28	0.60	0.27
	4	0.27	-0.49	-0.68	0.24	0.57	0.26
	5	0.27	-0.46	-0.66	0.26	0.62	0.24
	6	0.32	-0.52	-0.66	0.28	0.60	0.30
Cm-243	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.11	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.87
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Cm-244	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.11	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.87
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Co-60	1	NS	NS	-0.63	NS	0.55	0.54
	2	NS	NS	-0.78	NS	0.74	0.23
	3	0.15	-0.14	-0.77	NS	0.72	0.24
	4	NS	-0.12	-0.79	NS	0.70	0.26
	5	0.12	-0.10	-0.78	NS	0.75	0.23
	6	0.12	-0.11	-0.69	NS	0.64	0.38

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	DKSUS (resuspension rate)	LAMBDAT (building air exchange rate)	INGE (ingestion rate)	AIRFR[a] (air fraction)	RFO (source Release time)
Cs-137	1	0.28	-0.35	-0.52	0.16	0.47	0.56
	2	0.38	-0.45	-0.60	0.19	0.53	0.47
	3	0.34	-0.43	-0.56	0.15	0.53	0.47
	4	0.33	-0.41	-0.59	0.24	0.46	0.42
	5	0.35	-0.42	-0.60	0.20	0.52	0.42
	6	0.32	-0.40	-0.57	0.17	0.48	0.45
Eu-152	1	0.10	-0.10	-0.76	NS	0.70	0.35
	2	NS	NS	-0.82	NS	0.82	NS
	3	0.13	-0.11	-0.85	-0.10	0.82	NS
	4	0.13	-0.18	-0.83	NS	0.80	NS
	5	0.22	-0.22	-0.85	NS	0.83	NS
	6	0.10	NS	-0.82	NS	0.78	0.20
Eu-154	1	NS	NS	-0.78	NS	0.72	0.31
	2	NS	NS	-0.83	NS	0.84	NS
	3	0.10	NS	-0.86	NS	0.83	NS
	4	NS	-0.14	-0.83	NS	0.82	NS
	5	0.15	-0.13	-0.84	NS	0.83	NS
	6	NS	NS	-0.83	NS	0.79	0.14
Fe-55	1	NS	NS	-0.85	NS	0.83	NS
	2	NS	NS	-0.84	0.13	0.84	NS
	3	NS	NS	-0.86	NS	0.84	NS
	4	NS	NS	-0.84	NS	0.82	NS
	5	0.11	NS	-0.85	NS	0.84	NS
	6	NS	NS	-0.86	NS	0.83	NS
H-3	1	0.44	-0.48	-0.93	0.22	NA - Deterministic value of 1.0 used.	-0.33
	2	0.38	-0.46	-0.93	0.22		-0.22
	3	0.38	-0.45	-0.92	0.25		-0.17
	4	0.43	-0.49	-0.93	0.28		-0.35
	5	0.40	-0.49	-0.93	0.22		-0.21
	6	0.37	-0.43	-0.93	0.23		-0.29

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	**DKSUS** (resuspension rate)	**LAMBDAT** (building air exchange rate)	**INGE** (ingestion rate)	**AIRFR**[a] (air fraction)	**RFO** (source Release time)
Nb-94	1	NS	-0.24	-0.76	NS	0.71	0.51
	2	0.14	-0.32	-0.85	NS	0.83	-0.33
	3	0.22	-0.33	-0.86	NS	0.81	-0.41
	4	0.23	-0.39	-0.84	NS	0.84	-0.33
	5	0.32	-0.45	-0.86	NS	0.85	-0.27
	6	0.14	-0.26	-0.84	0.10	0.81	0.19
Ni-59	1	NS	-0.20	-0.88	0.19	0.89	-0.64
	2	0.12	-0.23	-0.89	0.19	0.89	-0.69
	3	0.17	-0.26	-0.89	NS	0.86	-0.66
	4	0.19	-0.32	-0.89	0.12	0.89	-0.66
	5	0.22	-0.31	-0.90	0.12	0.89	-0.66
	6	0.10	-0.22	-0.89	0.21	0.87	-0.63
Ni-63	1	NS	-0.11	-0.88	0.13	0.88	-0.58
	2	0.10	-0.14	-0.90	0.14	0.89	-0.63
	3	0.16	-0.18	-0.89	NS	0.86	-0.61
	4	0.16	-0.24	-0.88	NS	0.88	-0.58
	5	0.20	-0.22	-0.89	NS	0.89	-0.57
	6	NS	-0.11	-0.89	0.16	0.87	-0.56
Pu-238	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.10	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Pu-239	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	0.10	0.91	-0.89
	3	NS	NS	-0.92	NS	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87

ROC	Source Number	PRCC Values					
		UD (deposition velocity)	**DKSUS** (resuspension rate)	**LAMBDAT** (building air exchange rate)	**INGE** (ingestion rate)	**AIRFR**[a] (air fraction)	**RFO** (source Release time)
Pu-240	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	NS	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Pu-241	1	NS	NS	-0.92	NS	0.91	-0.87
	2	NS	NS	-0.92	NS	0.92	-0.89
	3	NS	NS	-0.92	-0.10	0.90	-0.87
	4	NS	NS	-0.91	NS	0.90	-0.86
	5	NS	NS	-0.92	NS	0.91	-0.88
	6	NS	NS	-0.92	NS	0.91	-0.87
Sr-90	1	NS	NS	-0.88	0.11	0.88	-0.45
	2	NS	NS	-0.88	0.10	0.87	-0.44
	3	0.13	-0.13	-0.89	NS	0.85	-0.52
	4	0.15	-0.21	-0.86	NS	0.87	-0.43
	5	0.19	-0.18	-0.88	NS	0.88	-0.41
	6	NS	NS	-0.88	0.14	0.86	-0.43
Tc-99	1	0.12	-0.28	-0.85	0.21	0.84	-0.23
	2	0.13	-0.31	-0.84	0.21	0.82	-0.24
	3	0.22	-0.34	-0.85	0.12	0.80	-0.36
	4	0.23	-0.40	-0.84	0.20	0.83	-0.25
	5	0.35	-0.47	-0.86	0.15	0.85	-0.18
	6	0.12	-0.29	-0.84	0.28	0.82	-0.25

[a] Not sensitive.

Table F-2: 25th, 50th, and 75th Percentile Values for Sensitive RESRAD-Build 3.5 Parameters

Sensitive Parameter[a]	Percentile Value		
	25th	50th	75th
LAMBDAT	8.4E-01	1.5E+00	2.7E+00
UD	1.5E-05	8.5E-05	4.8E-04
DKSUS	6.6E-10	1.8E-08	4.7E-07
INGE	5.0E-05	9.0E-05	1.6E-04
AIRFR(1)	1.6E-01	3.2E-01	5.2E-01
AIRFR(2)	1.6E-01	3.2E-01	5.2E-01
AIRFR(3)	1.6E-01	3.2E-01	5.2E-01
AIRFR(4)	1.6E-01	3.2E-01	5.2E-01
AIRFR(5)	1.6E-01	3.2E-01	5.2E-01
AIRFR(6)	1.6E-01	3.2E-01	5.2E-01
RFO(1)	1.8E+04	3.3E+04	5.3E+04
RFO(2)	1.8E+04	3.3E+04	5.3E+04
RFO(3)	1.8E+04	3.3E+04	5.3E+04
RFO(4)	1.8E+04	3.3E+04	5.3E+04
RFO(5)	1.8E+04	3.3E+04	5.3E+04
RFO(6)	1.8E+04	3.3E+04	5.3E+04

[a] LAMBDAT = building air exchange rate, UD = deposition velocity, DKSUS = resuspension rate, INGE = indirect ingestion rate, AIRFR(#) = air release fraction (for source number), and RFO(#) = source removal time (for source number).

