CVP-2002-00010
Rev. 0

Cleanup Verification Package for the 116-F-6 Liquid Waste Disposal Trench

Prepared for the U.S. Department of Energy by Bechtel Hanford, Inc.

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EXECUTIVE SUMMARY

E1.0 INTRODUCTION

This cleanup verification package documents completion of remedial action for the 116-F-6 Liquid Waste Disposal Trench (also referred to as the 116-F-6 site). The 116-F-6 site is located within the 100-FR-1 Operable Unit in the 100-F Area of the Hanford Site in southeastern Washington State. The site is located approximately 55 m (180 ft) southeast of the southeastern corner of the 105-F Reactor Building inside the 105-F Exclusion Area fence. The site was an unlined trench 91 m (300 ft) long, 30 m (100 ft) wide, and 3 m (10 ft) deep. The trench was used intermittently to dispose of cooling water from the 105-F Reactor via the 1608-F Pumping Station while maintenance and repairs were being performed on the effluent system. The site was active from 1952 through 1965.

Remedial action objectives and goals for the 116-F-6 site were established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. These goals and objectives are documented in the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (ROD) (EPA 1997) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2002).

The selected remedial action for the 116-F-6 site included (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 Areas of the Hanford Site, and (3) backfilling the site with clean soil to average adjacent grade elevation. Excavation was driven by remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, remedial action goals (RAGs) were established to identify radionuclide and nonradionuclide contaminants of concern (COCs). Waste site

COCs identified through process knowledge were listed in the *100 Area Remedial Action Sampling and Analysis Plan* (DOE-RL 2001). The COCs for this site consist of the following:

- Cesium-137
- Cobalt-60
- Europium-152
- Europium-154
- Strontium- 90
- Hexavalent chromium.

E2.0 RESULTS

Site excavation and waste disposal are complete, and the exposed surfaces have been sampled and analyzed to verify attainment of the RAGs. At the completion of the remedial action, the total excavation was approximately 5,272 m^2 (56,747 ft^2) in area with a depth of 4.6 m (15 ft). Approximately 32,156 metric tons (35,446 tons) of material from the site were disposed of at the Environmental Restoration Disposal Facility.

Results of the sampling, laboratory analyses, and data evaluations for the 116-F-6 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). The following sections discuss these results.

Table ES-1. Summary of Cleanup Verification Results for the 116-F-6 Fuel Storage Basin Trench.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	1. Attain 15 mrem/yr dose rate above background over 1,000 years.	1. Maximum dose rate calculated by RESRAD is 5.81 mrem/yr (not accounting for clean backfill).	Yes	a
Direct Exposure – Nonradionuclides	1. Attain individual COC RAGs.	1. All individual COC concentrations are below the RAGs.	Yes	b
Meet Nonradionuclide Risk Requirements	1. Hazard quotient of <1 for noncarcinogens.	1. All hazard quotients are below 1.	Yes	b
	2. Cumulative hazard quotient of <1 for noncarcinogens.	2. Cumulative hazard quotient is 1.33×10^{-3}.		b
	3. Excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	3. Excess cancer risk for individual carcinogens are all less than 1×10^{-6}.		b
	4. Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	4. Total excess cancer risk is 2.5×10^{-7}.		b
Groundwater/River Protection – Radionuclides	1. Attain single-COC groundwater and river protection RAGs.	1. All single-COC groundwater and river RAGs have been attained.	Yes	a
	2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	2. All organ-specific dose rates are below the 4 mrem/yr dose rate limit.		c
	3. Meet drinking water standards for alpha emitters: the more stringent of the 15 pCi/L MCL or 1/25th of the derived concentration guide per DOE Order 5400.5.	3. There are no alpha-emitting COCs for this site.		a
	4. Meet total uranium standard of 21.2 pCi/L.[f]	4. Uranium is not a COC for this site.		
Groundwater/River Protection – Nonradionuclides	1. Attain individual nonradionuclide groundwater and river cleanup requirements.	1. All the groundwater and river RAGs have been attained.	Yes	a,b
Other supporting Information	1. Sample variance calculation.			d
	2. Sample location design.			e

[a] *116-F-6 RESRAD Calculation*, 0100F-CA-V0143, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[b] *116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation*, 0100F-CA-V0141, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[c] *116-F-6 Trench Comparison to Drinking Water Standards,* 0100F-CA-V0142, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[d] *16-F-6 Liquid Waste Trench Sample Variance Calculation*, 0100F-CA-V0152, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[e] *16-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design*, 0100F-CA-V0159, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[f] Since the time of ROD signature, the U.S. Environmental Protection Agency has promulgated a more restrictive maximum contaminant level (MCL) of 30 µg/L for total uranium (65 *Federal Register* 76708). Based on the isotopic distribution of uranium in the 100 Areas, the 30 µg/L MCL corresponds to 21.2 pCi/L (BHI 2001).

E2.1 DIRECT EXPOSURE SOIL CLEANUP STANDARDS

E2.1.1 Radionuclides

The ROD (EPA 1997), developed in compliance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300), expresses the RAG for direct exposure to radionuclides in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The total dose rate above background, considering all radionuclide COCs and pathways, was predicted from the RESidual RADioactivity (RESRAD) dose assessment model (ANL 2002). The results indicate that the maximum dose rate above background from the site is 5.81 mrem/yr and would occur at present (year 2003); this dose rate decreases to 1.39×10^{-9} mrem/yr in 1,000 years. The estimated total dose rate in 2018 is 3.87 mrem/yr. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). Total dose rate estimates never exceed the direct exposure RAG of 15 mrem/yr above background.

Although the RAG for radionuclides is expressed in terms of radiation dose, the cleanup verification package also includes radionuclide excess lifetime cancer risk estimates as additional information. The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. The RESRAD model calculated the total excess cancer risk for radionuclides using the U.S. Environmental Protection Agency's Health Effects Assessment Summary Tables (HEAST) (dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast). Because of radioactive decay, the risk associated with radionuclides decreases over time. Based on RESRAD results, the excess lifetime cancer risk is largest, 8.13×10^{-5} at present (year 2003), and decreases to 1.64×10^{-14} from the site in 1,000 years. The estimated excess cancer risk due to radionuclides in 2018 is 9.94×10^{-6}.

E2.1.2 Nonradionuclides

The only nonradionuclide COC for this site is hexavalent chromium. The hexavalent chromium concentration is below the RAG for direct exposure.

Hexavalent chromium is associated with both noncarcinogenic and carcinogenic health effects. With respect to noncarcinogenic risk, the hazard quotient for hexavalent chromium is below the corresponding RAG (a hazard quotient of 1.0). With respect to carcinogenic risk, the excess lifetime cancer risk estimate in the shallow zone (0 to 4.6 m [15 ft]) due to residual hexavalent chromium is below the risk limit for individual COCs of 1×10^{-6}, and also below the excess lifetime total cancer risk estimate limit of 1×10^{-5}.

E2.2 PROTECTION OF GROUNDWATER AND THE RIVER

E2.2.1 Radionuclides

The estimated radionuclide dose rate via the groundwater and river pathways is below the RAG of 4 mrem/yr for beta and gamma emitters. There are no alpha-emitting COCs or uranium COCs for this site; therefore, groundwater and river protectiveness standards for alpha emitters and uranium are met. In summary, all radionuclide RAGs for protection of groundwater and the river have been met.

E2.2.2 Nonradionuclides

Based on comparison with groundwater and river protection RAGs, cleanup verification results indicate that the residual concentration of hexavalent chromium, the only nonradionuclide COC for this site, is protective of groundwater and the river.

E3.0 WASTE SITE RECLASSIFICATION

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. 1998) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998). A copy of the waste site reclassification form is included as Attachment ES-1.

Attachment ES-1
Waste Site Reclassification Form

Date Submitted: 09/11/03 **Originator:** R. A. Carlson **Phone:** 372-9632	**Operable Unit(s):** 100-FR-1 **Waste Site ID:** 116-F-6, Fuel Storage Basin Trench **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2003-06 **Lead Agency:** EPA

This form documents agreement among the parties listed below authorizing classification of the subject unit as rejected, interim closed out, or no action and authorizing backfill of the site, if appropriate. Final removal from the National Priorities List (NPL) of no action or closed-out sites will occur at a future date.

Description of current waste site condition:

Remedial action at this site has been performed in accordance with remedial action objectives and goals established by the U.S. Environmental Protection Agency and the Washington State Department of Ecology, in concurrence with the U.S. Department of Energy, Richland Operations Office. The selected remedial action involves (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, and (3) backfilling the site with clean soil to adjacent grade elevations. The excavation and disposal activities have been completed.

Basis for reclassification:

The 116-F-6, Liquid Waste Disposal Trench has been remediated to meet the cleanup standards specified in the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington. Remedial actions were performed so as to allow rural-residential use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep) and to protect groundwater and the Columbia River. The cleanup verification package does not demonstrate the acceptability of unrestricted access to deep zone soils (i.e., below 4.6 m [15 ft]); therefore, institutional controls to prevent uncontrolled drilling or excavation into deep zone soils are required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 116-F-6 Liquid Waste Disposal Trench* (CVP-2002-00010), Bechtel Hanford, Inc., Richland, Washington.

