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CVP-2009-00010
Rev. 1
Reclass #

# Cleanup Verification Package for the 118-DR-1, 105-DR Gas Loop Burial Ground

**Prepared for the U.S. Department of Energy by Washington Closure Hanford**

**June 2010**

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# EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action, sampling activities, and compliance with cleanup criteria for the 118-DR-1, 105-DR Gas Loop Burial Ground on the Hanford Site. The 118-DR-1 site is located in the 100-DR-2 Operable Unit of the 100-D/DR Area, south of the 105-DR Reactor Building. The site was a gunite-lined trench, originally used to perform examinations and sectioning of irradiated test assemblies. It was later used for the disposal of irradiated metal assemblies from the 105-DR gas loop.

Remedial action at the 118-DR-1 site began on June 3, 2008, and was completed on July 23, 2008. Remedial action activities involved removing contaminated soil and debris. All contaminated materials were disposed at the Environmental Restoration Disposal Facility. The exposed surfaces have been sampled and analyzed to verify attainment of the remedial action goals. Results of the verification sampling, laboratory analyses, and data evaluations for the 118-DR-1 site indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met (see Table ES-1).

**Table ES-1. Summary of Cleanup Verification Results for the 100-D-47 Burial Ground. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Direct Exposure – Radionuclides | Attain 15 mrem/yr dose rate above background over 1,000 years. | Cumulative radionuclide activities are below the 15 mrem/yr dose rate RAG. | Yes |
| Direct Exposure – Nonradionuclides | Attain individual COC/COPC RAGs. | All individual COC/COPC concentrations are below direct exposure RAGs. | Yes |
| Nonradionuclide Risk Requirements | Attain hazard quotient of <1 for noncarcinogens. | All hazard quotients are <1. | Yes |
| | Attain cumulative hazard quotient of <1 for noncarcinogens. | The cumulative hazard quotient ($1.6 \times 10^{-3}$) is <1. | |
| | Attain excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens. | Excess cancer risk values for individual nonradionuclide COCs/COPCs are less than $1 \times 10^{-6}$. | |
| | Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens. | The cumulative excess cancer risk ($1.1 \times 10^{-7}$) is $<1 \times 10^{-5}$. | |

**Table ES-1. Summary of Cleanup Verification Results for the 100-D-47 Burial Ground. (2 Pages)**

| Regulatory Requirement | Remedial Action Goals | Results | Remedial Action Objectives Attained? |
|---|---|---|---|
| Groundwater/River Protection – Radionuclides | Attain single COC/COPC groundwater and river protection RAGs. | No radionuclide COCs/COPCs were quantified above groundwater/river protection lookup values. | Yes |
| | Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptors/organs.[a] | No radionuclide COCs/COPCs were quantified above groundwater/river protection lookup values. | |
| | Meet drinking water standards for nonuranium alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.[b] | No alpha-emitting radionuclide COCs/COPCs were detected. | |
| | Meet total uranium standard of 21.2 pCi/L.[c] | Uranium isotopes were not identified as site COCs/COPCs. | |
| Groundwater/River Protection – Nonradionuclides | Attain individual nonradionuclide groundwater and river cleanup requirements. | All COC/COPC concentrations are below soil RAGs for groundwater and river protection. | Yes |

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).
[b] *Radiation Protection of the Public and the Environment* (DOE Order 5400.5).
[c] Based on the isotopic distribution of uranium in the Hanford Site background, the 30 µg/L uranium MCL (40 *Code of Federal Regulations* 141.66) corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038 (BHI 2001).

COC = contaminant of concern
COPC = contaminant of potential concern
MCL = maximum contaminant level (drinking water standard)
RAG = remedial action goal

Soil cleanup levels were established in the *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-1, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units Hanford Site, (100 Area Burial Grounds) Benton County, Washington* (Burial Grounds ROD) (EPA 2000) based on a limited ecological risk assessment. Although not required by the Burial Grounds ROD, a comparison against ecological risk screening levels has been made for the site contaminants of concern and other constituents and is presented in Appendix A. Screening levels were exceeded for antimony, boron, manganese, and vanadium. Exceeding screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese and vanadium are below Hanford Site background levels (DOE-RL 2005), and antimony concentrations are below Washington State background levels (Ecology 1994, note that state background levels are only used when a Hanford Site background value is not available), it is believed that the presence of these

constituents does not pose a risk to ecological receptors. No established background value is available for boron; a final cleanup level for boron, including consideration of background, will be established through the integrated 100 Area remedial investigation/feasibility study (RI/FS) process. Exceedances for boron will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

The site meets cleanup standards and has been reclassified as Interim Closed Out in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 2007). A copy of the waste site reclassification form is included as Attachment ES-1 to this document.

| Date Submitted: 10/01/09<br>Originator: M. L. Proctor<br>Phone: 372-9227 | **WASTE SITE RECLASSIFICATION FORM**<br>Operable Unit(s): 100-DR-2<br>Waste Site Code: 118-DR-1<br>Type of Reclassification Action:<br>Closed Out ☐ Interim Closed Out ☒ No Action ☐<br>RCRA Postclosure ☐ Rejected ☐ Consolidated ☐ | Control Number: 2009-029 ✓ |
|---|---|---|

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:

The 118-DR-1, 105-DR Gas Loop Burial Ground was a gunite-lined trench, originally used to perform examination and sectioning of irradiated test assemblies. It was later used for the disposal of irradiated metal assemblies from the 105-DR gas loop. It operated from 1963 to 1964. The material excavated during remediation included contaminated soil and debris (concrete, piping, metallic debris, and drums). The site has been remediated and will be backfilled with concurrence from the lead regulatory agency. Remediation, verification sampling, and comparison of residual contaminant concentrations against cleanup levels have been performed in accordance with remedial action objectives and goals established by the *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington. The selected remedy involved (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification as Interim Closed Out.

Basis for reclassification:

In accordance with this evaluation, the verification sampling results support a reclassification of this site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding remedial action goals established in the *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington. The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. The 118-DR-1 waste site excavation has a maximum depth of approximately 6 m (20 ft), which includes both shallow zone and deep zone soil. However, the entire excavation area is being closed out using the more restrictive shallow zone cleanup criteria; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 118-DR-1, 105-DR Gas Loop Burial Ground* (CVP-2009-00010), Washington Closure Hanford, Richland, Washington.

Regulator Comments:

Approval of this WSRF documents regulator agreement that the 118-DR-1 waste site qualifies for "Interim Closed Out" under this Interim Action ROD. In addition, Ecology has evaluated the data for this site against WAC 173-340 (2007) clean-up levels for direct contact, groundwater protection, and river protection. This evaluation is documented in the letter transmitting Ecology's approval of this site's interim reclassification to "Interim Closed Out."

Waste Site Controls:
Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒
If any of the Waste Site Controls are checked Yes specify control requirements including reference to the Record of Decision, TSD Closure Letter, or other relevant documents.

| | | |
|---|---|---|
| M. S. French<br>DOE Federal Project Director (printed) | M S French<br>Signature | 6/9/10<br>Date |
| N. Menard<br>Ecology Project Manager (printed) | Nina M. Menard<br>Signature | 6/10/10<br>Date |
| NA<br>EPA Project Manager (printed) | Signature | Date |

# CONTENTS

1.0 STATEMENT OF PROTECTIVENESS ..... 1

2.0 BACKGROUND AND GENERAL SITE INFORMATION ..... 1
2.1 GENERAL SITE INFORMATION ..... 3
2.2 GEOPHYSICAL SURVEY ..... 3

3.0 REMEDIAL ACTION SUMMARY ..... 3
3.1 EXCAVATION AND DISPOSAL ..... 3
3.2 ANOMALOUS MATERIALS ..... 5

4.0 SAMPLING ACTIVITIES ..... 5
4.1 CONTAMINANTS OF CONCERN FOR VERIFICATION SAMPLING ..... 5
4.2 FIELD SCREENING ..... 8
4.2.1 Radiological Surveys ..... 8
4.3 VERIFICATION SAMPLING DESIGN ..... 8
4.3.1 Decision Unit Sampling ..... 11
4.3.2 Statistical Sampling Design ..... 11
4.3.3 Focused Sampling Design ..... 11

5.0 SAMPLING RESULTS ..... 12
5.1 STATISTICAL SAMPLE RESULTS ..... 12
5.2 FOCUSED SAMPLE RESULTS ..... 16
5.3 DATA QUALITY ASSESSMENT PROCESS ..... 18

6.0 CLEANUP VERIFICATION DATA EVALUATION ..... 18
6.1 COMPARISON OF SAMPLE DATA TO RAGS ..... 19
6.2 ATTAINMENT OF RADIONUCLIDE RAGS ..... 19
6.2.1 Attainment of Radionuclide Direct Exposure RAGs ..... 19
6.2.2 Attainment of Radionuclide Excess Lifetime Cancer Risk Goal ..... 19
6.2.3 Attainment of Radionuclide Groundwater and River Protection RAGs ..... 19
6.3 ATTAINMENT OF NONRADIONUCLIDE RAGS ..... 20
6.3.1 Direct Comparison to RAGs ..... 20
6.3.2 Direct Contact Noncarcinogenic Hazard Quotient RAG Attained ..... 20
6.3.3 Direct Contact Carcinogenic Risk RAG Attained ..... 20
6.3.4 Hazard Quotient and Carcinogenic Risk Calculation for Groundwater ..... 20
6.4 THREE-PART TEST FOR NONRADIONUCLIDES ..... 21

7.0 SUMMARY FOR WASTE SITE RECLASSIFICATION ..... 21

8.0 REFERENCES ..... 22

## APPENDICES

A EXCEEDANCES OF ECOLOGICAL SCREENING LEVELS ..... A-i

B CALCULATIONS ..... B-i
- B1 *118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculation*, 0100D-CA-V0318, Rev. 0 ..... B-3
- B2 *118-DR-1 Gas Loop Burial Ground Direct Contact Hazard Quotient and Carcinogenic Risk Calculation*, 0100D-CA-V0321, Rev. 1 ..... B-21
- B3 *118-DR-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater*, 0100D-CA-V0322, Rev. 0 ..... B-25
- B4 *118-DR-1 RESRAD Calculation Brief*, 0100D-CA-V0326, Rev. 0 ..... B-29

C DATA QUALITY ASSESSMENT ..... C-i

## FIGURES

1. Overall Site Location Map of the 118-DR-1 Burial Ground. ..... 2
2. Geophysical Survey Results for the 118-DR-1 Burial Ground ..... 4
3. 118-DR-1 Post-Excavation Topography Survey Map. ..... 6
4. Photograph of Miscellaneous Debris Removed from the 118-DR-1 Burial Ground. ..... 7
5. Photograph of Anomalous Waste Item Found in the 118-DR-1 Burial Ground. ..... 8
6. Initial GPERS Survey of the 118-DR-1 Excavation. ..... 9
7. Resurvey of the 118-DR-1 Excavation Footprint Following Additional Soil and Debris Removal. ..... 10
8. 118-DR-1 Statistical and Focused Verification Sample Locations. ..... 14

## TABLES

1. 118-DR-1 Statistical Verification Sample Summary. ..... 13
2. Comparison of Statistical or Maximum Contaminant Concentrations to Action Levels for the 118-DR-1 Excavation Verification Sampling ..... 15
3. Comparison of Maximum Contaminant Concentrations to Action Levels for the 118-DR-1 Focused Verification Sampling ..... 17

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BCM | bank cubic meter |
| BCY | bank cubic yard |
| CFR | *Code of Federal Regulations* |
| COC | contaminant of concern |
| COPC | contaminant of potential concern |
| CVP | cleanup verification package |
| DOE-RL | U.S. Department of Energy, Richland Operations Office |
| DQA | data quality assessment |
| ENRE | Environmental Restoration database |
| EPA | U.S. Environmental Protection Agency |
| ERDF | Environmental Restoration Disposal Facility |
| GPERS | Global Positioning Environmental Radiological Surveyor |
| HEIS | Hanford Environmental Information System |
| RAG | remedial action goal |
| RESRAD | RESidual RADioactivity |
| RDR/RAWP | remedial design report/remedial action work plan |
| ROD | record of decision |
| SAP | sampling and analysis plan |
| UCL | upper confidence limit |
| VSP | Visual Sample Plan |
| WAC | *Washington Administrative Code* |
| WIDS | Waste Information Data System |

## 1.0 STATEMENT OF PROTECTIVENESS

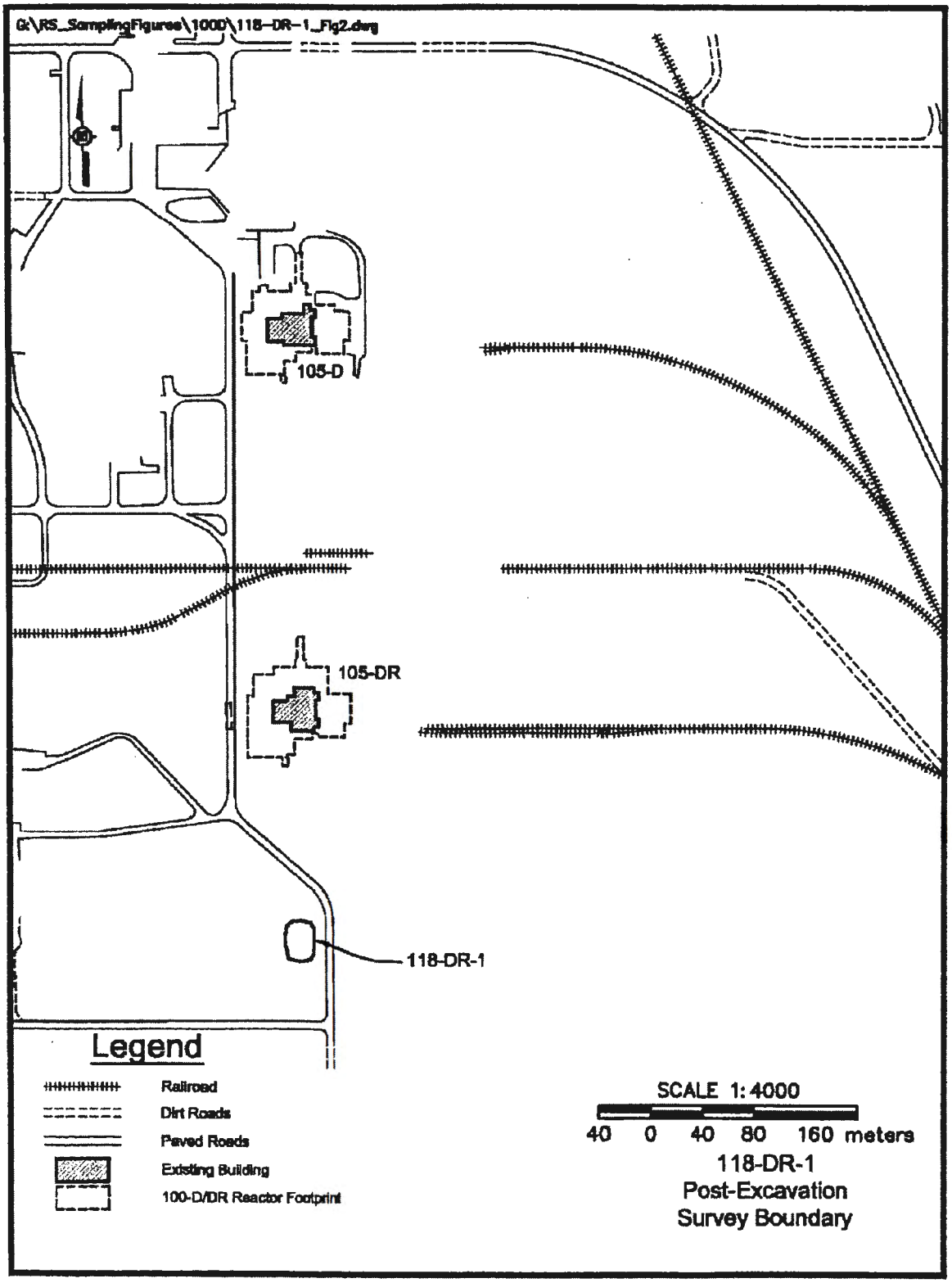
This report demonstrates that the 118-DR-1, 105-DR Gas Loop Burial Ground waste site meets the objectives for interim closure as established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005) and the *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units, Hanford Site (100 Area Burial Grounds), Benton County, Washington* (Burial Grounds ROD) (EPA 2000). The results of verification sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils. The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River.

Soil cleanup levels were established in the *Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-1, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units Hanford Site, (100 Area Burial Grounds) Benton County, Washington* (Burial Grounds ROD) (EPA 2000) based on a limited ecological risk assessment. Although not required by the Burial Grounds ROD, a comparison against ecological risk screening levels has been made for the site contaminants of concern and other constituents and is presented in Appendix A. Screening levels were exceeded for antimony, boron, manganese, and vanadium. Exceeding screening values is intended to trigger additional evaluation and does not necessarily indicate the existence of risk to ecological receptors. Because concentrations of manganese and vanadium are below Hanford Site background levels (DOE-RL 2005), and antimony concentrations are below Washington State background levels (Ecology 1994, note that state background levels are only used when a Hanford Site background value is not available), it is believed that the presence of these constituents does not pose a risk to ecological receptors. No established background value is available for boron; a final cleanup level for boron, including consideration of background, will be established through the integrated 100 Area remedial investigation/feasibility study (RI/FS) process. Exceedances for boron will be evaluated in the context of additional lines of evidence for risk to ecological receptors as part of the final closeout decision for this site.

## 2.0 BACKGROUND AND GENERAL SITE INFORMATION

The purpose of this cleanup verification package (CVP) is to document that the 118-DR-1, 105-DR Gas Loop Burial Ground was remediated in accordance with the Burial Grounds ROD (EPA 2000). Remedial action objectives and goals for the 118-DR-1 site were established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy, Richland Operations Office (DOE-RL), in concurrence with the Washington State Department of Ecology. These goals and objectives are documented in the Burial Grounds ROD (EPA 2000) and the

**Figure 1. Overall Site Location Map of the 118-DR-1 Burial Ground.**



RDR/RAWP (DOE-RL 2005). The Burial Grounds ROD (EPA 2000) provides DOE-RL the authority, guidance, and objectives to conduct this remedial action.

The preferred remedy specified in the Burial Grounds ROD (EPA 2000) and conducted for the 118-DR-1 site included (1) excavating the site to the extent required to meet specified soil cleanup levels and (2) disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility (ERDF) at the 200 Area of the Hanford Site. Backfilling the site with overburden and clean soil to the average adjacent grade elevation will be conducted after waste site reclassification is approved. Excavation was driven by remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River.

## 2.1 GENERAL SITE INFORMATION

The 118-DR-1, 105-DR Gas Loop Burial Ground, part of the 100-DR-2 Operable Unit, was located south of the 105-DR Reactor Building (Figure 1). The 118-DR-1 Burial Ground was an inactive solid waste site that operated from 1963 to 1964. The site contained a single north-south gunite-lined trench, originally used to perform examinations and sectioning of irradiated test assemblies. It was later used for the disposal of irradiated metal assemblies from the 105-DR gas loop (WHC 1993).

## 2.2 GEOPHYSICAL SURVEY

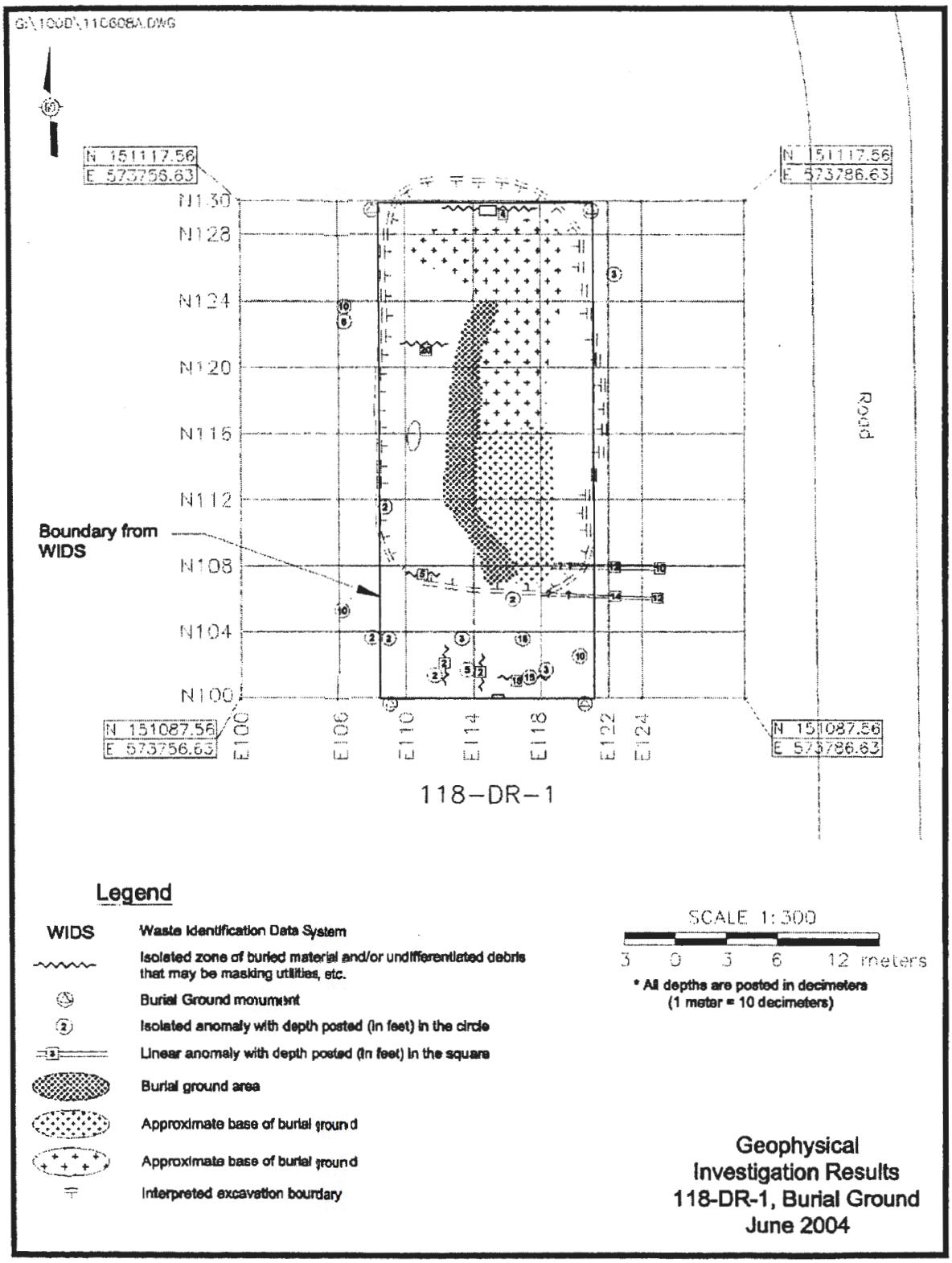
A geophysical survey was conducted at the 118-DR-1 Burial Ground site in June 2004. The survey identified several geophysical anomalous zones within the survey boundary exhibiting the characteristics of buried debris (Bergstrom and Mitchell 2004). The Waste Information Data System (WIDS) boundary is overlaid on the geophysical survey map and is shown in Figure 2.

# 3.0 REMEDIAL ACTION SUMMARY

## 3.1 EXCAVATION AND DISPOSAL

Remedial action at the 118-DR-1 Burial Ground began on June 3, 2008, and continued through July 23, 2008. Approximately 1,673 bank cubic meters (BCM) (2,188 bank cubic yards [BCY]) of soil and debris was removed for disposal at ERDF. Approximately 221 BCM (290 BCY) of clean soil was removed from outside of the burial ground excavation footprint and stockpiled west of the burial ground excavation. The soil was removed during construction of a ramp into the excavation, allowing the excavator equipment access to continue to remove soil and debris at a greater depth. The ramp soil stockpile is not considered overburden; therefore, it was not included in the closeout sample design. This material will be used as backfill material

**Figure 2. Geophysical Survey Results for the 118-DR-1 Burial Ground.**



during general backfill of the site. No overburden was removed from the 118-DR-1 Burial Ground. A post-remediation survey is provided in Figure 3. The survey also shows the WIDS boundary in relation to the post-remediation excavation boundary.

Contaminated soil and debris (concrete, piping, metallic debris, and drums) were excavated and removed from the burial ground. Photographs of some of the types of debris removed are shown in Figure 4.

## 3.2 ANOMALOUS MATERIALS

One anomalous waste item was encountered in the 118-DR-1 Burial Ground. A breached 208-L (55-gal) drum suspected of containing an undetermined amount of liquid was removed from the sidewall of the excavation (Figure 5). The drum, along with the soil directly below the drum, was placed on a plastic sheet within the burial ground footprint for waste characterization sampling. However, the drum was found to be empty so the soil that was removed with the drum was sampled for waste characterization.

No spent nuclear fuel was discovered at the 118-DR-1 Burial Ground.

# 4.0 SAMPLING ACTIVITIES

## 4.1 CONTAMINANTS OF CONCERN FOR VERIFICATION SAMPLING

The *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (Burial Grounds SAP) (DOE-RL 2001a) identified contaminants of concern (COCs) for the 118-DR-1 Burial Ground as cobalt-60 and nickel-63. Cesium-137, lead, and mercury were detected in the waste characterization soil sample and therefore were included as contaminants of potential concern (COPCs). Due to a site-wide effort to identify the source of chromium contamination in the groundwater, hexavalent chromium was added as a COPC.

In addition to the COCs/COPCs listed above, polychlorinated biphenyls, pesticides, and polyaromatic hydrocarbons were included as COPCs for the focused sample location where the breached drum was found within the excavation.

**Figure 3. 118-DR-1 Post-Excavation Topography Survey Map.**

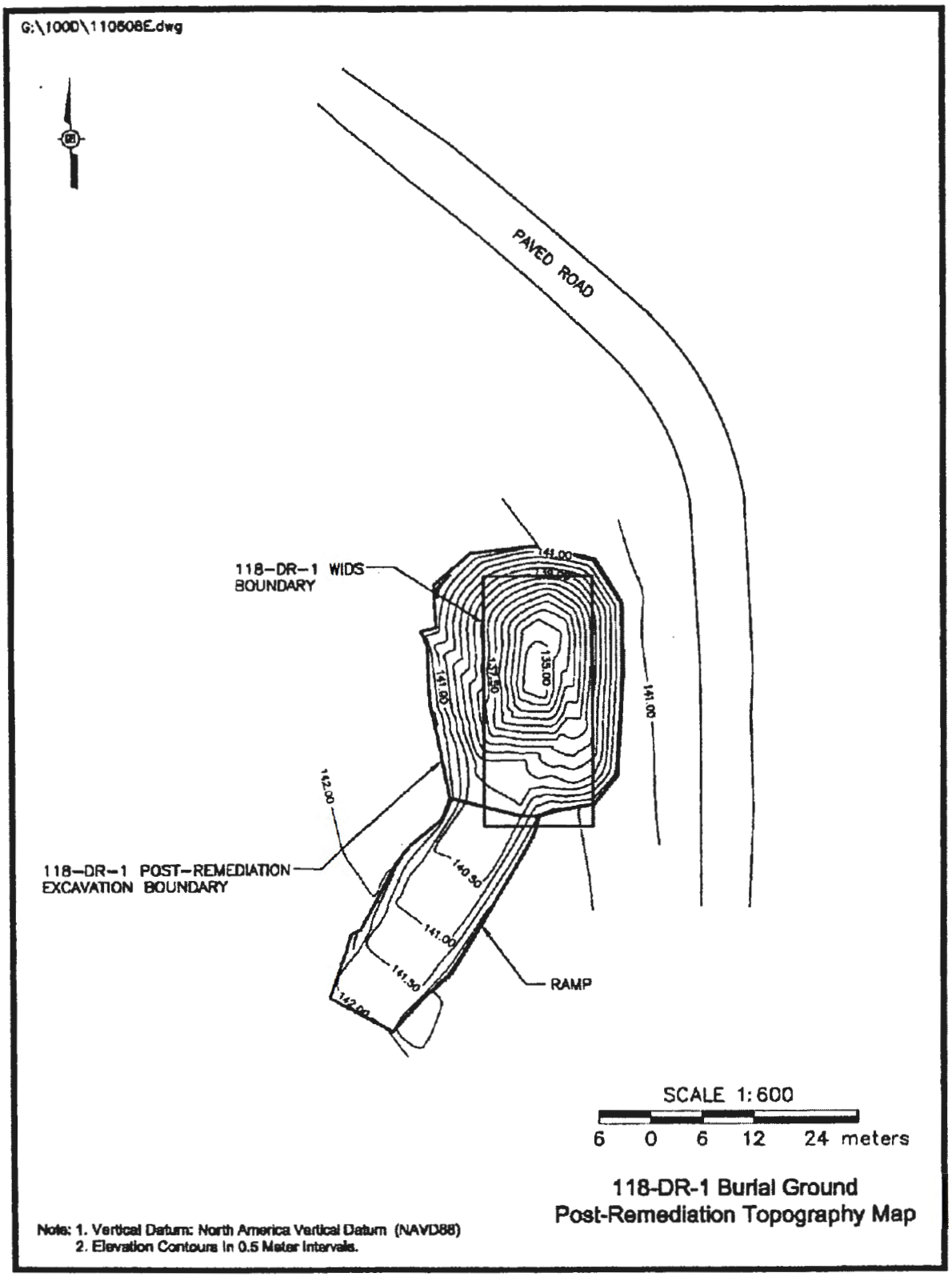


**Figure 4. Photograph of Miscellaneous Debris Removed from the 118-DR-1 Burial Ground.**

**(a)**

**(b)**

**Figure 5. Photograph of Anomalous Waste Item Found in the 118-DR-1 Burial Ground.**

## 4.2 FIELD SCREENING

### 4.2.1 Radiological Surveys

Global Positioning Environmental Radiological Surveys (GPERS) were conducted within the 118-DR-1 Burial Ground excavation upon completion of remedial action activities. The initial survey of the burial ground (Figure 6) indicated elevated radioactivity greater than two times background in the northern end of the excavation. Additional soil and debris was removed from the location and the area was resurveyed. A composite map showing the resurveyed area, as well as the ramp excavated to access the deeper excavation, is shown in Figure 7.

## 4.3 VERIFICATION SAMPLING DESIGN

This section describes the design for verification sampling to support closeout of the 118-DR-1 Burial Ground. Verification sampling was performed to support a determination that potential residual contaminant concentrations at this site meet the cleanup criteria specified in the RDR/RAWP (DOE-RL 2005) and the Burial Grounds ROD (EPA 2000).

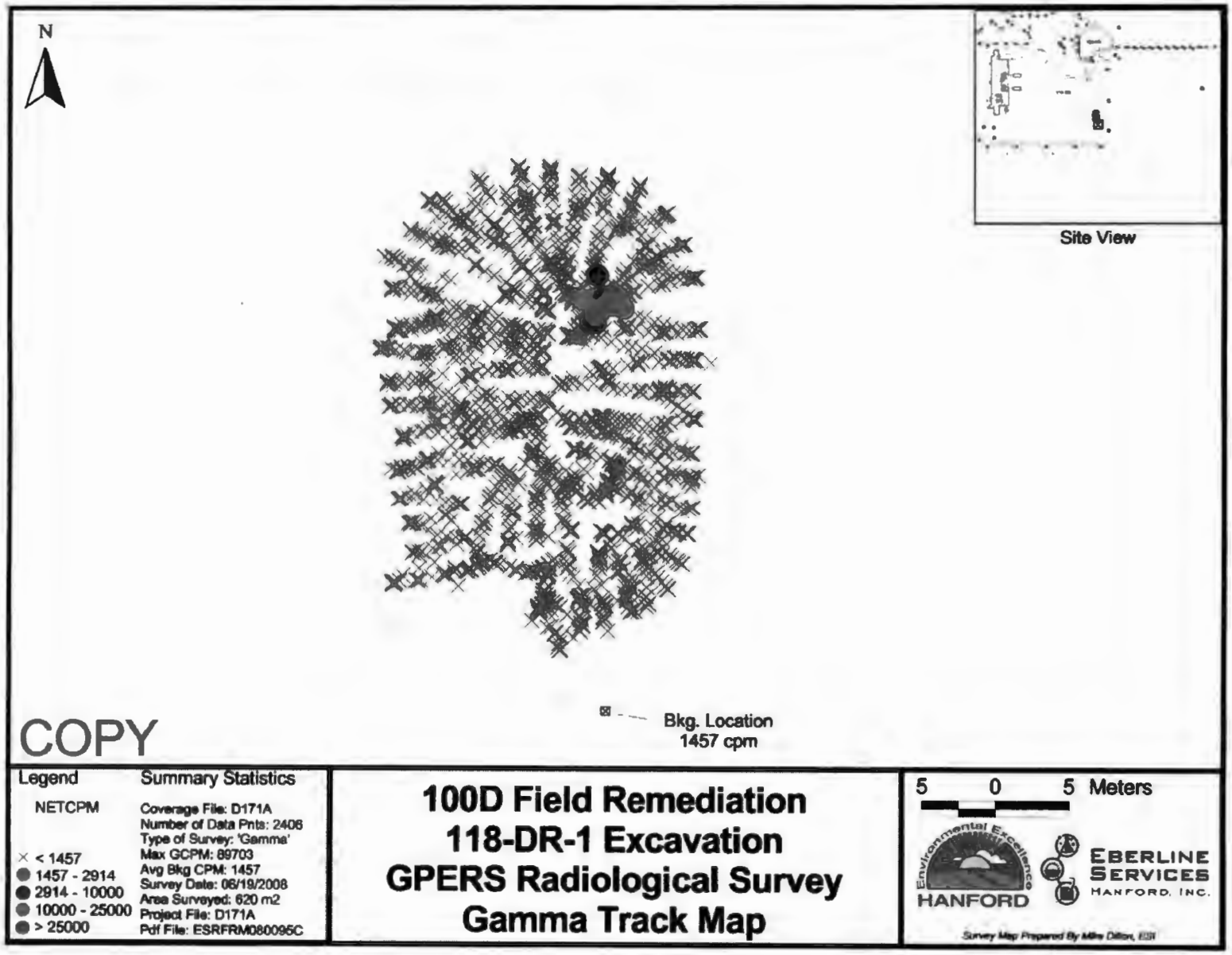
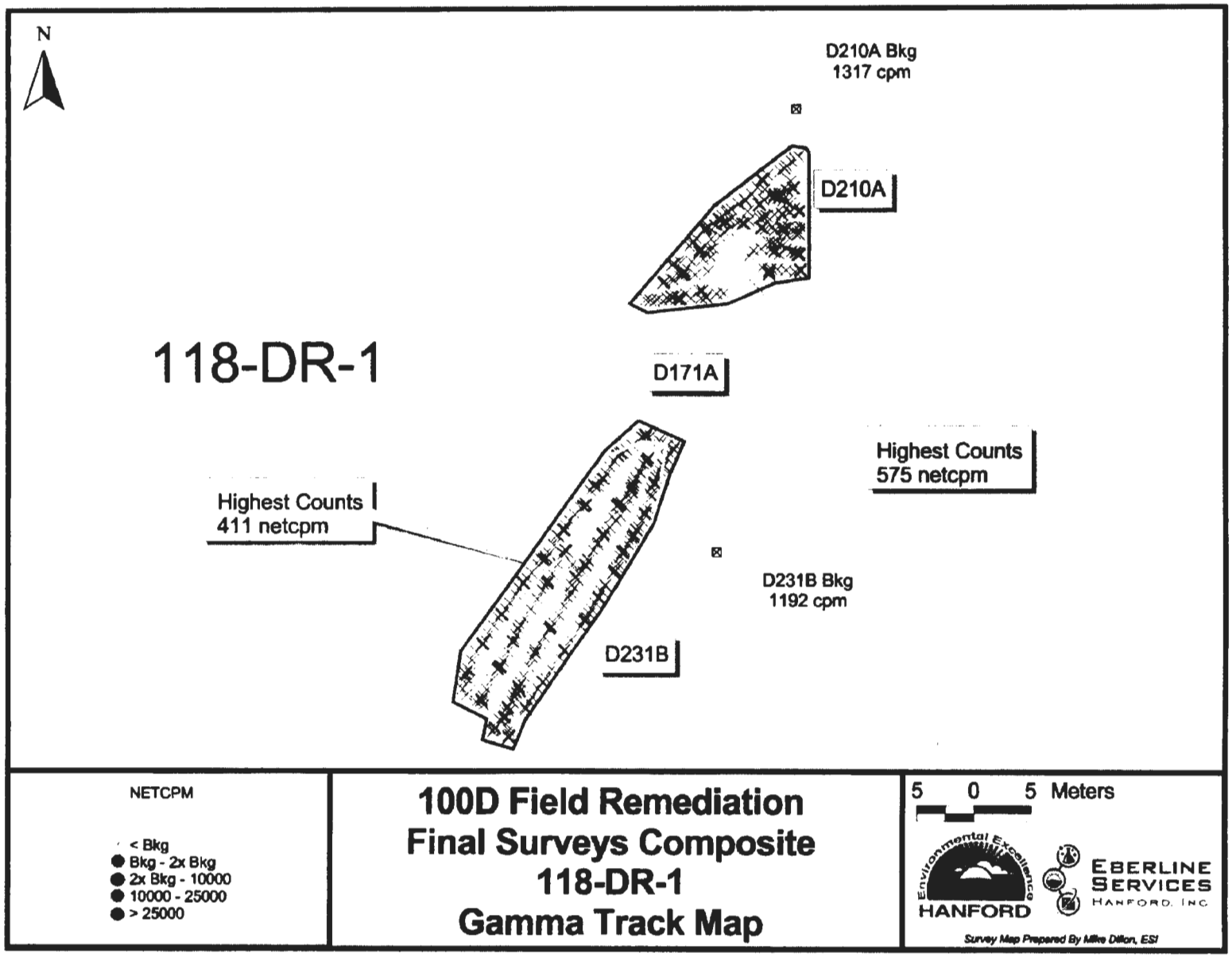



**Figure 6. Initial GPERS Survey of the 118-DR-1 Excavation.**

**Figure 7. Resurvey of the 118-DR-1 Excavation Footprint Following Additional Soil and Debris Removal.**



### 4.3.1 Decision Unit Sampling

The excavation footprint is the only decision unit identified for the 118-DR-1 waste site for verification sampling. Two methods for selecting the sampling locations were utilized: statistical sampling design and focused sampling.