Appendix G

Summary of Input Values for CR3 DCGL Calculations
(Extracted from Reference 15)

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (generic soil type values assigned to contaminated, unsaturated. and saturated zones) (cm^3/g)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.44	1.1	0.001	0.999	1700
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
C-14	P	1	S D	Truncated lognormal-n 7.1E+01	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	3.04	1.82	0.001	0.999	21
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Co-60	P	1	S D	Truncated lognormal-n 3.1E+03	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	6.17	2.77	0.001	0.999	480
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.09	1.95	0.001	0.999	1200
Eu-152	P	1	S D	Truncated lognormal-n 1.4E+04	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	6.86	4.01	0.001	0.999	955
Eu-154	P	1	S D	Truncated lognormal-n 1.4E+04	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	6.86	4.01	0.001	0.999	955
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.78	0.69	0.001	0.999	880
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.61	3.22	0.001	0.999	5
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.81	0.5	0.001	0.999	0.06
Nb-94	P	1	S D	Truncated lognormal-n 3.8E+03	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	7.31	1.39	0.001	0.999	1500
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.58	1.79	0.001	0.999	36
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.6	1.1	0.001	0.999	2000
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.65	2.30	0.001	0.999	2100
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.19	1.61	0.001	0.999	180
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Sr-90	P	1	S D	Truncated lognormal-n 1.7E+02	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	3.95	1.79	0.001	0.999	52
Tc-99	P	1	S D	Truncated lognormal-n 8.8E-01	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	-1.61	2.20	0.001	0.999	0.2
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-232	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	Ground water uncontaminated	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0		NR	NR	NR	NR	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										

Table G-1: Input Values and Bases for CR3 DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Area of contaminated zone (m^2)	P	2	D	64,821	CR3 PA= 64,821 m^2	NR	NR	NR	NR	
Thickness of contaminated zone (m)	P	2	D	0.1524	Depth of soil mixing layer (6 inches) as defined for the Resident Farmer Scenario in NUREG/CR-5512	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	287	Assumed diameter of a circle with an area = CR3 contaminated zone, 64,821 m^2	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	Consistent with resident farmer scenario - no cover assumed	NR	NR	NR	NR	
Density of contaminated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Contaminated zone erosion rate (m/y)	P	2	D	6E-04	NUREG/CR-7267; assumed erosion rate for site with shallow slope	NR	NR	NR	NR	
Contaminated zone total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300					
Contaminated zone hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Humidity in air (g/m^3)	P	3	D	13.8	*Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations*	NR	NR	NR	NR	
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-7267	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	D	3.5	*Crystal River HSA*	NR	NR	NR	NR	
Precipitation (m/y)	P	2	D	1.5	Upper end of precipitation range is applied: "rainfall averages about 50 to 60 inches per year" *Crystal River HSA*	NR	NR	NR	NR	
Irrigation (m/y)	B	3	S	Uniform	Distribution determined using methodology described in 2015 updated *Data Collection Handbook* and NUREG/CR-6697.	0	0.6	NR	NR	0.3
Irrigation mode	B	3	D	Overhead	Overhead irrigation is common practice for crops in U.S.	NR	NR	NR	NR	

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Runoff coefficient	P	2	D	0.2	Value determined using methodology described in *Data Collection Handbook* and NUREG/CR-7267	NR	NR	NR	NR	
Watershed area for nearby stream or pond (m^2)	P	3	D	1.3E+07	https://en.wikipedia.org/wiki/Crystal_River_(Florida)	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.4	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	100,000	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	S	Bounded Lognormal-n 1.8E-03	Distribution from NUREG/CR-7267 applied to all ROCs except H-3 and Tc-99 25th percentile value applied to H-3 and Tc-99	-5.11	1.77	7.0E-05	0.5	0.006
Saturated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Water table drop rate (m/y)	P	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Well pump intake depth (m below water table)	P	2	S	Triangular 1.1E+01	Distribution from NUREG/CR-7267 applied to all ROCs except H-3 25th percentile value applied to H-3	6	10	30		14.51
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	ND model recommended for contaminant areas >1,000 m^2	NR	NR	NR	NR	
Well pumping rate (m^3/y)	P	2	S	Uniform	Min, and max value based on site irrigation rate and information from NUREG/CR-7267.	407	1605			802.5
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Unsat. zone 1, thickness (m)	P	1	S	uniform	Distribution developed from depth range for site groundwater, 5 ft – 9 ft (H&A *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station*); thickness of burm area, 21ft (H&A Technical Support Document, File No. 134300), and scenario default thickness of CZ, 0.5 ft.	7.92	8.99			8.46
Unsat. zone 1, soil density (g/cm^3)	P	2	D	1.5	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, effective porosity	P	2	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, soil-specific b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Occupancy										
Inhalation rate (m^3/y)	B	3	D	8400	NUREG/CR-7267	NR	NR	NR	NR	
Mass loading for inhalation (g/m^3)	P	2	S	Continuous linear	NUREG/CR-7267					2.3E-5
Exposure duration	B	3	D	30	RESRAD Default	NR	NR	NR	NR	
Indoor dust filtration factor	P	2	S	Uniform	NUREG/CR-7267	0.15	0.95			0.55
Shielding factor, external gamma	P	2	S D	Bounded lognormal-n 4.0E-01	Distribution from NUREG/CR-7267 applied to C-14, Cm-244, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99 75th percentile value applied to Am-241, Cm-243, Co-60, Cs-137, Eu-152, Eu-154, and Nb-94	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.6571	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Fraction of time spent outdoors	B	3	D	0.1181	NUREG/CR-5512, Vol. 3 (outdoors + gardening)	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	RESRAD Default - Circular contaminated zone assumed	NR	NR	NR	NR	
Ingestion, Dietary										

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Fruits, vegetables, grain consumption (kg/y)	B	2	D	112	NUREG/CR-5512, Vol. 3 (other vegetables + fruits + grain)	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	B	3	D	21.4	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk consumption (L/y)	B	2	D	233	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	B	3	D	65.1	NUREG/CR5512, Vol. 3 (beef + poultry)	NR	NR	NR	NR	
Fish consumption (kg/y)	B	3	D	20.6	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Other seafood consumption (kg/y)	B	3	D	0.9	RESRAD Default	NR	NR	NR	NR	
Soil ingestion rate (g/yr)	B	2	D	18.26	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Drinking water intake (L/y)	B	2	D	478.5	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of drinking water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water	P	3		NA						
Contamination fraction of livestock water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of irrigation water	P	3	D	1	RESRAD Default - all water assumed contaminate	NR	NR	NR	NR	
Contamination fraction of aquatic food	P	2	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of plant food	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of meat	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of milk	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/d)	M	3	D	27.1	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/d)	M	3	D	63.2	NUREG/CR5512, Vol. 3, forage + grain + hay	NR	NR	NR	NR	
Livestock water intake for meat (L/d)	M	3	D	50.6	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock water intake for milk (L/d)	M	3	D	60	NUREG/CR5512, Vol. 3	NR	NR	NR	NR	
Livestock soil intake (kg/d)	M	3	D	0.5	RESRAD Default	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	4.00E-04	NUREG/CR-5512, Vol. 3, gardening	NR	NR	NR	NR	

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Depth of soil mixing layer (m)	P	2	S	Triangular 1.5E-01	Distribution from NUREG/CR-7267 applied to C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Sr-90, and Tc-99 25th percentile value applied to Am-241, Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, and Pu-241	0	0.15	0.6		0.23
Depth of roots (m)	P	1	S D	Uniform 1.2E+00	Distribution from NUREG/CR-7267 applied to Co-60, Eu-152, Eu-154, and Nb-94 25th percentile value applied to Am-241, C-14, Cm-243, Cm-244, Cs-137, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99	0.3	4			1.85
Drinking water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Household water fraction from ground water (if used)	P	3		NA						
Livestock water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Irrigation fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	Truncated lognormal-n	NUREG/CR-7267	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	2.88921	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	1.8868	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	0.246	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	0.123	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	0.082	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	0.1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Weathering Removal Constant for Vegetation (1/y)	P	2	S	Triangular	NUREG/CR-7267	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Wet Foliar Interception Fraction for Leafy	P	2	S	Triangular	NUREG/CR-7267	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	14	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Leafy vegetables	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry	B	3	D	20	NUREG/CR-5512, Vol. 3 (holdup period for beef)	NR	NR	NR	NR	
Fish	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Well water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Surface water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Livestock fodder	B	3	D	45	RESRAD Default	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	2.00E-05	RESRAD Default	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	3.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	2.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	9.80E-01	RESRAD Default	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	S	Triangular	NUREG/CR-7267	0.2	0.3	0.6		0.3
C-14 evasion flux rate from soil (1/s)	P	3	D	7.00E-07	RESRAD Default	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/s)	P	3	D	1.00E-10	RESRAD Default	NR	NR	NR	NR	
Fraction of grain in beef cattle feed	B	3	D	0.2500	NUREG/CR-7267	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	0.1000	NUREG/CR-7267	NR	NR	NR	NR	
Inhalation Dose Conversion Factors (mrem/pCi inhaled) from FGR11 (contained in RESRAD Dose Conversion Library)										

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Ingestion Dose Conversion Factors (mrem/pCi ingested) from FGR11 (contained in RESRAD Dose Conversion Library)										
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	1.1	0.001	0.999	1.0E-03
Am-241	P	1	D	1.8E-03	75th percentile value					
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-0.4	0.9	0.001	0.999	6.7E-01
Cm-243	P	1	D	1.8E-03	75th percentile value					
Cm-244	P	1	D	1.8E-03	75th percentile value					
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.5	0.9	0.001	0.999	8.0E-02
Cs-137	P	1	D	8.0E-02	75th percentile value					
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Fe-55	P	1	D	1.8E-03	75th percentile value					
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	1.1	0.001	0.999	5.0E+00
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.0	0.001	0.999	2.0E-03
Ni-59	P	1	D	9.1E-02	75th percentile value					
Ni-63	P	1	D	9.1E-02	75th percentile value					
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.9	0.9	0.001	0.999	2.0E-02
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.1	0.001	0.999	1.0E-02
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-5.5	0.9	0.001	0.999	4.0E-04
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-238	P	1	D	1.8E-03	75th percentile value					
Pu-239	P	1	D	1.8E-03	75th percentile value					
Pu-240	P	1	D	1.8E-03	75th percentile value					
Pu-241	P	1	D	1.8E-03	75th percentile value					
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Sr-90	P	1	D	5.9E-01	75th percentile value					
Tc-99	P	1	D	9.1E+00	75th percentile value					