H. E. Bilson DOE-RL Assistant Project Manager	Signature	9/16/03 Date
NA Ecology Project Manager	Signature	Date
Dennis A. Faulk EPA Project Manager	Signature	11-3-03 Date

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ACRONYMS AND ABBREVIATIONS

CFR	*Code of Federal Regulations*
COC	contaminant of concern
CVP	cleanup verification package
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HEAST	Health Effects Assessment Summary Tables
MDA	minimum detectable activity
MS	matrix spike
NaI	sodium iodide
PQL	practical quantitation limit
QA/QC	quality assurance/quality control
RAG	remedial action goal
RAO	remedial action objective
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RESRAD	RESidual RADioactivity dose assessment model
ROD	Record of Decision
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group
TDL	target detection limit
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this cleanup verification package (CVP) is to document that the 116-F-6 Liquid Waste Disposal Trench site (herein referred to as the 116-F-6 site) was remediated in accordance with the *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (ROD) (EPA 1997). The ROD provides the U.S. Department of Energy, Richland Operations Office the authority, guidance, and objectives to conduct this remedial action. The preferred remedy specified in the ROD (EPA 1997) and conducted for the 116-F-6 site was excavation and disposal of contaminated materials at the Environmental Restoration Disposal Facility (ERDF).

1.2 DOCUMENT ORGANIZATION

The cleanup verification evaluation is presented in the following sections:

- Section 2.0 Site Description and Supporting Information
- Section 3.0 Summary of Remedial Action Objectives and Goals
- Section 4.0 Remedial Action Field Activities
- Section 5.0 Cleanup Verification Data Evaluation
- Section 6.0 Evaluation of Remedial Action Goal Attainment
- Section 7.0 Radionuclide Risk Information
- Section 8.0 Statement of Protectiveness
- Section 9.0 References
- Section 10.0 Bibliography

The main text is supported by the following appendices:

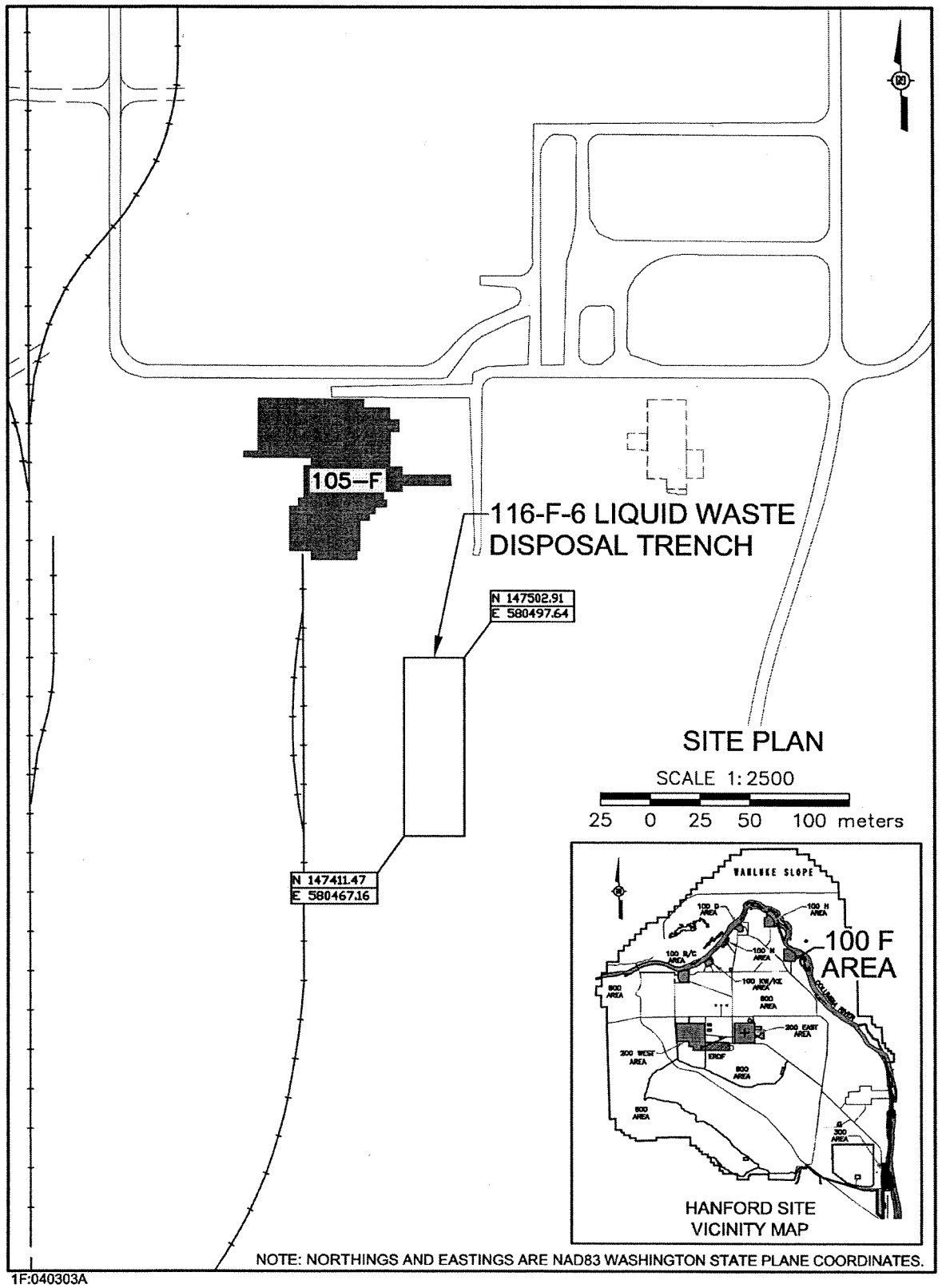
- Appendix A Summary of Verification Soil Sampling and Analytical Results
- Appendix B Data Quality Assessment
- Appendix C RESRAD Input Parameters and Calculation Brief Excerpts.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

2.1 SITE HISTORY

The 116-F-6 site is located in the 100-FR-1 Operable Unit of the 100-F Area approximately 55 m (180 ft) southeast of the southeastern corner of the 105-F Reactor Building inside the 105-F Exclusion Area fence (Figure 1).

Figure 1. Hanford Site Map and 116-F-6 Site Plan.



The site was an unlined trench 91 m (300 ft) long, 30 m (100 ft) wide, and 3 m (10 ft) deep. The trench was used intermittently to dispose of cooling water from the 105-F Reactor via the 1608-F Pumping Station while maintenance and repairs were being performed on the effluent system. This practice was used during several reactor upgrades from 1952 through 1965. In the spring of 1956, effluent water overflowed the trench, flooding an area south of the site. The overflow was not treated as an unplanned release, but the trench area was expanded to include the area of the overflow.

2.2 SUBSURFACE CONDITIONS

The soil column underlying the waste site and extending to groundwater consists of materials belonging to the Hanford and Ringold Formations. The shallower Hanford formation consists predominantly of medium dense to dense sand and gravel, with varying amounts of silt and cobble. The underlying Ringold Formation consists of dense, well-cemented gravels with sand and silt interbeds. The Hanford/Ringold contact is approximately 12.2 to 18.3 m (40 to 60 ft) below the surface grade level. The long-term groundwater level beneath the site is estimated at El. 114 m (374 ft) for analysis purposes, based on historical and current information from adjacent groundwater wells. The depth to groundwater is estimated to be 8.4 m (27.6 ft) beneath the floor of the excavation and 13.5 m (44.3 ft) beneath surface grade level. Groundwater elevations in adjacent wells are influenced by the nearby Columbia River and other factors such as atmospheric pressure.

2.3 CONTAMINANTS OF CONCERN

Waste site contaminants of concern (COCs) identified through process knowledge are listed in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The COCs for this site consist of the following:

- Cesium-137
- Cobalt-60
- Europium-152
- Europium-154
- Strontium- 90
- Hexavalent chromium.

3.0 SUMMARY OF REMEDIAL ACTION OBJECTIVES AND GOALS

3.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) for the 116-F-6 site were established in the ROD (EPA 1997). The RAOs are qualitative statements defining the extent to which waste sites require cleanup to protect human health and the environment. For a detailed discussion of the RAOs, see the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002) and the ROD (EPA 1997).

3.2 REMEDIAL ACTION GOALS

Remedial action goals (RAGs) are the specific numeric goals against which the cleanup verification data are evaluated in order to demonstrate attainment of the RAOs. The RAGs were developed to support a rural-residential exposure scenario. This scenario involves exposures to soils less than 4.6 m (15 ft) deep only. In the rural-residential scenario, an individual is assumed to live for 30 years in a residence built on the waste site and to spend 60% of his or her time indoors, 20% outdoors, and 20% offsite. The scenario assumes a portion of the resident's time is spent in the basement of the home. It further assumes that he or she consumes crops, meat, and milk from plants and animals raised on the waste site, and consumes fish from a pond downgradient from the waste site. Residual (post-cleanup) contaminant concentrations in the shallow zone (i.e., less than 4.6 m [15 ft]) are assumed for the soils in which crops are raised and on which animals providing meat and milk are raised. Water used by the resident for drinking, showering, watering livestock, and for fish production is assumed to be taken from groundwater derived from surface water that has infiltrated through the soil column at the site. The scenario assumes institutional controls against uncontrolled drilling or digging into deep zone soils (i.e., below 4.6 m [15 ft]). A more detailed description of the rural-residential scenario, and how it is applied, is provided in the RDR/RAWP (DOE-RL 2002).

The contaminant-specific RAGs applicable to the 116-F-6 site are listed in Table 1.

Table 1. Summary of Remedial Action Goals.