The statistical sampling design for the excavated area was developed using Visual Sample Plan[1] (VSP) and is discussed in Section 4.3.2. The focused sample locations are discussed in Section 4.3.3.

### 4.3.2 Statistical Sampling Design

The decision rule for demonstrating compliance with the cleanup criteria requires comparison of the true population mean, as estimated by the 95% upper confidence limit (UCL) on the sample mean, with the cleanup level. Therefore, a statistical sampling design was the preferred verification sampling approach for this site because the distribution of potential residual soil contamination over the study area (site) was uncertain. The Washington State Department of Ecology publication *Guidance on Sampling and Data Analysis Methods* (Ecology 1995) recommends that systematic sampling with sample locations distributed over the entire study area be used.

Visual Sample Plan was used as a tool to develop the statistical sampling design for the verification sampling. Additional details concerning the use of VSP to develop the statistical sampling design and derive the number of verification samples to collect are discussed in *Work Instruction for Verification Sampling of 118-DR-1, 105-DR Gas Loop Burial Ground* (WCH 2009c).

**4.3.2.1 Statistical Sampling Design – Excavation Footprint.** A global positioning survey was used to determine the boundaries of the excavation area requiring soil verification sampling. A total of 12 soil samples were collected on a random-start, triangular grid. A triangular grid was selected for this investigation based on studies that indicate triangular grids are superior to square grids (Gilbert 1987).

The sampling locations for the excavation are listed in Table 1, and the sampling locations are shown in Figure 8.

### 4.3.3 Focused Sampling Design

In addition to performing statistical sampling of the burial ground excavation and the overburden stockpiles, two focused soil samples were collected.

Focused samples are collected to verify the absence of contamination in residual soil beneath locations exhibiting visual stains, locations of buried liquid wastes or

[1] Visual Sample Plan is a site map-based user-interface program that may be downloaded at http://dqo.pnl.gov.

equipment, mercury-containing piping, or large inventories of dangerous/hazardous wastes (e.g., lead bricks). Additionally, focused samples may be collected from locations where process knowledge indicates the potential for elevated concentrations of alpha or beta contamination, or where waste characterization sampling results indicate elevated concentrations of chemical contaminants above the remedial action goals (RAGs).

The initial post-remediation radiological survey identified an area where elevated radiological activity was greater than twice the background level. Additional soil and debris was removed from the location and the area was resurveyed. One focused soil sample was collected from this area. In addition, one focused soil sample was collected at the location where a 208-L (55-gal) drum containing an undetermined amount of liquid was found in the excavation. The sample location coordinates and requested analyses are provided in Table 1, and the sample locations are shown in Figure 8.

# 5.0 SAMPLING RESULTS

The verification samples were submitted to an offsite laboratory for analysis using approved EPA analytical methods, as required per the Burial Grounds SAP (DOE-RL 2001a).

## 5.1 STATISTICAL SAMPLE RESULTS

The laboratory-reported data results from the verification sampling were used in the statistical calculations. The primary statistical calculation to evaluate compliance with cleanup standards is the 95% UCL on the arithmetic mean of the data. The 95% UCL values for each COC are computed for the 118-DR-1 Burial Ground decision unit as specified by the 100 Area RDR/RAWP (DOE-RL 2005) (Appendix B).

Comparisons of the statistical results for site COCs with the RAGs (cleanup criteria) for the 118-DR-1 Burial Ground are listed in Table 2. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations database (Ecology 2005) under the *Washington Administrative Code* (WAC) 173-340-740(3) for aluminum and potassium; therefore, these constituents are not considered site COCs/COPCs.

The laboratory-reported data results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to archival in the Hanford Environmental Information System (HEIS) and are presented as part of the 95% UCL calculation in Appendix B.

**Table 1. 118-DR-1 Statistical Verification Sample Summary.**

| Sample Location | HEIS Sample Number | Northing (m) | Easting (m) | Sample Analysis |
|---|---|---|---|---|
| EX-1 | J18NP8 | 151091.0 | 573766.0 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-2 | J18NP9 | 151091.0 | 573773.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-3 | J18NR0 | 151097.8 | 573762.1 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-4 | J18NR1 | 151097.8 | 573769.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-5 | J18NR2 | 151097.8 | 573777.8 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-6 | J18NR3 | 151104.6 | 573766.0 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-7 | J18NR4 | 151104.6 | 573773.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-8 | J18NR5 | 151111.4 | 573762.1 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-9 | J18NR6 | 151111.4 | 573769.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-10 | J18NR7 | 151111.4 | 573777.8 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-11 | J18NR8 | 151118.2 | 573766.0 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| EX-12 | J18NR9 | 151118.2 | 573773.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| Duplicate EX-2 | J18NT0 | 151091.0 | 573773.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| Split EX-2 | J18NT1 | 151091.0 | 573773.9 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| Equipment blank | J18NP7 | NA | NA | ICP metals,[a] mercury |
| FS-1 | J18NT5 | 151111.3 | 573774.3 | ICP metals,[a] mercury, hexavalent chromium, GEA, nickel-63 |
| FS-2 | J18NT6 | 151116.3 | 573770.5 | ICP metals,[a] mercury, hexavalent chromium, PAH, PCB, pesticides, GEA, nickel-63 |

Source: Field logbook EL-1607-6 (WCH 2009a).

[a] The expanded list of ICP metals was performed to include antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, silver, selenium, vanadium, and zinc in the analytical results package.

ICP = inductively coupled plasma
GEA = gamma energy analysis
NA = not applicable
PAH = polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl

**Figure 8. 118-DR-1 Statistical and Focused Verification Sample Locations.**

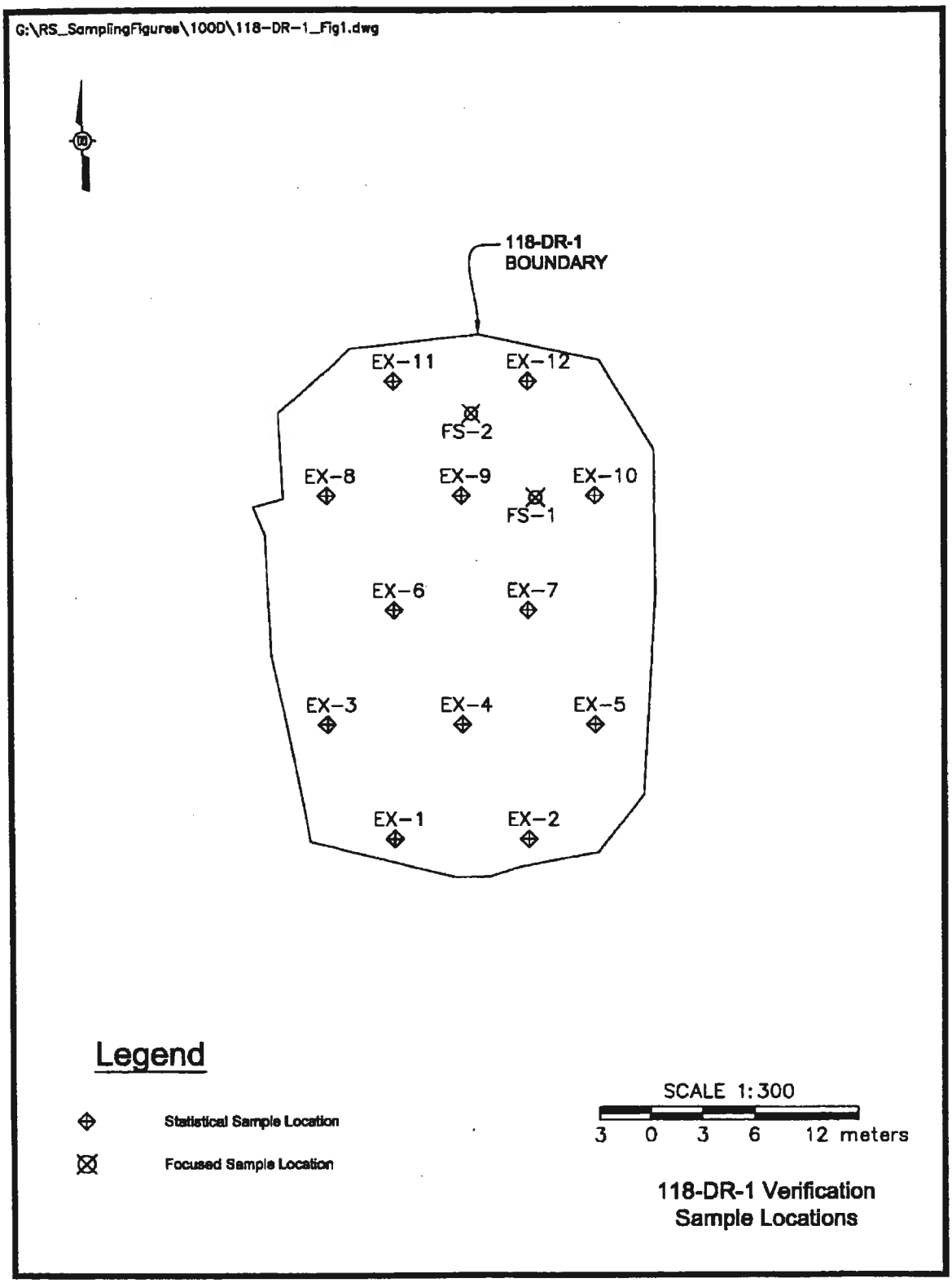


**Table 2. Comparison of Statistical or Maximum Contaminant Concentrations to Action Levels for the 118-DR-1 Excavation Verification Sampling. (2 Pages)**

| COC/COPC | Statistical Result (pCi/g) | Site Lookup Values[a] (pCi/g) | | | Does the Statistical Result Exceed Lookup Values? | Does the Statistical Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Shallow Zone Lookup Value | Groundwater Protection Lookup Value | River Protection Lookup Value | | |
| Cesium-137 | 0.0565 | 6.2 | 1,465 | 2,930 | No | -- |
| Cobalt-60 | 0.310 | 1.4 | 13,900 | 27,800 | No | -- |
| Nickel-63 | 110 | 4,013 | 83 | 166 | Yes | Yes[b] |
| **COC/COPC** | **Statistical or Maximum Result[c] (mg/kg)** | **Remedial Action Goals[a] (mg/kg)** | | | **Does the Statistical or Maximum Result Exceed Lookup Values?** | **Does the Statistical or Maximum Result Pass RESRAD Modeling?** |
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Arsenic | 2.2 (<BG) | 20[d] | 20[d] | 20[d] | No | -- |
| Barium | 57 (<BG) | 5,600 | 200 | 400 | No | -- |
| Beryllium | 1.1 (<BG) | 10.4[e] | 1.51[d] | 1.51[d] | No | -- |
| Boron[f] | 1.3 | 7,200 | 320 | -- | No | -- |
| Cadmium | 0.057 (<BG) | 13.9[e] | 0.81[d] | 0.81[d] | No | -- |
| Chromium (total) | 7.4 (<BG) | 80,000 | 18.5[d] | 18.5[d] | No | -- |
| Cobalt | 8.8 (<BG) | 24 | 15.7[d] | -- | No | -- |
| Copper | 13 (<BG) | 2,960 | 59.2 | 22.0[d] | No | -- |
| Hexavalent chromium[f] | 0.216 | 2.1[e] | 4.8 | 2 | No | -- |
| Lead | 4.1 (<BG) | 353 | 10.2[d] | 10.2[d] | No | -- |
| Manganese | 287 (<BG) | 3,760 | 512[d] | 512[d] | No | -- |
| Mercury | 0.0068 (<BG) | 24 | 0.33[d] | 0.33[d] | No | -- |
| Nickel | 10 (<BG) | 1,600 | 19.1[d] | 27.4 | No | -- |
| Vanadium | 56 (<BG) | 560 | 85.1[d] | -- | No | -- |

**Table 2. Comparison of Statistical or Maximum Contaminant Concentrations to Action Levels for the 118-DR-1 Excavation Verification Sampling. (2 Pages)**

| COC/COPC | Statistical or Maximum Result[c] (mg/kg) | Remedial Action Goals[a] (mg/kg) | | | Does the Statistical or Maximum Result Exceed Lookup Values? | Does the Statistical or Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Zinc | 41 (<BG) | 24,000 | 480 | 67.8[d] | No | -- |

[a] Lookup values and remedial action goals (RAGs) obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2005) or calculated per *Washington Administrative Code* (WAC) 173-340-720, WAC 173-340-730, and WAC 173-340-740, Method B (Ecology 1996), unless otherwise noted.
[b] The site-specific RESRAD model (WCH 2009b) predicts the contaminant will not reach groundwater within 1,000 years.
[c] Maximum or 95% UCL result, depending on data censorship, as described in the 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculation (Appendix B).
[d] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996). The arsenic level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers as discussed in Section 2.1.2.1 of the 100 Area RDR/RAWP (DOE-RL 2005).
[e] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340 750[3]) (Ecology 1996) using an airborne particulate mass-loading rate of 0.0001 g/m$^3$ (WDOH 1997).
[f] No Hanford Site-specific or Washington State background value available.

-- = not applicable
BG = background (obtained from DOE-RL [1996] and DOE-RL [2001b], unless otherwise noted)
COC = contaminant of concern
COPC = contaminant of potential concern
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose assessment model)
UCL = upper confidence limit

## 5.2 FOCUSED SAMPLE RESULTS

Two focused samples were collected from the 118-DR-1 waste site. Statistical analysis (e.g., calculation of a 95% UCL value) is inappropriate to use for evaluation of focused samples; therefore, the sample results for each focused sample are evaluated using the maximum detected activity for each COC/COPC and comparing the value directly to the cleanup level. Table 3 provides a comparison of the maximum result of the focused samples against the cleanup criteria. Individual sample results are provided in Appendix B.

**Table 3. Comparison of Maximum Contaminant Concentrations to Action Levels for the 118-DR-1 Focused Verification Sampling. (2 Pages)**

| COC/COPC | Maximum Result (pCi/g) | Site Lookup Values[a] (pCi/g) | | | Does the Maximum Result Exceed Lookup Values? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Shallow Zone Lookup Value | Groundwater Protection Lookup Value | River Protection Lookup Value | | |
| Cesium-137 | 0.0495 | 6.2 | 1,465 | 2,930 | No | -- |
| Nickel-63 | 9.70 | 4,013 | 83 | 166 | No | -- |
| **COC/COPC** | **Maximum Result (mg/kg)** | **Remedial Action Goals[a] (mg/kg)** | | | **Does the Maximum Result Exceed Lookup Values?** | **Does the Maximum Result Pass RESRAD Modeling?** |
| | | **Direct Exposure** | **Soil Cleanup Level for Groundwater Protection** | **Soil Cleanup Level for River Protection** | | |
| Antimony | 1.5 (<BG) | 32 | 5[b] | 5[b] | No | -- |
| Arsenic | 2.8 (<BG) | 20[b] | 20[b] | 20[b] | No | -- |
| Barium | 62 (<BG) | 5,600 | 200 | 400 | No | -- |
| Beryllium | 0.48 (<BG) | 10.4[c] | 1.51[b] | 1.51[b] | No | -- |
| Boron[d] | 1.1 | 7,200 | 320 | -- | No | -- |
| Cadmium | 0.079 (<BG) | 13.9[c] | 0.81[b] | 0.81[b] | No | -- |
| Chromium (total) | 7.3 (<BG) | 80,000 | 18.5[b] | 18.5[b] | No | -- |
| Cobalt | 7.6 (<BG) | 24 | 15.7[b] | -- | No | -- |
| Copper | 14 (<BG) | 2,960 | 59.2 | 22.0[b] | No | -- |
| Lead | 3.7 (<BG) | 353 | 10.2[b] | 10.2[b] | No | -- |
| Manganese | 290 (<BG) | 3,760 | 512[b] | 512[b] | No | -- |
| Mercury | 0.0064 (<BG) | 24 | 0.33[b] | 0.33[b] | No | -- |
| Nickel | 9.2 (<BG) | 1,600 | 19.1[b] | 27.4 | No | -- |
| Vanadium | 54 (<BG) | 560 | 85.1[b] | -- | No | -- |
| Zinc | 40 (<BG) | 24,000 | 480 | 67.8[b] | No | -- |
| Benzo(b) fluoranthene | 0.004 | 1.37 | 0.015[e] | 0.015[e] | No | -- |

**Table 3. Comparison of Maximum Contaminant Concentrations to Action Levels for the 118-DR-1 Focused Verification Sampling. (2 Pages)**

| COC/COPC | Maximum Result (mg/kg) | Remedial Action Goals[a] (mg/kg) | | | Does the Maximum Result Exceed Lookup Values? | Does the Maximum Result Pass RESRAD Modeling? |
|---|---|---|---|---|---|---|
| | | Direct Exposure | Soil Cleanup Level for Groundwater Protection | Soil Cleanup Level for River Protection | | |
| Heptachlor epoxide | 0.00049 | 0.11 | 0.002 | 0.002 | No | -- |

[a] Lookup values and remedial action goals (RAGs) obtained from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE-RL 2005) or calculated per *Washington Administrative Code* (WAC) 173-340-720, WAC 173-340-730, and WAC 173-340-740, Method B (Ecology 1996), unless otherwise noted.
[b] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700[4][d] (Ecology 1996). The arsenic level of 20 mg/kg has been agreed to by the Tri-Party Agreement Project Managers as discussed in Section 2.1.2.1 of the 100 Area RDR/RAWP (DOE-RL 2005).
[c] Carcinogenic cleanup level calculated based on the inhalation exposure pathway (WAC 173-340-750[3]) (Ecology 1996) using an airborne particulate mass-loading rate of 0.0001 g/m$^3$ (WDOH 1997).
[d] No Hanford Site-specific or Washington State background value available.
[e] Where cleanup levels are less than the RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996).

-- = not applicable
BG = background (obtained from DOE-RL [1996] and DOE-RL [2001a], unless otherwise noted)
COC = contaminant of concern
COPC = contaminant of potential concern
RAG = remedial action goal
RDL = required detection limit
RESRAD = RESidual RADioactivity (dose assessment model)

## 5.3 DATA QUALITY ASSESSMENT PROCESS

A data quality assessment (DQA) was performed to compare the verification sampling approach (WCH 2009c), the field logbooks (WCH 2009a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 118-DR-1 site established that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation verified that the sample design was sufficient for the purpose of clean site verification. The cleanup verification sample analytical data are stored in the ENRE project-specific database for data evaluation prior to archival in the HEIS and are summarized in Appendix B. The detailed DQA is presented in Appendix C.

# 6.0 CLEANUP VERIFICATION DATA EVALUATION

This section demonstrates that remedial actions at the 118-DR-1 Burial Ground have achieved the RAGs developed to support unrestricted land use at the 100 Area as established in the Burial Grounds ROD (EPA 2000) and documented in the RDR/RAWP (DOE-RL 2005). This section also describes the RESidual RADioactivity (RESRAD) modeling performed that predicts the dose rate, the excess lifetime cancer risk, and the

impact on groundwater and the river from residual radionuclide COC/COPC concentrations.

## 6.1 COMPARISON OF SAMPLE DATA TO RAGS

Tables 2 and 3 compare the cleanup verification statistical and focused sample values to the soil RAGs and lookup values for direct exposure, protection of groundwater, and protection of the Columbia River. Evaluation of the results indicates that all COCs/COPCs were undetected and/or quantified below RAGs and lookup values.

## 6.2 ATTAINMENT OF RADIONUCLIDE RAGS

For radionuclide contaminants, site-specific RESRAD (ANL 2005) modeling was used to determine contaminant migration and to predict the dose rate, the excess lifetime cancer risk, and the impact on groundwater and the Columbia River from residual radionuclide COC/COPC concentrations (DOE-RL 2005). Results from statistical and focused sampling in Tables 2 and 3 were entered into the RESRAD computer code with the results included in the RESRAD calculation in Appendix B. Specific results from the calculations are summarized in the following subsections.

### 6.2.1 Attainment of Radionuclide Direct Exposure RAGs

The direct exposure RAG for radionuclide COC/COPCs is expressed in terms of an allowable radiation dose rate above background, which is 15 mrem/yr over 1,000 years. The maximum "all pathways" RESRAD dose rate prediction for the 118-DR-1 Burial Ground 95% UCL of the statistical samples is calculated to be 3.29 mrem/yr, occurring in the current year (2009). The maximum all pathways dose rate for the 118-DR-1 maximum analysis from the focused sampling area is predicted to be 0.0886 mrem/yr, also occurring in the current year (2009).

### 6.2.2 Attainment of Radionuclide Excess Lifetime Cancer Risk Goal

The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* [CFR] 300) presents a target range for residual radionuclide risk of $10^{-4}$ to $10^{-6}$. The RESRAD model calculates the excess lifetime cancer risk associated with the estimated radiation dose rates. The maximum excess lifetime cancer risk for the 118-DR-1 95% UCL of the statistical samples is $2.52 \times 10^{-5}$at year zero (2009). The maximum excess lifetime cancer risk for the 118-DR-1 maximum analysis from the focused sampling area is $1.46 \times 10^{-6}$ at year zero (2009).

### 6.2.3 Attainment of Radionuclide Groundwater and River Protection RAGs

The attainment of groundwater and river protection RAGs for radionuclides is determined by four criteria: (1) attain single COC/COPC groundwater and river RAGs, (2) attain the National Primary Drinking Water Regulations (40 CFR 141) 4 mrem/yr

(beta/gamma) dose standard to target receptor/organ, (3) meet drinking water standards for nonuranium alpha emitters (the more stringent of 15 pCi/L MCL or 1/25$^{th}$ of the derived concentration guide [DOE Order 5400.5]), and (4) meet the total uranium standard of 21.1 pCi/L.

The RESRAD model predicts that radionuclide contaminants detected at the waste site will not impact groundwater within 1,000 years. Therefore, the comparison to drinking water standards (maximum contaminant limit) calculation brief was not performed and calculation of cumulative organ-specific dose via the groundwater (and river) pathway was not necessary to determine that the 4 mrem/yr drinking water dose limitation is met.

## 6.3 ATTAINMENT OF NONRADIONUCLIDE RAGS

### 6.3.1 Direct Comparison to RAGs

Evaluation of the results listed in Tables 2 and 3 from the verification sampling at the 118-DR-1 Burial Ground indicates that all COC/COPCs were undetected and/or quantified below RAGs and lookup values.

### 6.3.2 Direct Contact Noncarcinogenic Hazard Quotient RAG Attained

For nonradionuclide noncarcinogenic COCs/COPCs, WAC 173-340-740(3)(a)(iii)(A) and (B) (Ecology 1996) specifies the evaluation of the hazard quotient, which is given as a daily intake divided by a reference dose. Both individual and cumulative hazard quotient values must be less than 1.0. For the 118-DR-1 site, all individual hazard quotients are less than 1.0 and the cumulative hazard quotient of $1.6 \times 10^{-3}$ is less than 1.0 (Appendix B). Therefore, the noncarcinogenic hazard quotient RAG has been attained for the 118-DR-1 Burial Ground.

### 6.3.3 Direct Contact Carcinogenic Risk RAG Attained

For individual nonradionuclide carcinogenic COCs/COPCs, the WAC 173-340 Method B (Ecology 1996) cleanup limits are based on an incremental cancer risk of $1 \times 10^{-6}$. For nonradionuclide carcinogenic COCs/COPCs, the total excess cancer risk must be less than $1 \times 10^{-5}$. For the 118-DR-1 site, all individual carcinogenic risk values are less than $1 \times 10^{-6}$. The cumulative carcinogenic risk value is $1.1 \times 10^{-7}$ (Appendix B). Therefore, the carcinogenic risk RAG has been attained for the 118-DR-1 Burial Ground.

### 6.3.4 Hazard Quotient and Carcinogenic Risk Calculation for Groundwater

An additional calculation of the hazard quotient and carcinogenic (excess cancer) risk values for the potential impact to groundwater was performed for nonradionuclides. This calculation is located in Appendix B. The comparisons for the groundwater pathway include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than $1 \times 10^{-6}$, and a cumulative excess carcinogenic risk of less than $1 \times 10^{-5}$. These risk

values were conservatively calculated for the entire waste site using the highest applicable values from each of the decision units. Risk values were not calculated for constituents that were not detected, were detected at concentrations below Hanford Site background values, or were not predicted to reach groundwater in 1,000 years according to fate and transport modeling. The calculations indicated that all individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 118-DR-1 waste site is $4.9 \times 10^{-2}$. No carcinogenic constituents from groundwater met the criteria for evaluation at the 118-DR-1 site; therefore, no calculations of excess carcinogenic risk were performed.

## 6.4 THREE-PART TEST FOR NONRADIONUCLIDES

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test. The WAC 173-340 three-part test consists of the following criteria: (1) the cleanup verification 95% UCL value must be less than the cleanup level, (2) no single detection can exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The application of the three-part test for the 118-DR-1 waste site is included in the 95% UCL calculation (Appendix B). The results of this evaluation indicate that all residual COC/COPC concentrations pass the three-part test in comparison against applicable RAGs. Therefore, the requirements of the three-part test are met.

# 7.0 SUMMARY FOR WASTE SITE RECLASSIFICATION

This CVP demonstrates that remedial action at the 118-DR-1 site has achieved the remedial action objectives and corresponding RAGs established in the Burial Grounds ROD (EPA 2000) and RDR/RAWP (DOE-RL 2005). The remaining soils at the 118-DR-1 site have been sampled, analyzed, and modeled. The results of this effort indicate that the materials from the 118-DR-1 site containing COCs at concentrations exceeding RAGs have been excavated and disposed of at ERDF. These results also indicate that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario and that residual concentrations throughout the site pose no threat to groundwater or the Columbia River. The 118-DR-1 excavation area has a maximum depth of approximately 6 m (20 ft), which includes both shallow zone and deep zone soils. However, the entire excavation area is considered one decision unit and will be closed out using the more restrictive shallow zone cleanup criteria; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are not required. The 118-DR-1 site is verified to be remediated in accordance with the Burial Grounds ROD (EPA 2000).

## 8.0 REFERENCES

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# APPENDIX A

# EXCEEDANCES OF ECOLOGICAL SCREENING LEVELS

## Maximum Contaminant Concentrations that Exceed Ecological Screening Levels for the 118-DR-1 Site.[a]

| Hazardous Substance | | 2007 WAC 173-340 Table 749-3 | | | EPA Ecological Soil Screening Levels[b] | | | | Maximum of Focused or Statistical Result |
|---|---|---|---|---|---|---|---|---|---|
| | | Plants | Soil Biota | Wildlife | Plants | Soil Biota | Avian[c] | Mammalian[c] | |
| METALS (mg/kg) | | | | | | | | | |
| | Background | | | | | | | | |
| Antimony | 5 | 5 | | | NA | 78 | NA | 0.27 | 1.5 (<BG) |
| Boron | NA | 0.5 | | | | | | | 1.3 |
| Manganese | 512 | 1,100 | | 1,500 | 220 | 450 | 4,300 | 4,000 | 290 (<BG) |
| Vanadium | 85.1 | 2 | | | NA | NA | 7.8 | 280 | 56 (<BG) |

Note: Shaded cells are exceeded by the maximum of the focused or statistical result.

[a] Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. All exceedances must be evaluated in the context of additional lines of evidence for ecological effects following a baseline risk assessment for the river corridor portion of the Hanford Site which will include a more complete quantitative ecological risk assessment.

[b] Available on the internet at (www.epa.gov/ecotox/ecossl)

[c] Wildlife

BG = background

NA = not available

# APPENDIX B

# CALCULATIONS

# APPENDIX B

## CALCULATIONS

The calculations in this appendix are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the file will be stored in a U.S. Department of Energy, Richland Operations Office, repository. These calculations have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculation," Washington Closure Hanford, Richland, Washington. The following calculations are provided in this appendix:

*118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculation*, 0100D-CA-V0318, Rev. 1 ..... B-3

*118-DR-1 Gas Loop Burial Ground Direct Contact Hazard Quotient and Carcinogenic Risk Calculation*, 0100D-CA-V0321, Rev. 1 ..... B-21

*118-DR-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater,* 0100D-CA-V0322, Rev. 1 ..... B-25

*118-DR-1 RESRAD Calculation Brief,* 0100D-CA-V0326, Rev. 0 ..... B-29

**DISCLAIMER FOR CALCULATIONS**

The calculations provided in this appendix have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents.

Acrobat 8.0

# CALCULATION COVER SHEET

Project Title: 100-D Field Remediation **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0318

Subject: 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculation

Computer Program: Excel Program No: Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover = 1<br>Sheets = 10<br>Attm. 1 = 5<br>Total = 16 | J. D. Skoglie | H. M. Sulloway | L. D. Habel | D. F. Obenauer | Signed 8/3/09 |
| 1 | Cover = 1<br>Sheets = 10<br>Attm. 1 = 5<br>Total = 16 | J. D. Skoglie | H. M. Sulloway | NA | D. F. Obenauer | 1/13/10 |
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## SUMMARY OF REVISION

| | |
|---|---|
| 1 | Page 4, Line 21: Corrected reference to sample number J18NP9 with J18NT1.<br>Page 10, Lines 6, 12, 18, 24, 30, and 36: Deleted split sample analysis rows per Ecology request. |
| | |
| | |

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

***Washington Closure Hanford*** **CALCULATION SHEET**

| | | | | | |
|---|---|---|---|---|---|
| **Originator** J. D. Skoglie | **Date** 07/27/09 | **Calc. No.** 0100D-CA-V0318 | **Rev. No.** 0 |
| **Project** 100-D Field Remediation | **Job No.** 14655 | **Checked** H. M. Sulloway | **Date** 07/27/09 |
| **Subject** 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations | | | **Sheet No.** 1 of 10 |

**Summary**

**Purpose:**
Calculate the 95% upper confidence limit (UCL) values to evaluate compliance with cleanup standards for the subject site. Also, perform the *Washington Administrative Code* (WAC) 173-340-740(7)(e) Model Toxics Control Act (MTCA) 3-part test for nonradionuclide analytes and calculate the relative percent difference (RPD) for primary-duplicate sample pairs for each contaminant of concern (COC) and contaminant of potential concern (COPC), as necessary.

**Table of Contents:**
Sheets 1 to 4 - Calculation Sheet Summary
Sheet 5 to 6- Calculation Sheet Verification Data - Excavation
Sheet 7 to 9 - Ecology Software (MTCAStat) Results
Sheet 10 - Calculation Sheet Split - Duplicate Analysis
Attachment 1 - 118-DR-1, Verification Sampling Results (5 sheets)

**Given/References:**
1) Sample Results (Attachment 1).
2) Background values and remedial action goals (RAGs) are taken from DOE-RL (2005b), DOE-RL (2001), and Ecology (1996).
3) DOE-RL, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2005a, *100 Area Remedial Action Sampling and Analysis Plan* (SAP), DOE/RL-96-22, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) DOE-RL, 2005b, *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
6) Ecology, 1992, *Statistical Guidance for Ecology Site Managers*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
7) Ecology, 1993, *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-detection Limit or Below-PQL Values (Censored Data Sets)*, Publication #92-54, Washington Department of Ecology, Olympia, Washington.
8) Ecology, 1996, *Model Toxic Control Act Cleanup Levels and Risk Calculations (CLARC II)*, Publication #94-145, Washington State Department of Ecology, Olympia, Washington.
9) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," *Washington Administrative Code*.

**Solution:**
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2005b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Cleanup Verification Package (CVP).

**Calculation Description:**
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 118-DR-1 Burial Ground. The data were entered into an EXCEL 2003 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP (DOE-RL 2005b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the CVP for this site.

**Methodology:**
The excavation area of 118-DR-1 burial ground underwent statistical and focused sampling and is considered one decision unit for verification sampling.

Analytical results for all sampling locations are summarized in the tables provided on sheets 3 and 4. Further information of the sample data quality is presented in the data quality assessment section of the associated CVP.

**Summary (continued)**

**Methodology, continued:**

For nonradioactive analytes with ≤50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in Ecology (2005) under WAC 173-340-740(3) for aluminum and potassium; therefore, these constituents are not considered site COCs/COPCs and are also not included in these calculations.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above. Data is not evalutated for results that only have detections in the split analysis. For radionuclide data, calculation of the statistics s done using the reported value. In cases where the laboratory does not report a value below the minimum detectable activity (MDA), half of the MDA is used in the calculation. For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n < 10), the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2005b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

The WAC 173-340-740(7)(e) 3-part test is performed for nonradionuclide analytes only and determines if:
1) the 95% UCL exceeds the most stringent cleanup limit for each COPC/COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each COPC/COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each COPC/COC.

The WAC 173-340-740(7)(e) 3-part test is not performed for COPCs where the statistical value defaults to the maximum value in the data set. Instead, direct comparison of the maximum value against site remedial action goals (RAGs) (within the CVP) is used as the compliance basis.

The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed in Table II-1 of the SAP (DOE-RL 2005a). Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

$$RPD = [\,|M-S|/((M+S)/2)]*100$$

where, M = Main Sample Value S = Split (or duplicate) Sample Value

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. To assist in the identification of anomalous sample pairs, when an analyte is detected in the primary or duplicate/split sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate/split results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable CVP.

*Washington Closure Hanford* CALCULATION SHEET

Originator J. D. Skoglie Date 07/27/09 Calc. No. 0100D-CA-V0318 Rev. No. 0
Project 100-D Field Remediation Job No. 14655 Checked H. M. Sulloway Date 07/27/09
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations Sheet No. 3 of 10

**Summary (continued)**

**Results:**
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the shallow zone excavation, the WAC 173-340-740(7)(e) 3-part test evaluation, and the RPD calculations, and are for use in risk analysis and the CVP for this site.

**Results Summary - Excavation [a]**

| Analyte | 95% UCL Result | Maximum Result | Units |
|---|---|---|---|
| Cesium-137 | 0.0565 | – | pCi/g |
| Cobalt-60 | 0.310 | – | pCi/g |
| Nickel-63 | 110 | – | pCi/g |
| Arsenic | 2.2 | – | mg/kg |
| Barium | 57 | – | mg/kg |
| Beryllium | 1.1 | – | mg/kg |
| Cadmium | 0.057 | – | mg/kg |
| Chromium | 7.4 | – | mg/kg |
| Cobalt | 6.8 | – | mg/kg |
| Copper | 13 | – | mg/kg |
| Hexavalent Chromium | 0.216 | | mg/kg |
| Lead | 4.1 | – | mg/kg |
| Manganese | 287 | – | mg/kg |
| Mercury | 0.0068 | – | mg/kg |
| Nickel | 10 | – | mg/kg |
| Vanadium | 56 | – | mg/kg |
| Zinc | 41 | – | mg/kg |
| Boron | – | 1.3 | mg/kg |

**WAC 173-340-740(7)(e) Evaluation:**

WAC 173-340 3-Part Test for most stringent RAG:
95% UCL > Cleanup Limit? NO
> 10% above Cleanup Limit? NO
Any sample > 2x Cleanup Limit? NO

**Results Summary - Focused Samples**

| Analyte | Maximum Result | Units |
|---|---|---|
| Cesium-137 | 0.0495 | pCi/g |
| Nickel-63 | 9.70 | pCi/g |
| Antimony | 1.5 | mg/kg |
| Arsenic | 2.8 | mg/kg |
| Barium | 62 | mg/kg |
| Beryllium | 0.48 | mg/kg |
| Boron | 1.1 | mg/kg |
| Cadmium | 0.079 | mg/kg |
| Chromium | 7.3 | mg/kg |
| Cobalt | 7.6 | mg/kg |
| Copper | 14 | mg/kg |
| Lead | 3.7 | mg/kg |
| Manganese | 290 | mg/kg |
| Mercury | 0.0064 | mg/kg |
| Nickel | 9.2 | mg/kg |
| Vanadium | 54 | mg/kg |
| Zinc | 40 | mg/kg |
| Benzo(b)fluoranthene | 4.4 | ug/kg |
| Heptachlor epoxide | 0.49 | ug/kg |

[a] The 95% UCL result or maximum value, depending on data censorship, as described in the methodology section.