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.47	1.0	0.001	0.999	3.1E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.75	0.8	0.001	0.999	4.3E-04
Cs-137	P	2	D	4.0E-02	75th percentile value					
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Fe-55	P	2	D	1.8E-02	75th percentile value					
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.42	1.0	0.001	0.999	1.2E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.9	0.001	0.999	1.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	1.0	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.26	0.9	0.001	0.999	7.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.7	0.001	0.999	5.0E-03
Pu-238	P	2	S	9.4E-06	75th percentile value					
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	1.1	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.21	0.7	0.001	0.999	1.0E-04
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-232	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.4	0.9	0.001	0.999	1.2E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.12	0.7	0.001	0.999	1.1E-04
Cs-137	P	2	D	7.4E-03	75th percentile value					
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.26	0.7	0.001	0.999	3.5E-05
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	0.9	0.001	0.999	1.0E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Ni-59	P	2	D	3.2E-02	75th percentile value					

Table G-1: Input Values and Bases for CR3 DCGL Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ni-63	P	2	D	3.2E-02	75th percentile value					
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-11.51	0.7	0.001	0.999	1.0E-05
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.11	0.9	0.001	0.999	3.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.47	0.6	0.001	0.999	2.1E-04
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	0.5	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+01
Am-241	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
Am-243	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
C-14	P	2	S	Lognormal-n	NUREG/CR-7267	13.0	1.1			4.4E+05
Cm-243	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Cm-244	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Co-60	P	2	S	Lognormal-n	NUREG/CR-7267	4.3	0.9			7.4E+01
Cs-137	P	2	S	Lognormal-n	NUREG/CR-7267	7.8	0.9			2.4E+03
Eu-152	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Eu-154	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Fe-55	P	2	S	Lognormal-n	NUREG/CR-7267	5.1	1.9			1.6E+02
Gd-152	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
H-3	P	2	S	Lognormal-n	NUREG/CR-7267	0	0.1			1.0E+00
Nb-94	P	2	S	Lognormal-n	NUREG/CR-7267	5.7	1.1			3.0E+02
Ni-59	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Ni-63	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Np-237	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Pa-231	P	2	S	Lognormal-n	NUREG/CR-7267	2.3	1.1			1.0E+01
Pb-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.4E+01
Po-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.6	1.5			3.7E+01
Pu-238	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-239	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-240	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-241	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Ra-226	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Ra-228	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Sr-90	P	2	S	Lognormal-n	NUREG/CR-7267	1.1	1.4			3.0E+00
Tc-99	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Th-228	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-229	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-230	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
U-233	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-234	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-235	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-236	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L)) RESRAD default value for each radionuclide applied										
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	

Table G-1: Input Values and Bases for CR3 DCGL Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Table G-1 notes:

[a] P = physical, B = behavioral, M = metabolic
[b] 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter
[c] D = deterministic, S = stochastic, NR = none recommended
[d] Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum

Appendix H

RESRAD-Onsite 7.2 DCGL Calculation Results
(Extracted from Reference 15)

Table H-1: RESRAD-Onsite 7.2 Results and DCGL Values for Soil by ROC

ROC	Dose (mrem/y per pCi/g)	DCGL (pCi/g)
Am-241	1.23E-01	2.04E+02
C-14	3.57E-01	7.00E+01
Cm-243	3.27E-01	7.65E+01
Cm-244	9.54E-02	2.62E+02
Co-60	4.87E+00	5.13E+00
Cs-137	1.36E+00	1.84E+01
Eu-152	2.26E+00	1.11E+01
Eu-154	2.40E+00	1.04E+01
Fe-55	3.44E-04	7.27E+04
H-3	5.69E-04	4.40E+04
Nb-94	3.22E+00	7.77E+00
Ni-59	2.29E-03	1.09E+04
Ni-63	6.27E-03	3.99E+03
Pu-238	1.50E-01	1.67E+02
Pu-239	1.75E-01	1.43E+02
Pu-240	1.75E-01	1.43E+02
Pu-241	4.01E-03	6.24E+03
Sr-90	1.82E+00	1.38E+01
Tc-99	1.06E-01	2.35E+02

Appendix I

Summary of RESRAD-Build 3.5 Input for DCGL Calculations
(Extracted from Reference 16)

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Exposure Duration (d)	B	All ROCs	D	365.25	NUREG/CR-5512; NUREG/CR-7267
Indoor Fraction	B	All ROCs	D	0.267	NUREG/CR-5512; NUREG/CR-7267
Evaluation Time (y)	P	All ROCs	D	1 (1, 5, 10, 25, 50 for Pu-241)	T=1 corresponds to dose over the 1st year; multiple input applied to Pu-241 verify time of peak dose
Number of Rooms	P	All ROCs	D	1	NUREG/CR-5512 building occupancy scenario assumption
Deposition Velocity (m/s)	P	Am-241, Cm-243, Cm-244, Pu-238, Pu-239, Pu-240, Pu-241	D	8.5E-05	50th percentile value
		C-14, Co-60, Cs-137, Eu-152, Eu-154, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	D	4.8E-04	75th percentile value
Resuspension Rate (s^{-1})	P	C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	D	6.6E-10	25th percentile value
		Am-241, Cm-243, Cm-244, Fe-55, Pu-238, Pu-239, Pu-240, Pu-241	D	1.8E-08	50th percentile value
Air Exchange Rate for Room (h^{-1})	P	All ROCs	D	8.41E-01	25th percentile value
Room Area (m^2)	P	All ROCs	D	64	NURGEG/CR-6755
Room Height (m)	P	All ROCs	D	3	NURGEG/CR-6755
Time Fraction	B	All ROCs	D	1	NUREG/CR-7267
Inhalation Rate (m^3/d)	M	All ROCs	D	33.6	NUREG/CR-5512, vol. 3
Indirect Ingestion Rate (m^2/h)	B	Am-241, Cm-243, Cm-244, Eu-152, Pu-238, Pu-241	D	5.0E-05	25th percentile value
		Co-60, Eu-154, Pu-240	D	9.0E-05	50th percentile value
		C-14, Cs-137, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Pu-239, Sr-90, Tc-99	D	1.6E-04	75th percentile value

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Receptor Location	B	All ROCs	D	4, 4,1	NUREG/CR-5512; center of room based on scenario room dimensions from NUREG/CR-5512 and NUREG/CR-7267
Shielding Thickness (cm)	P	All ROCs	D	0	no shielding assumed
Shielding Density (g/cm^3)	P	All ROCs	D	1	Input value required for code execution – input has no impact due to shield thickness input
Shielding Material	P	All ROCs	D	water	Input value required for code execution – input has no impact due to shield thickness input
Number of Sources	P	All ROCs		6	Includes floor, ceiling, and 4 walls consistent to scenario assumptions in NUREG/CR-6755 and NUREG/CR-7267
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Inhalation Dose Conversion Factor, (mrem/pCi)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Ingestionl Dose Conversion Factor, (mrem/pCi)	M	All ROCs	D	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Source 1: Floor					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 4, 0	Center of floor based on dimensions for defined room

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Area (m^2)	P	All ROCs	D	---	Source length input used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR-6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-5512 and NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Fe-55 C-14, Co-60, Cs-137, Eu-152, Eu-154, Nb-94	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 2: Wall 1					
Type	P	All ROCs		Area	NUREG/CR-5512
Direction	P	All ROCs		Y	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 0, 1.5	Center of wall based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source dimension used

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR-6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Eu-152, Eu-154, Fe-55 C-14, Co-60, Cs-137	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 3: Wall 2					
Type	P	All ROCs		Area	NUREG/CR-5512
Direction	P	All ROCs		X	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	0.0, 4, 1.5	center of wall based on dimensions for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source dimension used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR-6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99	D	1.8E+04	25th percentile value
		Eu-152, Eu-154, Fe-55	D	3.3E+04	50th percentile value
		C-14, Co-60, Cs-137	D	5.3E+04	75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 4: Wall 3					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		Y	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 8, 1.5	center of wall based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source dimension used
Air Release Fraction	B	H-3	D	1.0	NUREG/CR-7267
		All other ROCs	D	5.2E-01	75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR-6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99	D	1.8E+04	25th percentile value
		Eu-152, Eu-154, Fe-55	D	3.3E+04	50th percentile value
		C-14, Co-60, Cs-137	D	5.3E+04	75Th percentile value

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 5: Wall 4					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		x	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All ROCs	D	8, 4, 1.5	center of wall based on dimensions for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Z-axis (m)	P	All ROCs	D	3	Based on height (3 m) for defined room
Area (m^2)	P	All ROCs	D	---	Source length inputs used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR-6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Nb-94, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Eu-152, Eu-154, Fe-55 C-14, Co-60, Cs-137	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-
Source 6: Ceiling					
Type	P	All ROCs		area	NUREG/CR-5512
Direction	P	All ROCs		Z	NUREG/CR-5512

Table I-1: RESRAD-Build 3.5 Input Values for CR3 DCGL Calculations					
Parameter	**Type[a]**	**Nuclide**	**Treatment[b]**	**Value/Distribution**	**Value Reference Source**
Location of Center of Source: x,y,z (m)	P	All ROCs	D	4, 4, 3	center of ceiling based on dimensions for defined room
Source length X-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Source length Y-axis (m)	P	All ROCs	D	8	Based on area dimensions (64 m^2) for defined room
Area (m^2)	P	All ROCs	D	---	Source length inputs used
Air Release Fraction	B	H-3 All other ROCs	D D	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	B	All ROCs	D	4.91E-7	NUREG/CR-6755
Removable Fraction	P	All ROCs	D	0.1	NUREG/CR-6755
Time for Source Removal (d)	P	Am-241, Cm-243, Cm-244, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Fe-55, Nb-94 C-14, Co-60, Cs-137, Eu-152, Eu-154, Nb-94	D D D	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All ROCs	D	1.0	-

[a] P = physical, B = behavioral, M = metabolic

[b] D = deterministic (non-stochastic).