COCs	Direct Exposure RAG	Groundwater Protection RAG (pCi/L)	Columbia River Protection RAG (pCi/L)
Radionuclides			
Cesium-137	15 mrem/yr (cumulative)[a]	4 mrem/yr (cumulative)	4 mrem/yr (cumulative)
Cobalt-60			
Europium-152			
Europium-154			
Strontium-90[b]		8[c]	8[c]
Nonradionuclides			
COCs	**Direct Exposure RAGs (mg/kg)**	**Soil RAG for Groundwater Protection (mg/kg)**	**Soil RAG for Columbia River Protection (mg/kg)**
Hexavalent chromium	400[d] 2.1[e,f]	8[g]	2[h]

[a]Lookup values that correspond to the 15 mrem/yr dose rate are based on a generic site model and are presented in the RDR/RAWP (DOE-RL 2002).
[b]Strontium-90 also contributes to the 4 mrem/yr dose rate limit (cumulative) for groundwater and river protection.
[c]Promulgated groundwater protection standard (40 *Code of Federal Regulations* 141).
[d]*Washington Administrative Code* (WAC) 173-340 Method B noncarcinogenic cleanup limit based on inhalation exposure pathway.
[e]WAC 173-340 Method B carcinogenic cleanup limit.
[f]*Calculation of Hexavalent Chromium Carcinogenic Risk*, 0100X-CA-V0031 (BHI 2000).
[g]Soil RAG based on "100 times groundwater cleanup" rule as presented in the RDR/RAWP (DOE-RL 2002).
[h]Soil RAG based on 100 times dilution attenuation factor times surface water quality standard as presented in the RDR/RAWP (DOE-RL 2002).

3.2.1 Direct Exposure RAGs

Under the rural-residential scenario, direct exposure RAGs are applicable to soils that are less than 4.6 m (15 ft) below ground surface (shallow zone soils). Direct exposure RAGs are listed in Table 1 and summarized below.

- **Radionuclide COCs:** For radionuclide COCs in the shallow zone (all pathways) and in the deep zone (water-dependent pathways), meet a 15 mrem/yr above background total dose rate (this RAG must be met for 1,000 years).

- **Nonradionuclide COCs:**

  – Hazard quotient of less than 1.0 for noncarcinogenic contaminants.

  – Excess cancer risk of less than 1×10^{-6} for individual carcinogenic contaminants.

  – Cumulative excess cancer risk of less than 1×10^{-5}.

  – Cleanup verification sample results pass the *Washington Administrative Code* (WAC) 173-340 (*Model Toxics Control Act Cleanup Regulation)* three-part test.

3.2.2 Groundwater and River Protection

Groundwater and river protection RAGs are applicable to all vadose zone soils (shallow and deep zone soils). For this CVP, river protection and surface water protection are synonymous, since the Columbia River is the only surface water in proximity to the Hanford Site. The term river protection is used throughout this CVP. The groundwater and river protection RAGs are listed in Table 1 and summarized below.

- **Beta- and gamma-emitting radionuclide COCs:** Meet "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* [CFR] 141.66) dose rate standards (4 mrem/yr total body or organ dose rate) for a period of 1,000 years starting from site cleanup. Meet individual COC RAGs as applicable.

- **Alpha-emitting radionuclide COCs:** Meet drinking water standards for nonuranium alpha-emitting radionuclides based on the more stringent of the 15 pCi/L maximum contaminant level or 1/25th of the derived concentration guide per DOE Order 5400.5. The maximum contaminant level for uranium is 30 μg/L as promulgated by the U.S. Environmental Protection Agency (EPA) on December 7, 2000 (65 *Federal Register* 76708). For the 116-F-6 site there were no alpha-emitting COCs, including uranium.

- **Nonradionuclide COCs:** Meet the individual RAGs listed in Table 1 with cleanup verification sample results passing the WAC 173-340 three-part test, or demonstrate by site-specific modeling that residual COC levels do not pose an unacceptable threat to groundwater or surface water for 1,000 years (i.e., residual soil levels do not have the potential to exceed groundwater or river protection RAGs). The nonradionuclide groundwater and river protection RAGs listed in Table 1 were calculated using the WAC 173-340 "100 times rule," as established in the ROD (EPA 1997).

4.0 REMEDIAL ACTION FIELD ACTIVITIES

4.1 EXCAVATION AND DISPOSAL

Remedial action at the 116-F-6 site began in October 2002. Excavation of the site involved removing the overburden materials and underlying contaminated soil. Contaminated materials were disposed of at the ERDF.

In November of 2002, the majority of excavation was completed. Initial results indicated areas of contamination, and additional remediation of a small portion of the site was completed (shallow zone sample areas B6 and D3) in January of 2003. As part of the 116-F-6 remediation, a small amount of overburden was removed and stockpiled west of the waste site. The original excavation design depth was 3.2 m (10.5 ft) below the surface. After approximately one-third of the site was excavated, it was determined by

in-process sampling that the bottom of the excavation would not meet shallow zone RAGs. Consequently, the site was excavated to a depth of 4.6 m (15 ft) to meet shallow and deep zone criteria. To facilitate the additional remediation, clean material was placed (padding) on the bottom of the excavation to prevent contamination of excavation equipment. The material used for the padding was taken from the overburden pile. At the conclusion of remediation, nearly all of the overburden pile had been used for padding and subsequently removed from the waste site and disposed of at the ERDF. The remaining overburden soil was leveled to existing grade.

Pre- and post-remediation topographic maps are shown in Figures 2 and 3, respectively. At the conclusion of excavation activities, the elevation of the bottom of the excavation was at 122.4 m (402 ft). The excavation was approximately 843 m^2 (9,070 ft^2) in area with a depth of approximately 5.1 m (17 ft). Approximately 32,156 metric tons (35,446 tons) of material from the site were disposed of at the ERDF. No pipe was encountered at the southeast corner of the site. A pipe to the northcentral part of the site was encountered, removed, and disposed of at the ERDF. This pipe was excavated to north of the site. It is now added to Figure 2.

4.2 FIELD SCREENING

Field screening was conducted during the site remedial action as specified in the SAP (DOE-RL 2001). Field screening was used to guide the excavation to quickly assess for the presence and level of contamination. Field screening for the 116-F-6 site included using a radiological data mapping system survey, hand-held sodium iodide (NaI) detectors, and gamma energy analyses. The radiological mapping survey is performed over more than 50% of the site excavation surface area. The hand-held NaI detector is used to screen excavated waste material and to screen for potential excavation wall and floor hot spots. Gamma energy analyses were used to support waste characterization and to corroborate the radiological mapping survey and hand-held NaI detector data.

4.3 VARIANCE SAMPLING AND ANALYSIS

Variance analysis was performed following field screening. The variance analysis quantifies the variability of residual contamination. This information was used to determine the site-specific number of final cleanup verification samples to be collected.

Variance sampling and testing was performed in November 2002 and January 2003. As specified in the SAP and the instruction guide (DOE-RL 2001, BHI 2002), variance analysis was performed for the shallow zone unit. A total of 96 variance samples were collected from the shallow zone of the 116-F-6 site. Variance samples were collected in the locations shown on the sample design calculation brief (Appendix C).

The results of the variance analysis indicated that the number of verification samples to be taken was less than the default number of four; therefore, four final verification samples were collected from each shallow zone decision subunit.

Figure 2. 116-F-6 Pre-Remediation Topographic Plan.