-- = not applicable
B = blank contamination (inorganic constituents)
C = Sample was <= 5X the blank concentration
DE = direct exposure
GW = groundwater
J = estimate
L = dilution indicating physical and chemical interference are present
M = sample duplicate precision not met
MTCA = *Model Toxics Control Act*
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control

RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
U = undetected
UCL = upper confidence limit
WAC = Washington Administrative Code

*Washington Closure Hanford* **CALCULATION SHEET**

**Originator** J. D. Skoglie **Date** 07/27/09 **Calc. No.** 0100D-CA-V0318 **Rev. No.** 1
**Project** 100-D Field Remediation **Job No.** 14655 **Checked** H. M. Sulloway **Date** 01/13/10
**Subject** 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations **Sheet No.** 4 of 10

**Summary (continued)**

**Relative Percent Difference Results and QA/QC Analysis[a]**

| Analyte | Excavation | |
|---|---|---|
| | Duplicate Analysis | Split Analysis[b] |
| Nickel-63 | 26.6% | |
| Aluminum | 0.0% | |
| Barium | 1.8% | |
| Chromium | 5.0% | |
| Copper | 8.0% | |
| Lead | 16.9% | |
| Manganese | 7.4% | |
| Vanadium | 0.0% | |
| Zinc | 2.4% | |

[a]RPD listed where result produced, based on criteria. If RPD not required, no value is listed. The significance of the reported RPD values, including values greater than 30%, is addressed in the data quality assessment section of the
[b]Excavation split sample J18NT1 was sent to the same laboratory as the primary sample, therefore, does not meet the requirements of a split QA/QC sample.

**Maximum Result For All Detected Analytes in Statistical Data Sets[a]**

| Analytes | Excavation | Units |
|---|---|---|
| Aluminum | 8300 | mg/kg |
| Arsenic | 2.7 | mg/kg |
| Barium | 75 | mg/kg |
| Beryllium | 1.2 | mg/kg |
| Boron | 1.3 | mg/kg |
| Cadmium | 0.067 | mg/kg |
| Chromium | 9.5 | mg/kg |
| Cobalt | 9.8 | mg/kg |
| Copper | 15 | mg/kg |
| Hexavalent Chromium | 0.374 | mg/kg |
| Lead | 5.4 | mg/kg |
| Manganese | 320 | mg/kg |
| Mercury | 0.0095 | mg/kg |
| Nickel | 12 | mg/kg |
| Potassium | 2000 | mg/kg |
| Vanadium | 63 | mg/kg |
| Zinc | 43 | mg/kg |

[a]The maximum result is shown for all non-radiological analytes with at least one detected result. This summary is for use in comparison to ecological screening values.

CALCULATION SHEET

Washington Closure Hanford
Originator J. D. Skoglie
Project 100-D Field Remediation
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations

Date 07/27/09
Job No. 14655

Calc. No. 0100D-CA-V0318
Checked H. M. Sulloway

Rev. No. 0
Date 07/27/09
Sheet No. 5 of 10

1 118-DR-1 Statistical Calculations
2 Verification Data - Excavation

| 3 | Sample | Sample | Sample | Cesium-137 | | | Cobalt-60 | | | Nickel-63 | | | Arsenic | | | Barium | | | Beryllium | | | Cadmium | | | Chromium | | | Cobalt | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Area | Number | Date | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 5 | EX-2 | J18NP9 | 4/14/09 | 0.0985 | | 0.0244 | 0.935 | | 0.0245 | 132 | | 6.09 | 2.0 | B | 0.89 | 55 | | 0.080 | 0.92 | | 0.035 | 0.064 | B | 0.043 | 5.9 | | 0.061 | 7.6 | L | 0.11 |
| 6 | Duplicate of J18NP9 | J18NT0 | 4/14/09 | 0.100 | | 0.0318 | 0.822 | | 0.0342 | 101 | | 6.12 | 1.8 | B | 0.69 | 54 | | 0.080 | 0.93 | | 0.035 | 0.085 | B | 0.043 | 6.2 | | 0.061 | 8.1 | L | 0.11 |
| 7 | EX-1 | J18NP8 | 4/14/09 | 0.144 | | 0.0362 | 0.00457 | U | 0.0339 | 0.654 | U | 6.51 | 2.2 | | 0.89 | 61 | | 0.080 | 0.99 | | 0.035 | 0.061 | B | 0.043 | 7.8 | | 0.061 | 8.1 | L | 0.10 |
| 8 | EX-3 | J18NR0 | 4/14/09 | 0.00264 | U | 0.0334 | 0.0310 | U | 0.0428 | 29.5 | | 6.10 | 2.0 | B | 0.88 | 54 | | 0.079 | 1.1 | | 0.034 | 0.044 | B | 0.042 | 5.5 | | 0.06 | 9.8 | L | 0.10 |
| 9 | EX-4 | J18NR1 | 4/14/09 | 0.00432 | U | 0.0297 | 0.0788 | U | 0.0497 | 7.54 | | 6.33 | 1.9 | B | 0.68 | 52 | | 0.078 | 1.2 | | 0.034 | 0.053 | B | 0.042 | 4.2 | | 0.060 | 9.4 | L | 0.10 |
| 10 | EX-5 | J18NR2 | 4/14/09 | -0.0120 | U | 0.0233 | 0.0834 | U | 0.0364 | 77.0 | | 6.02 | 2.1 | | 0.68 | 38 | | 0.078 | 1.1 | | 0.034 | 0.045 | B | 0.042 | 4.7 | | 0.059 | 8.6 | L | 0.10 |
| 11 | EX-6 | J18NR3 | 4/14/09 | -0.0293 | U | 0.0658 | 0.00776 | U | 0.0874 | 6.27 | | 5.93 | 1.7 | B | 0.69 | 38 | | 0.079 | 0.82 | | 0.034 | 0.043 | U | 0.043 | 4.2 | | 0.061 | 7.9 | L | 0.10 |
| 12 | EX-7 | J18NR4 | 4/14/09 | 0.0184 | U | 0.0401 | 0.326 | | 0.0342 | 117 | | 6.05 | 2.2 | | 0.87 | 48 | | 0.077 | 0.98 | | 0.034 | 0.067 | B | 0.042 | 6.4 | | 0.059 | 8.1 | L | 0.10 |
| 13 | EX-8 | J18NR5 | 4/14/09 | 0.0120 | U | 0.0273 | -0.0121 | U | 0.0274 | 4.35 | U | 5.95 | 2.7 | | 0.88 | 75 | | 0.080 | 0.82 | | 0.035 | 0.052 | B | 0.043 | 9.5 | | 0.061 | 7.9 | L | 0.10 |
| 14 | EX-9 | J18NR6 | 4/14/09 | 0.0481 | U | 0.0412 | 0.758 | | 0.0275 | 359 | | 5.70 | 2.2 | | 0.86 | 49 | | 0.078 | 1.1 | | 0.034 | 0.048 | B | 0.042 | 7.3 | | 0.059 | 9.1 | L | 0.10 |
| 15 | EX-10 | J18NR7 | 4/14/09 | 0.0861 | | 0.0256 | -0.00708 | U | 0.0262 | 2.81 | U | 5.96 | 2.2 | | 0.87 | 60 | | 0.078 | 0.92 | | 0.034 | 0.056 | B | 0.042 | 7.7 | | 0.059 | 8.1 | L | 0.10 |
| 16 | EX-11 | J18NR8 | 4/14/09 | 0.00564 | U | 0.0281 | -0.00382 | U | 0.0294 | 0.0883 | U | 6.38 | 2.2 | | 0.89 | 38 | | 0.080 | 0.80 | | 0.035 | 0.055 | B | 0.043 | 7.3 | | 0.061 | 7.7 | L | 0.10 |
| 17 | EX-12 | J18NR9 | 4/14/09 | 0.00282 | U | 0.0291 | 0.000184 | U | 0.0290 | 5.13 | U | 5.52 | 2.2 | | 0.87 | 39 | | 0.078 | 1.1 | | 0.034 | 0.042 | B | 0.042 | 5.2 | | 0.059 | 8.8 | L | 0.10 |

18
19 Statistical Computation Input Data

| 20 | Sample | Sample | Sample | Cesium-137 | Cobalt-60 | Nickel-63 | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Area | Number | Date | pCi/g | pCi/g | pCi/g | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 22 | EX-2 | J18NP9/ J18NT0 | 4/14/09 | 0.0994 | 0.779 | 117 | 1.9 | 55 | 0.93 | 0.063 | 6.1 | 7.9 |
| 23 | EX-1 | J18NP8 | 4/14/09 | 0.144 | 0.00457 | 0.654 | 2.2 | 61 | 0.99 | 0.061 | 7.8 | 8.1 |
| 24 | EX-3 | J18NR0 | 4/14/09 | 0.00264 | 0.0310 | 29.5 | 2.0 | 54 | 1.1 | 0.044 | 5.5 | 9.8 |
| 25 | EX-4 | J18NR1 | 4/14/09 | 0.00432 | 0.0788 | 7.54 | 1.9 | 52 | 1.2 | 0.053 | 4.2 | 9.4 |
| 26 | EX-5 | J18NR2 | 4/14/09 | -0.0120 | 0.0834 | 77.0 | 2.1 | 38 | 1.1 | 0.045 | 4.7 | 8.6 |
| 27 | EX-6 | J18NR3 | 4/14/09 | -0.0293 | 0.00776 | 6.27 | 1.7 | 38 | 0.82 | 0.022 | 4.2 | 7.9 |
| 28 | EX-7 | J18NR4 | 4/14/09 | 0.0184 | 0.326 | 117 | 2.2 | 48 | 0.98 | 0.067 | 6.4 | 8.1 |
| 29 | EX-8 | J18NR5 | 4/14/09 | 0.0120 | -0.0121 | 4.35 | 2.7 | 75 | 0.82 | 0.052 | 9.5 | 7.9 |
| 30 | EX-9 | J18NR6 | 4/14/09 | 0.0481 | 0.758 | 359 | 2.2 | 49 | 1.1 | 0.048 | 7.3 | 9.1 |
| 31 | EX-10 | J18NR7 | 4/14/09 | 0.0861 | -0.00708 | 2.81 | 2.2 | 60 | 0.92 | 0.056 | 7.7 | 8.1 |
| 32 | EX-11 | J18NR8 | 4/14/09 | 0.00564 | -0.00382 | 0.0883 | 2.2 | 38 | 0.80 | 0.055 | 7.3 | 7.7 |
| 33 | EX-12 | J18NR9 | 4/14/09 | 0.00282 | 0.000184 | 5.13 | 2.2 | 39 | 1.1 | 0.042 | 5.2 | 8.8 |

34 Statistical Computations

| 35 | | Cesium-137 | Cobalt-60 | Nickel-63 | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt |
|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 95% UCL based on | Radionuclide data set. Use nonparametric z-statistic | Radionuclide data set. Use nonparametric z-statistic | Radionuclide data set. Use nonparametric z-statistic. | Large data set (n ≥10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥10), use MTCAStat lognormal distribution. | Large data set (n ≥10), use MTCAStat lognormal distribution. | Large data set (n ≥10), use MTCAStat normal distribution. | Large data set (n ≥10), use MTCAStat lognormal distribution. | Large data set (n ≥10), lognormal and normal distribution rejected, use z-statistic. |
| 37 | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 38 | % < Detection limit | 75% | 75% | 42% | 0% | 0% | 0% | 8% | 0% | 0% |
| 39 | Mean | 0.0318 | 0.170 | 50.5 | 2.1 | 51 | 1.0 | 0.051 | 6.3 | 8.4 |
| 40 | Standard deviation | 0.0520 | 0.294 | 104 | 0.25 | 11 | 0.13 | 0.012 | 1.8 | 0.58 |
| 41 | z-statistic | 1.645 | 1.645 | 1.645 | | | | | | |
| 42 | 95% UCL on mean | 0.0565 | 0.310 | 110 | 2.2 | 57 | 1.1 | 0.057 | 7.4 | 8.8 |
| 43 | Maximum value | 0.144 | 0.935 | 359 | 2.7 | 75 | 1.2 | 0.067 | 9.5 | 9.5 |
| 46 | Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) | | | | 20 DE, GW & River Protection | 200 GW Protection | 1.51 GW & River Protection | 0.81 GW & River Protection | 18.5 GW & River Protection | 15.7 GW Protection |
| 47 | WAC 173-340 3-PART TEST | | | | | | | | | |
| 48 | 95% UCL > Cleanup Limit? | | | | NA | NA | NA | NA | NA | NA |
| 49 | > 10% above Cleanup Limit? | | | | NA | NA | NA | NA | NA | NA |
| 50 | Any sample > 2X Cleanup Limit? | | | | NA | NA | NA | NA | NA | NA |
| 51 | WAC 173-340 Compliance? | | | | Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required | Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required |

CALCULATION SHEET
*Washington Closure Hanford*
Originator J. D. Stoppe — Date 07/27/09 — Calc. No. 0100D-CA-V0318 — Rev. No. 0
Project 100-D Field Remediation — Job No. 14655 — Checked H. M. Sullowey — Date 07/27/09
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations — Sheet No. 6 of 10

1 118-DR-1 Statistical Calculations

2 Verification Data - Excavation

| 3 | Sample | Sample | Sample | Copper | | | Hexavalent Chromium | | | Lead | | | Manganese | | | Mercury | | | Nickel | | | Vanadium | | | Zinc | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Area | Number | Date | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| 5 | EX-2 | J18NP9 | 4/14/09 | 13 | | 0.23 | 0.220 | | 0.150 | 4.5 | | 0.28 | 280 | L | 0.11 | 0.0065 | B | 0.0058 | 8.9 | L | 0.13 | 51 | | 0.099 | 42 | | 0.42 |
| 6 | Duplicate of J18NP9 | J18NT0 | 4/14/09 | 12 | | 0.23 | 0.152 | U | 0.152 | 3.8 | | 0.28 | 260 | L | 0.11 | 0.0066 | B | 0.0058 | 9.1 | L | 0.13 | 51 | | 0.099 | 41 | | 0.42 |
| 7 | EX-1 | J18NP8 | 4/14/09 | 13 | | 0.23 | 0.160 | U | 0.160 | 5.4 | | 0.28 | 270 | L | 0.10 | 0.0059 | B | 0.0058 | 10 | L | 0.13 | 50 | | 0.098 | 41 | | 0.42 |
| 8 | EX-3 | J18NR0 | 4/14/09 | 13 | | 0.22 | 0.199 | | 0.154 | 2.8 | | 0.28 | 300 | L | 0.10 | 0.0060 | B | 0.0057 | 8.4 | L | 0.13 | 61 | | 0.097 | 42 | | 0.41 |
| 9 | EX-4 | J18NR1 | 4/14/09 | 14 | | 0.22 | 0.374 | | 0.155 | 3.2 | | 0.28 | 270 | L | 0.10 | 0.0057 | U | 0.0057 | 7.7 | L | 0.13 | 63 | | 0.097 | 43 | | 0.41 |
| 10 | EX-5 | J18NR2 | 4/14/09 | 12 | | 0.22 | 0.153 | U | 0.153 | 2.4 | | 0.28 | 260 | L | 0.10 | 0.0057 | U | 0.0057 | 7.9 | LM | 0.13 | 59 | | 0.096 | 41 | | 0.41 |
| 11 | EX-6 | J18NR3 | 4/14/09 | 13 | | 0.23 | 0.286 | | 0.153 | 2.9 | | 0.28 | 230 | L | 0.10 | 0.0062 | B | 0.0058 | 7.0 | L | 0.13 | 43 | | 0.096 | 34 | | 0.42 |
| 12 | EX-7 | J18NR4 | 4/14/09 | 13 | | 0.22 | 0.150 | U | 0.150 | 3.8 | | 0.27 | 280 | L | 0.10 | 0.0056 | B | 0.0056 | 9.6 | L | 0.13 | 50 | | 0.096 | 42 | | 0.40 |
| 13 | EX-8 | J18NR5 | 4/14/09 | 13 | | 0.23 | 0.286 | | 0.152 | 4.3 | | 0.28 | 320 | L | 0.10 | 0.0058 | U | 0.0058 | 11 | L | 0.13 | 41 | | 0.099 | 40 | | 0.42 |
| 14 | EX-9 | J18NR6 | 4/14/09 | 13 | | 0.22 | 0.153 | U | 0.153 | 3.5 | | 0.28 | 280 | L | 0.10 | 0.0060 | B | 0.0057 | 12 | L | 0.13 | 55 | | 0.096 | 42 | | 0.41 |
| 15 | EX-10 | J18NR7 | 4/14/09 | 13 | | 0.22 | 0.194 | | 0.152 | 4.0 | | 0.28 | 280 | L | 0.10 | 0.0069 | B | 0.0057 | 9.8 | L | 0.13 | 47 | | 0.096 | 39 | | 0.41 |
| 16 | EX-11 | J18NR8 | 4/14/09 | 15 | | 0.23 | 0.179 | | 0.154 | 3.6 | | 0.28 | 240 | L | 0.10 | 0.0095 | B | 0.0058 | 10 | L | 0.13 | 41 | | 0.096 | 36 | | 0.42 |
| 17 | EX-12 | J18NR9 | 4/14/09 | 13 | | 0.22 | 0.153 | U | 0.153 | 2.5 | | 0.28 | 280 | L | 0.10 | 0.0057 | U | 0.0057 | 8.9 | L | 0.13 | 56 | | 0.096 | 39 | | 0.41 |

19 Statistical Computation Input Data

| 20 | Sample | Sample | Sample | Copper | Hexavalent Chromium | Lead | Manganese | Mercury | Nickel | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Area | Number | Date | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 22 | EX-2 | J18NP9/ J18NT0 | 4/14/09 | 13 | 0.148 | 4.2 | 270 | 0.0066 | 9.0 | 51 | 42 |
| 23 | EX-1 | J18NP8 | 4/14/09 | 13 | 0.0750 | 5.4 | 270 | 0.0059 | 10 | 50 | 41 |
| 24 | EX-3 | J18NR0 | 4/14/09 | 13 | 0.199 | 2.8 | 300 | 0.0060 | 8.4 | 61 | 42 |
| 25 | EX-4 | J18NR1 | 4/14/09 | 14 | 0.374 | 3.2 | 270 | 0.0029 | 7.7 | 63 | 43 |
| 26 | EX-5 | J18NR2 | 4/14/09 | 12 | 0.0765 | 2.4 | 260 | 0.0029 | 7.9 | 59 | 41 |
| 27 | EX-6 | J18NR3 | 4/14/09 | 13 | 0.286 | 2.9 | 230 | 0.0062 | 7.0 | 43 | 34 |
| 28 | EX-7 | J18NR4 | 4/14/09 | 13 | 0.0750 | 3.8 | 280 | 0.0056 | 10 | 50 | 42 |
| 29 | EX-8 | J18NR5 | 4/14/09 | 13 | 0.286 | 4.3 | 320 | 0.0029 | 11.0 | 41 | 40 |
| 30 | EX-9 | J18NR6 | 4/14/09 | 13 | 0.0765 | 3.5 | 280 | 0.0060 | 12 | 55 | 42 |
| 31 | EX-10 | J18NR7 | 4/14/09 | 13 | 0.194 | 4.0 | 280 | 0.0069 | 10 | 47 | 39 |
| 32 | EX-11 | J18NR8 | 4/14/09 | 15 | 0.179 | 3.6 | 240 | 0.0095 | 10 | 41 | 36 |
| 33 | EX-12 | J18NR9 | 4/14/09 | 13 | 0.0765 | 2.5 | 280 | 0.0029 | 8.9 | 56 | 39 |

34 Statistical Computations

| 35 | | Copper | Hexavalent Chromium | Lead | Manganese | Mercury | Nickel | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|
| 36 | 95% UCL based on | Large data set (n ≥10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥10), lognormal and normal distribution rejected, use z-statistic. | Large data set (n ≥10), use MTCAStat lognormal distribution. | Large data set (n ≥10), use MTCAStat lognormal distribution. | Large data set (n ≥10), use MTCAStat normal distribution. | Large data set (n ≥10), use MTCAStat lognormal distribution. | Large data set (n ≥10), use MTCAStat lognormal distribution | Large data set (n ≥10), lognormal and normal distribution rejected, use z-statistic. |
| 37 | N | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 38 | % < Detection limit | 0% | 42% | 0% | 0% | 33% | 0% | 0% | 0% |
| 39 | Mean | 13 | 0.189 | 3.5 | 273 | 0.0058 | 9.3 | 51 | 40 |
| 40 | Standard deviation | 0.74 | 0.100 | 0.86 | 23.9 | 0.0023 | 1.4 | 7.8 | 2.7 |
| 41 | 95% UCL on mean | 13 | 0.216 | 4.1 | 287 | 0.0068 | 10 | 56 | 41 |
| 42 | Maximum value | 15 | 0.374 | 5.4 | 320 | 0.0095 | 12 | 63 | 43 |
| 43 | Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg) | 22.0 River Protection | 2.0 River Protection | 10.2 GW & River Protection | 512 GW & River Protection | 0.33 GW & River Protection | 19.1 GW Protection | 85.1 GW Protection | 67.8 River Protection |
| 44 | WAC 173-340 3-PART TEST | | | | | | | | |
| 45 | 95% UCL > Cleanup Limit? | NA | NO | NA | NA | NA | NA | NA | NA |
| 46 | > 10% above Cleanup Limit? | NA | NO | NA | NA | NA | NA | NA | NA |
| 47 | Any sample > 2X Cleanup Limit? | NA | NO | NA | NA | NA | NA | NA | NA |
| 48 | WAC 173-340 Compliance? | Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required. | The data set meets the 3-part test criteria when compared to the most stringent RAG. | Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required | Because all values are below background (0.33 mg/kg) the WAC 173-340 3-part test is not requirec | Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required. | Because all values are below background (67.8 mg/kg) the WAC 173-340 3-part test is not required. |

CALCULATION SHEET

*Washington Closure Hanford*
Originator J. D. Skoglie
Project 100-D Field Remediation
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations

Date 07/27/09
Job No. 14555

Calc. No. 0100D-CA-V0318
Checked H. M. Sullaway

Rev. No. 0
Date 07/27/09
Sheet No. 7 of 10

**Ecology Software (MTCAStat) Results, 118-DR-1 Excavation**

**Arsenic 95% UCL Calculation**

| DATA | ID |
|---|---|
| 1.9 | J18NP9/ J18NT0 |
| 2.2 | J18NP8 |
| 2.0 | J18NR0 |
| 1.9 | J18NR1 |
| 2.1 | J18NR2 |
| 1.7 | J18NR3 |
| 2.2 | J18NR4 |
| 2.7 | J18NR5 |
| 2.2 | J18NR6 |
| 2.2 | J18NR7 |
| 2.2 | J18NR8 |
| 2.2 | J18NR9 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 2.1 |
| Censored | | Lognormal mean | 2.1 |
| Detection limit or PQL | | Std. devn. | 0.25 |
| Method detection limit | | Median | 2.2 |
| TOTAL | 12 | Min. | 1.7 |
| | | Max. | 2.7 |

Lognormal distribution? r-squared is: 0.860
Normal distribution? r-squared is: 0.841
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 2.2

**Barium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 55 | J18NP9/ J18NT0 |
| 61 | J18NP8 |
| 54 | J18NR0 |
| 52 | J18NR1 |
| 38 | J18NR2 |
| 38 | J18NR3 |
| 48 | J18NR4 |
| 75 | J18NR5 |
| 49 | J18NR6 |
| 50 | J18NR7 |
| 38 | J18NR8 |
| 39 | J18NR9 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 51 |
| Censored | | Lognormal mean | 51 |
| Detection limit or PQL | | Std. devn. | 11 |
| Method detection limit | | Median | 51 |
| TOTAL | 12 | Min. | 38 |
| | | Max. | 75 |

Lognormal distribution? r-squared is: 0.927
Normal distribution? r-squared is: 0.914
Recommendations:
Use lognormal distribution

UCL (Land's method) is 57

**Beryllium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.93 | J18NP9/ J18NT0 |
| 0.99 | J18NP8 |
| 1.1 | J18NR0 |
| 1.2 | J18NR1 |
| 1.1 | J18NR2 |
| 0.82 | J18NR3 |
| 0.96 | J18NR4 |
| 0.82 | J18NR5 |
| 1.1 | J18NR6 |
| 0.92 | J18NR7 |
| 0.80 | J18NR8 |
| 1.1 | J18NR9 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 0.99 |
| Censored | | Lognormal mean | 0.99 |
| Detection limit or PQL | | Std. devn. | 0.13 |
| Method detection limit | | Median | 0.98 |
| TOTAL | 12 | Min. | 0.80 |
| | | Max. | 1.2 |

Lognormal distribution? r-squared is: 0.927
Normal distribution? r-squared is: 0.929
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 1.1

**Cadmium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 0.065 | J18NP9/ J18NT0 |
| 0.061 | J18NP8 |
| 0.044 | J18NR0 |
| 0.053 | J18NR1 |
| 0.045 | J18NR2 |
| 0.022 | J18NR3 |
| 0.067 | J18NR4 |
| 0.052 | J18NR5 |
| 0.048 | J18NR6 |
| 0.056 | J18NR7 |
| 0.055 | J18NR8 |
| 0.042 | J18NR9 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 0.051 |
| Censored | | Lognormal mean | 0.051 |
| Detection limit or PQL | | Std. devn. | 0.012 |
| Method detection limit | | Median | 0.053 |
| TOTAL | 12 | Min | 0.022 |
| | | Max | 0.067 |

Lognormal distribution? r-squared is: 0.782
Normal distribution? r-squared is: 0.912
Recommendations:
Use normal distribution

UCL (based on t-statistic) is 0.057

**Chromium 95% UCL Calculation**

| DATA | ID |
|---|---|
| 6.1 | J18NP9/ J18NT0 |
| 7.8 | J18NP8 |
| 5.5 | J18NR0 |
| 4.2 | J18NR1 |
| 4.7 | J18NR2 |
| 4.2 | J18NR3 |
| 6.4 | J18NR4 |
| 9.5 | J18NR5 |
| 7.3 | J18NR6 |
| 7.7 | J18NR7 |
| 7.3 | J18NR8 |
| 5.2 | J18NR9 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 6.3 |
| Censored | | Lognormal mean | 6.3 |
| Detection limit or PQL | | Std. devn. | 1.6 |
| Method detection limit | | Median | 6.2 |
| TOTAL | 12 | Min | 4.2 |
| | | Max | 9.5 |

Lognormal distribution? r-squared is: 0.965
Normal distribution? r-squared is: 0.956
Recommendations:
Use lognormal distribution

UCL (Land's method) is 7.4

**Cobalt 95% UCL Calculation**

| DATA | ID |
|---|---|
| 7.9 | J18NP9/ J18NT0 |
| 8.1 | J18NP8 |
| 9.6 | J18NR0 |
| 9.4 | J18NR1 |
| 8.6 | J18NR2 |
| 7.9 | J18NR3 |
| 8.1 | J18NR4 |
| 7.9 | J18NR5 |
| 9.1 | J18NR6 |
| 8.1 | J18NR7 |
| 7.7 | J18NR8 |
| 8.8 | J18NR9 |

| Number of samples | | Uncensored values | |
|---|---|---|---|
| Uncensored | 12 | Mean | 8.4 |
| Censored | | Lognormal mean | 8.4 |
| Detection limit or PQL | | Std. devn. | 0.68 |
| Method detection limit | | Median | 8.1 |
| TOTAL | 12 | Min. | 7.7 |
| | | Max. | 9.6 |

Lognormal distribution? r-squared is: 0.891
Normal distribution? r-squared is: 0.878
Recommendations:
Reject BOTH lognormal and normal distributions

UCL (based on Z-statistic) is 8.8

**CALCULATION SHEET**

*Washington Closure Hanford*

Originator J. D. Skoglie
Project 100-D Field Remediation
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations

Date 07/27/09
Job No. 14655

Calc. No. 01000-CA-V0316
Checked H. M. Sullaway

Rev. No. 0
Date 07/27/09
Sheet No. 8 of 10

Ecology Software (MTCAStat) Results, 118-DR-1 Excavation

| | DATA | ID | Copper 95% UCL Calculation | | | | DATA | ID | Hexavalent Chromium 95% UCL Calculation | | | | DATA | ID | Lead 95% UCL Calculation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | | |
| 2 | 13 | J18NP9/ J18NT0 | | | | | 0.148 | J18NP9/ J18NT0 | | | | | 4.2 | J18NP9/ J18NT0 | | | | |
| 3 | 13 | J18NP8 | | | | | 0.0750 | J18NP8 | | | | | 5.4 | J18NP8 | | | | |
| 4 | 13 | J18NR0 | Number of samples | | Uncensored values | | 0.199 | J18NR0 | Number of samples | | Uncensored values | | 2.8 | J18NR0 | Number of samples | | Uncensored values | |
| 5 | 14 | J18NR1 | Uncensored | 12 | Mean | 13 | 0.374 | J18NR1 | Uncensored | 12 | Mean | 0.169 | 3.2 | J18NR1 | Uncensored | 12 | Mean | 3.5 |
| 6 | 12 | J18NR2 | Censored | | Lognormal mean | 13 | 0.0785 | J18NR2 | Censored | | Lognormal mean | 0.172 | 2.4 | J18NR2 | Censored | | Lognormal mean | 3.6 |
| 7 | 13 | J18NR3 | Detection limit or PQL | | Std. devn. | 0.74 | 0.286 | J18NR3 | Detection limit or PQL | | Std. devn. | 0.100 | 2.9 | J18NR3 | Detection limit or PQL | | Std. devn. | 0.88 |
| 8 | 13 | J18NR4 | Method detection limit | | Median | 13 | 0.0750 | J18NR4 | Method detection limit | | Median | 0.164 | 3.8 | J18NR4 | Method detection limit | | Median | 3.6 |
| 9 | 13 | J18NR5 | TOTAL | 12 | Min. | 12 | 0.286 | J18NR5 | TOTAL | 12 | Min. | 0.0750 | 4.3 | J18NR5 | TOTAL | 12 | Min. | 2.4 |
| 10 | 13 | J18NR6 | | | Max | 15 | 0.0785 | J18NR6 | | | Max. | 0.374 | 3.5 | J18NR6 | | | Max. | 5.4 |
| 11 | 13 | J18NR7 | | | | | 0.194 | J18NR7 | | | | | 4.0 | J18NR7 | | | | |
| 12 | 15 | J18NR8 | | | | | 0.179 | J18NR8 | | | | | 3.6 | J18NR8 | | | | |
| 13 | 13 | J18NR9 | | | | | 0.0765 | J18NR9 | | | | | 2.5 | J18NR9 | | | | |
| 14 | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | |
| 17 | | | Lognormal distribution? | | Normal distribution? | | | | Lognormal distribution? | | Normal distribution? | | | | Lognormal distribution? | | Normal distribution? | |
| 18 | | | r-squared is: 0.738 | | r-squared is: | 0.723 | | | r-squared is: 0.878 | | r-squared is: | 0.879 | | | r-squared is: 0.979 | | r-squared is: | 0.955 |
| 19 | | | Recommendations: | | | | | | Recommendations: | | | | | | Recommendations: | | | |
| 20 | | | Reject BOTH lognormal and normal distributions. | | | | | | Reject BOTH lognormal and normal distributions. | | | | | | Use lognormal distribution. | | | |
| 21 | | | | | | | | | | | | | | | | | | |
| 22 | | | UCL (based on Z-statistic) is | 13 | | | | | UCL (based on Z-statistic) is | 0.216 | | | | | UCL (Land's method) is | 4.1 | | |
| 23 | | | | | | | | | | | | | | | | | | |

| | DATA | ID | Manganese 95% UCL Calculation | | | | DATA | ID | Mercury 95% UCL Calculation | | | | DATA | ID | Nickel 95% UCL Calculation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | | | | | | | | | | | | | | | | | | |
| 25 | 270 | J18NP9/ J18NT0 | | | | | 0.0066 | J18NP9/ J18NT0 | | | | | 9.0 | J18NP9/ J18NT0 | | | | |
| 26 | 270 | J18NP8 | | | | | 0.0059 | J18NP8 | | | | | 10 | J18NP8 | | | | |
| 27 | 300 | J18NR0 | Number of samples | | Uncensored values | | 0.0060 | J18NR0 | Number of samples | | Uncensored values | | 8 | J18NR0 | Number of samples | | Uncensored values | |
| 28 | 270 | J18NR1 | Uncensored | 12 | Mean | 273 | 0.0029 | J18NR1 | Uncensored | 12 | Mean | 0.0056 | 7.7 | J18NR1 | Uncensored | 12 | Mean | 9.3 |
| 29 | 260 | J18NR2 | Censored | | Lognormal mean | 273 | 0.0029 | J18NR2 | Censored | | Lognormal mean | 0.0057 | 7.9 | J18NR2 | Censored | | Lognormal mean | 9.3 |
| 30 | 230 | J18NR3 | Detection limit or PQL | | Std. devn. | 23.9 | 0.0082 | J18NR3 | Detection limit or PQL | | Std. devn. | 0.0023 | 7.0 | J18NR3 | Detection limit or PQL | | Std. devn. | 1.4 |
| 31 | 280 | J18NR4 | Method detection limit | | Median | 275 | 0.0056 | J18NR4 | Method detection limit | | Median | 0.0060 | 10 | J18NR4 | Method detection limit | | Median | 9.3 |
| 32 | 320 | J18NR5 | TOTAL | 12 | Min. | 230 | 0.0029 | J18NR5 | TOTAL | 12 | Min. | 0.0029 | 11 | J18NR5 | TOTAL | 12 | Min. | 7.0 |
| 33 | 280 | J18NR6 | | | Max. | 320 | 0.0090 | J18NR6 | | | Max. | 0.0095 | 12 | J18NR6 | | | Max. | 12 |
| 34 | 280 | J18NR7 | | | | | 0.0069 | J18NR7 | | | | | 10 | J18NR7 | | | | |
| 35 | 240 | J18NR8 | | | | | 0.0095 | J18NR8 | | | | | 10 | J18NR8 | | | | |
| 36 | 280 | J18NR9 | | | | | 0.0029 | J18NR9 | | | | | 8.9 | J18NR9 | | | | |
| 37 | | | | | | | | | | | | | | | | | | |
| 38 | | | | | | | | | | | | | | | | | | |
| 39 | | | Lognormal distribution? | | Normal distribution? | | | | Lognormal distribution? | | Normal distribution? | | | | Lognormal distribution? | | Normal distribution? | |
| 40 | | | r-squared is: 0.923 | | r-squared is: | 0.926 | | | r-squared is: 0.863 | | r-squared is: | 0.900 | | | r-squared is: 0.986 | | r-squared is: | 0.981 |
| 41 | | | Recommendations: | | | | | | Recommendations: | | | | | | Recommendations: | | | |
| 42 | | | Use lognormal distribution. | | | | | | Use normal distribution. | | | | | | Use lognormal distribution. | | | |
| 43 | | | | | | | | | | | | | | | | | | |
| 44 | | | UCL (Land's method) is | 287 | | | | | UCL (based on t-statistic) is | 0.0068 | | | | | UCL (Land's method) is | 10 | | |
| 45 | | | | | | | | | | | | | | | | | | |

CALCULATION SHEET

*Washington Closure Hanford*

Originator J. D. Skoglie | Date 07/27/09 | Calc. No. 0100D-CA-V0318 | Rev. No. 0
Project 100-D Field Remediation | Job No. 14655 | Checked H. M. Sullowav | Date 07/27/09
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations | Sheet No. 9 of 10

**Ecology Software (MTCAStat) Results, 118-DR-1 Excavation**

| | DATA | ID | Vanadium 95% UCL Calculation | | | | DATA | ID | Zinc 95% UCL Calculation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | DATA | ID | Vanadium 95% UCL Calculation | | | | DATA | ID | Zinc 95% UCL Calculation | | | |
| 2 | 51 | J18NP9/ J18NT0 | | | | | 42 | J18NP9/ J18NT0 | | | | |
| 3 | 50 | J18NP8 | | | | | 41 | J18NP8 | | | | |
| 4 | 61 | J18NR0 | Number of samples | | Uncensored values | | 42 | J18NR0 | Number of samples | | Uncensored values | |
| 5 | 63 | J18NR1 | Uncensored | 12 | Mean | 51 | 43 | J18NR1 | Uncensored | 12 | Mean | 40 |
| 6 | 59 | J18NR2 | Censored | | Lognormal mean | 51 | 41 | J18NR2 | Censored | | Lognormal mean | 40 |
| 7 | 43 | J18NR3 | Detection limit or PQL | | Std. devn. | 7.8 | 34 | J18NR3 | Detection limit or PQL | | Std. devn. | 2.7 |
| 8 | 50 | J18NR4 | Method detection limit | | Median | 51 | 42 | J18NR4 | Method detection limit | | Median | 41 |
| 9 | 41 | J18NR5 | TOTAL | 12 | Min. | 41 | 40 | J18NR5 | TOTAL | 12 | Min. | 34 |
| 10 | 55 | J18NR6 | | | Max. | 63 | 42 | J18NR6 | | | Max. | 43 |
| 11 | 47 | J18NR7 | | | | | 39 | J18NR7 | | | | |
| 12 | 41 | J18NR8 | | | | | 36 | J18NR8 | | | | |
| 13 | 56 | J18NR9 | | | | | 39 | J18NR9 | | | | |
| 14 | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | |
| 17 | | | Lognormal distribution? | | Normal distribution? | | | | Lognormal distribution? | | Normal distribution? | |
| 18 | | | r-squared is: 0.960 | | r-squared is: 0.965 | | | | r-squared is: 0.835 | | r-squared is: 0.854 | |
| 19 | | | Recommendations: | | | | | | Recommendations: | | | |
| 20 | | | Use lognormal distribution. | | | | | | Reject BOTH lognormal and normal distributions. | | | |
| 21 | | | | | | | | | | | | |
| 22 | | | UCL (Land's method) is | | 56 | | | | UCL (based on Z-statistic) is | | 41 | |
| 23 | | | | | | | | | | | | |