Appendix J

RESRAD-Build 3.5 Results and DCGL Values for Building Structures
(Extracted from Reference 16)

Table J-1. RESRAD-Build 3.5 Results and DCGL Values for CR3 Buildings Structures

	DCGL Value Development:		
Nuclide	Dose (mrem/y per 1pCi/m^2)	$DCGL_{25}$ (pCi/m^2)	DCGL (dpm/100cm^2)
Am-241	3.36E-04	7.44E+04	1.65E+03
C-14	8.64E-08	2.89E+08	6.42E+06
Cm-243	2.31E-04	1.08E+05	2.40E+03
Cm-244	1.83E-04	1.37E+05	3.03E+03
Co-60	4.11E-05	6.08E+05	1.35E+04
Cs-137	1.18E-05	2.12E+06	4.70E+04
Eu-152	2.05E-05	1.22E+06	2.71E+04
Eu-154	2.17E-05	1.15E+06	2.56E+04
Fe-55	1.46E-08	1.71E+09	3.80E+07
H-3	2.64E-09	9.47E+09	2.10E+08
Nb-94	2.16E-05	1.16E+06	2.57E+04
Ni-59	1.64E-08	1.52E+09	3.38E+07
Ni-63	3.41E-08	7.33E+08	1.63E+07
Pu-238	2.95E-04	8.47E+04	1.88E+03
Pu-239	3.26E-04	7.67E+04	1.70E+03
Pu-240	3.26E-04	7.67E+04	1.70E+03
Pu-241	8.21E-06	3.05E+06	6.76E+04
Sr-90	6.82E-06	3.67E+06	8.14E+04
Tc-99	1.10E-07	2.27E+08	5.05E+06

Appendix K

RESRAD-Onsite 7.2 Input for Area Factors for Use with CR3 Soil DCGL Values

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (generic soil type values assigned to contaminated, unsaturated. and saturated zones) (cm³/g)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.44	1.1	0.001	0.999	1700
Am-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.86	1.79	0.001	0.999	2600
C-14	P	1	S D	Truncated lognormal-n 7.1E+01	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	3.04	1.82	0.001	0.999	21
Cm-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Cm-244	P	1	S	Truncated lognormal-n	NUREG/CR-7267	9.14	1.39	0.001	0.999	9300
Co-60	P	1	S D	Truncated lognormal-n 3.1E+03	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	6.17	2.77	0.001	0.999	480
Cs-137	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.09	1.95	0.001	0.999	1200
Eu-152	P	1	S D	Truncated lognormal-n 1.4E+04	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	6.86	4.01	0.001	0.999	955
Eu-154	P	1	S D	Truncated lognormal-n 1.4E+04	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	6.86	4.01	0.001	0.999	955
Fe-55	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.78	0.69	0.001	0.999	880
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.61	3.22	0.001	0.999	5
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.81	0.5	0.001	0.999	0.06
Nb-94	P	1	S D	Truncated lognormal-n 3.8E+03	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	7.31	1.39	0.001	0.999	1500

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations
Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ni-59	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Ni-63	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.63	1.95	0.001	0.999	280
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	3.58	1.79	0.001	0.999	36
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.6	1.1	0.001	0.999	2000
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.65	2.30	0.001	0.999	2100
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.19	1.61	0.001	0.999	180
Pu-238	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-239	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-240	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Pu-241	P	1	S	Truncated lognormal-n	NUREG/CR-7267	6.61	1.39	0.001	0.999	740
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.82	2.56	0.001	0.999	2500
Sr-90	P	1	S D	Truncated lognormal-n 1.7E+02	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	3.95	1.79	0.001	0.999	52
Tc-99	P	1	S D	Truncated lognormal-n 8.8E-01	Distribution from NUREG/CR-7267 applied to UZ and SZ 75th percentile value applied to CZ	-1.61	2.20	0.001	0.999	0.2
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
Th-232	P	1	S	Truncated lognormal-n	NUREG/CR-7267	7.55	2.3	0.001	0.999	1900
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	5.3	2.48	0.001	0.999	200
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	Ground water uncontaminated	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0		NR	NR	NR	NR	

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	Variable	Input values provided in Table K-2	NR	NR	NR	NR	
Thickness of contaminated zone (m)	P	2	D	0.1524	Depth of soil mixing layer (6 inches) as defined for the Resident Farmer Scenario in NUREG/CR-5512	NR	NR	NR	NR	
Length parallel to aquifer flow (m) (LCZPAQ)	P	2	D	Variable	Input values provided in Table K-2	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	Consistent with resident farmer scenario - no cover assumed	NR	NR	NR	NR	
Density of contaminated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Contaminated zone erosion rate (m/y)	P	2	D	6E-04	NUREG/CR-7267; assumed erosion rate for site with shallow slope	NR	NR	NR	NR	
Contaminated zone total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300					
Contaminated zone hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Humidity in air (g/m^3)	P	3	D	13.8	*Regional and Site-Specific Absolute Humidity Data for Use in Tritium Dose Calculations*	NR	NR	NR	NR	
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-7267	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	D	3.5	TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Precipitation (m/y)	P	2	D	1.5	Upper end of precipitation range is applied: "rainfall averages about 50 to 60 inches per year" TSD 16-015 *Crystal River HSA* Rev00	NR	NR	NR	NR	
Irrigation (m/y)	B	3	S	Uniform	Distribution determined using methodology described in 2015 updated *Data Collection Handbook* and NUREG/CR-6697.	0	0.6	NR	NR	0.3

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Irrigation mode	B	3	D	Overhead	Overhead irrigation is common practice for crops in U.S.	NR	NR	NR	NR	
Runoff coefficient	P	2	D	0.2	Value determined using methodology described in *Data Collection Handbook* and NUREG/CR-7267	NR	NR	NR	NR	
Watershed area for nearby stream or pond (m^2)	P	3	D	1.3E+07	https://en.wikipedia.org/wiki/Crystal_River_(Florida)	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	1	D	1.5	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.4	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	100,000	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	S	Bounded Lognormal-n 1.8E-03	Distribution from NUREG/CR-7267 applied to all ROCs except H-3 and Tc-99 25[th] percentile value applied to H-3 and Tc-99	-5.11	1.77	7.0E-05	0.5	0.006
Saturated zone b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Water table drop rate (m/y)	P	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Well pump intake depth (m below water table)	P	2	S	Triangular 1.1E+01	Distribution from NUREG/CR-7267 applied to all ROCs except H-3 25[th] percentile value applied to H-3	6	10	30		14.51
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	ND model recommended for contaminant areas >1,000 m2	NR	NR	NR	NR	
Well pumping rate (m^3/y)	P	2	S	Uniform	Min, and max value based on site irrigation rate and information from NUREG/CR-7267.	407	1605			802.5
Unsaturated Zone Hydrological Data										