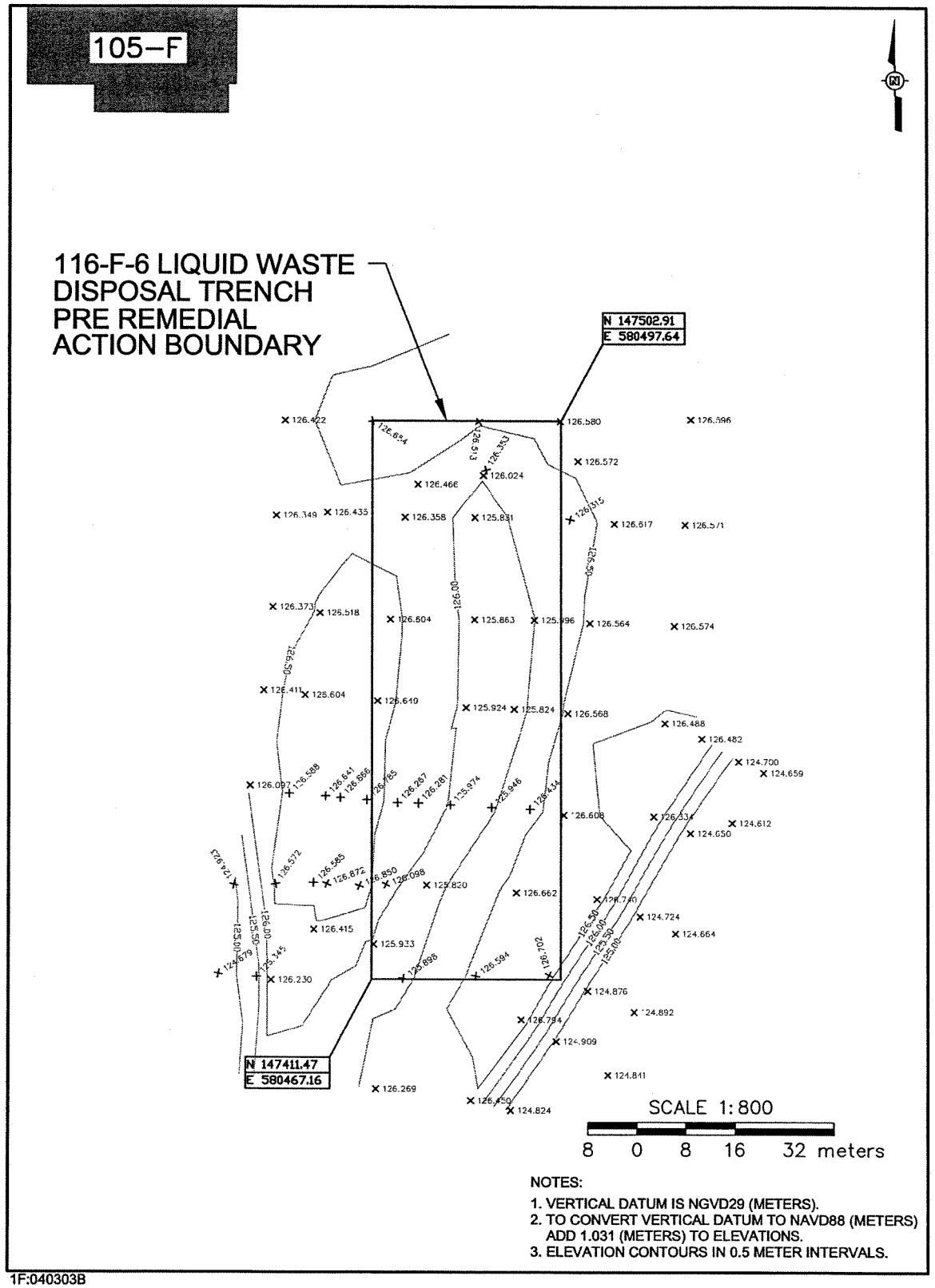


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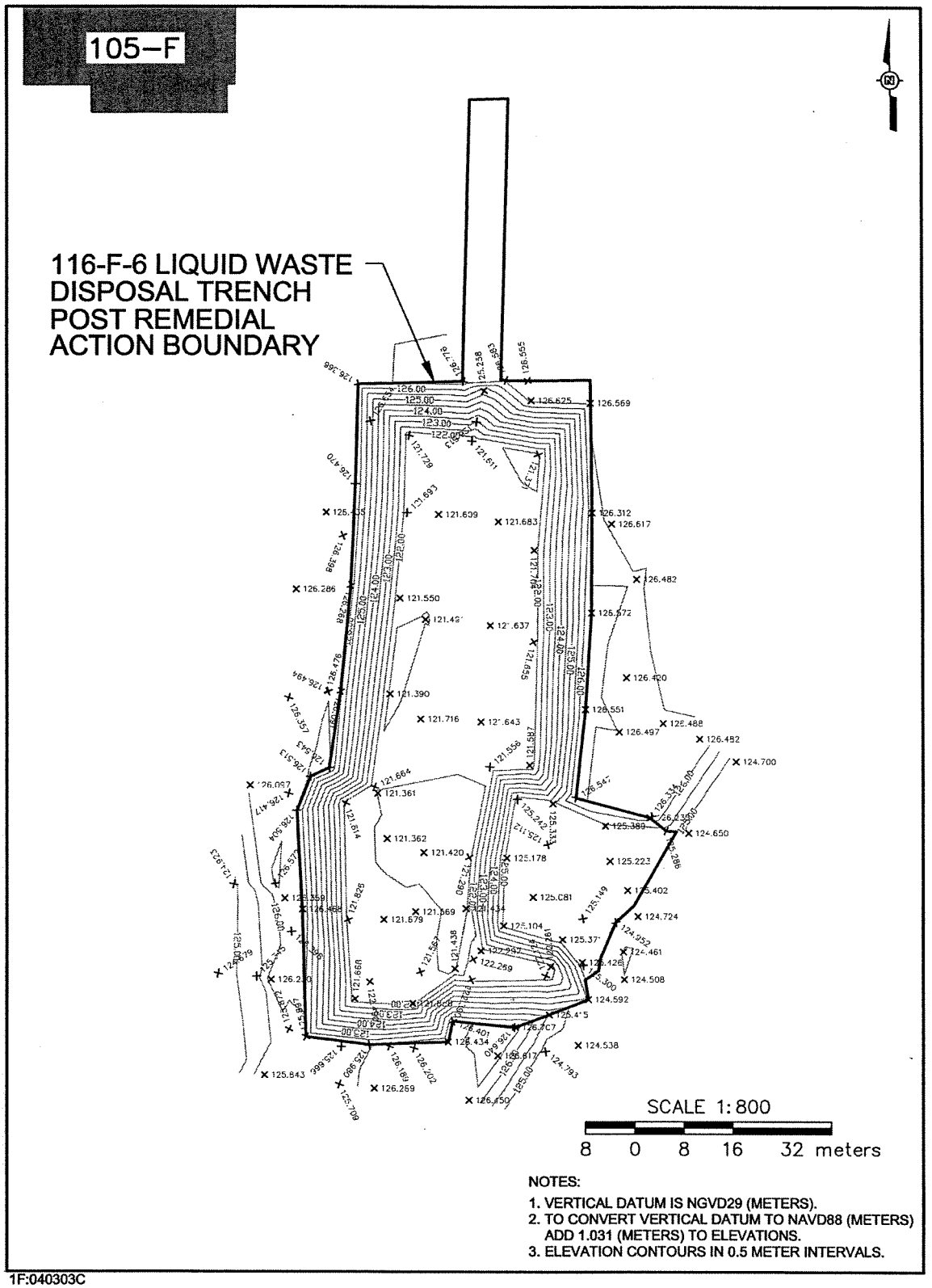
Figure 3. 116-F-6 Post-Remediation Topographic Plan.



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4.4 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Final cleanup verification samples were collected following variance sampling, analysis, and data evaluation. Cleanup verification sampling began on November 20, 2002. Initial analytical results indicated areas of strontium-90 contamination, and additional remediation of a small portion of the site was completed. Following additional remedial excavation (Section 4.1), resampling occurred on January 6, 2003. Verification sample data for strontium-90 were replaced with resampling data and used in calculations for this site (see Appendices A and C). Profiles of decreasing contaminant concentrations at greater depth (greater distance from former contaminant source) have been generally observed for residual contamination in the bottom of remedial action excavations throughout the 100 Areas. Therefore, use of data from near source or shallower samples for some COCs is conservative. The final verification samples were submitted to offsite laboratories for analysis using EPA-approved analytical methods, as required per the SAP (DOE-RL 2001). Each verification sample was a composite formed by combining soil collected at four randomly selected nodes within each sampling area. The sample design methodology and sample location figures are presented in the calculation briefs for variance analysis and sample design in Appendix C.

The division of the site excavation into decision units (shallow zone and deep zone), as shown on the sample design figures on pages C-62 and C-63, is a function of the applicable RAGs (Section 3.2, "Remedial Action Goals"). The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface. This soil zone is referred to as the shallow zone. The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface. This soil zone is referred to as the deep zone.

The noncontiguous area of the shallow zone sample design on page C-62 shows where uncontaminated surface soil was stockpiled before being used for trackhoe padding during excavation of the deep zone (Section 4.1). During the development of the sample design, the remaining soil from the overburden pile and associated surface areas (places where overburden was staged then removed), were included as part of the waste site shallow zone sample area. This was done to verify and document the area was clean. See the sample design calculation brief in Appendix C. This soil was eventually removed and disposed of at the ERDF. The area of the stockpile was sampled as part of the shallow zone to verify that it was clean.

The 100 Area SAP (DOE-RL 2001) does not address incorporation of areas that lie outside waste site boundaries into the primary waste site sample design. In the case of 116-F-6, sample area A1 is completely located within the overburden surface area. Sample area A2 contains sample nodes within both the overburden surface area and the primary site sample design. On the basis that the added overburden surface area does not result in a significant change in the 116-F-6 sample design, and on the basis that both variance and cleanup verification sample data from sample areas A1 and A2 indicate that the direct exposure RAGs are met, this sampling approach was approved by the regulators for the 116-F-6 site (BHI 2003).

The 116-F-6 site consisted of both a shallow and a deep zone decision unit. The site was excavated to a depth of approximately 5.1 m (17 ft), with the shallow zone consisting of the excavation sidewalls to a depth of 4.6 m (15 ft) and the deep zone consisting of the excavation sidewalls below 4.6 m (15 ft) together with the floor of the excavation. All deep zone samples were collected below 4.6 m (15 ft).

The shallow zone decision unit contained 4 decision subunits, which were divided into 16 sampling areas (A1-A4, B5-B8, C1, C2, C9, C10, and D3-D6). The deep zone decision unit contained two decision subunits, which were divided into six sampling areas (A1-A3, B4-B6, C7-C9, D-10, D1, and D2). One composite cleanup verification sample was collected from each sample area. The sample design for this site is documented in the sample area and location calculation brief included in Appendix C.

As described in Section 4.3, the required number of composite samples for each decision subunit in the shallow zone was less than the default number of four composite samples specified in the SAP (DOE-RL 2001). Therefore, the default number of four samples were collected from each shallow zone decision subunit (excluding the quality assurance/quality control samples). As specified in the SAP (DOE-RL 2001), three composite samples were collected from each of the deep zone (i.e., below 4.6 m [15 ft]) decision subunits in addition to quality assurance/quality control samples.

5.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 116-F-6 cleanup verification data for comparison with the data quality criteria and RAGs.