**CALCULATION SHEET**

*Washington Closure Hanford*

Originator J. D. Skoglie
100-D 100-D Field Remediation
Subject 118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations

Date 01/13/10
Job No. 14856

Calc. No. 0100D-CA-V0318
Checked H. M. Sulloway

Rev. No. 1
Date 01/13/10
Sheet No. 10 of 10

1 Duplicate and Split Analysis - 118-D-6 Excavation

| | Sampling Area | Sample Number | Sample Date | Cesium-137 mg/kg | Q | PQL | Cobalt-60 mg/kg | Q | PQL | Nickel-63 mg/kg | Q | PQL | Aluminum mg/kg | Q | PQL | Arsenic mg/kg | Q | PQL | Barium mg/kg | Q | PQL | Beryllium mg/kg | Q | PQL | Cadmium mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | EX-2 | J18NP9 | 4/14/09 | 0.0988 | | 0.0244 | 0.935 | | 0.0245 | 132 | | 6.08 | 5300 | | 1.6 | 2.0 | B | 0.69 | 55 | | 0.080 | 0.92 | | 0.035 | 0.064 | B | 0.043 |
| 5 | Duplicate of J18NP9 | J18NT0 | 4/14/09 | 0.100 | | 0.0318 | 0.622 | | 0.0342 | 101 | | 6.12 | 5300 | | 1.6 | 1.8 | B | 0.69 | 54 | | 0.080 | 0.93 | | 0.035 | 0.085 | B | 0.043 |

6 Analysis:

| | | Cesium-137 | Cobalt-60 | Nickel-63 | Aluminum | Arsenic | Barium | Beryllium | Cadmium |
|---|---|---|---|---|---|---|---|---|---|
| 7 | TDL | 5 | 5 | 5 | 5 | 1 | 0.5 | 0.2 | 0.2 |
| 8 | Duplicate Analysis: Both > POL? | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| 9 | Duplicate Analysis: Both >5xTDL? | No-Stop (acceptable) | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) |
| 10 | Duplicate Analysis: RPD | | | 28.6% | 0.0% | | 1.8% | | |
| 11 | Duplicate Analysis: Difference > 2 TDL? | No - acceptable | No - acceptable | Not applicable | Not applicable | No - acceptable | Not applicable | No - acceptable | No - acceptable |

12
13

| | Sampling Area | HEIS Number | Sample Date | Chromium mg/kg | Q | PQL | Cobalt mg/kg | Q | PQL | Copper mg/kg | Q | PQL | Hexavalent Chromium mg/kg | Q | PQL | Lead mg/kg | Q | PQL | Manganese mg/kg | Q | PQL | Mercury mg/kg | Q | PQL | Nickel mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | EX-2 | J18NP9 | 4/14/09 | 5.9 | | 0.061 | 7.8 | L | 0.11 | 13 | | 0.23 | 0.220 | | 0.150 | 4.5 | | 0.28 | 290 | L | 0.11 | 0.0065 | B | 0.0058 | 8.9 | L | 0.13 |
| 17 | Duplicate of J18NP9 | J18NT0 | 4/14/09 | 6.2 | | 0.061 | 8.1 | L | 0.11 | 12 | | 0.23 | 0.152 | U | 0.152 | 3.8 | | 0.28 | 260 | L | 0.11 | 0.0086 | B | 0.0058 | 9.1 | L | 0.13 |

18 Analysis:

| | | Chromium | Cobalt | Copper | Hexavalent Chromium | Lead | Manganese | Mercury | Nickel |
|---|---|---|---|---|---|---|---|---|---|
| 19 | TDL | 0.2 | 2 | 1 | 0.5 | 0.5 | 5 | 0.2 | 4 |
| 20 | Duplicate Analysis: Both > POL? | Yes (continue) | Yes (continue) | Yes (continue) | No-Stop (acceptable) | Yes (continue) | Yes (continue) | Yes (continue) | Yes (continue) |
| 21 | Duplicate Analysis: Both >5xTDL? | Yes (calc RPD) | No-Stop (acceptable) | Yes (calc RPD) | | Yes (calc RPD) | Yes (calc RPD) | No-Stop (acceptable) | No-Stop (acceptable) |
| 22 | Duplicate Analysis: RPD | 5.0% | | 8.0% | | 16.9% | 7.4% | | |
| 23 | Duplicate Analysis: Difference > 2 TDL? | Not applicable | No - acceptable | Not applicable | No - acceptable | Not applicable | Not applicable | No - acceptable | No - acceptable |

24
25

| | Sampling Area | HEIS Number | Sample Date | Potassium mg/kg | Q | PQL | Vanadium mg/kg | Q | PQL | Zinc mg/kg | Q | PQL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | |
| 28 | EX-2 | J18NP9 | 4/14/09 | 826 | | 43 | 51 | | 0.099 | 42 | | 0.42 |
| 29 | Duplicate of J18NP9 | J18NT0 | 4/14/09 | 870 | | 43 | 51 | | 0.099 | 41 | | 0.42 |

30 Analysis:

| | | Potassium | Vanadium | Zinc |
|---|---|---|---|---|
| 31 | TDL | 400 | 2.5 | 1 |
| 32 | Duplicate Analysis: Both > POL? | Yes (continue) | Yes (continue) | Yes (continue) |
| 33 | Duplicate Analysis: Both >5xTDL? | No-Stop (acceptable) | Yes (calc RPD) | Yes (calc RPD) |
| 34 | Duplicate Analysis: RPD | | 0.0% | 2.4% |
| 35 | Duplicate Analysis: Difference > 2 TDL? | No - acceptable | Not applicable | Not applicable |

36

**Attachment 1. 118-DR-1 Burial Ground Verification Sample Results**

| Sample Location | HEIS Number | Sample Date | Cesium-137 | | | Cobalt-60 | | | Europium-152 | | | Europium-154 | | | Europium-155 | | | Nickel-63 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA | pCi/g | Q | MDA |
| EX-2 | J18NP9 | 100-D | 0.0988 | | 0.0244 | 0.935 | | 0.0245 | 0.00313 | U | 0.0598 | -0.0219 | U | 0.0744 | 0.0291 | U | 0.0687 | 132 | | 6.08 |
| Duplicate of J18NP9 | J18NT0 | 4/14/09 | 0.100 | | 0.0318 | 0.622 | | 0.0342 | 0.00981 | U | 0.0785 | -0.0248 | U | 0.0902 | 0.0250 | U | 0.0951 | 101 | | 6.12 |
| EX-1 | J18NP8 | 4/14/09 | 0.144 | | 0.0362 | 0.00457 | U | 0.0339 | 0.00370 | U | 0.0847 | -0.0162 | U | 0.0975 | 0.00591 | U | 0.0832 | 0.654 | U | 6.51 |
| EX-3 | J18NR0 | 4/14/09 | 0.00264 | U | 0.0334 | 0.0310 | U | 0.0428 | -0.00815 | U | 0.0924 | -0.00420 | U | 0.103 | 0.0212 | U | 0.0911 | 29.5 | | 6.10 |
| EX-4 | J18NR1 | 4/14/09 | 0.00432 | U | 0.0297 | 0.0788 | U | 0.0497 | 0.0206 | U | 0.0759 | -0.0403 | U | 0.0899 | 0.0144 | U | 0.0739 | 7.54 | | 6.33 |
| EX-5 | J18NR2 | 4/14/09 | -0.0120 | U | 0.0233 | 0.0834 | U | 0.0364 | -0.0300 | U | 0.0653 | 0.0229 | U | 0.0705 | -0.00684 | U | 0.0826 | 77.0 | | 6.02 |
| EX-6 | J18NR3 | 4/14/09 | -0.0293 | U | 0.0558 | 0.00776 | U | 0.0874 | -0.0673 | U | 0.143 | -0.0970 | U | 0.186 | 0.0176 | U | 0.119 | 6.27 | | 5.93 |
| EX-7 | J18NR4 | 4/14/09 | 0.0184 | U | 0.0401 | 0.326 | | 0.0342 | -0.0098 | U | 0.0919 | -0.0518 | U | 0.101 | -0.0169 | U | 0.0871 | 117 | | 6.05 |
| EX-8 | J18NR5 | 4/14/09 | 0.0120 | U | 0.0273 | -0.0121 | U | 0.0274 | -0.00663 | U | 0.0641 | -0.0473 | U | 0.084 | 0.0551 | U | 0.0808 | 4.35 | U | 5.95 |
| EX-9 | J18NR6 | 4/14/09 | 0.0481 | U | 0.0412 | 0.758 | | 0.0275 | -0.0290 | U | 0.0775 | 0.00439 | U | 0.101 | -0.0204 | U | 0.0788 | 359 | | 5.70 |
| EX-10 | J18NR7 | 4/14/09 | 0.0861 | | 0.0256 | -0.00708 | U | 0.0262 | -0.0139 | U | 0.0740 | -0.0140 | U | 0.0773 | -0.0171 | U | 0.0947 | 2.61 | U | 5.96 |
| EX-11 | J18NR8 | 4/14/09 | 0.00564 | U | 0.0281 | -0.00382 | U | 0.0294 | 0.0301 | U | 0.0727 | 0.00405 | U | 0.0956 | 0.0647 | U | 0.0968 | 0.0883 | U | 6.38 |
| EX-12 | J18NR9 | 4/14/09 | 0.00262 | U | 0.0291 | 0.000184 | U | 0.0290 | 0.00511 | U | 0.0694 | 0.00357 | U | 0.0821 | 0.00877 | U | 0.0683 | 5.13 | U | 5.52 |
| Split of J18NP9 | J18NT1 | 4/14/09 | 0.0918 | | 0.0371 | 0.627 | | 0.0332 | 0.0107 | U | 0.0836 | 0.0442 | U | 0.111 | 0.0631 | U | 0.0889 | 114 | | 5.93 |
| FS-1 | J18NT5 | 4/14/09 | 0.0495 | | 0.0294 | 0.0354 | U | 0.0362 | -0.00230 | U | 0.0752 | 0.0110 | U | 0.0941 | 0.0282 | U | 0.0764 | 9.70 | | 6.78 |
| FS-2 | J18NT6 | 4/14/09 | 0.00746 | U | 0.0246 | 0.000637 | U | 0.0288 | 0.0151 | U | 0.0655 | -0.0370 | U | 0.0762 | 0.0217 | U | 0.0796 | 8.14 | | 6.96 |
| Blank | J18NP7 | 4/14/09 | 0.0138 | U | 0.0291 | -0.00628 | U | 0.0262 | 0.000904 | U | 0.0741 | -0.0143 | U | 0.0803 | -0.00813 | U | 0.0637 | -1.41 | U | 6.20 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 1 of 5 |
| Originator | J. D. Skoglie | Date | 07/27/09 |
| Checked | H. M. Sulloway | Date | 07/27/09 |
| Calc. No. | 0100D-CA-V0318 | Rev. No. | 0 |

Acronyms and notes apply to all of the tables in this attachment.
Note: qualified with B, C, and/or J are considered acceptable values.
B = blank contamination (inorganic constituents)
C = analyte detected in sample and QC blank and sample concentration was <= 5 times blank
HEIS = Hanford Environmental Information System
J = estimate
L = dilution indicating physical and chemical interference are present
M = sample duplicate precision not met
MDA = minimum detection allowed
PQL = practical quantitation limit
Q = qualifier
R = rejected
U = undetected
X = more than 40% difference between primary and confirmation detector results

**Attachment 1. 118-DR-1 Burial Ground Verification Sample Results**

| Sample Location | HEIS Number | Sample Date | Aluminum | | | Antimony | | | Arsenic | | | Barium | | | Beryllium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EX-2 | 100-D | 4/14/09 | 5300 | | 1.6 | 0.40 | U | 0.40 | 2.0 | B | 0.69 | 55 | | 0.080 | 0.92 | | 0.035 |
| Duplicate of J18NP9 | J18NT0 | 4/14/09 | 5300 | | 1.6 | 0.40 | U | 0.40 | 1.8 | B | 0.69 | 54 | | 0.080 | 0.93 | | 0.035 |
| EX-1 | J18NP8 | 4/14/09 | 6400 | | 1.6 | 0.40 | U | 0.40 | 2.2 | | 0.69 | 61 | | 0.080 | 0.99 | | 0.035 |
| EX-3 | J18NR0 | 4/14/09 | 5300 | | 1.6 | 0.39 | U | 0.39 | 2.0 | B | 0.68 | 54 | | 0.079 | 1.1 | | 0.034 |
| EX-4 | J18NR1 | 4/14/09 | 5600 | | 1.6 | 0.39 | U | 0.39 | 1.9 | B | 0.68 | 52 | | 0.078 | 1.2 | | 0.034 |
| EX-5 | J18NR2 | 4/14/09 | 4600 | | 1.6 | 0.39 | U | 0.39 | 2.1 | | 0.68 | 38 | | 0.078 | 1.1 | | 0.034 |
| EX-6 | J18NR3 | 4/14/09 | 4600 | | 1.6 | 0.40 | U | 0.40 | 1.7 | B | 0.69 | 38 | | 0.079 | 0.82 | | 0.034 |
| EX-7 | J18NR4 | 4/14/09 | 5500 | | 1.6 | 0.39 | U | 0.39 | 2.2 | | 0.67 | 48 | | 0.077 | 0.96 | | 0.034 |
| EX-8 | J18NR5 | 4/14/09 | 8300 | | 1.6 | 0.40 | U | 0.40 | 2.7 | | 0.69 | 75 | | 0.080 | 0.82 | | 0.035 |
| EX-9 | J18NR6 | 4/14/09 | 5900 | | 1.6 | 0.39 | U | 0.39 | 2.2 | | 0.68 | 49 | | 0.078 | 1.1 | | 0.034 |
| EX-10 | J18NR7 | 4/14/09 | 6700 | | 1.6 | 0.39 | U | 0.39 | 2.2 | | 0.67 | 60 | | 0.078 | 0.92 | | 0.034 |
| EX-11 | J18NR8 | 4/14/09 | 5800 | | 1.6 | 0.40 | U | 0.40 | 2.2 | | 0.69 | 38 | | 0.080 | 0.80 | | 0.035 |
| EX-12 | J18NR9 | 4/14/09 | 5100 | | 1.6 | 0.39 | U | 0.39 | 2.2 | | 0.67 | 39 | | 0.078 | 1.1 | | 0.034 |
| Split of J18NP9 | J18NT1 | 4/14/09 | 5900 | | 1.6 | 0.4 | U | 0.40 | 2.1 | | 0.7 | 62 | | 0.081 | 0.92 | | 0.035 |
| FS-1 | J18NT5 | 4/14/09 | 6700 | | 1.6 | 1.5 | BJ | 0.40 | 2.8 | | 0.69 | 62 | | 0.080 | 0.48 | B | 0.035 |
| FS-2 | J18NT6 | 4/14/09 | 5200 | | 1.6 | 1.2 | BJ | 0.39 | 2.4 | | 0.67 | 52 | | 0.077 | 0.48 | B | 0.034 |
| Blank | J18NP7 | 4/14/09 | 160 | | 1.6 | 0.38 | U | 0.38 | 0.66 | U | 0.66 | 2.5 | | 0.076 | 0.033 | U | 0.033 |

| Sample Location | HEIS Number | Sample Date | Boron | | | Cadmium | | | Chromium | | | Cobalt | | | Copper | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EX-2 | J18NP9 | 4/14/09 | 1.0 | U | 1.0 | 0.064 | B | 0.043 | 5.9 | | 0.061 | 7.6 | L | 0.11 | 13 | | 0.23 |
| Duplicate of J18NP9 | J18NT0 | 4/14/09 | 1.0 | U | 1.0 | 0.065 | B | 0.043 | 6.2 | | 0.061 | 8.1 | L | 0.11 | 12 | | 0.23 |
| EX-1 | J18NP8 | 4/14/09 | 1.3 | B | 1.0 | 0.061 | B | 0.043 | 7.8 | | 0.061 | 8.1 | L | 0.10 | 13 | | 0.23 |
| EX-3 | J18NR0 | 4/14/09 | 1.0 | U | 1.0 | 0.044 | B | 0.042 | 5.5 | | 0.06 | 9.8 | L | 0.10 | 13 | | 0.22 |
| EX-4 | J18NR1 | 4/14/09 | 1.0 | U | 1.0 | 0.053 | B | 0.042 | 4.2 | | 0.060 | 9.4 | L | 0.10 | 14 | | 0.22 |
| EX-5 | J18NR2 | 4/14/09 | 1.0 | U | 1.0 | 0.045 | B | 0.042 | 4.7 | | 0.059 | 8.6 | L | 0.10 | 12 | | 0.22 |
| EX-6 | J18NR3 | 4/14/09 | 1.0 | U | 1.0 | 0.043 | U | 0.043 | 4.2 | | 0.061 | 7.9 | L | 0.10 | 13 | | 0.23 |
| EX-7 | J18NR4 | 4/14/09 | 1.0 | U | 1.0 | 0.067 | B | 0.042 | 6.4 | | 0.059 | 8.1 | L | 0.10 | 13 | | 0.22 |
| EX-8 | J18NR5 | 4/14/09 | 1.2 | B | 1.0 | 0.052 | B | 0.043 | 9.5 | | 0.061 | 7.9 | L | 0.10 | 13 | | 0.23 |
| EX-9 | J18NR6 | 4/14/09 | 1.0 | U | 1.0 | 0.048 | B | 0.042 | 7.3 | | 0.059 | 9.1 | L | 0.10 | 13 | | 0.22 |
| EX-10 | J18NR7 | 4/14/09 | 1.0 | U | 1.0 | 0.056 | B | 0.042 | 7.7 | | 0.059 | 8.1 | L | 0.10 | 13 | | 0.22 |
| EX-11 | J18NR8 | 4/14/09 | 1.0 | U | 1.0 | 0.055 | B | 0.043 | 7.3 | | 0.061 | 7.7 | L | 0.10 | 15 | | 0.23 |
| EX-12 | J18NR9 | 4/14/09 | 1.0 | U | 1.0 | 0.042 | B | 0.042 | 5.2 | | 0.059 | 8.6 | L | 0.10 | 13 | | 0.22 |
| Split of J18NP9 | J18NT1 | 4/14/09 | 1.0 | U | 1.0 | 0.075 | B | 0.043 | 6.9 | | 0.062 | 8.1 | L | 0.11 | 12 | | 0.23 |
| FS-1 | J18NT5 | 4/14/09 | 1.1 | B | 1.0 | 0.079 | B | 0.043 | 7.3 | | 0.061 | 6.9 | | 0.10 | 14 | | 0.23 |
| FS-2 | J18NT6 | 4/14/09 | 1.0 | U | 1.0 | 0.058 | B | 0.042 | 5.1 | | 0.059 | 7.6 | | 0.10 | 14 | | 0.22 |
| Blank | J18NP7 | 4/14/09 | 0.98 | U | 0.98 | 0.041 | U | 0.041 | 0.13 | B | 0.058 | 0.10 | UL | 0.10 | 0.22 | U | 0.22 |

| | | | |
|---|---|---|---|
| Attachment | 1 | Sheet No. | 2 of 5 |
| Originator | J. D. Skoglie | Date | 07/27/09 |
| Checked | H. M. Sulloway | Date | 07/27/09 |
| Calc. No. | 0100D-CA-V0318 | Rev. No. | 0 |

**Attachment 1. 118-DR-1 Burial Ground Verification Sample Results**

| sample location | HEIS Number | Sample Date | Hexavalent Chromium | | | Lead | | | Manganese | | | Mercury | | | Molybdenum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EX-2 | J18NP9 | 4/14/09 | 0.220 | | 0.150 | 4.5 | | 0.28 | 280 | L | 0.11 | 0.0065 | B | 0.0058 | 0.27 | U | 0.27 |
| Duplicate of J18NP9 | J18NT0 | 4/14/09 | 0.152 | U | 0.152 | 3.8 | | 0.28 | 260 | L | 0.11 | 0.0066 | B | 0.0058 | 0.27 | U | 0.27 |
| EX-1 | J18NP8 | 4/14/09 | 0.150 | U | 0.150 | 5.4 | | 0.28 | 270 | L | 0.10 | 0.0059 | B | 0.0058 | 0.27 | U | 0.27 |
| EX-3 | J18NR0 | 4/14/09 | 0.199 | | 0.154 | 2.8 | | 0.28 | 300 | L | 0.10 | 0.0060 | B | 0.0057 | 0.27 | U | 0.27 |
| EX-4 | J18NR1 | 4/14/09 | 0.374 | | 0.155 | 3.2 | | 0.28 | 270 | L | 0.10 | 0.0057 | U | 0.0057 | 0.27 | U | 0.27 |
| EX-5 | J18NR2 | 4/14/09 | 0.153 | U | 0.153 | 2.4 | | 0.28 | 260 | L | 0.10 | 0.0057 | U | 0.0057 | 0.27 | U | 0.27 |
| EX-6 | J18NR3 | 4/14/09 | 0.266 | | 0.153 | 2.9 | | 0.28 | 230 | L | 0.10 | 0.0062 | B | 0.0058 | 0.27 | U | 0.27 |
| EX-7 | J18NR4 | 4/14/09 | 0.150 | U | 0.150 | 3.8 | | 0.27 | 280 | L | 0.10 | 0.0056 | B | 0.0056 | 0.26 | U | 0.26 |
| EX-8 | J18NR5 | 4/14/09 | 0.286 | | 0.152 | 4.3 | | 0.28 | 320 | L | 0.10 | 0.0058 | U | 0.0058 | 0.27 | U | 0.27 |
| EX-9 | J18NR6 | 4/14/09 | 0.153 | U | 0.153 | 3.5 | | 0.28 | 280 | L | 0.10 | 0.0090 | B | 0.0057 | 0.27 | U | 0.27 |
| EX-10 | J18NR7 | 4/14/09 | 0.194 | | 0.152 | 4.0 | | 0.28 | 280 | L | 0.10 | 0.0069 | B | 0.0057 | 0.27 | U | 0.27 |
| EX-11 | J18NR8 | 4/14/09 | 0.179 | | 0.154 | 3.6 | | 0.28 | 240 | L | 0.10 | 0.0095 | B | 0.0058 | 0.27 | U | 0.27 |
| EX-12 | J18NR9 | 4/14/09 | 0.153 | U | 0.153 | 2.5 | | 0.28 | 280 | L | 0.10 | 0.0057 | U | 0.0057 | 0.27 | U | 0.27 |
| Split of J18NP9 | J18NT1 | 4/14/09 | 0.150 | U | 0.150 | 4.0 | | 0.29 | 290 | L | 0.11 | 0.012 | BM | 0.0059 | 0.28 | U | 0.28 |
| FS-1 | J18NT5 | 4/14/09 | 0.155 | UJ | 0.155 | 3.7 | | 0.28 | 290 | L | 0.10 | 0.0064 | B | 0.0058 | 0.27 | U | 0.27 |
| FS-2 | J18NT6 | 4/14/09 | 0.155 | UJ | 0.155 | 2.5 | | 0.27 | 270 | L | 0.10 | 0.0056 | U | 0.0056 | 0.26 | U | 0.26 |
| Blank | J18NP7 | 4/14/09 | 0.152 | U | 0.152 | 0.46 | B | 0.27 | 5.0 | L | 0.10 | 0.0055 | U | 0.0055 | 0.26 | U | 0.26 |

| sample location | HEIS Number | Sample Date | Nickel | | | Potassium | | | Selenium | | | Silver | | | Vanadium | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL | mg/kg | Q | PQL |
| EX-2 | J18NP9 | 4/14/09 | 8.9 | L | 0.13 | 820 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 51 | | 0.099 |
| Duplicate of J18NP9 | J18NT0 | 4/14/09 | 9.1 | L | 0.13 | 870 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 51 | | 0.099 |
| EX-1 | J18NP8 | 4/14/09 | 10 | L | 0.13 | 1100 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 50 | | 0.098 |
| EX-3 | J18NR0 | 4/14/09 | 8.4 | L | 0.13 | 800 | | 42 | 0.89 | U | 0.89 | 0.17 | U | 0.17 | 61 | | 0.097 |
| EX-4 | J18NR1 | 4/14/09 | 7.7 | L | 0.13 | 730 | | 42 | 0.89 | U | 0.89 | 0.17 | U | 0.17 | 63 | | 0.097 |
| EX-5 | J18NR2 | 4/14/09 | 7.9 | LM | 0.13 | 570 | | 42 | 0.88 | UN | 0.88 | 0.16 | U | 0.16 | 59 | | 0.096 |
| EX-6 | J18NR3 | 4/14/09 | 7.0 | L | 0.13 | 710 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 43 | | 0.098 |
| EX-7 | J18NR4 | 4/14/09 | 9.6 | L | 0.13 | 820 | | 42 | 0.87 | U | 0.87 | 0.16 | U | 0.16 | 50 | | 0.096 |
| EX-8 | J18NR5 | 4/14/09 | 11 | L | 0.13 | 2000 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 41 | | 0.099 |
| EX-9 | J18NR6 | 4/14/09 | 12 | L | 0.13 | 960 | | 42 | 0.88 | U | 0.88 | 0.16 | U | 0.16 | 55 | | 0.096 |
| EX-10 | J18NR7 | 4/14/09 | 9.8 | L | 0.13 | 1200 | | 42 | 0.88 | U | 0.88 | 0.16 | U | 0.16 | 47 | | 0.096 |
| EX-11 | J18NR8 | 4/14/09 | 10 | L | 0.13 | 750 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 41 | | 0.098 |
| EX-12 | J18NR9 | 4/14/09 | 8.9 | L | 0.13 | 610 | | 42 | 0.88 | U | 0.88 | 0.16 | U | 0.16 | 56 | | 0.096 |
| Split of J18NP9 | J18NT1 | 4/14/09 | 8.9 | L | 0.13 | 1000 | | 43 | 0.91 | U | 0.91 | 0.17 | U | 0.17 | 52 | L | 0.10 |
| FS-1 | J18NT5 | 4/14/09 | 9.2 | LM | 0.13 | 1200 | | 43 | 0.90 | U | 0.90 | 0.17 | U | 0.17 | 47 | | 0.099 |
| FS-2 | J18NT6 | 4/14/09 | 9.2 | L | 0.13 | 840 | | 42 | 0.87 | U | 0.87 | 0.16 | U | 0.16 | 54 | | 0.096 |
| Blank | J18NP7 | 4/14/09 | 0.12 | UL | 0.12 | 41 | B | 41 | 0.86 | U | 0.86 | 0.16 | U | 0.16 | 0.26 | B | 0.094 |

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|---|---|---|---|
| Attachment | 1 | Sheet No. | 3 of 5 |
| Originator | J. D. Skoglie | Date | 07/27/09 |
| Checked | H. M. Sulloway | Date | 07/27/09 |
| Calc. No. | 0100D-CA-V0318 | Rev. No. | 0 |

**Attachment 1. 118-DR-1 Burial Ground Verification Sample Results**

| sample location | HEIS Number | Sample Date | Zinc | | |
|---|---|---|---|---|---|
| | | | mg/kg | Q | PQL |
| EX-2 | J18NP9 | 4/14/09 | 42 | | 0.42 |
| Duplicate of J18NP9 | J18NT0 | 4/14/09 | 41 | | 0.42 |
| EX-1 | J18NP8 | 4/14/09 | 41 | | 0.42 |
| EX-3 | J18NR0 | 4/14/09 | 42 | | 0.41 |
| EX-4 | J18NR1 | 4/14/09 | 43 | | 0.41 |
| EX-5 | J18NR2 | 4/14/09 | 41 | | 0.41 |
| EX-6 | J18NR3 | 4/14/09 | 34 | | 0.42 |
| EX-7 | J18NR4 | 4/14/09 | 42 | | 0.40 |
| EX-8 | J18NR5 | 4/14/09 | 40 | | 0.42 |
| EX-9 | J18NR6 | 4/14/09 | 42 | | 0.41 |
| EX-10 | J18NR7 | 4/14/09 | 39 | | 0.41 |
| EX-11 | J18NR8 | 4/14/09 | 36 | | 0.42 |
| EX-12 | J18NR9 | 4/14/09 | 39 | | 0.41 |
| Split of J18NP9 | J18NT1 | 4/14/09 | 47 | L | 0.42 |
| FS-1 | J18NT5 | 4/14/09 | 40 | L | 0.42 |
| FS-2 | J18NT6 | 4/14/09 | 40 | L | 0.40 |
| Blank | J18NP7 | 4/14/09 | 1.1 | C | 0.40 |

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|---|---|---|---|
| Attachment | 1 | Sheet No. | 4 of 5 |
| Originator | J. D. Skoglie | Date | 07/27/09 |
| Checked | H. M. Sulloway | Date | 07/27/09 |
| Calc. No. | 0100D-CA-V0318 | Rev. No. | 0 |

**Attachment 1. 118-DR-1 Burial Ground Verification Sample Results**

| CONSTITUENT | FS-2 J18NT6 Sample Date 4/14/2009 | | |
|---|---|---|---|
| | ug/kg | Q | PQL |
| **PAH** | | | |
| Acenaphthene | 10 | U | 10 |
| Acenaphthylene | 9.1 | U | 9.1 |
| Anthracene | 3.1 | U | 3.1 |
| Benzo(a)anthracene | 3.2 | U | 3.2 |
| Benzo(a)pyrene | 6.5 | U | 6.5 |
| Benzo(b)fluoranthene | 4.4 | JX | 4.2 |
| Benzo(ghi)perylene | 7.2 | U | 7.2 |
| Benzo(k)fluoranthene | 4.0 | U | 4.0 |
| Chrysene | 4.9 | U | 4.9 |
| Dibenz[a,h]anthracene | 11 | U | 11 |
| Fluoranthene | 13 | U | 13 |
| Fluorene | 5.3 | U | 5.3 |
| Indeno(1,2,3-cd)pyrene | 12 | U | 12 |
| Naphthalene | 12 | U | 12 |
| Phenanthrene | 12 | U | 12 |
| Pyrene | 12 | U | 12 |
| **PCB** | | | |
| Aroclor-1016 | 2.8 | U | 2.8 |
| Aroclor-1221 | 8.1 | U | 8.1 |
| Aroclor-1232 | 2.0 | U | 2.0 |
| Aroclor-1242 | 4.7 | U | 4.7 |
| Aroclor-1248 | 4.7 | U | 4.7 |
| Aroclor-1254 | 2.6 | U | 2.6 |
| Aroclor-1260 | 2.6 | UJ | 2.6 |
| **Pesticides** | | | |
| Aldrin | 0.25 | U | 0.25 |
| Alpha-BHC | 0.22 | U | 0.22 |
| alpha-Chlordane | 0.33 | U | 0.33 |
| beta-1,2,3,4,5,6-Hexachlorocyclohexane | 0.67 | U | 0.67 |
| Delta-BHC | 0.40 | U | 0.40 |
| Dichlorodiphenyldichloroethane | 0.55 | U | 0.55 |
| Dichlorodiphenyldichloroethylene | 0.24 | U | 0.24 |
| Dichlorodiphenyltrichloroethane | 0.59 | U | 0.59 |
| Dieldrin | 0.21 | U | 0.21 |
| Endosulfan I | 0.18 | U | 0.18 |
| Endosulfan II | 0.29 | U | 0.29 |
| Endosulfan sulfate | 0.28 | U | 0.28 |
| Endrin | 0.31 | U | 0.31 |
| Endrin aldehyde | 0.17 | U | 0.17 |
| Endrin ketone | 0.49 | U | 0.49 |
| Gamma-BHC (Lindane) | 0.47 | U | 0.47 |
| gamma-Chlordane | 0.27 | U | 0.27 |
| Heptachlor | 0.22 | U | 0.22 |
| Heptachlor epoxide | 0.49 | JX | 0.43 |
| Methoxychlor | 0.45 | U | 0.45 |
| Toxaphene | 16 | U | 16 |

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|---|---|---|---|
| Attachment | 1 | Sheet No. | 5 of 5 |
| Originator | J. D. Skoglie | Date | 07/27/09 |
| Checked | H. M. Sulloway | Date | 07/27/09 |
| Calc. No. | 0100D-CA-V0318 | Rev. No. | 0 |

Acrobat 8.0

# CALCULATION COVER SHEET

Project Title: 100-D Field Remediation **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0321

Subject: 118-DR-1 Gas Loop Burial Ground Direct Contact Hazard Quotient and Carcinogenic Risk Calculation

Computer Program: Excel Program No: Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover = 1<br>Sheets = 3<br>Total = 4 | J. D. Skoglie | H. M. Sulloway | L. D. Habel | D. F. Obenauer | Signed 8/17/09 |
| 1 | Cover = 1<br>Sheets = 3<br>Total = 4 | J. D. Skoglie | H. M. Sulloway | N/A | D. F. Obenauer | 9/2/09 |
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## SUMMARY OF REVISION

| | |
|---|---|
| 1 | Added the words "Direct Contact" to all pages subject title.<br>Page 1: Line 3, added "direct contact".<br>Page 2: Line 6, added "direct contact".<br>Page 3: Line 1, added "Direct Contact" to the Table 1 title.<br>Line 27, added "direct contact". |
| | |
| | |

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford, Inc. CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 09/02/09 | Calc. No.: | 0100D-CA-V0321 | Rev.: | 1 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | H. M. Sulloway | Date: | 09/02/09 |
| Subject: | 118-DR-1 Gas Loop Burial Ground Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. 1 of 3 | |

**PURPOSE:**

Provide documentation to support the calculation of the direct contract hazard quotient (HQ) and excess carcinogenic risk for the 118-DR-1 Gas Loop Burial Ground. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2005), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

**GIVEN/REFERENCES:**

1) DOE-RL, 2005, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas*, DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, 1996.

3) WCH, 2009, *118-DR-1Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations*, (0100D-CA-V0318), Rev 0, Washington Closure Hanford, Inc., Richland, Washington.

**SOLUTION:**

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2005).

2) Sum the HQs and compare this value to the cumulative HQ of <1.0.

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the excess cancer risk of $<1 \times 10^{-6}$ (DOE-RL 2005).

4) Sum the excess cancer risk value(s) and compare it to the cumulative cancer risk of $<1 \times 10^{-5}$.

Washington Closure Hanford, Inc. CALCULATION SHEET

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|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 09/02/09 | Calc. No.: | 0100D-CA-V0321 | Rev.: | 1 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | H. M. Sulloway | Date: | 09/02/09 |
| Subject: | 118-DR-1 Gas Loop Burial Ground Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 2 of 3 |

## METHODOLOGY:

The 118-DR-1 Gas Loop Burial Ground consisted of an excavation area and focused samples for the purpose of verification sampling.

Direct contact hazard quotient and carcinogenic risk calculations for the 118-DR-1 Gas Loop Burial Ground were conservatively calculated for the entire waste site using the greater of the statistically determined or focused sample results for each analyte from WCH (2009). Of the contaminants of potential concern (COPCs) for this site boron, hexavalent chromium, benzo(b)fluoranthene, and heptachlor epoxide require HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. All other site nonradionuclide COPCs were not detected or were quantified below background levels. An example of the HQ and risk calculations is presented below:

1) For example, the maximum value for boron is 1.3 mg/kg, divided by the noncarcinogenic RAG value of 7,200 mg/kg (calculated in accordance with the noncarcinogenic toxics effects formula in WAC 173-340-740[3]), is $1.8 \times 10^{-4}$. Comparing this value, and all other individual values, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The sum of the HQ values is $1.6 \times 10^{-3}$. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by $1 \times 10^{-6}$. For example, the maximum value for hexavalent chromium is 0.216 mg/kg; divided by 2.1 mg/kg, and multiplied as indicated, is $1.0 \times 10^{-7}$. Comparing this value to the requirement of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk is obtained by summing the individual values. The sum of the excess cancer risk value is $1.1 \times 10^{-7}$. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

## RESULTS:

1) List individual noncarcinogens and corresponding HQs >1.0: None
2) List the cumulative noncarcinogenic HQ >1.0: None
3) List individual carcinogens and corresponding excess cancer risk $>1 \times 10^{-6}$: None
4) List the cumulative excess cancer risk for carcinogens $>1 \times 10^{-5}$: None.

Table 1 shows the results of the calculations.