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Number of unsaturated zone strata	P	3	D	1	Based on suggested uniform input for RESRAD-Onsite hydrologic parameters for the UZ (H&A Technical Support Document, File No. 134300) and assignment of generic soil type for UZ	NR	NR	NR	NR	
Unsat. zone 1, thickness (m)	P	1	S	uniform	Distribution developed from depth range for site groundwater, 5 ft – 9 ft (H&A *Phase II Site Investigation Report Crystal River 3 Nuclear Power Station*); thickness of burm area, 21ft (H&A Technical Support Document, File No. 134300), and scenario default thickness of CZ, 0.5 ft.	7.92	8.99			8.46
Unsat. zone 1, soil density (g/cm^3)	P	2	D	1.5	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, total porosity	P	2	D	0.4	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, effective porosity	P	2	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, field capacity	P	3	D	0.2	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, hydraulic conductivity (m/y)	P	2	D	100,000	H&A Technical Support Document, File No. 134300	NR	NR	NR	NR	
Unsat. zone 1, soil-specific b parameter	P	2	S	Bounded Lognormal-n	NUREG/CR-7267 distribution for generic soil type	1.06	0.66	0.50	30	2.886
Occupancy										
Inhalation rate (m^3/y)	B	3	D	8400	NUREG/CR-7267	NR	NR	NR	NR	
Mass loading for inhalation (g/m^3)	P	2	S	Continuous linear	NUREG/CR-7267					2.3E-5
Exposure duration	B	3	D	30	RESRAD Default	NR	NR	NR	NR	
Indoor dust filtration factor	P	2	S	Uniform	NUREG/CR-7267	0.15	0.95			0.55
Shielding factor, external gamma	P	2	S D	Bounded lognormal-n 4.0E-01	Distribution from NUREG/CR-7267 applied to C-14, Cm-244, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99 75th percentile value applied to Am-241, Cm-243, Co-60, Cs-137, Eu-152, Eu-154, and Nb-94	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.6571	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Fraction of time spent outdoors	B	3	D	0.1181	NUREG/CR-5512, Vol. 3 (outdoors + gardening)	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	RESRAD Default - Circular contaminated zone assumed	NR	NR	NR	NR	
Ingestion, Dietary										
Fruits, vegetables, grain consumption (kg/y)	B	2	D	112	NUREG/CR-5512, Vol. 3 (other vegetables + fruits + grain)	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	B	3	D	21.4	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk consumption (L/y)	B	2	D	233	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	B	3	D	65.1	NUREG/CR5512, Vol. 3 (beef + poultry)	NR	NR	NR	NR	
Fish consumption (kg/y)	B	3	D	20.6	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Other seafood consumption (kg/y)	B	3	D	0.9	RESRAD Default	NR	NR	NR	NR	
Soil ingestion rate (g/yr)	B	2	D	18.26	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Drinking water intake (L/y)	B	2	D	478.5	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of drinking water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water	P	3		NA						
Contamination fraction of livestock water	P	3	D	1	RESRAD Default - all water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of irrigation water	P	3	D	1	RESRAD Default - all water assumed contaminate	NR	NR	NR	NR	
Contamination fraction of aquatic food	P	2	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Contamination fraction of plant food (FPLANT)	P	3	D	Variable	Input values provided in Table K-2	NR	NR	NR	NR	
Contamination fraction of meat (FMEAT)	P	3	D	Variable	Input values provided in Table K-2	NR	NR	NR	NR	
Contamination fraction of milk (FMILK)	P	3	D	Variable	Input values provided in Table K-2	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/d)	M	3	D	27.1	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/d)	M	3	D	63.2	NUREG/CR5512, Vol. 3, forage + grain + hay	NR	NR	NR	NR	
Livestock water intake for meat (L/d)	M	3	D	50.6	NUREG/CR5512, Vol. 3, beef cattle + poultry + layer hen	NR	NR	NR	NR	

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Livestock water intake for milk (L/d)	M	3	D	60	NUREG/CR5512, Vol. 3	NR	NR	NR	NR	
Livestock soil intake (kg/d)	M	3	D	0.5	RESRAD Default	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	4.00E-04	NUREG/CR-5512, Vol. 3, gardening	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	S	Triangular 1.5E-01	Distribution from NUREG/CR-7267 applied to C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Sr-90, and Tc-99 25th percentile value applied to Am-241, Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, and Pu-241	0	0.15	0.6		0.23
Depth of roots (m)	P	1	S D	Uniform 1.2E+00	Distribution from NUREG/CR-7267 applied to Co-60, Eu-152, Eu-154, and Nb-94 25th percentile value applied to Am-241, C-14, Cm-243, Cm-244, Cs-137, Fe-55, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, and Tc-99	0.3	4			1.85
Drinking water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Household water fraction from ground water (if used)	P	3		NA						
Livestock water fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Irrigation fraction from ground water	P	3	D	1	RESRAD Default - all water assumed to be supplied from groundwater	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	Truncated lognormal-n	NUREG/CR-7267	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	2.88921	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	1.8868	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	0.246	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	0.123	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	0.082	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	0.1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Weathering Removal Constant for Vegetation (1/y)	P	2	S	Triangular	NUREG/CR-7267	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy	P	2	S	Triangular	NUREG/CR-7267	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	0.35	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	14	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Leafy vegetables	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Milk	B	3	D	1	NUREG/CR-5512, Vol. 3	NR	NR	NR	NR	
Meat and poultry	B	3	D	20	NUREG/CR-5512, Vol. 3 (holdup period for beef)	NR	NR	NR	NR	
Fish	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	7	RESRAD Default	NR	NR	NR	NR	
Well water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Surface water	B	3	D	1	RESRAD Default	NR	NR	NR	NR	
Livestock fodder	B	3	D	45	RESRAD Default	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	2.00E-05	RESRAD Default	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	3.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	2.00E-02	RESRAD Default	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	9.80E-01	RESRAD Default	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	S	Triangular	NUREG/CR-7267	0.2	0.3	0.6		0.3
C-14 evasion flux rate from soil (1/s)	P	3	D	7.00E-07	RESRAD Default	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/s)	P	3	D	1.00E-10	RESRAD Default	NR	NR	NR	NR	

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d] 1	2	3	4	Median/ Mean
Fraction of grain in beef cattle feed	B	3	D	0.2500	NUREG/CR-7267	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	0.1000	NUREG/CR-7267	NR	NR	NR	NR	
Inhalation Dose Conversion Factors (mrem/pCi inhaled) from FGR11 (contained in RESRAD Dose Conversion Library)										
Ingestion Dose Conversion Factors (mrem/pCi ingested) from FGR11 (contained in RESRAD Dose Conversion Library)										
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	1.1	0.001	0.999	1.0E-03
Am-241	P	1	D	1.8E-03	75th percentile value					
Am-243	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
C-14	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-0.4	0.9	0.001	0.999	6.7E-01
Cm-243	P	1	D	1.8E-03	75th percentile value					
Cm-244	P	1	D	1.8E-03	75th percentile value					
Co-60	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-2.5	0.9	0.001	0.999	8.0E-02
Cs-137	P	1	D	8.0E-02	75th percentile value					
Eu-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Eu-154	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
Fe-55	P	1	D	1.8E-03	75th percentile value					
Gd-152	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	1.1	0.001	0.999	2.0E-03
H-3	P	1	S	Truncated lognormal-n	NUREG/CR-7267	1.6	1.1	0.001	0.999	5.0E+00
Nb-94	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.0	0.001	0.999	2.0E-03
Ni-59	P	1	D	9.1E-02	75th percentile value					
Ni-63	P	1	D	9.1E-02	75th percentile value					
Np-237	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.9	0.9	0.001	0.999	2.0E-02
Pa-231	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	1.1	0.001	0.999	1.0E-02
Pb-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-5.5	0.9	0.001	0.999	4.0E-04
Po-210	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Pu-238	P	1	D	1.8E-03	75th percentile value					
Pu-239	P	1	D	1.8E-03	75th percentile value					
Pu-240	P	1	D	1.8E-03	75th percentile value					
Pu-241	P	1	D	1.8E-03	75th percentile value					
Ra-226	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02
Ra-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-3.2	0.9	0.001	0.999	4.0E-02

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario

Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Sr-90	P	1	D	5.9E-01	75th percentile value					
Tc-99	P	1	D	9.1E+00	75th percentile value					
Th-228	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-229	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
Th-230	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.9	0.9	0.001	0.999	1.0E-03
U-233	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-234	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-235	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
U-236	P	1	S	Truncated lognormal-n	NUREG/CR-7267	-6.2	0.9	0.001	0.999	2.0E-03
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.90	0.4	0.001	0.999	5.0E-05
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-3.47	1.0	0.001	0.999	3.1E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.82	1.0	0.001	0.999	2.0E-05
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.75	0.8	0.001	0.999	4.3E-04
Cs-137	P	2	D	4.0E-02	75th percentile value					
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
Fe-55	P	2	D	1.8E-02	75th percentile value					
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.21	1.0	0.001	0.999	2.0E-03
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.42	1.0	0.001	0.999	1.2E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.9	0.001	0.999	1.0E-06
Ni-59	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Ni-63	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.9	0.001	0.999	5.0E-03
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	1.0	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.26	0.9	0.001	0.999	7.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-5.3	0.7	0.001	0.999	5.0E-03
Pu-238	P	2	D	9.4E-06	75th percentile value					

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.72	3.2	0.001	0.999	1.1E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	1.1	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.21	0.7	0.001	0.999	1.0E-04
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
Th-232	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.38	1.1	0.001	0.999	2.3E-04
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.85	0.5	0.001	0.999	3.9E-04
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Am-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Am-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
C-14	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.4	0.9	0.001	0.999	1.2E-02
Cm-243	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Cm-244	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.9	0.001	0.999	2.0E-06
Co-60	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.12	0.7	0.001	0.999	1.1E-04
Cs-137	P	2	D	7.4E-03	75th percentile value					
Eu-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Eu-154	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
Fe-55	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-10.26	0.7	0.001	0.999	3.5E-05
Gd-152	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-9.72	0.9	0.001	0.999	6.0E-05
H-3	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-4.6	0.9	0.001	0.999	1.0E-02
Nb-94	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.12	0.7	0.001	0.999	2.0E-06
Ni-59	P	2	D	3.2E-02	75th percentile value					