5.1 DATA QUALITY ASSESSMENT PROCESS

A data quality assessment is performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The data quality assessment for the 116-F-6 site determined 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 Hanford Environmental Information System and are summarized in Appendix A. The detailed data quality assessment is presented in Appendix B.

5.2 CONTAMINANTS OF CONCERN 95% UPPER CONFIDENCE LIMIT

The primary statistical calculation to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC are computed for each decision unit (e.g., for the shallow and deep zones, as appropriate). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2001). This process is summarized below.

Verification sampling summary statistics (95% UCL values) are listed in Table 2. Individual sample cleanup verification results are presented in Appendix A.

- **Radionuclides:** The laboratory-reported value is used in the calculation of the 95% UCL. In cases where the laboratory does not report a value for data qualified with a "U" (i.e., less than the detection limit), half of the minimum detectable activity is used in the calculation of the 95% UCL.

- **Nonradionuclides:** For data flagged with a "U" (i.e., less than detection), a value equal to one-half the practical quantitation limit is used in the calculation of the 95% UCL, as required by Washington State Department of Ecology regulations (WAC 173-340-740[7][g]).

For nonradionuclides, if greater than half of the sample results for a given COC are below detection, then the statistical value is set equal to the maximum concentration detected (i.e., versus computing a 95% UCL).

Statistical calculations are presented in the 116-F-6 cleanup verification 95% UCL calculation brief (Appendix C). The columns on the left side of Table 2 are the 95% statistical values before subtraction of background, if appropriate. The columns on the right side of the table present statistical values adjusted for background, when background values exist. Typically, in the shallow and deep zone decision units, Hanford Site background concentration values are only subtracted for isotopic uranium. Isotopic uranium is not a COC for the 116-F-6 site. Table 2 summarizes the cleanup verification data set used for RESidual RADioactivity (RESRAD) modeling.

5.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

The statistical values that are summarized in Table 2 were evaluated and used to develop a site-specific cleanup verification model. For the 116-F-6 site, the site-specific cleanup verification model assumes the worst case described in the RDR/RAWP (DOE-RL 2002). A schematic cross section of this site-specific cleanup verification model is included in the RESRAD calculation brief in Appendix C.

Table 2. Cleanup Verification Data Set.

Radionuclide COCs	Radionuclide Activity[a] (pCi/g)				
	Shallow Zone	Deep Zone	Background	Shallow Zone	Deep Zone
Cesium-137	0.525	6.08	1.1	0.525	6.08
Cobalt-60	0.0267	0.340	0.008	0.0267	0.340
Europium-152	0.277	7.51	NA	0.277	7.51
Europium-154	0.0577	0.727	0.033	0.0577	0.727
Strontium-90	0.969	12.8	0.18	0.969	12.8
Nonradionuclide COCs	**Nonradionuclide Concentration[a] (mg/kg)**				
	Shallow Zone	**Deep Zone**	**Background**	**Shallow Zone**	**Deep Zone**
Hexavalent chromium	0.530	1.32	NA	0.530	1.32

[a]The shallow and deep zone concentrations are from the *116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0141, Rev. 0. Refer to Appendix C for additional details on determination of statistical values.
[b]NA = Not available; Contaminant was not evaluated during background studies.

5.4 RESRAD MODELING

The individual radionuclide cleanup verification statistical values (Table 2) were entered into the RESRAD computer code, Version 6.21 (ANL 2002), to estimate the dose rate and to estimate the impact on groundwater and the river from residual COC concentrations. The direct radiation exposure dose rate to the resident living in his or her basement (rural-residential scenario) was conservatively estimated by substituting (for analysis purposes) a case where the resident is standing on level ground with the soil containing concentrations representative of residual (i.e., post-cleanup) shallow zone soils. This is conservative because it ignores the potential shielding effects of concrete basement walls and any clean backfill between residual soils and the basement walls.

The RESRAD modeling methodologies, results, input values, and the site-specific cleanup verification model are included in the RESRAD calculation brief (Appendix C). The drinking water dose rate calculations based on the RESRAD estimated groundwater radionuclide concentrations are shown in the comparison to drinking water standards calculation brief (Appendix C). Specific results from the calculations are discussed in the RAG evaluation section (Section 6.0).

6.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

This section demonstrates that remedial actions at the 116-F-6 site have achieved the applicable RAGs. Sections 6.1, 6.2, and 6.3 address attainment of direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs, respectively. Section 6.4 documents application of the WAC 173-340 three-part test to

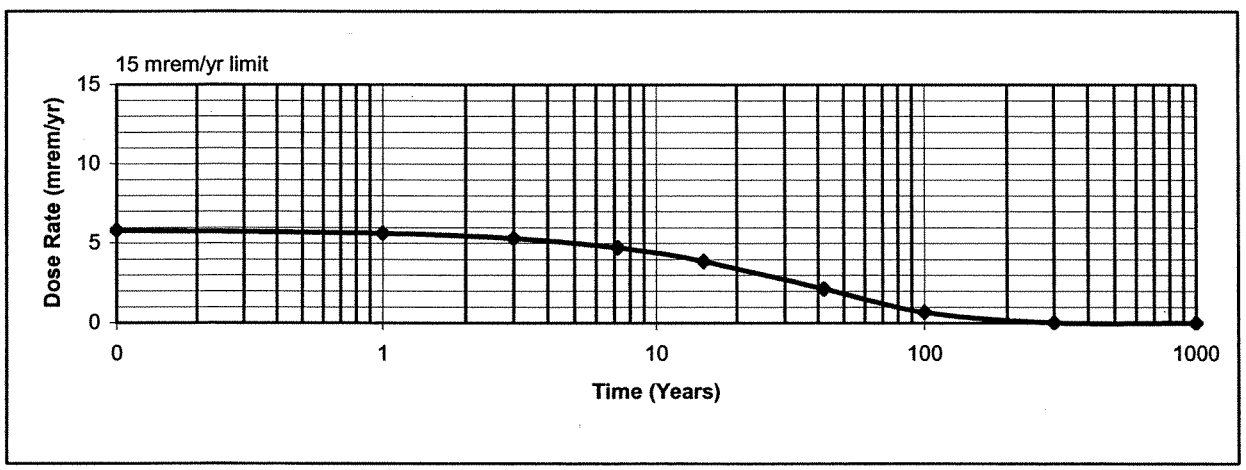
the shallow and deep zones. This test is required for nonradionuclide COCs only and is based on the most restrictive RAG for each zone.

6.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

6.1.1 Radionuclides

The results of the RESRAD dose rate estimates for the site all-pathways scenarios are presented in Figure 4. This dose rate represents the dose contributions from soils at relevant time periods. The dose rate is largest at present (year 2003), 5.81 mrem/yr, and decreases to 1.39 x 10^{-9} mrem/yr in 1,000 years for the shallow zone and deep zone. The estimated dose rate in the year 2018 is 3.87 mrem/yr for the site. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). All dose rate estimates are less than the 15 mrem/yr RAG. The RESRAD computations are presented in detail in the referenced calculation briefs summarized in Appendix C.

Figure 4. RESRAD Analysis – All-Radionuclides, All-Pathways Dose Rate Estimate.



6.1.2 Nonradionuclides

6.1.2.1 Direct Comparison to RAGs. Table 3 compares the cleanup verification statistical values presented in Table 2 to the direct exposure RAGs presented in Table 1.

Table 3. Attainment of Nonradionuclide Direct Exposure Standards.

Nonradionuclides	Direct Exposure RAG (mg/kg)	Statistical Value (mg/kg)	Direct Exposure RAGs Attained?[a]
Hexavalent chromium	2.1[b]	0.53	Yes

[a]Criterion is comparison to the cleanup criteria (RAG).
[b]*Calculation of Hexavalent Chromium Carcinogenic Risk*, Calculation No. 0100X-CA-V0031 (BHI 2000).

6.1.2.2 Noncarcinogenic Hazard Quotient RAG Attained. For noncarcinogenic COCs, WAC 173-340 specifies the evaluation of the hazard quotient, which is given as daily intake divided by a reference dose (DOE-RL 1995). For cleanup actions under the ROD (EPA 1997), a comparable conservative approach is used to demonstrate attainment of the noncarcinogenic risk requirements.

Hexavalent chromium, the only nonradionuclide COC for this site, has noncarcinogenic health effects. Hexavalent chromium is also associated with carcinogenic risk, which is discussed in Section 6.1.2.3. The hexavalent chromium hazard quotient for the shallow zone soils is 1.33×10^{-3}, which is below the limit of 1.0. Therefore, the noncarcinogenic risk requirements have been attained. Calculation of the hazard quotient is presented in the 95% UCL calculation brief (Appendix C).

6.1.2.3 Carcinogenic Risk RAG Attained. For individual nonradionuclide carcinogenic COCs, the WAC 173-340 Method B cleanup limits are based on an incremental cancer risk of 1×10^{-6}. For nonradionuclide carcinogenic COCs, the total excess cancer risk must be less than 1×10^{-5} (EPA et al. 1998).

The only nonradionuclide carcinogenic COC at this site is hexavalent chromium. For the shallow zone, the value for hexavalent chromium cancer risk is 2.52×10^{-7}. This value is below the individual and total risk limits; therefore, the carcinogenic risk standards have been attained for both individual and total excess cancer risk. This calculation is documented in the 95% UCL calculation brief (Appendix C).

6.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

6.2.1 Radionuclides

The estimated groundwater concentrations for all of the radionuclide COCs contributed by the site soils are shown in the RESRAD calculation brief (Appendix C). Table 4 shows the total peak concentration predicted for each radionuclide COC and provides the individual RAGs for comparison. No COC is predicted to exceed the RAGs; therefore, the RAGs are attained.