Washington Closure Hanford, Inc. CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | J. D. Skoglie | Date: | 09/02/09 | Calc. No.: | 0100D-CA-V032 | Rev.: | 1 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | H. M. Sulloway | Date: | 09/02/09 |
| Subject: | 118-DR-1 Gas Loop Burial Ground Direct Contact Hazard Quotient and Carcinogenic Risk Calculation | | | | | Sheet No. | 3 of 3 |

**Table 1. Direct Contact Hazard Quotient and Excess Cancer Risk Results for the 118-DR-1 Gas Loop Burial Ground.**

| Contaminants of Concern[a] | Maximum or Statistical Value[a] (mg/kg) | Noncarcinogen RAG[b] (mg/kg) | Hazard Quotient | Carcinogen RAG[b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| *Metals* | | | | | |
| Boron | 1.3 | 7,200 | 1.8E-04 | – | – |
| Hexavalent Chromium | 0.216 | 240 | 9.0E-04 | 2.1 | 1.0E-07 |
| *Semivolatiles* | | | | | |
| Benzo(b)fluoranthene | 0.0044 | – | – | 1.37 | 3.2E-09 |
| *Pesticides and PCBs* | | | | | |
| Heptachlor epoxide | 0.00049 | 1.04 | 4.7E-04 | 0.11 | 4.5E-09 |
| *Totals* | | | | | |
| **Cumulative Hazard Quotient:** | | | **1.6E-03** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **1.1E-07** |

Notes:
[a] = From WCH (2009).
[b] = Value obtained from the RDR/RAWP (DOE-RL 2005) or *Washington Administrative Code* (WAC) 173-340-740(3), Method B, 1996.
– = not applicable
RAG = remedial action goal

## CONCLUSION:

This calculation demonstrates that the 118-DR-1 Gas Loop Burial Ground meets the requirements for the direct contact hazard quotients and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2004).

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# CALCULATION COVER SHEET

Project Title: 100-D Field Remediation **Job No. 14655**

Area: 118-DR-1

Discipline: Environmental *Calculation No: 0100D-CA-V0322

Subject: 118-DR-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover = 1<br>Sheets = 3<br>Total = 4 | R. J. Nielson | B. L. Vedder | M. L. Proctor | D. F. Obenauer | 9/2/09 |
| 1 | Cover = 1<br>Sheets = 3<br>Total = 4 | R. J. Nielson | B. L. Vedder | NA | D. F. Obenauer | 1/13/10 |
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## SUMMARY OF REVISION

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|---|---|
| 1 | Cover page replaced.<br>Sheet 2, added additional explanatory text per Ecology comment. |
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WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford, Inc. CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | R. J. Nielson | Date: | 09/01/09 | Calc. No.: | 0100D-CA-V0322 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | B. L. Vedder | Date: | 09/01/09 |
| Subject: | 118-DR-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. | 1 of 3 |

**PURPOSE:**

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 118-DR-1 site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2005), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

**GIVEN/REFERENCES:**

1) BHI, 2005, *100 Area Analogous Sites RESRAD Evaluation*, Calculation No. 0100X-CA-V0050 Rev 0, Bechtel Hanford, Inc., Richland, Washington.

2) DOE-RL, 2005, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas*, DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3) WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, 1996.

4) WCH, 2009, *118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations*, 0100D-CA-V0318, Rev 0, Washington Closure Hanford, Inc., Richland, Washington.

**SOLUTION:**

1) Generate a HQ for each noncarcinogenic constituent detected above background in soil and with a $K_d$ less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

2) Sum the HQs and compare this value to the cumulative HQ of <1.0.

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background in soil and with a $K_d$ less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (BHI 2005).

4) Sum the excess cancer risk value(s) and compare it to the cumulative cancer risk of $<1 \times 10^{-5}$.

Washington Closure Hanford, Inc. CALCULATION SHEET

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|---|---|---|---|---|---|---|---|
| Originator: | R. J. Nielson | Date: | 01/13/10 | Calc. No.: | 0100D-CA-V0322 | Rev.: | 1 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | B. L. Vedder | Date: | 01/13/10 |
| Subject: | 118-DR-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. | 2 of 3 |

**METHODOLOGY:**

The 118-DR-1 site consisted of the excavation for the purpose of verification sampling.

Hazard quotient and carcinogenic risk calculations for potential impact to groundwater at the 118-DR-1 site were conservatively calculated for the entire waste site using the greater of the statistical or maximum value for each analyte in all decision units from the 95% UCL calculation (WCH 2009). Of the contaminants of potential concern (COPCs) for this site, boron and hexavalent chromium are included because no Hanford background value has been established and the distribution coefficients are less than that necessary to show no migration to groundwater in 1,000 years using the generic site RESRAD model (BHI 2005). Based on this model and a vadose zone of approximately 16 m (52 ft) thickness, a $K_d$ of 4.6 or greater is required to show no predicted migration to groundwater in 1,000 years. All other site nonradionuclide COPCs were not detected, quantified below background levels, or have a $K_d$ greater than or equal to 4.6. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (µg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720(3)(a)(ii)(A), 1996) x 100 x 1 mg/1000 µg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii)(A) (1996). For example, the maximum value for boron of 1.3 mg/kg, divided by the noncarcinogenic RAG value of 320 mg/kg is $4.1 \times 10^{-3}$. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 118-DR-1 waste site is $4.9 \times 10^{-2}$. Comparing this value to the requirement of <1.0, this criterion is met.

3) No carcinogenic constituents met the criteria for evaluation in groundwater at the 118-H-5 site; therefore, no calculations of excess carcinogenic risk were performed.

4) The soil cleanup RAGs for protection of groundwater are based on the "100 times" provision in WAC 173-340-740(3)(a)(ii)(A). WAC 173-340-740(3)(a)(ii)(A) (1996) provides the "100 times rule" but also states "unless it can be demonstrated that a higher soil concentration is protective of ground water at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

Washington Closure Hanford, Inc. CALCULATION SHEET

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|---|---|---|---|---|---|---|---|
| Originator: | R. J. Nielson | Date: | 09/01/09 | Calc. No.: | 0100D-CA-V0322 | Rev.: | 0 |
| Project: | 100-D Area Field Remediation | Job No: | 14655 | Checked: | B. L. Vedder | Date: | 09/01/09 |
| Subject: | 118-DR-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater | | | | | Sheet No. | 3 of 3 |

**Table 1. Hazard Quotient and Excess Cancer Risk Results for the 118-H-5 Waste Site.**

| Contaminants of Potential Concern | Statistical or Maximum Value[a] (mg/kg) | Noncarcinogen RAG[b] (mg/kg) | Hazard Quotient | Carcinogen RAG[b] (mg/kg) | Carcinogen Risk |
|---|---|---|---|---|---|
| ***Metals:*** | | | | | |
| Boron | 1.3 | 320 | 4.1E-03 | -- | -- |
| Chromium, hexavalent | 0.216 | 4.8 | 4.5E-02 | -- | -- |
| ***Totals:*** | | | | | |
| **Cumulative Hazard Quotient:** | | | **4.9E-02** | | |
| **Cumulative Excess Cancer Risk:** | | | | | **0.0E+00** |

Notes:

[a] = From WCH (2009).

[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and "100 times" model unless otherwise noted.

-- = not applicable

## CONCLUSION:

This calculation demonstrates that the 118-DR-1 site meets the requirements for the hazard quotients and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2005).

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# CALCULATION COVER SHEET

Project Title: Field Remediation **Job No. 14655**

Area: 100-D

Discipline: Environmental *Calculation No: 0100D-CA-V0326

Subject: 118-DR-1 RESRAD Calculation Brief

Computer Program: RESRAD Program No: Version 6.4

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

| Rev. | Sheet Numbers | Originator | Checker | Reviewer | Approval | Date |
|---|---|---|---|---|---|---|
| 0 | Cover – 1 pg<br>Summary – 4 pg<br>Attm. 1 - 1 pg<br>Attm. 2 - 18 pg<br>Attm. 3 - 19 pg<br>Attm. 4 - 9 pg<br>Attm. 5 - 18 pg<br>Attm. 6 - 19 pg<br>Attm. 7 - 9 pg<br>Total – 98 pages | S. W. Clark | M. W. Perrott | N/A | D. F. Obenauer | 8/31/09 |
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## SUMMARY OF REVISION

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WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

**Washington Closure Hanford** CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | S. W. Clark | Date: | 8/31/09 | Calc. No.: | 0100D-CA-V0326 | Rev.: | 0 |
| Project: | 100-D Field Remediation | Job No: | 14655 | Checked: | M. W. Perrott | Date: | 8/31/09 |
| Subject: | 118-DR-1 RESRAD Calculation Brief | | | | | Sheet No. 1 of 4 | |

**PURPOSE:**

Calculate the soil and groundwater concentrations, dose, and risk contributions over a period of 1,000 years from the activities of radionuclides for the 118-DR-1 statistical and focused cleanup verification samples.

**GIVEN/REFERENCES:**

1) For the purpose of performing RESRAD calculations for the contaminants of 118-DR-1, the radionuclide 95% UCL statistical analyses of soil from the sampling area and the radionuclide maximum analyses of soil from the focused sampling area were obtained from the *118-DR-1, 105-DR Gas Loop Burial Ground Cleanup Verification 95% UCL Calculations* (95% UCL), Calc. No. 0100D-CA-V0318, Rev. 0, Washington Closure Hanford, Richland, Washington.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) RESidual RADioactivity (RESRAD) computer code, Version 6.4, to calculate compliance with residual radioactivity guidelines, developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois.
5) Groundwater elevation from *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, DOE/RL-2008-66, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

**SOLUTION:**

1) To meet the remedial action objectives (RAOs) and remedial action goals (RAGs) of the 100 Area Interim Action Records of Decision (IARODs), radiation dose from contaminated sites is limited to 15 mrem/yr above site background levels for 1,000 years following the completion of a remedial action as described in the 100 Area RDR/RAWP. The radionuclide concentrations above detection limits were evaluated using the RESRAD 6.4 computer code to predict radiation dose, radionuclide risk and radionuclide groundwater concentrations for 1.000 years. The 95% UCL statistical concentrations of cesium-137, cobalt-60, and nickel-63 were above detection limits and are reported in Table 1. The maximum focused samples concentrations of cesium-137 and nickel-63 were above detection limits and are reported in Table 1.
2) Table 2 shows the elevations (NAVD88) and thickness of each soil horizon. The total area of the statistical sampling area is 643 square meters. The area of influence of the focused samples is 75 square meters. Test pit and/or borehole data from operable units within the 100 Area show that contaminant concentrations that are below direct exposure cleanup levels decrease to background concentrations within less than 3 m (10 ft) below the elevation at which the contamination occurs, as discussed in the 100 Area RDR/RAWP. Therefore, 3 m (10 ft) is used as the thickness of the residual contaminated zone beneath the statistical and focused sample locations in Table 2. As a result, the remaining thickness of the vadose zone (20 m [65.6 ft]) will be uncontaminated, as shown in Table 2. Attachment 1 shows

representative dimensions of soil horizons and contaminant pathways considered for dose, risk, and groundwater protection. Input factors for each run are reported in the "Summary" sections of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printouts in the Attachments to this Calculation Summary.

**Table 1. Cleanup Verification Data Set**

| Radionuclides | 95% UCL of Statistical Samples, (pCi/g) | Focused Samples Maximum Analysis, (pCi/g) |
|---|---|---|
| Cesium-137 | 0.0565 | 0.0495 |
| Cobalt-60 | 0.310 | NA |
| Nickel-63 | 110 | 9.70 |

NA = Not Available

**Table 2. Waste Site Dimensions for RESRAD Modeling**

| Parameter | Units | Statistical Samples | Focused Samples |
|---|---|---|---|
| *Contaminated Zone Dimensions* | | | |
| Cover Depth | m | 0 | 0 |
| Area of Contaminated Zone (CZ) | $m^2$ | 643 | 75 |
| Length Parallel to Aquifer Flow | m | 27 | 9 |
| *Elevations of Vadose Zone Horizons* | | | |
| Elevation: Surface | m | 141 | 141 |
| Elevation: Groundwater | m | 118 | 118 |
| Thickness: Contaminated Vadose Zone | m | 3 m (10 ft) | 3 m (10 ft) |
| Thickness: Uncontaminated Vadose Zone | m | 20 m (65.6 ft) | 20 m (65.6 ft) |

3) The year where the peak dose (or concentration) occurs from each individual radionuclide COC and layer is determined by a preliminary run. This year is then added for all horizons for the final RESRAD runs. For the statistical and focused samples direct exposure pathway (i.e. soil ingestion and inhalation and external radiation), the peak year occurs at year zero (year 2009) for all radionuclide COCs. For the statistical and focused samples water pathways (i.e. drinking water and food ingestion) no radionuclides are predicted to reach groundwater within 1,000 years.

**METHODOLOGY:**

1) Runs of RESRAD version 6.4 were completed for 118-DR-1 using the radionuclide activities presented in Table 1. RESRAD numerical output reports for dose, risk, and concentration are presented in the Attachments to this calculation summary.

**RESULTS:**

**1) Radionuclide "All Pathways" Dose Rate**

The "all pathways" (maximum) dose rates are shown in Table 3. The maximum all pathways dose rate for the 118-DR-1 95% UCL of the statistical samples is calculated to be 3.29 mrem/yr at year zero (2009). The maximum all pathways dose rate for the 118-DR-1 maximum analysis from the focused sampling area is predicted to be 0.0886 mrem/yr, also at year zero (2009).

**Table 3. All Pathways Dose Rate (mrem/yr)**

| RESRAD Run | Vadose Zone Horizon | "All Pathways" Dose Contributions in mrem/yr at Each Time Slice (yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 3 | 10 | 30 | 100 | 300 | 1000 |
| 118-DR-1 95% UCL of statistical samples | Shallow Zone | 3.29 | 2.91 | 2.90 | 1.03 | 0.222 | 0.0722 | 0.0129 | 5.56E-05 |
| 118-DR-1 maximum analysis from the focused sampling area | Shallow Zone | 0.0886 | 0.0866 | 0.0826 | 0.0703 | 0.044 | 0.0090 | 2.09E-04 | 5.72E-07 |

**2) Radionuclide Excess Lifetime Cancer Risk**

The radionuclide excess lifetime cancer risk (ELCR) results are shown in Table 4. The maximum ELCR for the 118-DR-1 95% UCL of the statistical samples is $2.52 \times 10^{-5}$ at year zero (2009). The maximum ELCR for the 118-DR-1 maximum analysis from the focused sampling area is $1.46 \times 10^{-6}$ at year zero (2009).

**Table 4. Radionuclide Excess Lifetime Cancer Risk**

| RESRAD Run | Vadose Zone Horizon | Excess Cancer Risk at Each Time Slice (yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 3 | 10 | 30 | 100 | 300 | 1000 |
| 118-DR-1 95% UCL of statistical samples | Shallow Zone | 2.52E-05 | 2.30E-05 | 1.93E-05 | 1.16E-05 | 5.97E-06 | 2.90E-06 | 5.76E-07 | 2.49E-09 |
| 118-DR-1 maximum analysis from the focused sampling area | Shallow Zone | 1.46E-06 | 1.43E-06 | 1.37E-06 | 1.17E-06 | 7.42E-07 | 1.63E-07 | 7.15E-09 | 2.56E-11 |

**3) Radionuclide Groundwater Protection**

The RESRAD model predicts that radionuclide contaminants will not impact groundwater within 1,000 years. Therefore the comparison to drinking water standards (MCL) calculation brief was not performed and calculation of cumulative organ specific dose via the groundwater (and river) pathway was not necessary to determine that the 4 mrem/yr drinking water dose limitation is met.

**Washington Closure Hanford** CALCULATION SHEET

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Originator: | S. W. Clark | Date: | 5/31/09 | Calc. No.: | 0100D-CA-V0326 | Rev.: | 0 |
| Project: | 100-D Field Remediation | Job No: | 14655 | Checked: | M. W. Perrott | Date: | 5/31/09 |
| Subject: | 118-DR-1 RESRAD Calculation Brief | | | | | Sheet No. 4 of 4 | |

## CONCLUSIONS:

- The "all pathways" (maximum) dose rates are shown in Table 3. The maximum 118-DR-1 all pathways dose rate for the 95% UCL of the statistical samples is calculated to be 3.29 mrem/yr at year zero (2009). The maximum all pathways dose rate for the 118-DR-1 maximum analysis from the focused sampling area is predicted to be 0.0886 mrem/yr at year zero (2009).

- The radionuclide excess lifetime cancer risk (ELCR) results are shown in Table 4. The maximum 118-DR-1 ELCR for the 95% UCL of the statistical samples is $2.52 \times 10^{-5}$ at year zero (2009). The maximum ELCR for the 118-DR-1 maximum analysis from the focused sampling area is $1.46 \times 10^{-6}$ at year zero (2009).

- The RESRAD model predicts that radionuclide contaminants will not impact groundwater within 1,000 years. Therefore the comparison to drinking water standards (MCL) calculation brief was not performed and calculation of cumulative organ specific dose via the groundwater (and river) pathway was not necessary to determine that the 4 mrem/yr drinking water dose limitation is met.

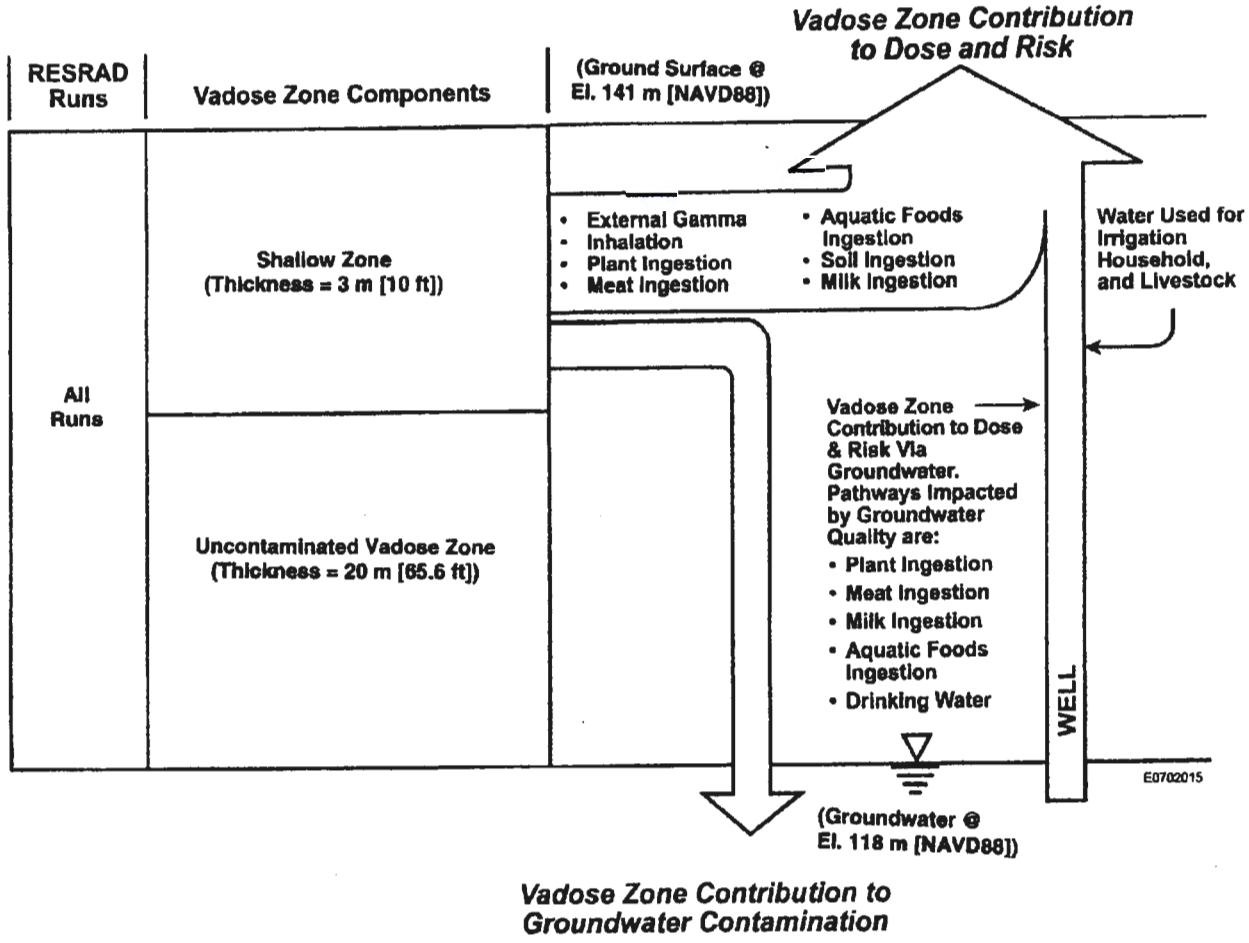
- None of the site COCs are projected to exceed remedial action goals (RAGs).

## ATTACHMENTS:

1. Graphic showing 118-DR-1 Cleanup Verification Model (1 page)
2. RESRAD Output: 118-DR-1 95% UCL Statistical Analyses – Mixture Sums and Single Radionuclide Guidelines (18 pages)
3. RESRAD Output: 118-DR-1 95% UCL Statistical Analyses – Intake Quantities and Health Risk Factors (19 pages)
4. RESRAD Output: 118-DR-1 95% UCL Statistical Analyses – Concentration of Radionuclides, (9 pages)
5. RESRAD Output: 118-DR-1 Maximum Analyses from the Focused Sampling Area – Mixture Sums and Single Radionuclide Guidelines (18 pages)
6. RESRAD Output: 118-DR-1 Maximum Analyses from the Focused Sampling Area – Intake Quantities and Health Risk Factors (19 pages)
7. RESRAD Output: 118-DR-1 Maximum Analyses from the Focused Sampling Area – Concentration of Radionuclides, (9 pages)

# ATTACHMENT 1

## 118-DR-1 RESRAD Calculation Brief Cleanup Verification Model




Attachment 1 Sheet No. 1 of 1
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

```
1RESRAD, Version 6.4      T½ Limit = 180 days       08/27/2009  14:40  Page   1
 Summary : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD
```

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines


| | |
|---|---|
| Dose Conversion Factor (and Related) Parameter Summary ... | 2 |
| Site-Specific Parameter Summary ..... | 3 |
| Summary of Pathway Selections ..... | 7 |
| Contaminated Zone and Total Dose Summary ..... | 8 |
| Total Dose Components | |
| Time = 0.000E+00 ..... | 9 |
| Time = 1.000E+00 ..... | 10 |
| Time = 3.000E+00 ..... | 11 |
| Time = 1.000E+01 ..... | 12 |
| Time = 3.000E+01 ..... | 13 |
| Time = 1.000E+02 ..... | 14 |
| Time = 3.000E+02 ..... | 15 |
| Time = 1.000E+03 ..... | 16 |
| Dose/Source Ratios Summed Over All Pathways ..... | 17 |
| Single Radionuclide Soil Guidelines ..... | 17 |
| Dose Per Nuclide Summed Over All Pathways ..... | 18 |
| Soil Concentration Per Nuclide ..... | 18 |


Attachment 2 Sheet No. 1 of 18
Originator: S. W. Clark Date 8/31/09
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Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 2
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

| Menu | Parameter | Current Value# | Base Case* | Parameter Name |
|---|---|---|---|---|
| A-1 | DCF's for external ground radiation, (mrem/yr)/(pCi/g) | | | |
| A-1 | Ba-137m (Source: FGR 12) | 3.606E+00 | 3.606E+00 | DCF1( 1) |
| A-1 | Co-60 (Source: FGR 12) | 1.622E+01 | 1.622E+01 | DCF1( 2) |
| A-1 | Cs-137 (Source: FGR 12) | 7.510E-04 | 7.510E-04 | DCF1( 3) |
| A-1 | Ni-63 (Source: FGR 12) | 0.000E+00 | 0.000E+00 | DCF1( 4) |
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Co-60 | 2.190E-04 | 2.190E-04 | DCF2( 1) |
| B-1 | Cs-137+D | 3.190E-05 | 3.190E-05 | DCF2( 2) |
| B-1 | Ni-63 | 6.290E-06 | 6.290E-06 | DCF2( 3) |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Co-60 | 2.690E-05 | 2.690E-05 | DCF3( 1) |
| D-1 | Cs-137+D | 5.000E-05 | 5.000E-05 | DCF3( 2) |
| D-1 | Ni-63 | 5.770E-07 | 5.770E-07 | DCF3( 3) |
| D-34 | Food transfer factors: | | | |
| D-34 | Co-60 , plant/soil concentration ratio, dimensionless | 8.000E-02 | 8.000E-02 | RTF( 1,1) |
| D-34 | Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 2.000E-02 | 2.000E-02 | RTF( 1,2) |
| D-34 | Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-03 | 2.000E-03 | RTF( 1,3) |
| D-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 2,1) |
| D-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 2,2) |
| D-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 8.000E-03 | 8.000E-03 | RTF( 2,3) |
| D-34 | Ni-63 , plant/soil concentration ratio, dimensionless | 5.000E-02 | 5.000E-02 | RTF( 3,1) |
| D-34 | Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 3,2) |
| D-34 | Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-02 | 2.000E-02 | RTF( 3,3) |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Co-60 , fish | 3.000E+02 | 3.000E+02 | BIOFAC( 1,1) |
| D-5 | Co-60 , crustacea and mollusks | 2.000E+02 | 2.000E+02 | BIOFAC( 1,2) |
| D-5 | Cs-137+D , fish | 2.000E+03 | 2.000E+03 | BIOFAC( 2,1) |
| D-5 | Cs-137+D , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2) |
| D-5 | Ni-63 , fish | 1.000E+02 | 1.000E+02 | BIOFAC( 3,1) |
| D-5 | Ni-63 , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 3,2) |

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Attachment 2 Sheet No. 2 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 3
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Site-Specific Parameter Summary

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 6.430E+02 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 3.000E+00 | 2.000E+00 | --- | THICK0 |
| R011 | Length parallel to aquifer flow (m) | 2.700E+01 | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 1.500E+01 | 3.000E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 3.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| R012 | Initial principal radionuclide (pCi/g): Co-60 | 3.100E-01 | 0.000E+00 | --- | S1(1) |
| R012 | Initial principal radionuclide (pCi/g): Cs-137 | 5.650E-02 | 0.000E+00 | --- | S1(2) |
| R012 | Initial principal radionuclide (pCi/g): Ni-63 | 1.100E+02 | 0.000E+00 | --- | S1(3) |
| R012 | Concentration in groundwater (pCi/L): Co-60 | not used | 0.000E+00 | --- | W1( 1) |
| R012 | Concentration in groundwater (pCi/L): Cs-137 | not used | 0.000E+00 | --- | W1( 2) |
| R012 | Concentration in groundwater (pCi/L): Ni-63 | not used | 0.000E+00 | --- | W1( 3) |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.600E+00 | 1.500E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 4.000E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 1.500E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 2.500E+02 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 4.050E+00 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 3.400E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 9.100E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 1.600E-01 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 7.600E-01 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 2.000E-01 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | 1.000E+06 | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | 1.000E-03 | 1.000E-03 | --- | EPS |
| R014 | Density of saturated zone (g/cm**3) | 1.600E+00 | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | 4.000E-01 | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | 2.500E-01 | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | 1.500E-01 | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | 5.530E+03 | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | 1.250E-03 | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | 4.050E+00 | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | 4.600E+00 | 1.000E+01 | --- | DWIBWT |

Attachment 2 Sheet No. 3 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 4
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | 2.500E+02 | 2.500E+02 | --- | UW |
| R015 | Number of unsaturated zone strata | 1 | 1 | --- | NS |
| R015 | Unsat. zone 1, thickness (m) | 2.000E+01 | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | 1.600E+00 | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | 4.000E-01 | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | 2.500E-01 | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | 1.500E-01 | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | 4.050E+00 | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | 2.500E+02 | 1.000E+01 | --- | HCUZ(1) |
| R016 | Distribution coefficients for Co-60 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 1.000E+03 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 1.000E+03 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 1.000E+03 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.322E-04 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| R016 | Distribution coefficients for Cs-137 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 4.600E+03 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 4.600E+03 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 4.600E+03 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.322E-04 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| R016 | Distribution coefficients for Ni-63 | | | | |
| R016 | Contaminated zone (cm**3/g) | 3.000E+01 | 1.000E+03 | --- | DCNUCC( 3) |
| R016 | Unsaturated zone 1 (cm**3/g) | 3.000E+01 | 1.000E+03 | --- | DCNUCU( 3,1) |
| R016 | Saturated zone (cm**3/g) | 3.000E+01 | 1.000E+03 | --- | DCNUCS( 3) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 5.528E-04 | ALEACH( 3) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 3) |
| R017 | Inhalation rate (m**3/yr) | 7.300E+03 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 3.000E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 4.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 8.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 6.000E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 2.000E-01 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |

Attachment 2 Sheet No. 4 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T< Limit = 180 days 08/27/2009 14:40 Page 5
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R017 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R017 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | 1.100E+02 | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | 2.700E+00 | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | 1.000E+02 | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | 3.600E+01 | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | 1.970E+01 | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | 9.000E-01 | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 7.300E+01 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | 7.300E+02 | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | 1.000E+00 | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | 1.000E+00 | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | 1.000E+00 | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | 5.000E-01 | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | -1 | -1 | 0.322E+00 | FPLANT |
| R018 | Contamination fraction of meat | -1 | -1 | 0.322E-01 | FMEAT |
| R018 | Contamination fraction of milk | -1 | -1 | 0.322E-01 | FMILK |
| R019 | Livestock fodder intake for meat (kg/day) | 6.800E+01 | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | 5.500E+01 | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | 5.000E+01 | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | 1.600E+02 | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | 5.000E-01 | 5.000E-01 | --- | LSI |

Attachment 2 Sheet No. 5 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 6
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R019 | Mass loading for foliar deposition (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | 9.000E-01 | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWIR |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | 7.000E-01 | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | 1.500E+00 | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | 1.100E+00 | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | 1.700E-01 | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | 2.500E-01 | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | 8.000E-02 | 8.000E-02 | --- | TE(3) |
| R19B | Translocation Factor for Non-Leafy | 1.000E-01 | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | 1.000E+00 | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | 1.000E+00 | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | 2.500E-01 | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | 2.500E-01 | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | 2.500E-01 | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | 2.500E-01 | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | 2.500E-01 | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | 2.500E-01 | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | 2.000E+01 | 2.000E+01 | --- | WLAM |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |

Attachment 2 Sheet No. 6 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 7
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Site-Specific Parameter Summary (continued)

| Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |
| TITL | Maximum number of integration points for dose | 1 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 5 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | active |
| 4 -- meat ingestion | active |
| 5 -- milk ingestion | active |
| 6 -- aquatic foods | active |
| 7 -- drinking water | active |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | suppressed |

Attachment 2 Sheet No. 7 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

```
1RESRAD, Version 6.4     T« Limit = 180 days      08/27/2009  14:40  Page   8
 Summary : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

      Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
      XXXXXXXXXXXXXXXXXXXXXXXXXXXX           XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
        Area:    643.00 square meters                 Co-60      3.100E-01
   Thickness:      3.00 meters                        Cs-137     5.650E-02
 Cover Depth:      0.00 meters                        Ni-63      1.100E+02
0
                                  Total Dose TDOSE(t), mrem/yr
                            Basic Radiation Dose Limit = 1.500E+01 mrem/yr
              Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
              XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
    t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
     TDOSE(t):  3.294E+00  2.914E+00  2.289E+00  1.031E+00  2.221E-01  7.220E-02  1.293E-02  5.560E-05
         M(t):  2.196E-01  1.943E-01  1.526E-01  6.872E-02  1.481E-02  4.813E-03  8.622E-04  3.707E-06
0Maximum TDOSE(t):  3.294E+00 mrem/yr   at t = 0.000E+00 years
```

| | | | |
|---|---|---|---|
| Attachment | 2 | Sheet No. | 8 of 18 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 2

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 9
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| XXXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX |
| Co-60 | 3.016E+00 | 0.9157 | 2.056E-06 | 0.0000 | 0.000E+00 | 0.0000 | 2.417E-02 | 0.0073 | 1.147E-03 | 0.0003 | 2.627E-04 | 0.0001 | 3.131E-04 | 0.0001 |
| Cs-137 | 1.149E-01 | 0.0349 | 5.457E-08 | 0.0000 | 0.000E+00 | 0.0000 | 4.094E-03 | 0.0012 | 3.159E-04 | 0.0001 | 1.962E-04 | 0.0001 | 1.061E-04 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.095E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.150E-01 | 0.0349 | 1.433E-03 | 0.0004 | 1.326E-02 | 0.0040 | 2.383E-03 | 0.0007 |
| ffffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff |
| .Total | 3.131E+00 | 0.9506 | 2.306E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.433E-01 | 0.0435 | 2.895E-03 | 0.0009 | 1.372E-02 | 0.0042 | 2.803E-03 | 0.0009 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Dependent Pathways

| 0 | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio- | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | | XXXXXXXXXXXXXXXX | |
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| XXXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX | XXXXXXXXX | XXXXXX |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.042E+00 | 0.9236 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.196E-01 | 0.0363 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.321E-01 | 0.0401 |
| ffffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff | ffffffffff | ffffff |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.294E+00 | 1.0000 |

0*Sum of all water independent and dependent pathways.

| | | | |
|---|---|---|---|
| Attachment | 2 | Sheet No. | 9 of 18 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 2