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Ni-63	P	2	D	3.2E-02	75th percentile value					
Np-237	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-11.51	0.7	0.001	0.999	1.0E-05
Pa-231	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Pb-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.11	0.9	0.001	0.999	3.0E-04
Po-210	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-8.47	0.6	0.001	0.999	2.1E-04
Pu-238	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-239	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-240	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Pu-241	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-13.82	0.5	0.001	0.999	1.0E-06
Ra-226	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Ra-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-7.88	0.8	0.001	0.999	3.8E-04
Sr-90	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.65	0.5	0.001	0.999	1.3E-03
Tc-99	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.91	0.7	0.001	0.999	1.0E-03
Th-228	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-229	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
Th-230	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-12.21	0.9	0.001	0.999	5.0E-06
U-233	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-234	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-235	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
U-236	P	2	S	Truncated lognormal-n	NUREG/CR-7267	-6.32	1.3	0.001	0.999	1.8E-03
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.5E+01
Am-241	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
Am-243	P	2	S	Lognormal-n	NUREG/CR-7267	5.5	1.1			2.4e+02
C-14	P	2	S	Lognormal-n	NUREG/CR-7267	13.0	1.1			4.4E+05
Cm-243	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Cm-244	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
Co-60	P	2	S	Lognormal-n	NUREG/CR-7267	4.3	0.9			7.4E+01
Cs-137	P	2	S	Lognormal-n	NUREG/CR-7267	7.8	0.9			2.4E+03
Eu-152	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02
Eu-154	P	2	S	Lognormal-n	NUREG/CR-7267	4.9	1.6			1.3E+02

Table K-1: Values and Bases for RESRAD-Onsite 7.2 Parameters for Area Factor Calculations Resident Farmer Scenario										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				Median/ Mean
						1	2	3	4	
Fe-55	P	2	S	Lognormal-n	NUREG/CR-7267	5.1	1.9			1.6E+02
Gd-152	P	2	S	Lognormal-n	NUREG/CR-7267	3.4	1.1			3.0E+01
H-3	P	2	S	Lognormal-n	NUREG/CR-7267	0	0.1			1.0E+00
Nb-94	P	2	S	Lognormal-n	NUREG/CR-7267	5.7	1.1			3.0E+02
Ni-59	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Ni-63	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	0.6			2.0E+01
Np-237	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Pa-231	P	2	S	Lognormal-n	NUREG/CR-7267	2.3	1.1			1.0E+01
Pb-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.2	1.1			2.4E+01
Po-210	P	2	S	Lognormal-n	NUREG/CR-7267	3.6	1.5			3.7E+01
Pu-238	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-239	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-240	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Pu-241	P	2	S	Lognormal-n	NUREG/CR-7267	10.0	1.0			2.2E+04
Ra-226	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Ra-228	P	2	S	Lognormal-n	NUREG/CR-7267	1.4	1.9			4.1E+00
Sr-90	P	2	S	Lognormal-n	NUREG/CR-7267	1.1	1.4			3.0E+00
Tc-99	P	2	S	Lognormal-n	NUREG/CR-7267	3.0	1.1			2.0E+01
Th-228	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-229	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
Th-230	P	2	S	Lognormal-n	NUREG/CR-7267	4.6	1.1			9.9E+01
U-233	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-234	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-235	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
U-236	P	2	S	Lognormal-n	NUREG/CR-7267	0.0	2.5			1.0E+00
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L)) RESRAD default value for each radionuclide applied										
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Table K-1 Notes:

[a] P = physical, B = behavioral, M = metabolic; (see NUREG/CR-7267, Appendix B, Table B-2)
[b] 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter (see NUREG/CR-6697, Attachment B, Table 4-2)
[c] D = deterministic, S = stochastic
NR = none recommended

[d] Distributions Statistical Parameters:

Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum

Table K-2: Input Values for RESRAD-Onsite 7.2 Code Executions for Area Factors Calculations

RESRAD-Onsite 7.2 Parameter	**Input Value**				
Contaminated Zone (m^2)	64,821[a]	2,000	1,000	500	100
LCZPAQ (m)	287[a]	50	36	25	11
FPLANT	1.0[a]	1.0	1.0	0.5	0.10
FMEAT	1.0[a]	0.1	0.05	0.025	0.005
FMILK	1.0[a]	0.1	0.05	0.025	0.005
Contaminated Zone (m^2)	50	10	5	1	
LCZPAQ (m)	8.0	3.6	2.5	1.1	
FPLANT	0.05	0.01	0.005	0.001	
FMEAT	0.0025	0.0005	0.00025	0.00005	
FMILK	0.0025	0.0005	0.00025	0.00005	

[a] Parameter value for DCGL modeling

Appendix L

Area Factors for Use with CR3 DCGL Values for Soil

(Extracted from Reference 17)

Table L-1: Area Factors for Use with CR3 DCGL Values for Soil

ROC	Area Factor for Contaminated Zone (m^2):							
	2000	1000	500	100	50	10	5	1
Am-241	1	1	2	5	7	13	18	40
C-14	1	1	4	45	124	1235	3211	25923
Cm-243	1	1	1	2	2	3	5	14
Cm-244	1	1	2	9	15	40	53	79
Co-60	1	1	1	1	1	2	4	11
Cs-137	1	1	1	1	1	2	4	12
Eu-152	1	1	1	1	1	2	3	11
Eu-154	1	1	1	1	1	2	3	11
Fe-55	1	1	3	14	28	136	264	1113
H-3	1	1	2	10	20	69	99	225
Nb-94	1	1	1	1	1	2	3	11
Ni59	1	1	2	12	25	123	246	1203
Ni63	1	1	2	12	25	123	246	1208
Pu-238	1	1	2	9	15	40	53	79
Pu-239	1	1	2	9	15	40	53	80
Pu-240	1	1	2	9	15	41	54	80
Pu241	1	1	2	6	8	15	21	44
Sr-90	1	1	2	10	19	84	160	716
Tc-99	1	1	2	10	20	100	199	990

Appendix M

RESRAD-Build 3.5 Input for Area Factors for CR3 Building Structure DCGL Values

Table M-1: RESRAD-Build 3.5 Input Parameter Values for Area Factors			
Parameter	**Nuclide**	**Value/Distribution**	**Value Reference Source**
Exposure Duration (d)	All ROCs	365.25	NUREG/CR-5512; NUREG/CR-7267
Indoor Fraction	All ROCs	0.267	NUREG/CR-5512; NUREG/CR-7267
Evaluation Time (y)	All ROCs	1 (1, 5, 10, 25, 50 for Pu-241)	T=1 corresponds to dose over the 1st year; multiple input applied to Pu241 verify time of peak dose
Number of Rooms	All ROCs	1	NUREG/CR-5512 building occupancy scenario assumption
Deposition Velocity (m/s)	Am-241, Cm-243, Cm-244, Pu-238, Pu-239, Pu-240, Pu-241	8.5E-05	50th percentile value
	C-14, Co-60, Cs-137, Eu-152, Eu-154, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	4.8E-04	75th percentile value
Resuspension Rate (s^{-1})	C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, Nb-94, Ni-59, Ni-63, Sr-90, Tc-99	6.6E-10	25th percentile value
	Am-241, Cm-243, Cm-244, Fe-55, Pu-238, Pu-239, Pu-240, Pu-241	1.8E-08	50th percentile value
Air Exchange Rate for Room (h^{-1})	All ROCs	8.41E-01	25th percentile value
Room Area (m^2)	All ROCs	64	NURGEG/CR-6755
Room Height (m)	All ROCs	3	NURGEG/CR-6755
Time Fraction	All ROCs	1	NUREG/CR-7267
Inhalation Rate (m^3/d)	All ROCs	33.6	NUREG/CR-5512, vol. 3
Indirect Ingestion Rate (m^2/h)	AM-241, Cm-243, Cm-244, Eu-152, Pu-238, Pu-241	5.0E-05	25th percentile value
	Co-60, Eu-154, Pu-240	9.0E-05	50th percentile value
	C-14, Cs-137, Fe-55, H-3, Nb-94, Ni-59, Ni-63, Pu-239, Sr-90, Tc-99	1.6E-04	75th percentile value
Receptor Location	All ROCs	4, 4,1	NUREG/CR-5512; center of room based on scenario room dimensions from NUREG/CR-5512; NUREG/CR-7267
Shielding Thickness (cm)	All ROCs	0	no shielding assumed
Shielding Density (g/cm^3)	All ROCs	1	Input value required for code execution – input has no impact due to shield thickness input
Shielding Material	All ROCs	water	Input value required for code execution – input has no impact due to shield thickness input