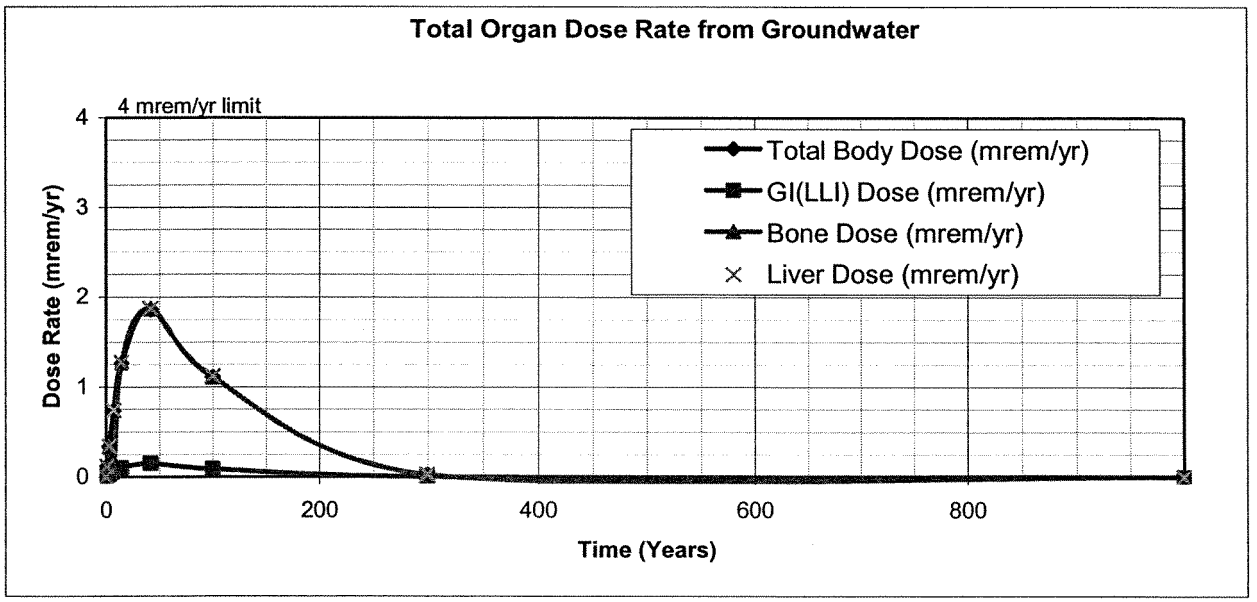
Table 4. Attainment of Radionuclide Remedial Action Goals for Protection of Groundwater and the Columbia River.

Radionuclide	Peak Concentration (pCi/L)	RAG (pCi/L)	RAGS Attained? (Yes/No)
Cesium-137	0.25	60[a]	Yes
Cobalt-60	0.0024	100[a]	Yes
Europium-152	NA[b]	200[a]	Yes
Europium-154	NA[b]	60[a]	Yes
Strontium-90	3.7	8[c]	Yes

[a]Lookup value from the RDR/RAWP (DOE-RL 2002) corresponding to a dose rate of 4 mrem/yr.
[b]NA = Not applicable. These radionuclides do not reach groundwater in 1,000 years.
[c]U.S. Environmental Protection Agency drinking water promulgated RAG (40 CFR 141.66).

Figure 5 shows individual organ dose rates for beta- and gamma-emitting radionuclides predicted over 1,000 years, as shown in the comparison to drinking water standards calculation brief (Appendix C). None of the organ dose rates predicted to exceed the 4 mrem/yr standard over 1,000 years. There are no alpha emitters identified at this site; the drinking water standard for nonuranium alpha emitters and the uranium standard of 30 µg/L have been met. Results of the RESRAD calculations are shown in Appendix C.

Figure 5. Dose Rates to Organs from Groundwater.



6.2.2 Nonradionuclides

Table 5 illustrates the comparison of cleanup verification statistical values to the groundwater protection RAGs. The table shows that the residual concentration (statistical value) of hexavalent chromium for the site is less than the listed groundwater protection soil RAG. The results of meeting the RAGs listed in Table 5 demonstrates that the groundwater protection RAGs have been attained for this site.

Table 5. Attainment of Nonradionuclide Remedial Action Goals for Protection of Groundwater and the Columbia River.

Nonradio-nuclides	Soil RAG for Groundwater Protection (mg/kg)	Soil RAG for Columbia River Protection (mg/kg)	Cleanup Verification Data Value (mg/kg)	Groundwater and/or River Protection RAGs Exceeded?	Does RESRAD Predict Migration to Groundwater in 1,000 Years?	RAGs Attained? (Yes/No)
Shallow Zone						
Hexavalent chromium	8.0	2.0	0.53	No	NA	Yes
Deep Zone						
Hexavalent chromium	8.0	2.0	1.32	No	NA	Yes

NA = Not applicable. RESRAD modeling was not performed because residual concentrations meet the groundwater and river protection RAGs.

6.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

6.3.1 Radionuclides

The river protection RAGs for radionuclides are identical to the groundwater protection RAGs. The RESRAD modeling results were compared to the groundwater protection RAGs in Table 4.

The results indicated that radionuclides are not predicted to reach groundwater (and by extension not predicted to reach the Columbia River) at levels above 4 mrem/yr; therefore, the Columbia River protection RAGs have been attained.

6.3.2 Nonradionuclides

Table 5 illustrates the comparison of cleanup verification statistical values to the Columbia River protection RAGs. The table shows that the residual concentration (statistical value) of hexavalent chromium for the site is less than the listed river protection soil RAG. The results of meeting the RAGs listed in Table 5 demonstrates that the Columbia River protection RAGs have been attained for this site.

6.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

Sections 6.1, 6.2, and 6.3 looked separately at compliance with direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs. Section 6.4 documents application of the WAC 173-340 three-part test for nonradionuclides using the most restrictive RAGs applicable to each decision unit (i.e., shallow zone, overburden, and deep zone). The most restrictive RAG is defined as the lowest of the direct exposure, groundwater protection, and river protection RAGs. The direct exposure, groundwater protection, and river protection RAGs are applicable to the shallow zone and overburden. Groundwater and river protection RAGs are applicable to the deep zone. The WAC 173-340 three-part test consists of the following criteria: (1) the cleanup verification statistical 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%.

Table 6 summarizes the results of the WAC 173-340 three-part test (WAC 173-340-740[7]) for the shallow and deep zone sample data sets. For hexavalent chromium, the only nonradionuclide COC for the 116-F-6 site, the table lists the most restrictive applicable RAG (selected from the RAGs in Table 1), the maximum detected value, the total number of samples collected, and the number of samples exceeding the most restrictive RAG. The final column of the table describes the result of applying the three WAC 173-340 criteria using the values listed in the preceding columns. Table 6 shows that hexavalent chromium passes the WAC 173-340 three-part test for the shallow and deep zone data sets.

Table 6. Application of the WAC 173-340 Three-Part Test.

Nonradionuclides	Most Stringent Applicable RAG (mg/kg)	Statistical Value (mg/kg)[a]	Maximum Detected (mg/kg)[b]	Total Number of Samples[c]	Number Exceeding Criteria[d]	RAGs Attained? (Yes/No)
Shallow Zone						
Hexavalent chromium	2.0	0.53	0.53	16	0	Yes
Deep Zone						
Hexavalent chromium	2.0	1.32	1.70	7	0	Yes

[a]Criterion is comparison to the cleanup criteria (RAG).
[b]Criterion is no single detection can exceed two times the cleanup criteria.
[c]The total number of samples includes field duplicate samples, which are included in the evaluation as separate samples.
[d]Criterion is the percentage of samples exceeding the cleanup criteria must be less than 10%.

7.0 RADIONUCLIDE RISK INFORMATION

The radionuclide RAG for direct exposure is derived from the ROD (EPA 1997) and is expressed in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The RAG evaluation (Section 5.0) involved using the RESRAD model to estimate total annual radiation dose rates for 1,000 years for comparison to the RAG. Radiation presents a carcinogenic risk, and the RESRAD model also calculates the excess lifetime cancer risk associated with the estimated radiation dose rates using the EPA's Health Effects Assessment Summary Tables (HEAST) (dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast). The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. Figure 6 illustrates excess lifetime cancer risk for the shallow zone as estimated using the RESRAD model. Because of radioactive decay, the risk decreases over time. The estimated risk is largest, 8.13×10^{-5}, at present (year 2003), and decreases to 1.64×10^{-14} in 1,000 years. The estimated risk in 2018 is 9.94×10^{-6}. Figure 7 plots the radiation dose rate above background for the shallow zone similar to Figure 4, and shows the corresponding radionuclide risk at present and in 2018.

Figure 6. RESRAD Analysis – Radionuclide Risk, All Pathways.