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 10
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 2.644E+00 | 0.9072 | 1.802E-06 | 0.0000 | 0.000E+00 | 0.0000 | 2.119E-02 | 0.0073 | 1.005E-03 | 0.0003 | 2.303E-04 | 0.0001 | 2.745E-04 | 0.0001 |
| Cs-137 | 1.122E-01 | 0.0385 | 5.331E-08 | 0.0000 | 0.000E+00 | 0.0000 | 4.000E-03 | 0.0014 | 3.086E-04 | 0.0001 | 1.917E-04 | 0.0001 | 1.036E-04 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.079E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.141E-01 | 0.0392 | 1.422E-03 | 0.0005 | 1.316E-02 | 0.0045 | 2.365E-03 | 0.0008 |
| Total | 2.756E+00 | 0.9457 | 2.264E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.393E-01 | 0.0478 | 2.735E-03 | 0.0009 | 1.358E-02 | 0.0047 | 2.743E-03 | 0.0009 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

| 0 Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.666E+00 | 0.9149 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.168E-01 | 0.0401 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.311E-01 | 0.0450 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.914E+00 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 10 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 11
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 2.031E+00 | 0.8873 | 1.384E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.628E-02 | 0.0071 | 7.721E-04 | 0.0003 | 1.769E-04 | 0.0001 | 2.108E-04 | 0.0001 |
| Cs-137 | 1.071E-01 | 0.0468 | 5.087E-08 | 0.0000 | 0.000E+00 | 0.0000 | 3.816E-03 | 0.0017 | 2.944E-04 | 0.0001 | 1.829E-04 | 0.0001 | 9.888E-05 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.047E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.123E-01 | 0.0491 | 1.400E-03 | 0.0006 | 1.296E-02 | 0.0057 | 2.328E-03 | 0.0010 |
| Total | 2.138E+00 | 0.9341 | 2.190E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.324E-01 | 0.0579 | 2.466E-03 | 0.0011 | 1.332E-02 | 0.0058 | 2.638E-03 | 0.0012 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

| Radio-Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.048E+00 | 0.8949 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.115E-01 | 0.0487 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.290E-01 | 0.0564 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.289E+00 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 11 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  14:40  Page  12
 Summary : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD
```

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Co-60 | 8.071E-01 | 0.7830 | 5.501E-07 | 0.0000 | 0.000E+00 | 0.0000 | 6.468E-03 | 0.0063 | 3.068E-04 | 0.0003 | 7.031E-05 | 0.0001 | 8.379E-05 | 0.0001 |
| Cs-137 | 9.086E-02 | 0.0881 | 4.317E-08 | 0.0000 | 0.000E+00 | 0.0000 | 3.239E-03 | 0.0031 | 2.499E-04 | 0.0002 | 1.552E-04 | 0.0002 | 8.392E-05 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.938E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.064E-01 | 0.1032 | 1.326E-03 | 0.0013 | 1.227E-02 | 0.0119 | 2.205E-03 | 0.0021 |
| Total | 8.979E-01 | 0.8711 | 1.998E-05 | 0.0000 | 0.000E+00 | 0.0000 | 1.161E-01 | 0.1126 | 1.882E-03 | 0.0018 | 1.250E-02 | 0.0121 | 2.373E-03 | 0.0023 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.140E-01 | 0.7897 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.459E-02 | 0.0918 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.222E-01 | 0.1186 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.031E+00 | 1.0000 |

*Sum of all water independent and dependent pathways.

| | | | |
|---|---|---|---|
| Attachment | 2 | Sheet No. | 12 of 18 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 2

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 13
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Co-60 | 5.778E-02 | 0.2602 | 3.938E-08 | 0.0000 | 0.000E+00 | 0.0000 | 4.631E-04 | 0.0021 | 2.197E-05 | 0.0001 | 5.034E-06 | 0.0000 | 5.999E-06 | 0.0000 |
| Cs-137 | 5.686E-02 | 0.2560 | 2.702E-08 | 0.0000 | 0.000E+00 | 0.0000 | 2.027E-03 | 0.0091 | 1.564E-04 | 0.0007 | 9.713E-05 | 0.0004 | 5.252E-05 | 0.0002 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.659E-05 | 0.0001 | 0.000E+00 | 0.0000 | 9.107E-02 | 0.4101 | 1.135E-03 | 0.0051 | 1.051E-02 | 0.0473 | 1.888E-03 | 0.0085 |
| Total | 1.166E-01 | 0.5162 | 1.666E-05 | 0.0001 | 0.000E+00 | 0.0000 | 9.356E-02 | 0.4213 | 1.313E-03 | 0.0059 | 1.061E-02 | 0.0478 | 1.946E-03 | 0.0088 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Dependent Pathways

| 0 Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.828E-02 | 0.2624 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.919E-02 | 0.2665 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.046E-01 | 0.4711 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.221E-01 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 13 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 14
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Co-60 | 5.675E-06 | 0.0001 | 3.868E-12 | 0.0000 | 0.000E+00 | 0.0000 | 4.548E-08 | 0.0000 | 2.158E-09 | 0.0000 | 4.944E-10 | 0.0000 | 5.892E-10 | 0.0000 |
| Cs-137 | 1.102E-02 | 0.1527 | 5.238E-09 | 0.0000 | 0.000E+00 | 0.0000 | 3.929E-04 | 0.0054 | 3.032E-05 | 0.0004 | 1.883E-05 | 0.0003 | 1.018E-05 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 9.630E-06 | 0.0001 | 0.000E+00 | 0.0000 | 5.285E-02 | 0.7321 | 6.585E-04 | 0.0091 | 6.097E-03 | 0.0845 | 1.096E-03 | 0.0152 |
| Total | 1.103E-02 | 0.1528 | 9.635E-06 | 0.0001 | 0.000E+00 | 0.0000 | 5.325E-02 | 0.7375 | 6.888E-04 | 0.0095 | 6.116E-03 | 0.0847 | 1.106E-03 | 0.0153 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.724E-06 | 0.0001 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.148E-02 | 0.1589 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.071E-02 | 0.8410 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.220E-02 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 14 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 15
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 2.009E-17 | 0.0000 | 1.369E-23 | 0.0000 | 0.000E+00 | 0.0000 | 1.610E-19 | 0.0000 | 7.638E-21 | 0.0000 | 1.750E-21 | 0.0000 | 2.086E-21 | 0.0000 |
| Cs-137 | 1.015E-04 | 0.0079 | 4.824E-11 | 0.0000 | 0.000E+00 | 0.0000 | 3.619E-06 | 0.0003 | 2.792E-07 | 0.0000 | 1.734E-07 | 0.0000 | 9.377E-08 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.034E-06 | 0.0002 | 0.000E+00 | 0.0000 | 1.117E-02 | 0.8634 | 1.391E-04 | 0.0108 | 1.288E-03 | 0.0996 | 2.314E-04 | 0.0179 |
| Total | 1.015E-04 | 0.0079 | 2.035E-06 | 0.0002 | 0.000E+00 | 0.0000 | 1.117E-02 | 0.8637 | 1.394E-04 | 0.0108 | 1.288E-03 | 0.0996 | 2.315E-04 | 0.0179 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

| 0 Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.026E-17 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.057E-04 | 0.0082 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.283E-02 | 0.9918 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.293E-02 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 15 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 16
Summary : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Cs-137 | 7.613E-12 | 0.0000 | 3.617E-18 | 0.0000 | 0.000E+00 | 0.0000 | 2.714E-13 | 0.0000 | 2.094E-14 | 0.0000 | 1.300E-14 | 0.0000 | 7.031E-15 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 8.819E-09 | 0.0002 | 0.000E+00 | 0.0000 | 4.840E-05 | 0.8705 | 6.030E-07 | 0.0108 | 5.584E-06 | 0.1004 | 1.003E-06 | 0.0180 |
| Total | 7.613E-12 | 0.0000 | 8.819E-09 | 0.0002 | 0.000E+00 | 0.0000 | 4.840E-05 | 0.8705 | 6.030E-07 | 0.0108 | 5.584E-06 | 0.1004 | 1.003E-06 | 0.0180 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

| Radio-Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.925E-12 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.560E-05 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.560E-05 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 16 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 2

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1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  14:40  Page  17
 Summary : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

                          Dose/Source Ratios Summed Over All Pathways
                     Parent and Progeny Principal Radionuclide Contributions Indicated
0  Parent    Product    Thread                 DSR(j,t) At Time in Years   (mrem/yr)/(pCi/g)
   (i)       (j)        Fraction   0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 ########## ########## ########## ########## ########## ########## ########## ########## ########## ########## ##########
 Co-60      Co-60      1.000E+00  9.813E+00 8.601E+00 6.608E+00 2.624E+00 1.880E-01 1.846E-05 6.537E-17 0.000E+00
0Cs-137+D   Cs-137+D   1.000E+00  2.116E+00 2.067E+00 1.973E+00 1.674E+00 1.048E+00 2.031E-01 1.871E-03 1.403E-10
0Ni-63      Ni-63      1.000E+00  1.201E-03 1.192E-03 1.173E-03 1.111E-03 9.511E-04 5.520E-04 1.166E-04 5.055E-07
 ########## ########## ########## ########## ########## ########## ########## ########## ########## ########## ##########
 The DSR includes contributions from associated (half-life 6 180 days) daughters.
0
                          Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                              Basic Radiation Dose Limit = 1.500E+01 mrem/yr
0Nuclide
   (i)      t= 0.000E+00   1.000E+00   3.000E+00   1.000E+01   3.000E+01   1.000E+02   3.000E+02   1.000E+03
 ########    ##########  ##########  ##########  ##########  ##########  ##########  ##########  ##########
 Co-60       1.529E+00   1.744E+00   2.270E+00   5.713E+00   7.979E+01   8.424E+05  *1.132E+15  *1.132E+15
 Cs-137      7.088E+00   7.256E+00   7.604E+00   8.960E+00   1.432E+01   7.385E+01   8.018E+03   1.069E+11
 Ni-63       1.249E+04   1.259E+04   1.279E+04   1.350E+04   1.577E+04   2.718E+04   1.286E+05   2.968E+07
 ########    ##########  ##########  ##########  ##########  ##########  ##########  ##########  ##########
 *At specific activity limit
0
             Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
             and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
          at tmin = time of minimum single radionuclide soil guideline
       and at tmax = time of maximum total dose = 0.000E+00 years
0Nuclide  Initial        tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)    (pCi/g)       (years)                (pCi/g)               (pCi/g)
 ########  ##########  ################  ##########  ##########  ##########  ##########
 Co-60    3.100E-01     0.000E+00       9.813E+00  1.529E+00  9.813E+00  1.529E+00
 Cs-137   5.650E-02     0.000E+00       2.116E+00  7.088E+00  2.116E+00  7.088E+00
 Ni-63    1.100E+02     0.000E+00       1.201E-03  1.249E+04  1.201E-03  1.249E+04
 ######## ##########  ################  ##########  ##########  ##########  ##########
```

| | | | |
|---|---|---|---|
| Attachment | 2 | Sheet No. 17 of 18 | |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Ck'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 2

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  14:40  Page  18
 Summary : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

                          Individual Nuclide Dose Summed Over All Pathways
                            Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   THF(i)                                  DOSE(j,t), mrem/yr
   (j)     (i)            t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 XXXXXXX XXXXXXX XXXXXXXXX    XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX
 Co-60   Co-60   1.000E+00    3.042E+00 2.666E+00 2.048E+00 8.140E-01 5.828E-02 5.724E-06 2.026E-17 0.000E+00
0Cs-137  Cs-137  1.000E+00    1.196E-01 1.168E-01 1.115E-01 9.459E-02 5.919E-02 1.148E-02 1.057E-04 7.925E-12
0Ni-63   Ni-63   1.000E+00    1.321E-01 1.311E-01 1.290E-01 1.222E-01 1.046E-01 6.071E-02 1.283E-02 5.560E-05
 ||||||| ||||||| |||||||||    ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| |||||||||
 THF(i) is the thread fraction of the parent nuclide.


                                Individual Nuclide Soil Concentration
                            Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   THF(i)                                    S(j,t), pCi/g
   (j)     (i)            t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 XXXXXXX XXXXXXX XXXXXXXXX    XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX
 Co-60   Co-60   1.000E+00    3.100E-01 2.717E-01 2.087E-01 8.295E-02 5.939E-03 5.833E-07 2.065E-18 0.000E+00
0Cs-137  Cs-137  1.000E+00    5.650E-02 5.519E-02 5.266E-02 4.470E-02 2.797E-02 5.422E-03 4.994E-05 3.745E-12
0Ni-63   Ni-63   1.000E+00    1.100E+02 1.091E+02 1.075E+02 1.018E+02 8.712E+01 5.056E+01 1.068E+01 4.630E-02
 ||||||| ||||||| |||||||||    ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| |||||||||
 THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time =    3.57 seconds
```

Attachment 2 Sheet No. 18 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

```
1RESRAD, Version 6.4      T½ Limit = 180 days       08/27/2009  14:40  Page   1
 Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD
```

Table of Contents

Part III: Intake Quantities and Health Risk Factors


Cancer Risk Slope Factors ..... 2
Risk Slope and ETFG for the Ground Pathway ..... 3
Amount of Intake Quantities and Excess Cancer Risks
Time= 0.000E+00 ..... 4
Time= 1.000E+00 ..... 6
Time= 3.000E+00 ..... 8
Time= 1.000E+01 ..... 10
Time= 3.000E+01 ..... 12
Time= 1.000E+02 ..... 14
Time= 3.000E+02 ..... 16
Time= 1.000E+03 ..... 18


Attachment 3 Sheet No. 1 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 2
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Cancer Risk Slope Factors Summary Table
Risk Library: HEAST 2001 Morbidity

| 0 Menu | Parameter | Current Value | Base Case* | Parameter Name |
|---|---|---|---|---|
| Sf-1 | Ground external radiation slope factors, 1/yr per (pCi/g): | | | |
| Sf-1 | Co-60 | 1.24E-05 | 1.24E-05 | SLPF( 1,1) |
| Sf-1 | Cs-137+D | 2.55E-06 | 5.32E-10 | SLPF( 2,1) |
| Sf-1 | Ni-63 | 0.00E+00 | 0.00E+00 | SLPF( 3,1) |
| Sf-2 | Inhalation, slope factors, 1/(pCi): | | | |
| Sf-2 | Co-60 | 3.58E-11 | 3.58E-11 | SLPF( 1,2) |
| Sf-2 | Cs-137+D | 1.19E-11 | 1.19E-11 | SLPF( 2,2) |
| Sf-2 | Ni-63 | 5.77E-12 | 5.77E-12 | SLPF( 3,2) |
| Sf-3 | Food ingestion, slope factors, 1/(pCi): | | | |
| Sf-3 | Co-60 | 2.23E-11 | 2.23E-11 | SLPF( 1,3) |
| Sf-3 | Cs-137+D | 3.74E-11 | 3.74E-11 | SLPF( 2,3) |
| Sf-3 | Ni-63 | 9.51E-13 | 9.51E-13 | SLPF( 3,3) |
| Sf-3 | Water ingestion, slope factors, 1/(pCi): | | | |
| Sf-3 | Co-60 | 1.57E-11 | 1.57E-11 | SLPF( 1,4) |
| Sf-3 | Cs-137+D | 3.04E-11 | 3.04E-11 | SLPF( 2,4) |
| Sf-3 | Ni-63 | 6.70E-13 | 6.70E-13 | SLPF( 3,4) |
| Sf-3 | Soil ingestion, slope factors, 1/(pCi): | | | |
| Sf-3 | Co-60 | 4.03E-11 | 4.03E-11 | SLPF( 1,5) |
| Sf-3 | Cs-137+D | 4.33E-11 | 4.33E-11 | SLPF( 2,5) |
| Sf-3 | Ni-63 | 1.79E-12 | 1.79E-12 | SLPF( 3,5) |

*Base Case means Default.Lib w/o Associate Nuclide contributions.

Attachment 3 Sheet No. 2 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  14:40  Page   3
 Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

                    Risk Slope and Environmental Transport Factors for the Ground Pathway
ONuclide  Slope(i)*                        ETFG(i,t) At Time in Years  (dimensionless)
  (i)            t= 0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
 XXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX
 Ba-137m  2.690E-06   5.958E-01  5.958E-01  5.958E-01  5.958E-01  5.958E-01  5.958E-01  5.958E-01  5.958E-01
 Co-60    1.240E-05   5.999E-01  5.999E-01  5.999E-01  5.999E-01  5.999E-01  5.999E-01  5.999E-01  5.999E-01
 Cs-137   5.320E-10   6.150E-01  6.150E-01  6.150E-01  6.150E-01  6.150E-01  6.150E-01  6.150E-01  6.150E-01
 Ni-63    0.000E+00   0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 ||||||| |||||||||  |||||||||  |||||||||  |||||||||  |||||||||  |||||||||  |||||||||  |||||||||  |||||||||
 * - Units are 1/yr per (pCi/g) at infinite depth and area.  Multiplication by ETFG(i,t) converts to site conditions.
```

| | | | |
|---|---|---|---|
| Attachment | 3 | Sheet No. | 3 of 19 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No.: | 0 |

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 4
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 9.387E-03 | 8.986E+02 | 4.263E+01 | 9.767E+00 | 1.164E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.626E+02 |
| Cs-137 | 1.711E-03 | 8.189E+01 | 6.317E+00 | 3.924E+00 | 2.122E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.425E+01 |
| Ni-63 | 3.331E+00 | 1.993E+05 | 2.483E+03 | 2.299E+04 | 4.131E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.289E+05 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 1.724E-05 | 0.6829 | 2.512E-12 | 0.0000 | 1.498E-07 | 0.0059 | 7.106E-09 | 0.0003 | 1.628E-09 | 0.0001 | 3.507E-09 | 0.0001 |
| Cs-137 | 1.846E-06 | 0.0731 | 4.386E-13 | 0.0000 | 6.599E-08 | 0.0026 | 5.091E-09 | 0.0002 | 3.162E-09 | 0.0001 | 1.979E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 5.143E-10 | 0.0000 | 5.071E-06 | 0.2009 | 6.319E-08 | 0.0025 | 5.850E-07 | 0.0232 | 1.979E-07 | 0.0078 |
| Total | 1.908E-05 | 0.7561 | 5.172E-10 | 0.0000 | 5.287E-06 | 0.2095 | 7.538E-08 | 0.0030 | 5.898E-07 | 0.0234 | 2.033E-07 | 0.0081 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.740E-05 | 0.6894 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.922E-06 | 0.0762 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.918E-06 | 0.2345 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.524E-05 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 4 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 5
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio-Nuclide | Ground risk | Ground fract. | Inhalation risk | Inhalation fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | Soil risk | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 1.724E-05 | 0.6829 | 2.512E-12 | 0.0000 | 0.000E+00 | 0.0000 | 1.498E-07 | 0.0059 | 7.106E-09 | 0.0003 | 1.628E-09 | 0.0001 | 3.507E-09 | 0.0001 |
| Cs-137 | 1.846E-06 | 0.0731 | 4.386E-13 | 0.0000 | 0.000E+00 | 0.0000 | 6.599E-08 | 0.0026 | 5.091E-09 | 0.0002 | 3.162E-09 | 0.0001 | 1.979E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 5.143E-10 | 0.0000 | 0.000E+00 | 0.0000 | 5.071E-06 | 0.2009 | 6.319E-08 | 0.0025 | 5.850E-07 | 0.0232 | 1.979E-07 | 0.0078 |
| Total | 1.908E-05 | 0.7561 | 5.172E-10 | 0.0000 | 0.000E+00 | 0.0000 | 5.287E-06 | 0.2095 | 7.538E-08 | 0.0030 | 5.898E-07 | 0.0234 | 2.033E-07 | 0.0081 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | Water fract. | Fish risk | Fish fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | All pathways risk | All pathways fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.740E-05 | 0.6894 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.922E-06 | 0.0762 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.918E-06 | 0.2345 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.524E-05 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 5 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 6
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+00 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 8.227E-03 | 7.876E+02 | 3.736E+01 | 8.561E+00 | 1.020E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.437E+02 |
| Cs-137 | 1.671E-03 | 7.999E+01 | 6.171E+00 | 3.833E+00 | 2.072E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.207E+01 |
| Ni-63 | 3.305E+00 | 1.977E+05 | 2.464E+03 | 2.281E+04 | 4.099E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.271E+05 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 1.511E-05 | 0.6569 | 2.202E-12 | 0.0000 | 1.313E-07 | 0.0057 | 6.228E-09 | 0.0003 | 1.427E-09 | 0.0001 | 3.074E-09 | 0.0001 |
| Cs-137 | 1.803E-06 | 0.0784 | 4.285E-13 | 0.0000 | 6.446E-08 | 0.0028 | 4.973E-09 | 0.0002 | 3.089E-09 | 0.0001 | 1.933E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 5.103E-10 | 0.0000 | 5.032E-06 | 0.2188 | 6.270E-08 | 0.0027 | 5.805E-07 | 0.0252 | 1.963E-07 | 0.0085 |
| Total | 1.691E-05 | 0.7353 | 5.129E-10 | 0.0000 | 5.228E-06 | 0.2273 | 7.390E-08 | 0.0032 | 5.850E-07 | 0.0254 | 2.013E-07 | 0.0088 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.525E-05 | 0.6630 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.878E-06 | 0.0816 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.872E-06 | 0.2553 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.300E-05 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 6 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 7
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FANILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground risk | Ground fract. | Inhalation risk | Inhalation fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | Soil risk | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 1.511E-05 | 0.6569 | 2.202E-12 | 0.0000 | 0.000E+00 | 0.0000 | 1.313E-07 | 0.0057 | 6.228E-09 | 0.0003 | 1.427E-09 | 0.0001 | 3.074E-09 | 0.0001 |
| Cs-137 | 1.803E-06 | 0.0784 | 4.285E-13 | 0.0000 | 0.000E+00 | 0.0000 | 6.446E-08 | 0.0028 | 4.973E-09 | 0.0002 | 3.089E-09 | 0.0001 | 1.933E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 5.103E-10 | 0.0000 | 0.000E+00 | 0.0000 | 5.032E-06 | 0.2188 | 6.270E-08 | 0.0027 | 5.805E-07 | 0.0252 | 1.963E-07 | 0.0085 |
| Total | 1.691E-05 | 0.7353 | 5.129E-10 | 0.0000 | 0.000E+00 | 0.0000 | 5.228E-06 | 0.2273 | 7.390E-08 | 0.0032 | 5.850E-07 | 0.0254 | 2.013E-07 | 0.0088 |

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | Water fract. | Fish risk | Fish fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | All pathways risk | All pathways fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.525E-05 | 0.6630 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.878E-06 | 0.0816 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.872E-06 | 0.2553 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.300E-05 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 7 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 8
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+00 years

| Radio-Nuclide | Water Independent Pathways (Inhalation w/o radon) Inhalation | Plant | Meat | Milk | Soil | Water Dependent Pathways Water | Fish | Plant | Meat | Milk | Total Ingestion* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 6.320E-03 | 6.051E+02 | 2.870E+01 | 6.577E+00 | 7.838E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.482E+02 |
| Cs-137 | 1.595E-03 | 7.633E+01 | 5.889E+00 | 3.658E+00 | 1.978E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.785E+01 |
| Ni-63 | 3.254E+00 | 1.947E+05 | 2.426E+03 | 2.246E+04 | 4.035E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.236E+05 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio-Nuclide | Ground risk | fract. | Inhalation risk | fract. | Plant risk | fract. | Meat risk | fract. | Milk risk | fract. | Soil risk | fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 1.161E-05 | 0.6017 | 1.691E-12 | 0.0000 | 1.009E-07 | 0.0052 | 4.785E-09 | 0.0002 | 1.096E-09 | 0.0001 | 2.361E-09 | 0.0001 |
| Cs-137 | 1.721E-06 | 0.0892 | 4.088E-13 | 0.0000 | 6.151E-08 | 0.0032 | 4.745E-09 | 0.0002 | 2.947E-09 | 0.0002 | 1.845E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 5.024E-10 | 0.0000 | 4.955E-06 | 0.2569 | 6.173E-08 | 0.0032 | 5.715E-07 | 0.0296 | 1.933E-07 | 0.0100 |
| Total | 1.333E-05 | 0.6909 | 5.045E-10 | 0.0000 | 5.117E-06 | 0.2653 | 7.126E-08 | 0.0037 | 5.756E-07 | 0.0298 | 1.975E-07 | 0.0102 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | fract. | Fish risk | fract. | Plant risk | fract. | Meat risk | fract. | Milk risk | fract. | All Pathways** risk | fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.172E-05 | 0.6074 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.792E-06 | 0.0929 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.782E-06 | 0.2997 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.929E-05 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 8 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 9
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground risk | Ground fract. | Inhalation risk | Inhalation fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | Soil risk | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 1.161E-05 | 0.6017 | 1.691E-12 | 0.0000 | 0.000E+00 | 0.0000 | 1.009E-07 | 0.0052 | 4.785E-09 | 0.0002 | 1.096E-09 | 0.0001 | 2.361E-09 | 0.0001 |
| Cs-137 | 1.721E-06 | 0.0892 | 4.088E-13 | 0.0000 | 0.000E+00 | 0.0000 | 6.151E-08 | 0.0032 | 4.745E-09 | 0.0002 | 2.947E-09 | 0.0002 | 1.845E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 5.024E-10 | 0.0000 | 0.000E+00 | 0.0000 | 4.955E-06 | 0.2569 | 6.173E-08 | 0.0032 | 5.715E-07 | 0.0296 | 1.933E-07 | 0.0100 |
| Total | 1.333E-05 | 0.6909 | 5.045E-10 | 0.0000 | 0.000E+00 | 0.0000 | 5.117E-06 | 0.2653 | 7.126E-08 | 0.0037 | 5.756E-07 | 0.0298 | 1.975E-07 | 0.0102 |

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | Water fract. | Fish risk | Fish fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | All pathways risk | All pathways fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.172E-05 | 0.6074 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.792E-06 | 0.0929 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.782E-06 | 0.2997 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.929E-05 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 9 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 10
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+01 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 2.512E-03 | 2.404E+02 | 1.141E+01 | 2.614E+00 | 3.115E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.576E+02 |
| Cs-137 | 1.353E-03 | 6.478E+01 | 4.998E+00 | 3.104E+00 | 1.678E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.456E+01 |
| Ni-63 | 3.082E+00 | 1.844E+05 | 2.297E+03 | 2.127E+04 | 3.822E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.118E+05 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 4.612E-06 | 0.3958 | 6.722E-13 | 0.0000 | 4.008E-08 | 0.0034 | 1.901E-09 | 0.0002 | 4.357E-10 | 0.0000 | 9.384E-10 | 0.0001 |
| Cs-137 | 1.460E-06 | 0.1253 | 3.470E-13 | 0.0000 | 5.220E-08 | 0.0045 | 4.027E-09 | 0.0003 | 2.501E-09 | 0.0002 | 1.566E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 4.758E-10 | 0.0000 | 4.692E-06 | 0.4027 | 5.846E-08 | 0.0050 | 5.413E-07 | 0.0465 | 1.831E-07 | 0.0157 |
| Total | 6.073E-06 | 0.5212 | 4.768E-10 | 0.0000 | 4.784E-06 | 0.4106 | 6.439E-08 | 0.0055 | 5.442E-07 | 0.0467 | 1.856E-07 | 0.0159 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.656E-06 | 0.3996 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.521E-06 | 0.1305 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.475E-06 | 0.4699 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.165E-05 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 10 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 11
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 4.612E-06 | 0.3958 | 6.722E-13 | 0.0000 | 0.000E+00 | 0.0000 | 4.008E-08 | 0.0034 | 1.901E-09 | 0.0002 | 4.357E-10 | 0.0000 | 9.384E-10 | 0.0001 |
| Cs-137 | 1.460E-06 | 0.1253 | 3.470E-13 | 0.0000 | 0.000E+00 | 0.0000 | 5.220E-08 | 0.0045 | 4.027E-09 | 0.0003 | 2.501E-09 | 0.0002 | 1.566E-09 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 4.758E-10 | 0.0000 | 0.000E+00 | 0.0000 | 4.692E-06 | 0.4027 | 5.846E-08 | 0.0050 | 5.413E-07 | 0.0465 | 1.831E-07 | 0.0157 |
| Total | 6.073E-06 | 0.5212 | 4.768E-10 | 0.0000 | 0.000E+00 | 0.0000 | 4.784E-06 | 0.4106 | 6.439E-08 | 0.0055 | 5.442E-07 | 0.0467 | 1.856E-07 | 0.0159 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.656E-06 | 0.3996 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.521E-06 | 0.1305 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.475E-06 | 0.4699 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.165E-05 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 11 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 12
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities GINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+01 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 1.798E-04 | 1.722E+01 | 8.167E-01 | 1.871E-01 | 2.230E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.844E+01 |
| Cs-137 | 8.469E-04 | 4.054E+01 | 3.128E+00 | 1.943E+00 | 1.050E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.666E+01 |
| Ni-63 | 2.638E+00 | 1.578E+05 | 1.967E+03 | 1.821E+04 | 3.271E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.813E+05 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 3.302E-07 | 0.0553 | 4.813E-14 | 0.0000 | 2.870E-09 | 0.0005 | 1.361E-10 | 0.0000 | 3.120E-11 | 0.0000 | 6.719E-11 | 0.0000 |
| Cs-137 | 9.139E-07 | 0.1530 | 2.171E-13 | 0.0000 | 3.267E-08 | 0.0055 | 2.520E-09 | 0.0004 | 1.565E-09 | 0.0003 | 9.798E-10 | 0.0002 |
| Ni-63 | 0.000E+00 | 0.0000 | 4.073E-10 | 0.0001 | 4.017E-06 | 0.6726 | 5.004E-08 | 0.0084 | 4.633E-07 | 0.0776 | 1.567E-07 | 0.0262 |
| Total | 1.244E-06 | 0.2083 | 4.076E-10 | 0.0001 | 4.052E-06 | 0.6785 | 5.270E-08 | 0.0088 | 4.649E-07 | 0.0779 | 1.577E-07 | 0.0264 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.333E-07 | 0.0558 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.516E-07 | 0.1593 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.687E-06 | 0.7848 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.972E-06 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 12 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 13
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

0
Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 3.302E-07 | 0.0553 | 4.813E-14 | 0.0000 | 0.000E+00 | 0.0000 | 2.870E-09 | 0.0005 | 1.361E-10 | 0.0000 | 3.120E-11 | 0.0000 | 6.719E-11 | 0.0000 |
| Cs-137 | 9.139E-07 | 0.1530 | 2.171E-13 | 0.0000 | 0.000E+00 | 0.0000 | 3.267E-08 | 0.0055 | 2.520E-09 | 0.0004 | 1.565E-09 | 0.0003 | 9.798E-10 | 0.0002 |
| Ni-63 | 0.000E+00 | 0.0000 | 4.073E-10 | 0.0001 | 0.000E+00 | 0.0000 | 4.017E-06 | 0.6726 | 5.004E-08 | 0.0084 | 4.633E-07 | 0.0776 | 1.567E-07 | 0.0262 |
| Total | 1.244E-06 | 0.2083 | 4.076E-10 | 0.0001 | 0.000E+00 | 0.0000 | 4.052E-06 | 0.6785 | 5.270E-08 | 0.0088 | 4.649E-07 | 0.0779 | 1.577E-07 | 0.0264 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.333E-07 | 0.0558 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.516E-07 | 0.1593 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.687E-06 | 0.7848 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.972E-06 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 13 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 14
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+02 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 1.766E-08 | 1.691E-03 | 8.021E-05 | 1.838E-05 | 2.190E-05 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.811E-03 |
| Cs-137 | 1.642E-04 | 7.859E+00 | 6.063E-01 | 3.766E-01 | 2.036E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.045E+00 |
| Ni-63 | 1.531E+00 | 9.160E+04 | 1.141E+03 | 1.057E+04 | 1.899E+03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.052E+05 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 3.243E-11 | 0.0000 | 4.726E-18 | 0.0000 | 2.818E-13 | 0.0000 | 1.337E-14 | 0.0000 | 3.064E-15 | 0.0000 | 6.598E-15 | 0.0000 |
| Cs-137 | 1.772E-07 | 0.0610 | 4.210E-14 | 0.0000 | 6.333E-09 | 0.0022 | 4.886E-10 | 0.0002 | 3.034E-10 | 0.0001 | 1.900E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.364E-10 | 0.0001 | 2.331E-06 | 0.8025 | 2.904E-08 | 0.0100 | 2.689E-07 | 0.0926 | 9.094E-08 | 0.0313 |
| Total | 1.772E-07 | 0.0610 | 2.364E-10 | 0.0001 | 2.337E-06 | 0.8047 | 2.953E-08 | 0.0102 | 2.692E-07 | 0.0927 | 9.113E-08 | 0.0314 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.274E-11 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.845E-07 | 0.0635 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.720E-06 | 0.9365 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.905E-06 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 14 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 15
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 3.243E-11 | 0.0000 | 4.726E-18 | 0.0000 | 0.000E+00 | 0.0000 | 2.818E-13 | 0.0000 | 1.337E-14 | 0.0000 | 3.064E-15 | 0.0000 | 6.598E-15 | 0.0000 |
| Cs-137 | 1.772E-07 | 0.0610 | 4.210E-14 | 0.0000 | 0.000E+00 | 0.0000 | 6.333E-09 | 0.0022 | 4.886E-10 | 0.0002 | 3.034E-10 | 0.0001 | 1.900E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.364E-10 | 0.0001 | 0.000E+00 | 0.0000 | 2.331E-06 | 0.8025 | 2.904E-08 | 0.0100 | 2.689E-07 | 0.0926 | 9.094E-08 | 0.0313 |
| Total | 1.772E-07 | 0.0610 | 2.364E-10 | 0.0001 | 0.000E+00 | 0.0000 | 2.337E-06 | 0.8047 | 2.953E-08 | 0.0102 | 2.692E-07 | 0.0927 | 9.113E-08 | 0.0314 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 3.274E-11 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.845E-07 | 0.0635 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.720E-06 | 0.9365 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.905E-06 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 15 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 16
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+02 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 6.252E-20 | 5.986E-15 | 2.839E-16 | 6.506E-17 | 7.754E-17 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.412E-15 |
| Cs-137 | 1.512E-06 | 7.238E-02 | 5.584E-03 | 3.468E-03 | 1.875E-03 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.331E-02 |
| Ni-63 | 3.234E-01 | 1.935E+04 | 2.411E+02 | 2.233E+03 | 4.011E+02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.223E+04 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 1.148E-22 | 0.0000 | 5.596E-30 | 0.0000 | 9.978E-25 | 0.0000 | 4.733E-26 | 0.0000 | 1.085E-26 | 0.0000 | 2.336E-26 | 0.0000 |
| Cs-137 | 1.632E-09 | 0.0028 | 3.877E-16 | 0.0000 | 5.833E-11 | 0.0001 | 4.500E-12 | 0.0000 | 2.795E-12 | 0.0000 | 1.750E-12 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 4.994E-11 | 0.0001 | 4.925E-07 | 0.8544 | 6.136E-09 | 0.0106 | 5.681E-08 | 0.0986 | 1.921E-08 | 0.0333 |
| Total | 1.632E-09 | 0.0028 | 4.994E-11 | 0.0001 | 4.925E-07 | 0.8545 | 6.140E-09 | 0.0107 | 5.682E-08 | 0.0986 | 1.921E-08 | 0.0333 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.159E-22 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.699E-09 | 0.0029 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.747E-07 | 0.9971 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.764E-07 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 16 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 17
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 1.148E-22 | 0.0000 | 5.596E-30 | 0.0000 | 0.000E+00 | 0.0000 | 9.978E-25 | 0.0000 | 4.733E-26 | 0.0000 | 1.085E-26 | 0.0000 | 2.336E-26 | 0.0000 |
| Cs-137 | 1.632E-09 | 0.0028 | 3.877E-16 | 0.0000 | 0.000E+00 | 0.0000 | 5.833E-11 | 0.0001 | 4.500E-12 | 0.0000 | 2.795E-12 | 0.0000 | 1.750E-12 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 4.994E-11 | 0.0001 | 0.000E+00 | 0.0000 | 4.925E-07 | 0.8544 | 6.136E-09 | 0.0106 | 5.681E-08 | 0.0986 | 1.921E-08 | 0.0333 |
| Total | 1.632E-09 | 0.0028 | 4.994E-11 | 0.0001 | 0.000E+00 | 0.0000 | 4.925E-07 | 0.8545 | 6.140E-09 | 0.0107 | 5.682E-08 | 0.0986 | 1.921E-08 | 0.0333 |

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.159E-22 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.699E-09 | 0.0029 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.747E-07 | 0.9971 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.764E-07 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 17 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 18
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+03 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Co-60 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 1.134E-13 | 5.428E-09 | 4.187E-10 | 2.601E-10 | 1.406E-10 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.247E-09 |
| Ni-63 | 1.402E-03 | 8.389E+01 | 1.045E+00 | 9.677E+00 | 1.739E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.635E+01 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Cs-137 | 1.224E-16 | 0.0000 | 2.907E-23 | 0.0000 | 4.374E-18 | 0.0000 | 3.374E-19 | 0.0000 | 2.096E-19 | 0.0000 | 1.312E-19 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.165E-13 | 0.0001 | 2.135E-09 | 0.8569 | 2.660E-11 | 0.0107 | 2.463E-10 | 0.0989 | 8.328E-11 | 0.0334 |
| Total | 1.224E-16 | 0.0000 | 2.165E-13 | 0.0001 | 2.135E-09 | 0.8569 | 2.660E-11 | 0.0107 | 2.463E-10 | 0.0989 | 8.328E-11 | 0.0334 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.274E-16 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.491E-09 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.491E-09 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 3 Sheet No. 18 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 3

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 19
Intrisk : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Cs-137 | 1.224E-16 | 0.0000 | 2.907E-23 | 0.0000 | 0.000E+00 | 0.0000 | 4.374E-18 | 0.0000 | 3.374E-19 | 0.0000 | 2.096E-19 | 0.0000 | 1.312E-19 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.165E-13 | 0.0001 | 0.000E+00 | 0.0000 | 2.135E-09 | 0.8569 | 2.660E-11 | 0.0107 | 2.463E-10 | 0.0989 | 8.328E-11 | 0.0334 |
| Total | 1.224E-16 | 0.0000 | 2.165E-13 | 0.0001 | 0.000E+00 | 0.0000 | 2.135E-09 | 0.8569 | 2.660E-11 | 0.0107 | 2.463E-10 | 0.0989 | 8.328E-11 | 0.0334 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Co-60 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.274E-16 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.491E-09 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.491E-09 | 1.0000 |

***CNRSI(i,p,t) Includes contribution from decay daughter radionuclides

Attachment 3 Sheet No. 19 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

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1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  14:40  Page    1
 Concent : Calculation of Dose for 118-DR-1 Statistical Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

                         Table of Contents
                         ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
              Part IV: Concentration of Radionuclides
              ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
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Concentration of radionuclides in different media


```
      Time= 0.000E+00 ....................................   2
      Time= 1.000E+00 ....................................   3
      Time= 3.000E+00 ....................................   4
      Time= 1.000E+01 ....................................   5
      Time= 3.000E+01 ....................................   6
      Time= 1.000E+02 ....................................   7
      Time= 3.000E+02 ....................................   8
      Time= 1.000E+03 ....................................   9
```


Attachment 4 Sheet No. 1 of 9
Originator: S. W. Clark [signature] Date 8/31/09
Chk'd By M. W. Perrott [signature] Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 2
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 0.000E+00 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 3.100E-01 | 3.100E-01 | 2.922E-06 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 5.650E-02 | 5.650E-02 | 5.326E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 1.100E+02 | 1.100E+02 | 1.037E-03 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 0.000E+00 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 2.480E+01 | 2.480E+01 | 2.480E+01 | 2.480E+01 | 3.683E+01 | 3.038E+00 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 2.260E+00 | 2.260E+00 | 2.260E+00 | 2.260E+00 | 5.458E+00 | 1.220E+00 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 5.500E+03 | 5.500E+03 | 5.500E+03 | 5.500E+03 | 2.145E+03 | 7.150E+03 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 2 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 14:40 Page 3
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+00 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 2.717E-01 | 2.717E-01 | 2.561E-06 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 5.519E-02 | 5.519E-02 | 5.203E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 1.091E+02 | 1.091E+02 | 1.029E-03 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+00 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 2.174E+01 | 2.174E+01 | 2.190E+01 | 2.175E+01 | 3.228E+01 | 2.663E+00 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 2.208E+00 | 2.208E+00 | 2.211E+00 | 2.208E+00 | 5.332E+00 | 1.192E+00 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 5.458E+03 | 5.458E+03 | 5.460E+03 | 5.458E+03 | 2.129E+03 | 7.095E+03 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 3 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 4
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+00 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 2.087E-01 | 2.087E-01 | 1.968E-06 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 5.266E-02 | 5.266E-02 | 4.965E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 1.075E+02 | 1.075E+02 | 1.013E-03 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 3.000E+00 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 1.670E+01 | 1.670E+01 | 1.682E+01 | 1.671E+01 | 2.480E+01 | 2.046E+00 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 2.107E+00 | 2.107E+00 | 2.109E+00 | 2.107E+00 | 5.088E+00 | 1.138E+00 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 5.373E+03 | 5.374E+03 | 5.376E+03 | 5.374E+03 | 2.096E+03 | 6.986E+03 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 4 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