Table M-1: RESRAD-Build 3.5 Input Parameter Values for Area Factors			
Parameter	**Nuclide**	**Value/Distribution**	**Value Reference Source**
Number of Sources	All ROCs	1	Floor in scenario is assumed as source
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.12 (FGR-12).
Inhalation Dose Conversion Factor, (mrem/pCi)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Ingestionl Dose Conversion Factor, (mrem/pCi)	All ROCs	RESRAD-Build library	Values were from Federal Guidance Report No.11 (FGR-11).
Source: scenario room floor			
Type	All ROCs	area	NUREG/CR-5512
Direction	All ROCs	Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	All ROCs	4, 4, 0	Center of 8m x 8m floor
Source length X-axis (m)	All ROCs	Square root of assumed source size	Input values provided in Table M-2
Source length Y-axis (m)	All ROCs	Square root of assumed source size	Input values provided in Table M-2
Area (m^2)	All ROCs	---	Source length input used
Air Release Fraction	H-3 All others	1.0 5.2E-01	NUREG/CR-7267 75th percentile value
Direct Ingestion (h^{-1})	All ROCs	4.91E-7	NUREG/CR6755
Removable Fraction	All ROCs	0.1	NUREG/CR-5512 and NUREG/CR-6755
Time for Source Removal (d)	Am-241, Cm-243, Cm-244, H-3, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, Tc-99 Fe-55 C-14, Co-60, Cs-137, Eu-152, Eu-154, Nb-94	1.8E+04 3.3E+04 5.3E+04	25th percentile value 50th percentile value 75Th percentile value
Radionuclide Concentration (pCi/m^2)	All ROCs	1.0	-

Table M-2	
Area Source (m^2)	**Length of X- and Y-axes (m)**
64	8.00
50	7.07
10	3.16
5.0	2.24
2.5	1.58
1.0	1.00

Appendix N

Area Factors for Use with CR3 Building Structure DCGL Values

(Extracted from Reference 18)

Table N-1: Building Structure Area Factors by Radionuclide and Area Size

Area (m^2)	Area Factor Values: Am-241	C-14	Cm-243	Cm-244	Co-60	Cs-137	Eu-152	Eu-154	Fe-55	H-3
64	1	1	1	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1	1	1
10	6	6	6	6	2	2	2	2	6	6
5	13	12	12	13	3	3	3	3	13	13
2.5	25	25	24	26	5	6	5	5	26	26
1	63	62	59	64	11	12	11	11	64	64
Area (m^2)	Area Factor Values: Nb-94	Ni-59	Ni-63	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90	Tc-99	
64	1	1	1	1	1	1	1	1	1	
50	1	1	1	1	1	1	1	1	1	
10	2	6	6	6	6	6	6	6	6	
5	3	13	13	13	13	13	13	12	12	
2.5	5	26	26	26	26	26	26	23	24	
1	11	64	64	64	64	64	64	57	58	

Enclosure 17

"*CR3 Site Remediation Equipment Methods and Techniques*"

November 2022

BEGINS ON NEXT PAGE

CR3 Site Remediation Equipment Methods and Techniques

November 2022

Discussion

Remediation actions are performed throughout the decommissioning process. The remediation action taken is dependent on the material contaminated. The principal materials that may be subjected to remediation are hardened structural surfaces and soils. Activities performed solely to accommodate FSS measurements (e.g., wiping down of surfaces, shaving concrete to allow for proper instrument probe geometries) will not be evaluated for ALARA.

Structures

Following the removal of designated equipment and components, structures will be surveyed as necessary, contaminated materials will be remediated or removed and disposed as radioactive waste. Contaminated structural surfaces that will remain onsite after license termination, if any, will be remediated to levels that will meet the established radiological criteria provided in Chapter 6. Each of the remediation tasks will be planned and scheduled prior to execution.

Remediation techniques that may be used for the structural surfaces include washing, wiping, pressure washing, vacuuming, scabbling, chipping, and sponge or abrasive blasting. Washing, wiping, abrasive blasting, vacuuming, and pressure washing techniques may be used for both metal and concrete surfaces. Scabbling and chipping are mechanical surface removal methods intended for concrete surfaces. Concrete removal, if required, may include using machines with hydraulic-assisted, remote-operated, articulating tools. These machines have the ability to exchange scabbling, shear, chisel, and other tool heads.

Scabbling and Shaving

As stated above, the principal remediation methods expected to be used for removing contaminants from concrete surfaces are scabbling and shaving. Scabbling is a surface removal process that uses pneumatically operated air pistons with (for example) tungsten-carbide tips that fracture the concrete surface to a nominal depth of 0.25 inch at a rate of about 20 ft^2 per hour.

The fractured media and dusts from both methods are deposited into a sealed removable container. The exhaust air passes through both roughing and absolute high efficiency particulate air (HEPA) filtration devices. Dust and debris generated through these remediation processes is collected and controlled during the operation.

Needle Guns

A second method of scabbling is accomplished using needle guns. The needle gun is a pneumatic air-operated tool containing a series of tungsten-carbide or hardened steel rods enclosed in a housing. The rods are connected to an air-driven piston to abrade and fracture the media surface.

Typically, one to two millimeters are removed per pass. Generated debris collection, transport, and dust control are accomplished in the same manner as other scabbling methods. Use of needle guns for removing and chipping media is usually reserved for areas not accessible to normal scabbling operations. These include, but are not limited to, inside corners, cracks, joints, and crevices. Needle gunning techniques can also be applied to painted and oxidized surfaces.

Chipping

Chipping includes the use of pneumatically operated chisels and similar tools coupled to vacuum-assisted collection devices. Chipping activities are usually reserved for cracks and crevices. This action is also a form of scabbling.

Sponge and Abrasive Blasting

Sponge and abrasive blasting are similar techniques that use media or materials coated with abrasive compounds such as silica sands, garnet, aluminum oxide, and walnut hulls. Sponge blasting is less aggressive, incorporating a foam media that, upon impact and compression, absorbs contaminants. The media is collected by vacuum and the contaminants are washed from the media so the media may be reused. Abrasive blasting is more aggressive than sponge blasting but less aggressive than scabbling.

Pressure Washing

Pressure washing uses a nozzle of intermediate water pressure to direct a jet of pressurized water that removes superficial materials from the suspect surface. A header may be used to minimize overspray. A wet vacuum system is used to suction the potentially contaminated water into containers for filtration or processing.

Washing and Wiping

Washing and wiping techniques are actions that are normally performed during the course of remediation activities and will not always be evaluated as a separate ALARA action. When washing and wiping techniques are used as the sole means to reduce residual contamination below DCGL levels, ALARA evaluations are performed. Washing and wiping techniques used as housekeeping or good practice measures will not be evaluated. Examples of washing and wiping activities for which ALARA evaluations would be performed include the following:

- Decontamination of structural materials, metals, or media for which decontamination reagents may be required
- Structure areas that do not provide sufficient access for use of other decontamination equipment such as pressure washing

Grit Blasting

Most contaminated piping will be removed and disposed as radioactive waste. Any remaining contaminated piping buried or embedded in concrete may be remediated using methods such as grit blasting. Grit blasting uses grit media such as garnet or sand under intermediate air pressure directed through a nozzle that is pulled through the closed piping at a fixed rate.

The grit blasting action removes the interior surface layer of the piping. A HEPA vacuum system maintains the sections being cleaned under negative pressure and collects the media for reuse or disposal.

Removal of Activated Concrete

Activated concrete will be evaluated and remediated or removed, as necessary.

Additional Remedial Actions

Mechanical abrasive equipment, such as hones, may be used to remove contamination from the surfaces of embedded or buried piping. Chemical removal means may be used, as appropriate, for the removal of certain contaminants.

Enclosure 18

"*Crystal River Unit 3 (CR3) – Decommissioning End State Conditions*"

February 2019

BEGINS ON NEXT PAGE

FLORIDA DEPARTMENT OF
Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Ron DeSantis
Governor

Jeanette Nuñez
Lt. Governor

Noah Valenstein
Secretary

February 15, 2019

Sent by Electronic Mail – Document Access Verification Requested

Terry Hobbs
General Manager Decommissioning SAFSTOR
Crystal River Nuclear Plant
15760 West Power Line Street
Crystal River, FL 34428
Terry.Hobbs@Duke-Energy.com

RE: Crystal River Unit 3 (CR3) – Decommissioning End State Conditions

Mr. Hobbs:

This letter is in response to your December 10, 2018, request for the Florida Department of Environmental Protection's (DEP's or Department's) concurrence on three specific end state conditions that will be used in Duke Energy Florida's (DEF's) development of a U.S. Nuclear Regulatory Commission (NRC) License Termination Plan (LTP) for the CR3 site. The three specific end state conditions are: 1) radioactivity dose limit for unrestricted site release; 2) excavation depth to which subsurface plant structures will be removed; and 3) reuse of clean concrete debris.