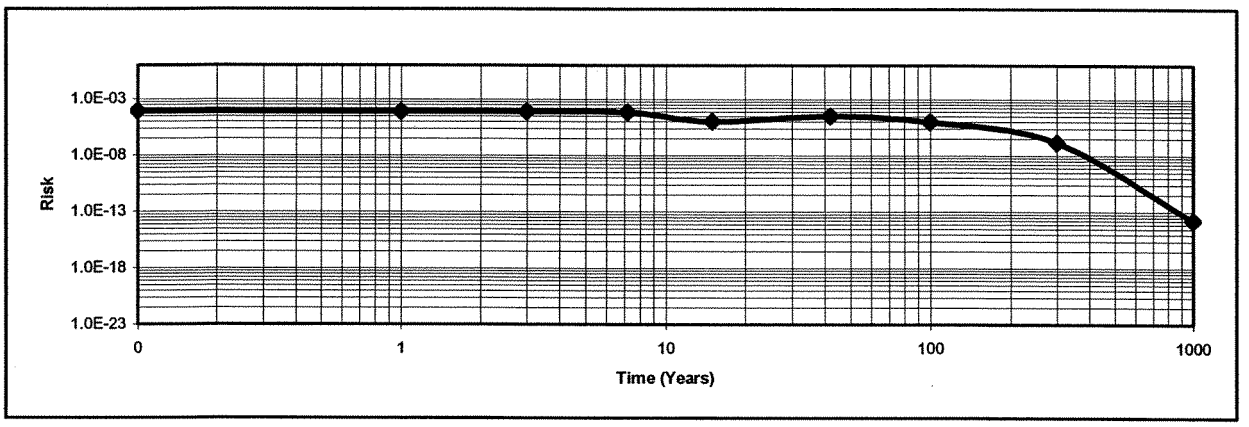
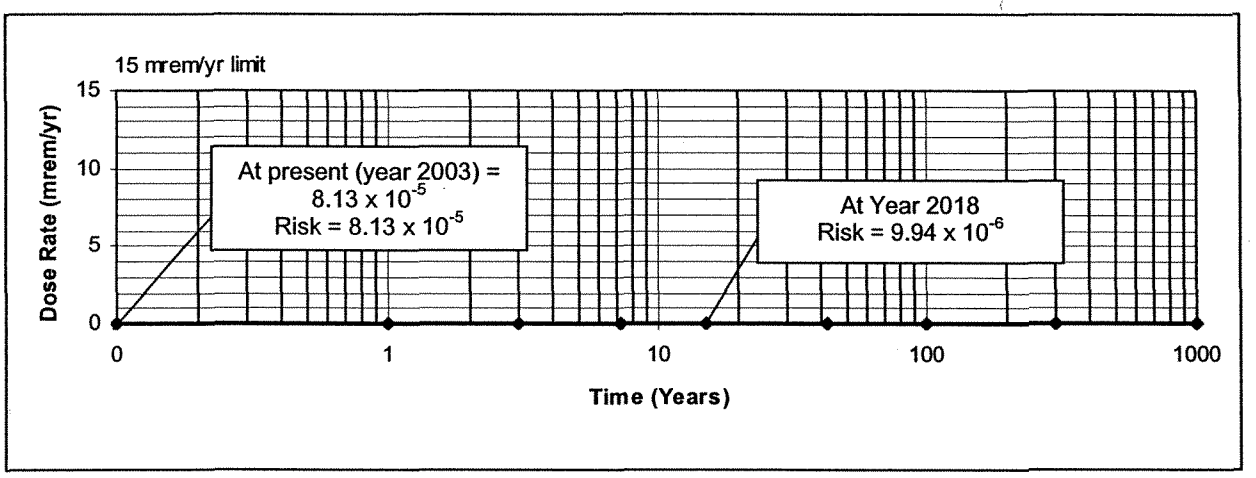


Figure 7. RESRAD Analysis – Radionuclide Dose Rate, All Pathways, With Corresponding Risk Values.



8.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial action at the 116-F-6 site has achieved the RAOs and corresponding RAGs established in the ROD (EPA 1997) and RDR/RAWP (DOE-RL 2002). The remaining soils at the 116-F-6 site have been sampled, analyzed, and modeled. The results of this effort indicate that the materials from the 116-F-6 site containing COCs at concentrations exceeding RAGs have been excavated and disposed of at the 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 acceptability of unrestricted direct exposure to deep zone soils has not been demonstrated; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone (i.e., below 4.6 m [15 ft]) are required. The 116-F-6 site is verified to be remediated in accordance with the ROD (EPA 1997) and may be backfilled.

9.0 REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*, as amended.

65 FR 76708, "National Primary Drinking Water Regulations; Radionuclides; Final Rule," *Federal Register*, Vol. 65, No. 236, p. 76708, December 7, 2000.

ANL, 2002, *RESRAD for Windows*, Version 6.21, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois.

BHI, 2000, *Calculation of Hexavalent Chromium Carcinogenic Risk*, Calculation No. 0100X-CA-V0031, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2001, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, Calculation No. 0100X-CA-V0038, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2002, *Instruction Guide for Remediation of the 100 Areas Waste Sites*, 0100X-IG-G0001, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2003, "116-F-6," CCN 109249, e-mail from M. Schwab to W. Thompson and P. Doctor, dated May 14, 2003, Bechtel Hanford, Inc., Richland, Washington.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1995, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes,* DOE/RL-92-24, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1998, *Tri-Party Agreement Handbook Management Procedures,* RL-TPA-90-0001, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2001, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1998, *Hanford Federal Facility Agreement and Consent Order,* 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA, 1997, *Amendment to the Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, Ecology, and RL, 1998, *Environmental Restoration Contractor Meeting Minutes - Remedial Action and Waste Disposal Unit Managers' Meeting -- 100 Area*, Draft, dated July 6, 1998, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WAC 173-340, "Model Toxics Control Act – Cleanup Regulation," *Washington Administrative Code*, as amended.

10.0 BIBLIOGRAPHY

BHI, 1994, *100-F Reactor Site Technical Baseline Report Including Operable Units 100-FR-1 and 100-FR-2*, BHI-00031, Rev. 0, Bechtel Hanford Incorporated, Richland, Washington.

BHI-DE-01, *Design Engineering Procedures*, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, as amended.

DOE-RL, 1994, *Limited Field Investigation Report for the 100-BC-1 Operable Unit*, DOE/RL-93-06, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, DOE/RL-96-12, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Dorian, J. J. and V. R. Richards, 1978, *Radiological Characterization of the Retired 100 Areas*, UNI-946, United Nuclear Industries, Richland, Washington.

EPA, 1986, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, SW-846, Third Edition, as revised, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1995, *Interim Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

EPA, 1997, *Establishment of Cleanup Level for CERCLA Sites with Radioactive Contamination*, OSWER Directive No. 9200-4-18, August 22, 1997, U.S. Environmental Protection Agency, Washington, D.C.

WDOH, 1997, *Hanford Guidance for Radiological Cleanup*, WDOH/320-015, Rev. 1, Division of Radiation Protection, Washington Department of Health, Olympia, Washington.

WHC, 1991, *Geology and Hydrology of the Hanford Site*, WHC-SD-ER-TI-003, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. Shallow Zone Cleanup Verification Data (November 25, 2002, and January 6, 2003).

Sample Area	HEIS No.	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Sr-90			Cr^{+6}		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL
SA1	J008F0	25-Nov-2002	3.13E-01		4.30E-02	4.20E-02	U	4.20E-02	1.60E-01		1.00E-01	1.30E-01	U	1.30E-01	1.58E+00		2.30E-01	4.10E-01	U	4.10E-01
Duplicate of J008F0	J008H6	25-Nov-2002	3.28E-01		3.30E-02	3.30E-02	U	3.30E-02	1.65E-01		6.60E-02	1.20E-01	U	1.20E-01	2.61E-01		2.20E-01	4.10E-01	U	4.10E-01
Split of J008F0	J008H7	25-Nov-2002	2.97E-01		1.81E-02	3.11E-02	U	2.46E-02	1.07E-01	U	6.00E-02	2.14E-02	U	6.25E-02	2.25E-01		1.40E-01	3.50E+00	U	3.50E-01
SA2	J008F1	25-Nov-2002	5.21E-01		3.20E-02	3.40E-02	U	3.40E-02	2.56E-01		6.60E-02	1.10E-01	U	1.10E-01	6.70E-02	U	3.10E-01	4.10E-01	U	4.10E-01
SA3	J008F2	25-Nov-2002	1.83E-01		2.80E-02	3.40E-02	U	3.40E-02	1.40E-01		7.70E-02	1.20E-01	U	1.20E-01	4.60E-02	U	2.80E-01	4.20E-01	U	4.20E-01
SA4	J008F3	25-Nov-2002	1.31E+00		3.60E-02	3.40E-02	U	3.40E-02	4.45E-01		6.70E-02	9.40E-02	U	9.40E-02	3.88E-01		2.20E-01	4.40E-01	U	4.40E-01
SB5	J008F4	25-Nov-2002	1.24E-01		4.00E-02	3.20E-02	U	3.20E-02	1.30E-01		6.10E-02	1.10E-01	U	1.10E-01	1.06E-01	U	2.70E-01	4.90E-01		4.20E-01
SB6	J008F5/ J00FF0	25-Nov-2002/ 06-Jan-2003	5.00E-02	U	5.00E-02	2.80E-02	U	2.80E-02	6.50E-02	U	6.50E-02	9.80E-02	U	9.80E-02	1.60E-02	U	2.10E-01	4.20E-01	U	4.20E-01
SB7	J008F6	25-Nov-2002	7.00E-02		1.90E-02	2.60E-02	U	2.60E-02	6.00E-02	U	6.00E-02	8.60E-02	U	8.60E-02	7.90E-02	U	1.80E-01	4.10E-01	U	4.10E-01
SB8	J008F7	25-Nov-2002	1.05E-01		2.70E-02	3.20E-02	U	3.20E-02	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01	-1.50E-02	U	2.70E-01	4.20E-01	U	4.20E-01
SC9	J008F8	25-Nov-2002	3.70E-02	U	3.70E-02	3.20E-02	U	3.20E-02	7.40E-02	U	7.40E-02	1.00E-01	U	1.00E-01	-9.00E-02	U	2.80E-01	4.10E-01	U	4.10E-01
SC10	J008F9	25-Nov-2002	3.50E-01		2.90E-02	3.00E-02	U	3.00E-02	1.97E-01		7.20E-02	1.00E-01	U	1.00E-01	8.20E-02	U	2.90E-01	4.10E-01	U	4.10E-01
SC1	J008H0	25-Nov-2002	1.68E-01		2.90E-02	3.50E-02	U	3.50E-02	1.38E-01		6.50E-02	1.10E-01	U	1.10E-01	4.14E+00		2.20E-01	4.20E-01	U	4.20E-01
SC2	J008H1	25-Nov-2002	1.31E+00		4.20E-02	8.30E-02		4.90E-02	6.31E-01		1.00E-01	1.50E-01	U	1.50E-01	1.70E+00		2.30E-01	5.30E-01		4.10E-01
SD3	J008H2/ J00FF1	25-Nov-2002/ 06-Jan-2003	6.26E-01		3.20E-02	3.50E-02	U	3.50E-02	3.02E-01		7.90E-02	1.20E-01	U	1.20E-01	8.60E-02	U	2.20E-01	4.10E-01	U	4.10E-01
SD4	J008H3	25-Nov-2002	1.92E-01		3.80E-02	4.00E-02	U	4.00E-02	1.99E-01		8.70E-02	1.40E-01	U	1.40E-01	9.30E-02	U	2.70E-01	4.30E-01	U	4.30E-01
SD5	J008H4	25-Nov-2002	1.53E-01		1.10E-02	1.00E-02	U	1.00E-02	1.27E-01		1.90E-02	3.40E-02	U	3.40E-02	1.37E-01	U	2.30E-01	4.10E-01	U	4.10E-01
SD6	J008H5	25-Nov-2002	2.37E-01		1.30E-02	2.00E-02	U	2.00E-02	4.27E-01		2.50E-02	3.90E-02	U	3.90E-02	7.22E-01		2.50E-01	4.10E-01	U	4.10E-01