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1RESRAD, Version 6.4      T½ Limit = 180 days       08/27/2009  14:40  Page   5
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+01 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 8.295E-02 | 8.295E-02 | 7.820E-07 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 4.470E-02 | 4.470E-02 | 4.213E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 1.018E+02 | 1.018E+02 | 9.594E-04 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+01 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 6.636E+00 | 6.636E+00 | 6.685E+00 | 6.639E+00 | 9.855E+00 | 8.130E-01 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 1.788E+00 | 1.788E+00 | 1.790E+00 | 1.788E+00 | 4.318E+00 | 9.655E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 5.089E+03 | 5.089E+03 | 5.091E+03 | 5.089E+03 | 1.985E+03 | 6.616E+03 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 5 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 6
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+01 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 5.939E-03 | 5.939E-03 | 5.599E-08 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 2.797E-02 | 2.797E-02 | 2.637E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 8.712E+01 | 8.712E+01 | 8.213E-04 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 3.000E+01 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 4.751E-01 | 4.751E-01 | 4.786E-01 | 4.753E-01 | 7.056E-01 | 5.821E-02 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 1.119E+00 | 1.119E+00 | 1.120E+00 | 1.119E+00 | 2.702E+00 | 6.042E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 4.356E+03 | 4.356E+03 | 4.358E+03 | 4.357E+03 | 1.699E+03 | 5.663E+03 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 6 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 7
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+02 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 5.833E-07 | 5.833E-07 | 5.499E-12 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 5.422E-03 | 5.422E-03 | 5.112E-08 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 5.056E+01 | 5.056E+01 | 4.766E-04 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+02 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 4.666E-05 | 4.666E-05 | 4.700E-05 | 4.668E-05 | 6.930E-05 | 5.716E-06 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 2.169E-01 | 2.169E-01 | 2.172E-01 | 2.169E-01 | 5.239E-01 | 1.171E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 2.528E+03 | 2.528E+03 | 2.529E+03 | 2.528E+03 | 9.861E+02 | 3.287E+03 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 7 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 14:40 Page 8
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+02 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 2.065E-18 | 2.065E-18 | 1.947E-23 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 4.994E-05 | 4.994E-05 | 4.708E-10 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 1.068E+01 | 1.068E+01 | 1.007E-04 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 3.000E+02 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 1.652E-16 | 1.652E-16 | 1.664E-16 | 1.653E-16 | 2.453E-16 | 2.024E-17 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 1.998E-03 | 1.998E-03 | 2.000E-03 | 1.998E-03 | 4.825E-03 | 1.079E-03 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 5.341E+02 | 5.341E+02 | 5.344E+02 | 5.342E+02 | 2.083E+02 | 6.944E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 8 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 4

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1RESRAD, Version 6.4      T½ Limit = 180 days       08/27/2009  14:40  Page   9
Concent : Calculation of Dose for 118-DR-1 Statistical Samples
File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_STATISTICAL_DOSE.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+03 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 3.745E-12 | 3.745E-12 | 3.530E-17 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 4.630E-02 | 4.630E-02 | 4.365E-07 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+03 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Co-60 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 |
| Cs-137 | 0.000E+00 | 1.498E-10 | 1.498E-10 | 1.500E-10 | 1.498E-10 | 3.618E-10 | 8.090E-11 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 2.315E+00 | 2.315E+00 | 2.316E+00 | 2.315E+00 | 9.030E-01 | 3.010E+00 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 4 Sheet No. 9 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

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1RESRAD, Version 6.4      T« Limit = 180 days      08/27/2009  15:21  Page   1
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD
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Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines


Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary ..... 3
Summary of Pathway Selections ..... 7
Contaminated Zone and Total Dose Summary ..... 8
Total Dose Components
Time = 0.000E+00 ..... 9
Time = 1.000E+00 ..... 10
Time = 3.000E+00 ..... 11
Time = 1.000E+01 ..... 12
Time = 3.000E+01 ..... 13
Time = 1.000E+02 ..... 14
Time = 3.000E+02 ..... 15
Time = 1.000E+03 ..... 16
Dose/Source Ratios Summed Over All Pathways ..... 17
Single Radionuclide Soil Guidelines ..... 17
Dose Per Nuclide Summed Over All Pathways ..... 18
Soil Concentration Per Nuclide ..... 18


Attachment 5 Sheet No. 1 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

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1RESRAD, Version 6.4      T½ Limit = 180 days       08/27/2009  15:21  Page   2
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD
```

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 11

| 0 Menu | Parameter | Current Value# | Base Case* | Parameter Name |
|---|---|---|---|---|
| A-1 | DCF's for external ground radiation, (mrem/yr)/(pCi/g) | | | |
| A-1 | Ba-137m (Source: FGR 12) | 3.606E+00 | 3.606E+00 | DCF1( 1) |
| A-1 | Cs-137 (Source: FGR 12) | 7.510E-04 | 7.510E-04 | DCF1( 2) |
| A-1 | Ni-63 (Source: FGR 12) | 0.000E+00 | 0.000E+00 | DCF1( 3) |
| B-1 | Dose conversion factors for inhalation, mrem/pCi: | | | |
| B-1 | Cs-137+D | 3.190E-05 | 3.190E-05 | DCF2( 1) |
| B-1 | Ni-63 | 6.290E-06 | 6.290E-06 | DCF2( 2) |
| D-1 | Dose conversion factors for ingestion, mrem/pCi: | | | |
| D-1 | Cs-137+D | 5.000E-05 | 5.000E-05 | DCF3( 1) |
| D-1 | Ni-63 | 5.770E-07 | 5.770E-07 | DCF3( 2) |
| D-34 | Food transfer factors: | | | |
| D-34 | Cs-137+D , plant/soil concentration ratio, dimensionless | 4.000E-02 | 4.000E-02 | RTF( 1,1) |
| D-34 | Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 3.000E-02 | 3.000E-02 | RTF( 1,2) |
| D-34 | Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 8.000E-03 | 8.000E-03 | RTF( 1,3) |
| D-34 | Ni-63 , plant/soil concentration ratio, dimensionless | 5.000E-02 | 5.000E-02 | RTF( 2,1) |
| D-34 | Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d) | 5.000E-03 | 5.000E-03 | RTF( 2,2) |
| D-34 | Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d) | 2.000E-02 | 2.000E-02 | RTF( 2,3) |
| D-5 | Bioaccumulation factors, fresh water, L/kg: | | | |
| D-5 | Cs-137+D , fish | 2.000E+03 | 2.000E+03 | BIOFAC( 1,1) |
| D-5 | Cs-137+D , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 1,2) |
| D-5 | Ni-63 , fish | 1.000E+02 | 1.000E+02 | BIOFAC( 2,1) |
| D-5 | Ni-63 , crustacea and mollusks | 1.000E+02 | 1.000E+02 | BIOFAC( 2,2) |

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Attachment 5 Sheet No. 2 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 3
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Site-Specific Parameter Summary

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R011 | Area of contaminated zone (m**2) | 7.500E+01 | 1.000E+04 | --- | AREA |
| R011 | Thickness of contaminated zone (m) | 3.000E+00 | 2.000E+00 | --- | THICK0 |
| R011 | Length parallel to aquifer flow (m) | 9.000E+00 | 1.000E+02 | --- | LCZPAQ |
| R011 | Basic radiation dose limit (mrem/yr) | 1.500E+01 | 3.000E+01 | --- | BRDL |
| R011 | Time since placement of material (yr) | 0.000E+00 | 0.000E+00 | --- | TI |
| R011 | Times for calculations (yr) | 1.000E+00 | 1.000E+00 | --- | T( 2) |
| R011 | Times for calculations (yr) | 3.000E+00 | 3.000E+00 | --- | T( 3) |
| R011 | Times for calculations (yr) | 1.000E+01 | 1.000E+01 | --- | T( 4) |
| R011 | Times for calculations (yr) | 3.000E+01 | 3.000E+01 | --- | T( 5) |
| R011 | Times for calculations (yr) | 1.000E+02 | 1.000E+02 | --- | T( 6) |
| R011 | Times for calculations (yr) | 3.000E+02 | 3.000E+02 | --- | T( 7) |
| R011 | Times for calculations (yr) | 1.000E+03 | 1.000E+03 | --- | T( 8) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T( 9) |
| R011 | Times for calculations (yr) | not used | 0.000E+00 | --- | T(10) |
| R012 | Initial principal radionuclide (pCi/g): Cs-137 | 4.950E-02 | 0.000E+00 | --- | S1(1) |
| R012 | Initial principal radionuclide (pCi/g): Ni-63 | 9.700E+00 | 0.000E+00 | --- | S1(2) |
| R012 | Concentration in groundwater (pCi/L): Cs-137 | not used | 0.000E+00 | --- | W1( 1) |
| R012 | Concentration in groundwater (pCi/L): Ni-63 | not used | 0.000E+00 | --- | W1( 2) |
| R013 | Cover depth (m) | 0.000E+00 | 0.000E+00 | --- | COVER0 |
| R013 | Density of cover material (g/cm**3) | not used | 1.500E+00 | --- | DENSCV |
| R013 | Cover depth erosion rate (m/yr) | not used | 1.000E-03 | --- | VCV |
| R013 | Density of contaminated zone (g/cm**3) | 1.600E+00 | 1.500E+00 | --- | DENSCZ |
| R013 | Contaminated zone erosion rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VCZ |
| R013 | Contaminated zone total porosity | 4.000E-01 | 4.000E-01 | --- | TPCZ |
| R013 | Contaminated zone field capacity | 1.500E-01 | 2.000E-01 | --- | FCCZ |
| R013 | Contaminated zone hydraulic conductivity (m/yr) | 2.500E+02 | 1.000E+01 | --- | HCCZ |
| R013 | Contaminated zone b parameter | 4.050E+00 | 5.300E+00 | --- | BCZ |
| R013 | Average annual wind speed (m/sec) | 3.400E+00 | 2.000E+00 | --- | WIND |
| R013 | Humidity in air (g/m**3) | not used | 8.000E+00 | --- | HUMID |
| R013 | Evapotranspiration coefficient | 9.100E-01 | 5.000E-01 | --- | EVAPTR |
| R013 | Precipitation (m/yr) | 1.600E-01 | 1.000E+00 | --- | PRECIP |
| R013 | Irrigation (m/yr) | 7.600E-01 | 2.000E-01 | --- | RI |
| R013 | Irrigation mode | overhead | overhead | --- | IDITCH |
| R013 | Runoff coefficient | 2.000E-01 | 2.000E-01 | --- | RUNOFF |
| R013 | Watershed area for nearby stream or pond (m**2) | 1.000E+06 | 1.000E+06 | --- | WAREA |
| R013 | Accuracy for water/soil computations | 1.000E-03 | 1.000E-03 | --- | EPS |
| R014 | Density of saturated zone (g/cm**3) | 1.600E+00 | 1.500E+00 | --- | DENSAQ |
| R014 | Saturated zone total porosity | 4.000E-01 | 4.000E-01 | --- | TPSZ |
| R014 | Saturated zone effective porosity | 2.500E-01 | 2.000E-01 | --- | EPSZ |
| R014 | Saturated zone field capacity | 1.500E-01 | 2.000E-01 | --- | FCSZ |
| R014 | Saturated zone hydraulic conductivity (m/yr) | 5.530E+03 | 1.000E+02 | --- | HCSZ |
| R014 | Saturated zone hydraulic gradient | 1.250E-03 | 2.000E-02 | --- | HGWT |
| R014 | Saturated zone b parameter | 4.050E+00 | 5.300E+00 | --- | BSZ |
| R014 | Water table drop rate (m/yr) | 1.000E-03 | 1.000E-03 | --- | VWT |
| R014 | Well pump intake depth (m below water table) | 4.600E+00 | 1.000E+01 | --- | DWIBWT |
| R014 | Model: Nondispersion (ND) or Mass-Balance (MB) | ND | ND | --- | MODEL |
| R014 | Well pumping rate (m**3/yr) | 2.500E+02 | 2.500E+02 | --- | UW |

Attachment 5 Sheet No. 3 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 4
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R015 | Number of unsaturated zone strata | 1 | 1 | --- | NS |
| R015 | Unsat. zone 1, thickness (m) | 2.000E+01 | 4.000E+00 | --- | H(1) |
| R015 | Unsat. zone 1, soil density (g/cm**3) | 1.600E+00 | 1.500E+00 | --- | DENSUZ(1) |
| R015 | Unsat. zone 1, total porosity | 4.000E-01 | 4.000E-01 | --- | TPUZ(1) |
| R015 | Unsat. zone 1, effective porosity | 2.500E-01 | 2.000E-01 | --- | EPUZ(1) |
| R015 | Unsat. zone 1, field capacity | 1.500E-01 | 2.000E-01 | --- | FCUZ(1) |
| R015 | Unsat. zone 1, soil-specific b parameter | 4.050E+00 | 5.300E+00 | --- | BUZ(1) |
| R015 | Unsat. zone 1, hydraulic conductivity (m/yr) | 2.500E+02 | 1.000E+01 | --- | HCUZ(1) |
| R016 | Distribution coefficients for Cs-137 | | | | |
| R016 | Contaminated zone (cm**3/g) | 5.000E+01 | 4.600E+03 | --- | DCNUCC( 1) |
| R016 | Unsaturated zone 1 (cm**3/g) | 5.000E+01 | 4.600E+03 | --- | DCNUCU( 1,1) |
| R016 | Saturated zone (cm**3/g) | 5.000E+01 | 4.600E+03 | --- | DCNUCS( 1) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 3.322E-04 | ALEACH( 1) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 1) |
| R016 | Distribution coefficients for Ni-63 | | | | |
| R016 | Contaminated zone (cm**3/g) | 3.000E+01 | 1.000E+03 | --- | DCNUCC( 2) |
| R016 | Unsaturated zone 1 (cm**3/g) | 3.000E+01 | 1.000E+03 | --- | DCNUCU( 2,1) |
| R016 | Saturated zone (cm**3/g) | 3.000E+01 | 1.000E+03 | --- | DCNUCS( 2) |
| R016 | Leach rate (/yr) | 0.000E+00 | 0.000E+00 | 5.528E-04 | ALEACH( 2) |
| R016 | Solubility constant | 0.000E+00 | 0.000E+00 | not used | SOLUBK( 2) |
| R017 | Inhalation rate (m**3/yr) | 7.300E+03 | 8.400E+03 | --- | INHALR |
| R017 | Mass loading for inhalation (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLINH |
| R017 | Exposure duration | 3.000E+01 | 3.000E+01 | --- | ED |
| R017 | Shielding factor, inhalation | 4.000E-01 | 4.000E-01 | --- | SHF3 |
| R017 | Shielding factor, external gamma | 8.000E-01 | 7.000E-01 | --- | SHF1 |
| R017 | Fraction of time spent indoors | 6.000E-01 | 5.000E-01 | --- | FIND |
| R017 | Fraction of time spent outdoors (on site) | 2.000E-01 | 2.500E-01 | --- | FOTD |
| R017 | Shape factor flag, external gamma | 1.000E+00 | 1.000E+00 | >0 shows circular AREA. | FS |
| R017 | Radii of shape factor array (used if FS = -1): | | | | |
| R017 | Outer annular radius (m), ring 1: | not used | 5.000E+01 | --- | RAD_SHAPE( 1) |
| R017 | Outer annular radius (m), ring 2: | not used | 7.071E+01 | --- | RAD_SHAPE( 2) |
| R017 | Outer annular radius (m), ring 3: | not used | 0.000E+00 | --- | RAD_SHAPE( 3) |
| R017 | Outer annular radius (m), ring 4: | not used | 0.000E+00 | --- | RAD_SHAPE( 4) |
| R017 | Outer annular radius (m), ring 5: | not used | 0.000E+00 | --- | RAD_SHAPE( 5) |
| R017 | Outer annular radius (m), ring 6: | not used | 0.000E+00 | --- | RAD_SHAPE( 6) |
| R017 | Outer annular radius (m), ring 7: | not used | 0.000E+00 | --- | RAD_SHAPE( 7) |
| R017 | Outer annular radius (m), ring 8: | not used | 0.000E+00 | --- | RAD_SHAPE( 8) |
| R017 | Outer annular radius (m), ring 9: | not used | 0.000E+00 | --- | RAD_SHAPE( 9) |
| R017 | Outer annular radius (m), ring 10: | not used | 0.000E+00 | --- | RAD_SHAPE(10) |
| R017 | Outer annular radius (m), ring 11: | not used | 0.000E+00 | --- | RAD_SHAPE(11) |
| R017 | Outer annular radius (m), ring 12: | not used | 0.000E+00 | --- | RAD_SHAPE(12) |

Attachment 5 Sheet No. 4 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 5
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R017 | Fractions of annular areas within AREA: | | | | |
| R017 | Ring 1 | not used | 1.000E+00 | --- | FRACA( 1) |
| R017 | Ring 2 | not used | 2.732E-01 | --- | FRACA( 2) |
| R017 | Ring 3 | not used | 0.000E+00 | --- | FRACA( 3) |
| R017 | Ring 4 | not used | 0.000E+00 | --- | FRACA( 4) |
| R017 | Ring 5 | not used | 0.000E+00 | --- | FRACA( 5) |
| R017 | Ring 6 | not used | 0.000E+00 | --- | FRACA( 6) |
| R017 | Ring 7 | not used | 0.000E+00 | --- | FRACA( 7) |
| R017 | Ring 8 | not used | 0.000E+00 | --- | FRACA( 8) |
| R017 | Ring 9 | not used | 0.000E+00 | --- | FRACA( 9) |
| R017 | Ring 10 | not used | 0.000E+00 | --- | FRACA(10) |
| R017 | Ring 11 | not used | 0.000E+00 | --- | FRACA(11) |
| R017 | Ring 12 | not used | 0.000E+00 | --- | FRACA(12) |
| R018 | Fruits, vegetables and grain consumption (kg/yr) | 1.100E+02 | 1.600E+02 | --- | DIET(1) |
| R018 | Leafy vegetable consumption (kg/yr) | 2.700E+00 | 1.400E+01 | --- | DIET(2) |
| R018 | Milk consumption (L/yr) | 1.000E+02 | 9.200E+01 | --- | DIET(3) |
| R018 | Meat and poultry consumption (kg/yr) | 3.600E+01 | 6.300E+01 | --- | DIET(4) |
| R018 | Fish consumption (kg/yr) | 1.970E+01 | 5.400E+00 | --- | DIET(5) |
| R018 | Other seafood consumption (kg/yr) | 9.000E-01 | 9.000E-01 | --- | DIET(6) |
| R018 | Soil ingestion rate (g/yr) | 7.300E+01 | 3.650E+01 | --- | SOIL |
| R018 | Drinking water intake (L/yr) | 7.300E+02 | 5.100E+02 | --- | DWI |
| R018 | Contamination fraction of drinking water | 1.000E+00 | 1.000E+00 | --- | FDW |
| R018 | Contamination fraction of household water | not used | 1.000E+00 | --- | FHHW |
| R018 | Contamination fraction of livestock water | 1.000E+00 | 1.000E+00 | --- | FLW |
| R018 | Contamination fraction of irrigation water | 1.000E+00 | 1.000E+00 | --- | FIRW |
| R018 | Contamination fraction of aquatic food | 5.000E-01 | 5.000E-01 | --- | FR9 |
| R018 | Contamination fraction of plant food | -1 | -1 | 0.375E-01 | FPLANT |
| R018 | Contamination fraction of meat | -1 | -1 | 0.375E-02 | FMEAT |
| R018 | Contamination fraction of milk | -1 | -1 | 0.375E-02 | FMILK |
| R019 | Livestock fodder intake for meat (kg/day) | 6.800E+01 | 6.800E+01 | --- | LFI5 |
| R019 | Livestock fodder intake for milk (kg/day) | 5.500E+01 | 5.500E+01 | --- | LFI6 |
| R019 | Livestock water intake for meat (L/day) | 5.000E+01 | 5.000E+01 | --- | LWI5 |
| R019 | Livestock water intake for milk (L/day) | 1.600E+02 | 1.600E+02 | --- | LWI6 |
| R019 | Livestock soil intake (kg/day) | 5.000E-01 | 5.000E-01 | --- | LSI |
| R019 | Mass loading for foliar deposition (g/m**3) | 1.000E-04 | 1.000E-04 | --- | MLFD |
| R019 | Depth of soil mixing layer (m) | 1.500E-01 | 1.500E-01 | --- | DM |
| R019 | Depth of roots (m) | 9.000E-01 | 9.000E-01 | --- | DROOT |
| R019 | Drinking water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWDW |
| R019 | Household water fraction from ground water | not used | 1.000E+00 | --- | FGWHH |
| R019 | Livestock water fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWLW |
| R019 | Irrigation fraction from ground water | 1.000E+00 | 1.000E+00 | --- | FGWIR |
| R19B | Wet weight crop yield for Non-Leafy (kg/m**2) | 7.000E-01 | 7.000E-01 | --- | YV(1) |
| R19B | Wet weight crop yield for Leafy (kg/m**2) | 1.500E+00 | 1.500E+00 | --- | YV(2) |
| R19B | Wet weight crop yield for Fodder (kg/m**2) | 1.100E+00 | 1.100E+00 | --- | YV(3) |
| R19B | Growing Season for Non-Leafy (years) | 1.700E-01 | 1.700E-01 | --- | TE(1) |
| R19B | Growing Season for Leafy (years) | 2.500E-01 | 2.500E-01 | --- | TE(2) |
| R19B | Growing Season for Fodder (years) | 8.000E-02 | 8.000E-02 | --- | TE(3) |

Attachment 5 Sheet No. 5 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 6
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| R19B | Translocation Factor for Non-Leafy | 1.000E-01 | 1.000E-01 | --- | TIV(1) |
| R19B | Translocation Factor for Leafy | 1.000E+00 | 1.000E+00 | --- | TIV(2) |
| R19B | Translocation Factor for Fodder | 1.000E+00 | 1.000E+00 | --- | TIV(3) |
| R19B | Dry Foliar Interception Fraction for Non-Leafy | 2.500E-01 | 2.500E-01 | --- | RDRY(1) |
| R19B | Dry Foliar Interception Fraction for Leafy | 2.500E-01 | 2.500E-01 | --- | RDRY(2) |
| R19B | Dry Foliar Interception Fraction for Fodder | 2.500E-01 | 2.500E-01 | --- | RDRY(3) |
| R19B | Wet Foliar Interception Fraction for Non-Leafy | 2.500E-01 | 2.500E-01 | --- | RWET(1) |
| R19B | Wet Foliar Interception Fraction for Leafy | 2.500E-01 | 2.500E-01 | --- | RWET(2) |
| R19B | Wet Foliar Interception Fraction for Fodder | 2.500E-01 | 2.500E-01 | --- | RWET(3) |
| R19B | Weathering Removal Constant for Vegetation | 2.000E+01 | 2.000E+01 | --- | WLAM |
| C14 | C-12 concentration in water (g/cm**3) | not used | 2.000E-05 | --- | C12WTR |
| C14 | C-12 concentration in contaminated soil (g/g) | not used | 3.000E-02 | --- | C12CZ |
| C14 | Fraction of vegetation carbon from soil | not used | 2.000E-02 | --- | CSOIL |
| C14 | Fraction of vegetation carbon from air | not used | 9.800E-01 | --- | CAIR |
| C14 | C-14 evasion layer thickness in soil (m) | not used | 3.000E-01 | --- | DMC |
| C14 | C-14 evasion flux rate from soil (1/sec) | not used | 7.000E-07 | --- | EVSN |
| C14 | C-12 evasion flux rate from soil (1/sec) | not used | 1.000E-10 | --- | REVSN |
| C14 | Fraction of grain in beef cattle feed | not used | 8.000E-01 | --- | AVFG4 |
| C14 | Fraction of grain in milk cow feed | not used | 2.000E-01 | --- | AVFG5 |
| STOR | Storage times of contaminated foodstuffs (days): | | | | |
| STOR | Fruits, non-leafy vegetables, and grain | 1.400E+01 | 1.400E+01 | --- | STOR_T(1) |
| STOR | Leafy vegetables | 1.000E+00 | 1.000E+00 | --- | STOR_T(2) |
| STOR | Milk | 1.000E+00 | 1.000E+00 | --- | STOR_T(3) |
| STOR | Meat and poultry | 2.000E+01 | 2.000E+01 | --- | STOR_T(4) |
| STOR | Fish | 7.000E+00 | 7.000E+00 | --- | STOR_T(5) |
| STOR | Crustacea and mollusks | 7.000E+00 | 7.000E+00 | --- | STOR_T(6) |
| STOR | Well water | 1.000E+00 | 1.000E+00 | --- | STOR_T(7) |
| STOR | Surface water | 1.000E+00 | 1.000E+00 | --- | STOR_T(8) |
| STOR | Livestock fodder | 4.500E+01 | 4.500E+01 | --- | STOR_T(9) |
| R021 | Thickness of building foundation (m) | not used | 1.500E-01 | --- | FLOOR1 |
| R021 | Bulk density of building foundation (g/cm**3) | not used | 2.400E+00 | --- | DENSFL |
| R021 | Total porosity of the cover material | not used | 4.000E-01 | --- | TPCV |
| R021 | Total porosity of the building foundation | not used | 1.000E-01 | --- | TPFL |
| R021 | Volumetric water content of the cover material | not used | 5.000E-02 | --- | PH2OCV |
| R021 | Volumetric water content of the foundation | not used | 3.000E-02 | --- | PH2OFL |
| R021 | Diffusion coefficient for radon gas (m/sec): | | | | |
| R021 | in cover material | not used | 2.000E-06 | --- | DIFCV |
| R021 | in foundation material | not used | 3.000E-07 | --- | DIFFL |
| R021 | in contaminated zone soil | not used | 2.000E-06 | --- | DIFCZ |
| R021 | Radon vertical dimension of mixing (m) | not used | 2.000E+00 | --- | HMIX |
| R021 | Average building air exchange rate (1/hr) | not used | 5.000E-01 | --- | REXG |
| R021 | Height of the building (room) (m) | not used | 2.500E+00 | --- | HRM |
| R021 | Building interior area factor | not used | 0.000E+00 | --- | FAI |
| R021 | Building depth below ground surface (m) | not used | -1.000E+00 | --- | DMFL |
| R021 | Emanating power of Rn-222 gas | not used | 2.500E-01 | --- | EMANA(1) |
| R021 | Emanating power of Rn-220 gas | not used | 1.500E-01 | --- | EMANA(2) |
| TITL | Number of graphical time points | 32 | --- | --- | NPTS |

Attachment 5 Sheet No. 6 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 7
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Site-Specific Parameter Summary (continued)

| 0 Menu | Parameter | User Input | Default | Used by RESRAD (If different from user input) | Parameter Name |
|---|---|---|---|---|---|
| TITL | Maximum number of integration points for dose | 1 | --- | --- | LYMAX |
| TITL | Maximum number of integration points for risk | 5 | --- | --- | KYMAX |

Summary of Pathway Selections

| Pathway | User Selection |
|---|---|
| 1 -- external gamma | active |
| 2 -- inhalation (w/o radon) | active |
| 3 -- plant ingestion | active |
| 4 -- meat ingestion | active |
| 5 -- milk ingestion | active |
| 6 -- aquatic foods | active |
| 7 -- drinking water | active |
| 8 -- soil ingestion | active |
| 9 -- radon | suppressed |
| Find peak pathway doses | suppressed |

Attachment 5 Sheet No. 7 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page   8
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

      Contaminated Zone Dimensions           Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ           ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:     75.00 square meters               Cs-137     4.950E-02
   Thickness:      3.00 meters                      Ni-63      9.700E+00
 Cover Depth:      0.00 meters
0
                                     Total Dose TDOSE(t), mrem/yr
                                 Basic Radiation Dose Limit = 1.500E+01 mrem/yr
                  Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
    t (years):  0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
     TDOSE(t):  8.860E-02  8.656E-02  8.264E-02  7.027E-02  4.426E-02  8.997E-03  2.092E-04  5.724E-07
         M(t):  5.906E-03  5.771E-03  5.509E-03  4.685E-03  2.951E-03  5.998E-04  1.394E-05  3.816E-08
0Maximum TDOSE(t):  8.860E-02 mrem/yr   at t = 0.000E+00 years
```

Attachment 5 Sheet No. 8 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page   9
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD
```

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

| Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 8.675E-02 | 0.9792 | 3.798E-08 | 0.0000 | 0.000E+00 | 0.0000 | 4.184E-04 | 0.0047 | 3.228E-05 | 0.0004 | 2.005E-05 | 0.0002 | 1.084E-05 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.468E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.183E-03 | 0.0133 | 1.473E-05 | 0.0002 | 1.364E-04 | 0.0015 | 2.451E-05 | 0.0003 |
| Total | 8.675E-02 | 0.9792 | 1.506E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.601E-03 | 0.0181 | 4.701E-05 | 0.0005 | 1.565E-04 | 0.0018 | 3.535E-05 | 0.0004 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

| Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.724E-02 | 0.9847 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.360E-03 | 0.0153 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.860E-02 | 1.0000 |

*Sum of all water independent and dependent pathways.

| | | | |
|---|---|---|---|
| Attachment | 5 | Sheet No. | 9 of 18 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 5

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 10
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 8.475E-02 | 0.9790 | 3.710E-08 | 0.0000 | 0.000E+00 | 0.0000 | 4.087E-04 | 0.0047 | 3.153E-05 | 0.0004 | 1.958E-05 | 0.0002 | 1.059E-05 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.456E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.174E-03 | 0.0136 | 1.462E-05 | 0.0002 | 1.354E-04 | 0.0016 | 2.432E-05 | 0.0003 |
| Total | 8.475E-02 | 0.9790 | 1.493E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.582E-03 | 0.0183 | 4.615E-05 | 0.0005 | 1.550E-04 | 0.0018 | 3.491E-05 | 0.0004 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
0 Water Dependent Pathways

| 0 Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.522E-02 | 0.9844 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.349E-03 | 0.0156 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.656E-02 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 5 Sheet No. 10 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4  T½ Limit = 180 days  08/27/2009  15:21  Page  11
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File  : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 8.086E-02 | 0.9785 | 3.540E-08 | 0.0000 | 0.000E+00 | 0.0000 | 3.900E-04 | 0.0047 | 3.009E-05 | 0.0004 | 1.869E-05 | 0.0002 | 1.010E-05 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.434E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.155E-03 | 0.0140 | 1.440E-05 | 0.0002 | 1.333E-04 | 0.0016 | 2.395E-05 | 0.0003 |
| Total | 8.086E-02 | 0.9785 | 1.469E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.545E-03 | 0.0187 | 4.448E-05 | 0.0005 | 1.520E-04 | 0.0018 | 3.405E-05 | 0.0004 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Dependent Pathways

| 0 Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.131E-02 | 0.9839 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.329E-03 | 0.0161 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.264E-02 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 5  Sheet No. 11 of 18
Originator: S. W. Clark  Date 8/31/09
Chk'd By M. W. Perrott  Date 8/31/09
Calc. No. 0100D-CA-V0326  Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 12
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_Focus_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 6.863E-02 | 0.9767 | 3.005E-08 | 0.0000 | 0.000E+00 | 0.0000 | 3.310E-04 | 0.0047 | 2.554E-05 | 0.0004 | 1.586E-05 | 0.0002 | 8.576E-06 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.358E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.094E-03 | 0.0156 | 1.363E-05 | 0.0002 | 1.262E-04 | 0.0018 | 2.268E-05 | 0.0003 |
| Total | 6.863E-02 | 0.9767 | 1.388E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.425E-03 | 0.0203 | 3.917E-05 | 0.0006 | 1.421E-04 | 0.0020 | 3.126E-05 | 0.0004 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
Water Dependent Pathways

| Radio-Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.901E-02 | 0.9821 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.258E-03 | 0.0179 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.027E-02 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 5 Sheet No. 12 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 13
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 4.295E-02 | 0.9703 | 1.880E-08 | 0.0000 | 0.000E+00 | 0.0000 | 2.071E-04 | 0.0047 | 1.598E-05 | 0.0004 | 9.925E-06 | 0.0002 | 5.367E-06 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.162E-06 | 0.0000 | 0.000E+00 | 0.0000 | 9.367E-04 | 0.0212 | 1.167E-05 | 0.0003 | 1.081E-04 | 0.0024 | 1.942E-05 | 0.0004 |
| Total | 4.295E-02 | 0.9703 | 1.181E-06 | 0.0000 | 0.000E+00 | 0.0000 | 1.144E-03 | 0.0258 | 2.765E-05 | 0.0006 | 1.180E-04 | 0.0027 | 2.478E-05 | 0.0006 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
0 Water Dependent Pathways

| D Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.319E-02 | 0.9757 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.077E-03 | 0.0243 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.426E-02 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 5 Sheet No. 13 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 14
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 Radio- Nuclide | Ground mrem/yr | Ground fract. | Inhalation mrem/yr | Inhalation fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | Soil mrem/yr | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 8.326E-03 | 0.9254 | 3.645E-09 | 0.0000 | 0.000E+00 | 0.0000 | 4.016E-05 | 0.0045 | 3.098E-06 | 0.0003 | 1.924E-06 | 0.0002 | 1.040E-06 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 6.746E-07 | 0.0001 | 0.000E+00 | 0.0000 | 5.436E-04 | 0.0604 | 6.773E-06 | 0.0008 | 6.271E-05 | 0.0070 | 1.127E-05 | 0.0013 |
| Total | 8.326E-03 | 0.9254 | 6.782E-07 | 0.0001 | 0.000E+00 | 0.0000 | 5.838E-04 | 0.0649 | 9.871E-06 | 0.0011 | 6.464E-05 | 0.0072 | 1.231E-05 | 0.0014 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
0 Water Dependent Pathways

| 0 Radio- Nuclide | Water mrem/yr | Water fract. | Fish mrem/yr | Fish fract. | Radon mrem/yr | Radon fract. | Plant mrem/yr | Plant fract. | Meat mrem/yr | Meat fract. | Milk mrem/yr | Milk fract. | All Pathways* mrem/yr | All Pathways* fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.372E-03 | 0.9305 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.251E-04 | 0.0695 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 8.997E-03 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 5 Sheet No. 14 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 15
Summary : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

| 0 | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 7.669E-05 | 0.3666 | 3.357E-11 | 0.0000 | 0.000E+00 | 0.0000 | 3.698E-07 | 0.0018 | 2.853E-08 | 0.0001 | 1.772E-08 | 0.0001 | 9.582E-09 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.425E-07 | 0.0007 | 0.000E+00 | 0.0000 | 1.149E-04 | 0.5491 | 1.431E-06 | 0.0068 | 1.325E-05 | 0.0633 | 2.381E-06 | 0.0114 |
| Total | 7.669E-05 | 0.3666 | 1.426E-07 | 0.0007 | 0.000E+00 | 0.0000 | 1.152E-04 | 0.5509 | 1.460E-06 | 0.0070 | 1.327E-05 | 0.0634 | 2.390E-06 | 0.0114 |

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

| 0 | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radio-Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.711E-05 | 0.3687 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.321E-04 | 0.6313 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.092E-04 | 1.0000 |

0*Sum of all water independent and dependent pathways.

| | |
|---|---|
| Attachment 5 | Sheet No. 15 of 18 |
| Originator: S. W. Clark | Date 8/31/09 |
| Chk'd By M. W. Perrott | Date 8/31/09 |
| Calc. No. 0100D-CA-V0326 | Rev. No. 0 |

# ATTACHMENT 5

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page  16
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD
```

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 5.750E-12 | 0.0000 | 2.518E-18 | 0.0000 | 0.000E+00 | 0.0000 | 2.773E-14 | 0.0000 | 2.140E-15 | 0.0000 | 1.329E-15 | 0.0000 | 7.185E-16 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 6.177E-10 | 0.0011 | 0.000E+00 | 0.0000 | 4.978E-07 | 0.8697 | 6.203E-09 | 0.0108 | 5.743E-08 | 0.1003 | 1.032E-08 | 0.0180 |
| Total | 5.750E-12 | 0.0000 | 6.177E-10 | 0.0011 | 0.000E+00 | 0.0000 | 4.978E-07 | 0.8697 | 6.203E-09 | 0.0108 | 5.743E-08 | 0.1003 | 1.032E-08 | 0.0180 |

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All Pathways* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. | mrem/yr | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.782E-12 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.724E-07 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.724E-07 | 1.0000 |

0*Sum of all water independent and dependent pathways.