As part of preparing the LTP, DEF has indicated that it is evaluating accelerating the decontamination and dismantlement (D&D) of CR3. Some of the topics to be covered in DEF's LTP include: radiological characterization of the site; identification of dismantlement activities; plans for site remediation; detailed plans for the final radiation survey; a description of the end use of the site, if restricted; and a description of any new or significant environmental change associated with the licensee's proposed termination activities. DEF will submit the LTP to the NRC for their review and approval in accordance with federal regulations. Additionally, as part of the FDEP Conditions of Certification (COC) for the Crystal River Energy Complex, DEF is required to submit a copy of the LTP to the Department when it is filed with the NRC to allow the Department to identify any deficiencies in the plan.

You stated in your letter that the ability to establish end state conditions with certainty is critical to DEF's ability to determine the estimated cost to perform accelerated D&D, and to decide when D&D should be initiated. You also stated that it is DEF's position that the end state conditions for which you seek concurrence are either associated with an existing pre-emptive federal regulatory requirement or will be part of the LTP.

The end state conditions that have been determined by DEF to have the greatest potential to affect accurate D&D cost estimation are those for which DEP review and concurrence is requested. The three specific requests are addressed separately below.

1. **Specific End State Condition 1: Radioactivity dose limit for unrestricted site release.**

   DEF requests concurrence from DEP that 25 millirem/year (distinguishable from background) is an acceptable dose limit for use in CR3 decommissioning plans for unrestricted site release.

   Federal Regulations

   In your submittal, you cite the NRC criteria for radiological release of a site during license termination in 10 CFR 20.1402 as no greater than 25 millirem/year and As Low As Reasonably Achievable (ALARA).[1] NRC Regulatory Guide 1.179 provides that the LTP should demonstrate that the dose from residual radioactivity that is distinguishable from background radiation does not exceed 25 millirem (mrem) per year, and that residual radioactivity means radioactivity in structures, materials, soils, ground water, and other media at a site resulting from activities under the licensee's control. According to your research, the NRC has not deviated from this regulation for any of the commercial nuclear power plants decommissioned to date.

   State Regulations

   Rule 62-550.310(6)(b), Florida Administrative Code (F.A.C.), includes a Primary Drinking Water standard for man-made radionuclides of an annual dose equivalent no greater than 4 millirem/year. Although the NRC criteria of 25 millirem/year applies to the total effective dose equivalent which would include any potential potable use of groundwater, among other things, DEF has committed to ensuring that the 4 millirem/year standard will be applied as a dose limit for any potential potable use of groundwater at the CR3 site.

   Department of Health Rule 64E-5, F.A.C., describes a site as acceptable for unrestricted use if the total effective dose equivalent from the residual radioactivity does not exceed 25 millirem/year including radioactivity from groundwater sources of drinking water and the residual radioactivity levels are as low as reasonably achievable. This is consistent with the NRC acceptance criteria of 25 millirem/year.

[1] U.S. Nuclear Regulatory Commission, Title 10, Code of Federal Regulations, Part 20, Subpart E, Section 20.1402, "Radiological criteria for unrestricted use."

Conclusion

DEP concurs that 4 millirem/year is an acceptable proposed dose limit for any potential drinking water use of groundwater at the site; and that the referenced federal and state 25 millirem/year criteria is an acceptable proposed dose limit for release of the site for unrestricted use in CR3 decommissioning plans to be submitted to the NRC for review and approval.

2. **Specific End State Condition 2: Excavation depth to which subsurface plant structures will be removed.**

DEF requests concurrence from DEP that three feet below grade is an acceptable depth to which all subsurface structures would be removed in preparation for final radiological surveys.

LTPs must address planned actions to either remove or evaluate the structural components that will remain behind before final site surveys are performed. Removal of components at a site assures the 25 millirem/year dose rate will be met for the release of the site for unrestricted use. In your letter, you refer to establishment of the acceptance of excavation of structures to a depth of three feet in 1976 as an industry standard. You further state that this industry standard has historically been used both during the development of regulatory required Decommissioning Cost Estimates (DCE), and in LTPs submitted and approved by the NRC. For example, you referenced the NRC's September 28, 2018, approval that included an LTP for the Zion Nuclear Power Station, Units 1 and 2 which reflected use of the three-foot depth as the excavation standard.

As you pointed out, DEF published its intent to implement its strategy in its Post-Shutdown Decommissioning Activity Report.[2]

> *'This study assumes that site structures addressed by this analysis are removed to a nominal depth of three feet below the top grade of the embankment, wherever possible. This assumption was applied to the disposition of all CR-3 facilities on the berm and, as a result, the general topography of the berm will be retained at the conclusion of site restoration. The three-foot depth allows for the placement of gravel for drainage, as well as topsoil, so that vegetation can be established for erosion control."*

For comparison, the quantity of fill required for closure of facilities such as landfills in Florida is typically specified as two feet of clean fill with the top six inches supportive of vegetative growth. The proposed end state condition for CR3 of excavation of subsurface structures to a three-foot depth and replacement of the

[2] CR-3 to NRC letter, 3F1213-02, "Crystal River Unit 3-Post-Shutdown Decommissioning Activities Report," December 2, 2013

excavated area with three feet of fill appears more stringent than landfill requirements.

Conclusion

With the understanding that DEF will assure remediation of the site will be performed to meet the 25 millirem/year limit in Rule 64E-5, F.A.C., DEP concurs that the proposed industry standard of a removal depth for subsurface structures to a resulting depth of three feet below final grade is acceptable in preparation for final radiological surveys for use in CR3 decommissioning plans to be submitted to the NRC for review and approval.

3. **Specific End State Condition 3: Reuse of clean concrete debris.**

CR3 requests concurrence from DEP with its plans to segregate clean concrete debris produced during the demolition of site structures and to recycle the clean concrete debris to backfill the subsurface structures that will remain in place.

Federal Regulations

According to the information provided in your letter, Supplement I of the NRC's Generic Environmental Impact Statement requires facilities to perform an analysis of acceptability of demolition debris prior to its reuse. The analysis is submitted and reviewed as part of the LTP. CR3 plans to perform the analysis required to obtain approval to segregate clean concrete debris produced during the demolition of site structures and to recycle the clean demolition debris to backfill the subsurface structures.

You note that in 2018, this practice was approved in the LTP for the Zion Nuclear Power Station in Illinois. Zion described how radiological surveys and samples would be performed to provide confidence that any plant-derived radionuclides would be detected, and agreed to assign a dose contribution to concrete debris designated for reuse, including for debris that surveys confirmed would be acceptable for an unconditional offsite release. The NRC Zion LTP Safety Evaluation Report issued in September 2018 concurred that Zion appropriately analyzed the acceptability of reuse of concrete debris with respect to assuring that any undetected contribution to the final radiological conditions of the site that might be present because of reuse of demolition debris would not impact the station's ability to meet the 25 millirem/year limit for unrestricted release.

State Regulations

As identified in your letter, Rule 62-701.730(17), F.A.C., includes a provision for recycling or reuse of demolition debris, via onsite disposal, on the property where it is generated. That is, this provision would allow reuse of non-contaminated concrete debris as structural fill for remaining subsurface structures. It is your understanding, based on discussions with DEP regulatory staff, that disposal of concrete, meeting the definition of "clean debris" contained in Rule 62-701.200, F.A.C., on the property where it was generated is allowable pursuant to this rule with no further required permitting. As defined in Rule 62-701.200(15), F.A.C., "Clean debris" means:

> *"any solid waste that is virtually inert, is not a pollution threat to ground water or surface waters, is not a fire hazard, and is likely to retain its physical and chemical structure under expected conditions of disposal or use. The term includes brick, glass, ceramics, and uncontaminated concrete including embedded pipe or steel."*

You stated, "It is DEF's position that so long as radiological surveys (i.e. inspections) are performed to verify concrete is not contaminated and would be acceptable for unconditional offsite release to any construction and debris landfill in accordance with federal guidelines, that the debris produced from demolition of the concrete would meet state requirements to be considered uncontaminated concrete and therefore clean debris if no other contaminants of concern are present."

Conclusion

With the understanding that DEF will perform radiological surveys and assure that the debris produced from demolition of the concrete would meet state requirements to be considered "clean debris" as defined in Rule 62-701.200(15), F.A.C., DEP concurs with DEF's plans to segregate clean concrete debris produced during the demolition of site structures and to recycle the clean demolition debris to backfill the subsurface structures that will remain in place. Please note that the cited provision under Rule 62-701.730(17), F.A.C., allowing clean debris such as non-contaminated concrete to be disposed of on the property where it is generated, also specifies that the final cover shall consist of a 24-inch-thick soil layer, as well as other requirements such as associated grading and side slope requirements.

If you have questions regarding this feedback please contact me at (850) 717-9110.

Sincerely,

Cindy Mulkey Digitally signed by Cindy Mulkey Date: 2019.02.15 15:05:39 -05'00'

Cindy Mulkey, Administrator
Siting Coordination Office

CC by email:
Paula Leverett Cobb, Duke
John A. Coates, DEP