Attachment 5 Sheet No. 16 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page  17
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

                              Dose/Source Ratios Summed Over All Pathways
                        Parent and Progeny Principal Radionuclide Contributions Indicated
0  Parent     Product    Thread                 DSR(j,t) At Time in Years   (mrem/yr)/(pCi/g)
   (i)        (j)        Fraction   0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX
 Cs-137+D  Cs-137+D  1.000E+00  1.762E+00 1.722E+00 1.643E+00 1.394E+00 8.724E-01 1.691E-01 1.558E-03 1.168E-10
0Ni-63     Ni-63     1.000E+00  1.402E-04 1.391E-04 1.370E-04 1.297E-04 1.110E-04 6.444E-05 1.361E-05 5.901E-08
 !!!!!!!!!! !!!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!! !!!!!!!!!
 The DSR includes contributions from associated (half-life ó 180 days) daughters.
0
                                Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                                  Basic Radiation Dose Limit = 1.500E+01 mrem/yr
0Nuclide
   (i)     t= 0.000E+00   1.000E+00   3.000E+00   1.000E+01   3.000E+01   1.000E+02   3.000E+02   1.000E+03
 XXXXXXX     XXXXXXXXXX   XXXXXXXXX   XXXXXXXXX   XXXXXXXXX   XXXXXXXXX   XXXXXXXXX   XXXXXXXXX   XXXXXXXXX
 Cs-137      8.511E+00   8.713E+00   9.131E+00   1.076E+01   1.719E+01   8.869E+01   9.629E+03   1.284E+11
 Ni-63       1.070E+05   1.078E+05   1.095E+05   1.156E+05   1.351E+05   2.328E+05   1.102E+06   2.542E+08
 !!!!!!!     !!!!!!!!!   !!!!!!!!!   !!!!!!!!!   !!!!!!!!!   !!!!!!!!!   !!!!!!!!!   !!!!!!!!!   !!!!!!!!!
0
             Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
             and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
          at tmin = time of minimum single radionuclide soil guideline
       and at tmax = time of maximum total dose = 0.000E+00 years
0Nuclide  Initial          tmin       DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
   (i)    (pCi/g)        (years)                  (pCi/g)               (pCi/g)
 XXXXXXX XXXXXXXXX  XXXXXXXXXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX  XXXXXXXXX
 Cs-137  4.950E-02      0.000E+00     1.762E+00  8.511E+00  1.762E+00  8.511E+00
 Ni-63   9.700E+00      0.000E+00     1.402E-04  1.070E+05  1.402E-04  1.070E+05
 !!!!!!! !!!!!!!!!  !!!!!!!!!!!!!!!!  !!!!!!!!!  !!!!!!!!!  !!!!!!!!!  !!!!!!!!!
```

Attachment 5 Sheet No. 17 of 18
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 5

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page  18
 Summary : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

                              Individual Nuclide Dose Summed Over All Pathways
                                Parent Nuclide and Branch Fraction Indicated
ONuclide Parent   THF(i)                                DOSE(j,t), mrem/yr
   (j)     (i)              t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 XXXXXXX XXXXXXX XXXXXXXXX    XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX
 Cs-137  Cs-137  1.000E+00    8.724E-02 8.522E-02 8.131E-02 6.901E-02 4.319E-02 8.372E-03 7.711E-05 5.782E-12
ONi-63   Ni-63   1.000E+00    1.360E-03 1.349E-03 1.329E-03 1.258E-03 1.077E-03 6.251E-04 1.321E-04 5.724E-07
 ||||||| ||||||| |||||||||    ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| |||||||||
 THF(i) is the thread fraction of the parent nuclide.


                                 Individual Nuclide Soil Concentration
                                Parent Nuclide and Branch Fraction Indicated
ONuclide Parent   THF(i)                                  S(j,t), pCi/g
   (j)     (i)              t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 XXXXXXX XXXXXXX XXXXXXXXX    XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX XXXXXXXXX
 Cs-137  Cs-137  1.000E+00    4.950E-02 4.835E-02 4.614E-02 3.916E-02 2.450E-02 4.751E-03 4.375E-05 3.281E-12
ONi-63   Ni-63   1.000E+00    9.700E+00 9.625E+00 9.476E+00 8.975E+00 7.682E+00 4.459E+00 9.420E-01 4.083E-03
 ||||||| ||||||| |||||||||    ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| ||||||||| |||||||||
 THF(i) is the thread fraction of the parent nuclide.
ORESCALC.EXE execution time =    5.77 seconds
```

| | | | |
|---|---|---|---|
| Attachment | 5 | Sheet No. | 18 of 18 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 6

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page   1
 Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD
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Table of Contents
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Part III: Intake Quantities and Health Risk Factors
¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡¡

Cancer Risk Slope Factors ................................ 2
Risk Slope and ETFG for the Ground Pathway .............. 3
Amount of Intake Quantities and Excess Cancer Risks
Time= 0.000E+00 .................................... 4
Time= 1.000E+00 .................................... 6
Time= 3.000E+00 .................................... 8
Time= 1.000E+01 .................................... 10
Time= 3.000E+01 .................................... 12
Time= 1.000E+02 .................................... 14
Time= 3.000E+02 .................................... 16
Time= 1.000E+03 .................................... 18

Attachment 6 Sheet No. 1 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 2
Intrisk : Calculation of Dose for 11B-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\11B-DR-1_FOCUS_DOSE.RAD

Cancer Risk Slope Factors Summary Table
Risk Library: HEAST 2001 Morbidity

| 0 Menu | Parameter | Current Value | Base Case* | Parameter Name |
|---|---|---|---|---|
| Sf-1 | Ground external radiation slope factors, 1/yr per (pCi/g): | | | |
| Sf-1 | Cs-137+D | 2.55E-06 | 5.32E-10 | SLPF( 1,1) |
| Sf-1 | Ni-63 | 0.00E+00 | 0.00E+00 | SLPF( 2,1) |
| Sf-2 | Inhalation, slope factors, 1/(pCi): | | | |
| Sf-2 | Cs-137+D | 1.19E-11 | 1.19E-11 | SLPF( 1,2) |
| Sf-2 | Ni-63 | 5.77E-12 | 5.77E-12 | SLPF( 2,2) |
| Sf-3 | Food ingestion, slope factors, 1/(pCi): | | | |
| Sf-3 | Cs-137+D | 3.74E-11 | 3.74E-11 | SLPF( 1,3) |
| Sf-3 | Ni-63 | 9.51E-13 | 9.51E-13 | SLPF( 2,3) |
| Sf-3 | Water ingestion, slope factors, 1/(pCi): | | | |
| Sf-3 | Cs-137+D | 3.04E-11 | 3.04E-11 | SLPF( 1,4) |
| Sf-3 | Ni-63 | 6.70E-13 | 6.70E-13 | SLPF( 2,4) |
| Sf-3 | Soil ingestion, slope factors, 1/(pCi): | | | |
| Sf-3 | Cs-137+D | 4.33E-11 | 4.33E-11 | SLPF( 1,5) |
| Sf-3 | Ni-63 | 1.79E-12 | 1.79E-12 | SLPF( 2,5) |

*Base Case means Default.Lib w/o Associate Nuclide contributions.

Attachment 6 Sheet No. 2 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page   3
 Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

                    Risk Slope and Environmental Transport Factors for the Ground Pathway
ONuclide  Slope(i)*                        ETFG(i,t) At Time in Years  (dimensionless)
   (i)            t= 0.000E+00  1.000E+00  3.000E+00  1.000E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
 ÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ
 Ba-137m  2.690E-06   5.137E-01  5.137E-01  5.137E-01  5.137E-01  5.137E-01  5.137E-01  5.137E-01  5.137E-01
 Cs-137   5.320E-10   5.360E-01  5.360E-01  5.360E-01  5.360E-01  5.360E-01  5.360E-01  5.360E-01  5.360E-01
 Ni-63    0.000E+00   0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 ïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï  ïïïïïïïïïï
 * - Units are 1/yr per (pCi/g) at infinite depth and area.  Multiplication by ETFG(i,t) converts to site conditions.
```

| | | | |
|---|---|---|---|
| Attachment | 6 | Sheet No. 3 of 19 | |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 4
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 0.000E+00 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 1.191E-03 | 8.368E+00 | 6.456E-01 | 4.010E-01 | 2.168E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.631E+00 |
| Ni-63 | 2.333E-01 | 2.050E+03 | 2.554E+01 | 2.364E+02 | 4.249E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.354E+03 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.394E-06 | 0.9530 | 3.053E-13 | 0.0000 | 6.743E-09 | 0.0046 | 5.202E-10 | 0.0004 | 3.231E-10 | 0.0002 | 2.023E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.602E-11 | 0.0000 | 5.216E-08 | 0.0357 | 6.499E-10 | 0.0004 | 6.017E-09 | 0.0041 | 2.035E-09 | 0.0014 |
| Total | 1.394E-06 | 0.9530 | 3.633E-11 | 0.0000 | 5.891E-08 | 0.0403 | 1.170E-09 | 0.0008 | 6.340E-09 | 0.0043 | 2.237E-09 | 0.0015 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.402E-06 | 0.9584 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.090E-08 | 0.0416 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.463E-06 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 6 Sheet No. 4 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 5
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.394E-06 | 0.9530 | 3.053E-13 | 0.0000 | 0.000E+00 | 0.0000 | 6.743E-09 | 0.0046 | 5.202E-10 | 0.0004 | 3.231E-10 | 0.0002 | 2.023E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.602E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.216E-08 | 0.0357 | 6.499E-10 | 0.0004 | 6.017E-09 | 0.0041 | 2.035E-09 | 0.0014 |
| Total | 1.394E-06 | 0.9530 | 3.633E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.891E-08 | 0.0403 | 1.170E-09 | 0.0008 | 6.340E-09 | 0.0043 | 2.237E-09 | 0.0015 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 0.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.402E-06 | 0.9584 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.090E-08 | 0.0416 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.463E-06 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 5 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 6
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+00 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 1.163E-03 | 8.174E+00 | 6.306E-01 | 3.917E-01 | 2.118E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.408E+00 |
| Ni-63 | 2.315E-01 | 2.034E+03 | 2.534E+01 | 2.346E+02 | 4.216E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.336E+03 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.362E-06 | 0.9524 | 2.982E-13 | 0.0000 | 6.587E-09 | 0.0046 | 5.082E-10 | 0.0004 | 3.156E-10 | 0.0002 | 1.976E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.575E-11 | 0.0000 | 5.176E-08 | 0.0362 | 6.449E-10 | 0.0005 | 5.971E-09 | 0.0042 | 2.019E-09 | 0.0014 |
| Total | 1.362E-06 | 0.9524 | 3.604E-11 | 0.0000 | 5.835E-08 | 0.0408 | 1.153E-09 | 0.0008 | 6.286E-09 | 0.0044 | 2.217E-09 | 0.0016 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.370E-06 | 0.9577 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.043E-08 | 0.0423 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.430E-06 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

| | | | |
|---|---|---|---|
| Attachment | 6 | Sheet No. | 6 of 19 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 7
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground risk | Ground fract. | Inhalation risk | Inhalation fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | Soil risk | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 1.362E-06 | 0.9524 | 2.982E-13 | 0.0000 | 0.000E+00 | 0.0000 | 6.587E-09 | 0.0046 | 5.082E-10 | 0.0004 | 3.156E-10 | 0.0002 | 1.976E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.575E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.176E-08 | 0.0362 | 6.449E-10 | 0.0005 | 5.971E-09 | 0.0042 | 2.019E-09 | 0.0014 |
| Total | 1.362E-06 | 0.9524 | 3.604E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.835E-08 | 0.0408 | 1.153E-09 | 0.0008 | 6.286E-09 | 0.0044 | 2.217E-09 | 0.0016 |

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+00 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | Water fract. | Fish risk | Fish fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | All pathways risk | All pathways fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.370E-06 | 0.9577 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.043E-08 | 0.0423 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.430E-06 | 1.0000 |

***CNRS1(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 7 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 8
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+00 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Total Ingestion* |
| Cs-137 | 1.110E-03 | 7.800E+00 | 6.018E-01 | 3.736E-01 | 2.021E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.978E+00 |
| Ni-63 | 2.279E-01 | 2.003E+03 | 2.495E+01 | 2.310E+02 | 4.151E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.300E+03 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.300E-06 | 0.9511 | 2.845E-13 | 0.0000 | 6.285E-09 | 0.0046 | 4.849E-10 | 0.0004 | 3.012E-10 | 0.0002 | 1.885E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.519E-11 | 0.0000 | 5.096E-08 | 0.0373 | 6.349E-10 | 0.0005 | 5.879E-09 | 0.0043 | 1.988E-09 | 0.0015 |
| Total | 1.300E-06 | 0.9511 | 3.548E-11 | 0.0000 | 5.725E-08 | 0.0419 | 1.120E-09 | 0.0008 | 6.180E-09 | 0.0045 | 2.177E-09 | 0.0016 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.307E-06 | 0.9565 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.950E-08 | 0.0435 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.366E-06 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

| | | | |
|---|---|---|---|
| Attachment | 6 | Sheet No. | 8 of 19 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 9
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.300E-06 | 0.9511 | 2.845E-13 | 0.0000 | 0.000E+00 | 0.0000 | 6.285E-09 | 0.0046 | 4.849E-10 | 0.0004 | 3.012E-10 | 0.0002 | 1.885E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.519E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.096E-08 | 0.0373 | 6.349E-10 | 0.0005 | 5.879E-09 | 0.0043 | 1.988E-09 | 0.0015 |
| Total | 1.300E-06 | 0.9511 | 3.548E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.725E-08 | 0.0419 | 1.120E-09 | 0.0008 | 6.180E-09 | 0.0045 | 2.177E-09 | 0.0016 |

0
Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+00 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.307E-06 | 0.9565 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.950E-08 | 0.0435 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.366E-06 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 9 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 10
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+01 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 9.419E-04 | 6.620E+00 | 5.107E-01 | 3.172E-01 | 1.715E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 7.619E+00 |
| Ni-63 | 2.159E-01 | 1.896E+03 | 2.363E+01 | 2.188E+02 | 3.931E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.178E+03 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.103E-06 | 0.9464 | 2.415E-13 | 0.0000 | 5.334E-09 | 0.0046 | 4.115E-10 | 0.0004 | 2.556E-10 | 0.0002 | 1.600E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.333E-11 | 0.0000 | 4.826E-08 | 0.0414 | 6.013E-10 | 0.0005 | 5.567E-09 | 0.0048 | 1.883E-09 | 0.0016 |
| Total | 1.103E-06 | 0.9464 | 3.357E-11 | 0.0000 | 5.360E-08 | 0.0460 | 1.013E-09 | 0.0009 | 5.823E-09 | 0.0050 | 2.043E-09 | 0.0018 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.109E-06 | 0.9517 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.635E-08 | 0.0483 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.166E-06 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 6 Sheet No. 10 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 11
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

| Radio-Nuclide | Ground risk | Ground fract. | Inhalation risk | Inhalation fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | Soil risk | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 1.103E-06 | 0.9464 | 2.415E-13 | 0.0000 | 0.000E+00 | 0.0000 | 5.334E-09 | 0.0046 | 4.115E-10 | 0.0004 | 2.556E-10 | 0.0002 | 1.600E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.333E-11 | 0.0000 | 0.000E+00 | 0.0000 | 4.826E-08 | 0.0414 | 6.013E-10 | 0.0005 | 5.567E-09 | 0.0048 | 1.883E-09 | 0.0016 |
| Total | 1.103E-06 | 0.9464 | 3.357E-11 | 0.0000 | 0.000E+00 | 0.0000 | 5.360E-08 | 0.0460 | 1.013E-09 | 0.0009 | 5.823E-09 | 0.0050 | 2.043E-09 | 0.0018 |

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+01 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | Water fract. | Fish risk | Fish fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | All pathways risk | All pathways fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.109E-06 | 0.9517 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.635E-08 | 0.0483 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.166E-06 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 11 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 12
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+01 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 5.894E-04 | 4.143E+00 | 3.196E-01 | 1.985E-01 | 1.073E-01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 4.768E+00 |
| Ni-63 | 1.848E-01 | 1.623E+03 | 2.023E+01 | 1.873E+02 | 3.365E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.865E+03 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 6.903E-07 | 0.9298 | 1.511E-13 | 0.0000 | 3.338E-09 | 0.0045 | 2.575E-10 | 0.0003 | 1.600E-10 | 0.0002 | 1.001E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.853E-11 | 0.0000 | 4.131E-08 | 0.0557 | 5.147E-10 | 0.0007 | 4.766E-09 | 0.0064 | 1.612E-09 | 0.0022 |
| Total | 6.903E-07 | 0.9298 | 2.868E-11 | 0.0000 | 4.465E-08 | 0.0601 | 7.722E-10 | 0.0010 | 4.926E-09 | 0.0066 | 1.712E-09 | 0.0023 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.941E-07 | 0.9350 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.823E-08 | 0.0650 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.423E-07 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 6 Sheet No. 12 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 13
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 6.903E-07 | 0.9298 | 1.511E-13 | 0.0000 | 0.000E+00 | 0.0000 | 3.338E-09 | 0.0045 | 2.575E-10 | 0.0003 | 1.600E-10 | 0.0002 | 1.001E-10 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 2.853E-11 | 0.0000 | 0.000E+00 | 0.0000 | 4.131E-08 | 0.0557 | 5.147E-10 | 0.0007 | 4.766E-09 | 0.0064 | 1.612E-09 | 0.0022 |
| Total | 6.903E-07 | 0.9298 | 2.868E-11 | 0.0000 | 0.000E+00 | 0.0000 | 4.465E-08 | 0.0601 | 7.722E-10 | 0.0010 | 4.926E-09 | 0.0066 | 1.712E-09 | 0.0023 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+01 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 6.941E-07 | 0.9350 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 4.823E-08 | 0.0650 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.423E-07 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 13 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 14
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+02 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 1.143E-04 | 8.031E-01 | 6.196E-02 | 3.848E-02 | 2.081E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.243E-01 |
| Ni-63 | 1.072E-01 | 9.422E+02 | 1.174E+01 | 1.087E+02 | 1.953E+01 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 1.082E+03 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

0

Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.338E-07 | 0.8232 | 2.930E-14 | 0.0000 | 6.471E-10 | 0.0040 | 4.993E-11 | 0.0003 | 3.101E-11 | 0.0002 | 1.941E-11 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.656E-11 | 0.0001 | 2.398E-08 | 0.1475 | 2.987E-10 | 0.0018 | 2.766E-09 | 0.0170 | 9.354E-10 | 0.0058 |
| Total | 1.338E-07 | 0.8232 | 1.659E-11 | 0.0001 | 2.462E-08 | 0.1515 | 3.486E-10 | 0.0021 | 2.797E-09 | 0.0172 | 9.548E-10 | 0.0059 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.346E-07 | 0.8278 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.799E-08 | 0.1722 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.626E-07 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

| | | | |
|---|---|---|---|
| Attachment | 6 | Sheet No. | 14 of 19 |
| Originator: | S. W. Clark | Date | 8/31/09 |
| Chk'd By | M. W. Perrott | Date | 8/31/09 |
| Calc. No. | 0100D-CA-V0326 | Rev. No. | 0 |

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 15
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio-Nuclide | Ground risk | Ground fract. | Inhalation risk | Inhalation fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | Soil risk | Soil fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 1.338E-07 | 0.8232 | 2.930E-14 | 0.0000 | 0.000E+00 | 0.0000 | 6.471E-10 | 0.0040 | 4.993E-11 | 0.0003 | 3.101E-11 | 0.0002 | 1.941E-11 | 0.0001 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.656E-11 | 0.0001 | 0.000E+00 | 0.0000 | 2.398E-08 | 0.1475 | 2.987E-10 | 0.0018 | 2.766E-09 | 0.0170 | 9.354E-10 | 0.0058 |
| Total | 1.338E-07 | 0.8232 | 1.659E-11 | 0.0001 | 0.000E+00 | 0.0000 | 2.462E-08 | 0.1515 | 3.486E-10 | 0.0021 | 2.797E-09 | 0.0172 | 9.548E-10 | 0.0059 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+02 years

Water Dependent Pathways

| Radio-Nuclide | Water risk | Water fract. | Fish risk | Fish fract. | Radon risk | Radon fract. | Plant risk | Plant fract. | Meat risk | Meat fract. | Milk risk | Milk fract. | All pathways risk | All pathways fract. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.346E-07 | 0.8278 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.799E-08 | 0.1722 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.626E-07 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 15 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 16
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 3.000E+02 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 1.052E-06 | 7.397E-03 | 5.707E-04 | 3.544E-04 | 1.916E-04 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 8.514E-03 |
| Ni-63 | 2.266E-02 | 1.991E+02 | 2.480E+00 | 2.296E+01 | 4.126E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 2.286E+02 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

0
Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.233E-09 | 0.1723 | 2.698E-16 | 0.0000 | 5.960E-12 | 0.0008 | 4.598E-13 | 0.0001 | 2.856E-13 | 0.0000 | 1.788E-13 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.498E-12 | 0.0005 | 5.065E-09 | 0.7081 | 6.311E-11 | 0.0088 | 5.843E-10 | 0.0817 | 1.976E-10 | 0.0276 |
| Total | 1.233E-09 | 0.1723 | 3.499E-12 | 0.0005 | 5.071E-09 | 0.7090 | 6.357E-11 | 0.0089 | 5.846E-10 | 0.0817 | 1.978E-10 | 0.0277 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.239E-09 | 0.1733 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.914E-09 | 0.8267 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.153E-09 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 6 Sheet No. 16 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 17
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 1.233E-09 | 0.1723 | 2.698E-16 | 0.0000 | 0.000E+00 | 0.0000 | 5.960E-12 | 0.0008 | 4.598E-13 | 0.0001 | 2.856E-13 | 0.0000 | 1.788E-13 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 3.498E-12 | 0.0005 | 0.000E+00 | 0.0000 | 5.065E-09 | 0.7081 | 6.311E-11 | 0.0088 | 5.843E-10 | 0.0817 | 1.976E-10 | 0.0276 |
| Total | 1.233E-09 | 0.1723 | 3.499E-12 | 0.0005 | 0.000E+00 | 0.0000 | 5.071E-09 | 0.7090 | 6.357E-11 | 0.0089 | 5.846E-10 | 0.0817 | 1.978E-10 | 0.0277 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 3.000E+02 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 1.239E-09 | 0.1733 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 5.914E-09 | 0.8267 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 7.153E-09 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 17 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 18
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Amount of Intake Quantities QINT(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As pCi/yr at t= 1.000E+03 years

| Radio- | Water Independent Pathways (Inhalation w/o radon) | | | | | Water Dependent Pathways | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | Inhalation | Plant | Meat | Milk | Soil | Water | Fish | Plant | Meat | Milk | Ingestion* |
| Cs-137 | 7.892E-14 | 5.547E-10 | 4.279E-11 | 2.658E-11 | 1.437E-11 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 6.384E-10 |
| Ni-63 | 9.821E-05 | 8.628E-01 | 1.075E-02 | 9.953E-02 | 1.788E-02 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 0.000E+00 | 9.910E-01 |

* Sum of all ingestion pathways, i.e. water independent plant, meat, milk, soil
and water-dependent water, fish, plant, meat, milk pathways

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

0 Water Independent Pathways (Inhalation excludes radon)

0

| Radio- | Ground | | Inhalation | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 9.242E-17 | 0.0000 | 2.023E-23 | 0.0000 | 4.469E-19 | 0.0000 | 3.448E-20 | 0.0000 | 2.142E-20 | 0.0000 | 1.341E-20 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.516E-14 | 0.0006 | 2.196E-11 | 0.8565 | 2.736E-13 | 0.0107 | 2.533E-12 | 0.0988 | 8.566E-13 | 0.0334 |
| Total | 9.242E-17 | 0.0000 | 1.516E-14 | 0.0006 | 2.196E-11 | 0.8565 | 2.736E-13 | 0.0107 | 2.533E-12 | 0.0988 | 8.566E-13 | 0.0334 |

0

Excess Cancer Risks CNRS(i,p,t) for Individual Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Plant | | Meat | | Milk | | All Pathways** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.294E-17 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.563E-11 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.563E-11 | 1.0000 |

** Sum of water independent ground, inhalation, plant, meat, milk, soil
and water dependent water, fish, plant, meat, milk pathways

Attachment 6 Sheet No. 18 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 6

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 19
Intrisk : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)
0

| Radio- | Ground | | Inhalation | | Radon | | Plant | | Meat | | Milk | | Soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 9.242E-17 | 0.0000 | 2.023E-23 | 0.0000 | 0.000E+00 | 0.0000 | 4.469E-19 | 0.0000 | 3.448E-20 | 0.0000 | 2.142E-20 | 0.0000 | 1.341E-20 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 1.516E-14 | 0.0006 | 0.000E+00 | 0.0000 | 2.196E-11 | 0.8565 | 2.736E-13 | 0.0107 | 2.533E-12 | 0.0988 | 8.566E-13 | 0.0334 |
| Total | 9.242E-17 | 0.0000 | 1.516E-14 | 0.0006 | 0.000E+00 | 0.0000 | 2.196E-11 | 0.8565 | 2.736E-13 | 0.0107 | 2.533E-12 | 0.0988 | 8.566E-13 | 0.0334 |

0

Total Excess Cancer Risk CNRS(i,p,t)*** for Initially Existent Radionuclides (i) and Pathways (p)
and Fraction of Total Risk at t= 1.000E+03 years

Water Dependent Pathways

| Radio- | Water | | Fish | | Radon | | Plant | | Meat | | Milk | | All pathways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nuclide | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. | risk | fract. |
| Cs-137 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 9.294E-17 | 0.0000 |
| Ni-63 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.563E-11 | 1.0000 |
| Total | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 0.000E+00 | 0.0000 | 2.563E-11 | 1.0000 |

***CNRSI(i,p,t) includes contribution from decay daughter radionuclides

Attachment 6 Sheet No. 19 of 19
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

```
1RESRAD, Version 6.4      T« Limit = 180 days       08/27/2009  15:21  Page   1
 Concent : Calculation of Dose for 118-DR-1 Focused Samples
 File    : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

                      Table of Contents
                      XXXXXXXXXXXXXXXXX
            Part IV: Concentration of Radionuclides
            !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

 Concentration of radionuclides in different media
      Time= 0.000E+00 ..................................   2
      Time= 1.000E+00 ..................................   3
      Time= 3.000E+00 ..................................   4
      Time= 1.000E+01 ..................................   5
      Time= 3.000E+01 ..................................   6
      Time= 1.000E+02 ..................................   7
      Time= 3.000E+02 ..................................   8
      Time= 1.000E+03 ..................................   9
```

Attachment 7 Sheet No. 1 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 2
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 0.000E+00 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 4.950E-02 | 4.950E-02 | 3.707E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 9.700E+00 | 9.700E+00 | 7.264E-05 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 0.000E+00 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.980E+00 | 1.980E+00 | 1.980E+00 | 1.980E+00 | 4.782E+00 | 1.069E+00 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 4.850E+02 | 4.850E+02 | 4.850E+02 | 4.850E+02 | 1.892E+02 | 6.305E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 2 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 3
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+00 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 4.835E-02 | 4.835E-02 | 3.621E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 9.625E+00 | 9.625E+00 | 7.208E-05 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+00 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.934E+00 | 1.934E+00 | 1.937E+00 | 1.934E+00 | 4.671E+00 | 1.045E+00 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 4.813E+02 | 4.813E+02 | 4.815E+02 | 4.813E+02 | 1.877E+02 | 6.257E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 3 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 4
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+00 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 4.614E-02 | 4.614E-02 | 3.455E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 9.476E+00 | 9.476E+00 | 7.097E-05 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 3.000E+00 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.846E+00 | 1.846E+00 | 1.848E+00 | 1.846E+00 | 4.457E+00 | 9.967E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 4.738E+02 | 4.738E+02 | 4.741E+02 | 4.739E+02 | 1.848E+02 | 6.160E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 4 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 5
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+01 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 3.916E-02 | 3.916E-02 | 2.932E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 8.975E+00 | 8.975E+00 | 6.721E-05 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+01 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.566E+00 | 1.566E+00 | 1.568E+00 | 1.567E+00 | 3.783E+00 | 8.459E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 4.487E+02 | 4.487E+02 | 4.490E+02 | 4.488E+02 | 1.750E+02 | 5.834E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 5 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 6
Concent : Calculation of Dose for 118-DR-1 Focused Samples
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Concentration of radionuclides in environmental media
at t = 3.000E+01 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 2.450E-02 | 2.450E-02 | 1.835E-07 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 7.682E+00 | 7.682E+00 | 5.753E-05 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 3.000E+01 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 9.802E-01 | 9.802E-01 | 9.815E-01 | 9.803E-01 | 2.367E+00 | 5.293E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 3.841E+02 | 3.841E+02 | 3.843E+02 | 3.842E+02 | 1.498E+02 | 4.994E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 6 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T½ Limit = 180 days 08/27/2009 15:21 Page 7
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+02 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 4.751E-03 | 4.751E-03 | 3.558E-08 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 4.459E+00 | 4.459E+00 | 3.339E-05 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+02 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.900E-01 | 1.900E-01 | 1.903E-01 | 1.901E-01 | 4.589E-01 | 1.026E-01 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 2.229E+02 | 2.229E+02 | 2.230E+02 | 2.230E+02 | 8.695E+01 | 2.898E+02 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 7 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 8
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 3.000E+02 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 4.375E-05 | 4.375E-05 | 3.277E-10 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 9.420E-01 | 9.420E-01 | 7.054E-06 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 3.000E+02 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.750E-03 | 1.750E-03 | 1.753E-03 | 1.750E-03 | 4.227E-03 | 9.452E-04 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 4.710E+01 | 4.710E+01 | 4.712E+01 | 4.710E+01 | 1.837E+01 | 6.123E+01 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 8 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# ATTACHMENT 7

1RESRAD, Version 6.4 T« Limit = 180 days 08/27/2009 15:21 Page 9
Concent : Calculation of Dose for 118-DR-1 Focused Samples
File : C:\RESRAD_FAMILY\RESRAD\118-DR-1_FOCUS_DOSE.RAD

Concentration of radionuclides in environmental media
at t = 1.000E+03 years

| Radio-Nuclide | Contaminated Zone pCi/g | Surface Soil* pCi/g | Air Particulate pCi/m**3 | Well Water pCi/L | Surface Water pCi/L |
|---|---|---|---|---|---|
| Cs-137 | 3.281E-12 | 3.281E-12 | 2.457E-17 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 4.083E-03 | 4.083E-03 | 3.058E-08 | 0.000E+00 | 0.000E+00 |

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+03 years*

| Radio-Nuclide | Drinking Water pCi/L | Nonleafy Vegetable pCi/kg | Leafy Vegetable pCi/kg | Fodder Meat pCi/kg | Fodder Milk pCi/kg | Meat pCi/kg | Milk pCi/L | Fish pCi/kg | Crustacea pCi/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cs-137 | 0.000E+00 | 1.312E-10 | 1.312E-10 | 1.314E-10 | 1.313E-10 | 3.170E-10 | 7.087E-11 | 0.000E+00 | 0.000E+00 |
| Ni-63 | 0.000E+00 | 2.042E-01 | 2.042E-01 | 2.043E-01 | 2.042E-01 | 7.963E-02 | 2.654E-01 | 0.000E+00 | 0.000E+00 |

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 7 Sheet No. 9 of 9
Originator: S. W. Clark Date 8/31/09
Chk'd By M. W. Perrott Date 8/31/09
Calc. No. 0100D-CA-V0326 Rev. No. 0

# APPENDIX C

# DATA QUALITY ASSESSMENT

# APPENDIX C

## VERIFICATION SAMPLING DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WHC 2009b). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001).

A review of the sample design (WCH 2009b), the field logbook (WCH 2009a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design, with one exception. Sample J18NT1 was collected as a split for primary sample J18NP9 from the 118-DR-1 Burial Ground excavation; however, since samples J18 NTI and J18NP9 were analyzed at the same laboratory, sample J18NT1 will not be evaluated as a quality assurance/quality control (QA/QC) split sample. It was noted the J18NT1 sample results showed good agreement with the primary and duplicate sample results from the same location.

The sample design included a statistical sampling approach. In order to calculate the number of samples needed in the statistical sampling plan, the standard deviation for each COC/COPC in the target population was assumed to be less than or equal to 40% of the corresponding decision threshold for each COC/COPC. Examination of the resulting data set shows that the sample standard deviations are consistent with those assumptions.

To ensure quality data, the SAP data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000a, 2000b) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification sample data collected at the 118-DR-1 waste sites were provided by the laboratories in three sample delivery groups (SDGs): SDG J00443, SDG J00444, and SDG J00445. SDG J00443 comprised only the results for the sample (J18NT1) that was intended to be a split QA/QC sample; as the sample will not be used to support the verification sampling for the 118-DR-1 Burial Ground, it is not evaluated as part of this DQA. SDG J00445 was submitted for third-party validation. No major deficiencies were found in the analytical data set. Minor deficiencies were identified in the analytical data set, and are discussed below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

**SDG J00444**

This SDG comprises 13 statistical soil samples (J18NP8 through J18NP9, J18NR0 through J18NR9, and J18NT0) collected from the 118-DR-1 excavation. A field duplicate pair (J18NP9/J18NT0) is included in this SDG. These samples were analyzed for inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, nickel-63 by liquid scintillation, and by gamma spectroscopy. In addition, one equipment blank (J18NP7) was collected and analyzed for ICP metals and mercury. Minor deficiencies are as follows:

For the gamma spectroscopy, insufficient sample material was available to prepare a laboratory duplicate of sample J18NP7. The duplicate result was obtained by recounting sample J18NP7 on a different detector.

In the ICP metals analysis, aluminum, antimony, and manganese matrix spike (MS) recoveries are out of project acceptance criteria. For aluminum and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony did not have mismatched spike and native concentrations in the original MS. The original MS recovery for antimony was 58%. The antimony data for SDG J00444 may be considered estimated. Estimated data are useable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate relative percent difference (RPD) for nickel is above the acceptance criteria (30%) at 32%. Elevated RPDs in environmental soil samples are generally attributed to heterogeneities in the sample matrix and not to deficiencies in the laboratory procedures. The data are useable for decision-making purposes.

**SDG J00445**

This SDG comprises two focus soil samples (J18NT5 and J18NT6) collected from the excavation. These samples were analyzed for ICP metals, mercury, hexavalent chromium, nickel-63 by liquid scintillation, and by gamma spectroscopy. In addition, sample J18NT6 was analyzed for polyaromatic hydrocarbons (PAH), polychlorinated biphenyls (PCBs), and pesticides. SDG J00445 was submitted for third-party validation. Minor deficiencies are as follows:

In the radionuclide analysis, all gamma spectroscopy results were qualified as estimates and flagged "J" by third-party validation, due to the lack of a laboratory control sample (LCS) analysis. Estimated data are useable for decision-making purposes.

In the hexavalent chromium analysis, the MS recovery is below project acceptance criteria, at 66%. The hexavalent chromium data for SDG J00445 are considered

estimated by third-party validation and flagged "J." The data are useable for decision-making purposes.

In the PCB analysis, the MS recovery for Aroclor-1260 is below project acceptance criteria, at 69%. The Aroclor-1260 data for SDG J00445 are considered estimated by third-party validation and flagged "J." The data are useable for decision-making purposes.

In the ICP metals analysis, aluminum, antimony, and manganese MS recoveries are out of project acceptance criteria. For aluminum and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. Antimony did not have mismatched spike and native concentrations in the original MS. The original MS recovery for antimony was 58%. The antimony data for SDG J00445 are considered estimated by third-party validation and flagged "J." The data are useable for decision-making purposes.

In the ICP metals analysis, the laboratory duplicate RPD for nickel is above the acceptance criteria (30%) at 40%. Elevated RPDs in environmental soil samples are generally attributed to heterogeneities in the sample matrix and not to deficiencies in the laboratory procedures. The data are useable for decision-making purposes.

## FIELD QUALITY ASSURANCE/QUALITY CONTROL

RPD evaluations of main sample(s) versus the laboratory duplicate(s) are routinely performed and reported by the laboratory. Any deficiencies in those calculations are reported by SDG in the previous sections.

Field QA/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbook (WCH 2009b), are the 118-DR-1 excavation sample primary and duplicate (J18NP9/J18NT0). The main and QA/QC sample results are presented in Appendix B.

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the sample/duplicate pair(s) for each contaminant of concern (COC). RPDs are not calculated for analytes that are not detected in both the main and duplicate sample at more than five times the target detection limit. RPDs of analytes detected at low concentrations (less than five times the detection limit) are not considered indicative of the analytical system performance. The 95% upper confidence

limit (UCL) calculation brief in Appendix B provides details on duplicate pair evaluation and RPD calculation.

None of the RPDs calculated for the field duplicates samples are above the acceptance criteria (30%). A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit (TDL), including undetected analytes. In these cases, a control limit of ± 2 times the TDL is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. No sample results required this check. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are useable for decision-making purposes.

**Summary**

Limited, random, or sample matrix-specific influenced batch QC issues such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 118-DR-1 waste sites verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for 118-DR-1 waste sites concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes. The verification sample analytical data are stored in the Environmental Restoration project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix B.

## REFERENCES

BHI, 2000a, *Data Validation Procedure for Chemical Analysis*, BHI-01435, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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WCH, 2009a, *Site-wide Miscellaneous Sampling*, Logbook EL-1607-6, pp. 6-7, Washington Closure Hanford, Richland, Washington.

WCH, 2009b, *Work Instruction for Verification Sampling of 118-DR-1, 105-DR Gas Loop Burial Ground,* 0100D-WI-G0048, Rev. 0, Washington Closure Hanford, Richland, Washington.

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