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

Table A-2. Deep Zone Cleanup Verification Data (November 21, 2002).

Sample Area	HEIS Number	Sample Date	Cs-137			Co-60			Eu-152			Eu-154			Sr-90			Cr^{+6}		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL
DA1	J008D1	21-Nov-2002	6.90E-02		3.40E-02	2.90E-02	U	2.90E-02	1.36E-01		6.50E-02	1.10E-01	U	1.10E-01	3.18E+01		3.30E-01	7.10E-01		4.10E-01
Duplicate of J008D1	J008D7	21-Nov-2002	9.50E-02		5.40E-02	5.50E-02	U	5.50E-02	1.80E-01	U	1.80E-01	1.80E-01	U	1.80E-01	8.71E-01		2.20E-01	6.00E-01		4.10E-01
Split of J008D1	J008D9	21-Nov-2002	5.62E-02		4.71E-02	8.35E-03	U	5.02E-02	5.54E-02	U	1.22E-01	1.90E-02	U	1.63E-01	1.74E+00		1.57E-01	4.98E-01		8.00E-02
DA2	J008D2	21-Nov-2002	4.77E-01		3.10E-02	3.90E-02		2.90E-02	1.12E+00		5.40E-02	1.06E-01		8.50E-02	1.83E+01		3.00E-01	6.80E-01		4.20E-01
DA3	J008D3	21-Nov-2002	1.66E-01		6.20E-02	5.30E-02	U	5.30E-02	6.90E-01		1.10E-01	2.00E-01	U	2.00E-01	1.94E+00		2.50E-01	1.70E+00		4.20E-01
DB4	J008D4	21-Nov-2002	4.46E-01		3.80E-02	3.80E-02	U	3.80E-02	3.40E-01		7.30E-02	1.30E-01	U	1.30E-01	2.32E+00		2.30E-01	4.20E-01	U	4.20E-01
DB5	J008D5	21-Nov-2002	3.80E+00		9.30E-02	4.61E-01		5.80E-02	8.51E+00		1.60E-01	7.74E-01		2.20E-01	1.97E+00		2.50E-01	4.10E-01	U	4.10E-01
DB6	J008D6	21-Nov-2002	1.22E+01		8.60E-02	5.14E-01		4.90E-02	1.27E+01		1.60E-01	1.24E+00		1.70E-01	5.17E+00		2.20E-01	1.70E+00		4.20E-01

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
PQL = practical quantitation limit
U = Analyte is below detection limits of the method and instruments used (not detected).

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 116-F-6 SITE

B1.1 OVERVIEW

This data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA involves the scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use (i.e., closeout decisions [EPA 2000]). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures.* Specific data quality objectives for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP (DOE-RL 2001) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002).

Prior to performing statistical tests, all of the analytical data are evaluated and a portion are validated for compliance with quality assurance (QA) project plan requirements (DOE-RL 2001). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. After data evaluation and validation, the appropriate statistical test is performed on the adjusted raw analytical data (see calculation briefs in Appendix C) to determine statistical values for each contaminant. The number of samples collected for cleanup verification is then evaluated to confirm assumptions concerning contaminant variability.

The DQA for the 116-F-6 site determined that the data are of the right type, quality, and quantity to support site cleanup 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. Additional quality requirements of the QA project plan included data acquisition requirements. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A.

The following subsections describe the DQA results for the 116-F-6 site, including formal data validation, supplementary data evaluation, and field QA/quality control (QC) program results. The statistical evaluation of the data is provided in the calculation brief excerpts included in Appendix C.

B1.2 DATA VALIDATION

B1.2.1 Laboratory QA/QC Analysis

All verification samples are subject to laboratory-specific QA requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory requirements for internal QC checks are performed, as appropriate, for the analytical method at a rate of 1 per sample delivery group (SDG), or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

- Analytical Accuracy. For most analyses, a known quantity of representative analytes of interest (matrix spike [MS]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

- Analytical Precision. Separate aliquots removed from the same sample container (replicate samples) are analyzed for each analytical batch. The replicate sample results (evaluated as relative percent differences [RPDs]) are used to assess analytical precision.

- QC Reference Samples. A QC reference sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.

Verification sample laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Bechtel Hanford, Inc. QA group to ensure that the laboratories are performing to meet laboratory contract requirements.

B1.2.2 Data Validation Results

After sampling was completed, all of the fixed-base laboratory data from one SDG, H2039, were validated to Level C per BHI-EE-01, Procedure 2.5, "Data Package Validation Process." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000a) and *Data Validation Procedure for Chemical Analysis* (BHI 2000b). Validation was performed by Tech Law, Inc. (Tech Law 2003a, 2003b, 2003c).

Under the Level C validation procedure, the following items were reviewed, as appropriate, for each analytical method:

- Sample holding times
- Method blanks
- MS recovery
- Surrogate recovery
- MS/matrix spike duplicate results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of target (or contractual) detection limits (TDLs).

Data flagged as estimated (i.e., "J") indicate that the associated concentration is an estimate but that the data may be used for decision-making purposes. Data flagged as below detection limits (i.e., "U") indicate the contaminant was analyzed for but not detected, and the concentration is below the minimum detectable activity (MDA) for radionuclides or the practical quantitation limit (PQL) (i.e., reporting limit) for nonradionuclides. For nonradionuclides, nondetects are reported as the PQL. For radionuclides, nondetects report the actual value obtained from analysis (positive or negative but less than the MDA) except for limited analyses where no value can be calculated. In these cases, the MDA is reported. This situation is applicable for sample results that are below detection limits. All other validated results are considered to be accurate within the standard errors associated with the methods.

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and TDLs pursuant to the SAP (DOE-RL 2001). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the TDL with the respective MDA or PQL is discussed in Section B1.3.

A summary of deficiencies noted during validation of SDG H2039 follows.

Radionuclides. The DQA noted no major deficiencies. Minor deficiencies noted during validation include the following:

- Reported radionuclide analytical detection levels for undetected analytes are compared against the SAP TDLs to ensure that laboratory detection levels meet the required criteria. Ten contaminant of concern (COC) analytes were reported above their TDL. Of the 10 missed TDL nondetects, none exceeded the TDL by more than a factor of 4. All missed TDL nondetects in shallow zone samples were less than one-tenth of their associated remedial action goals (RAGs). All other reported results met the analyte-specific TDL.

Nonradionuclides. No major or minor deficiencies were noted for nonradionuclides.

B1.3 DATA EVALUATION

The formal data validation described in the previous section included evaluation of only one SDG; however, DQA is required for all SDGs. Therefore, supplementary data evaluation was performed on the remaining SDGs. The following paragraphs include the results of the data evaluation of all SDGs.

To ensure adequate data quality, DQA investigators reviewed the study objectives in the SAP (DOE-RL 2001) to determine the context for assessing the data. The context for assessing the data includes evaluating the sample data using the statistical methodology of the SAP (included in the calculation brief excerpts in Appendix C) and a comparison of analytical results to the PARCC (precision, accuracy, representativeness, completeness, and comparability) parameters as specified in the SAP (DOE-RL 2001). This section summarizes the results of the PARCC parameter comparison and presents an evaluation of the affected data.

TDL Comparison: Reported analytical detection levels for nondetected analytes were compared to the TDLs specified in the SAP (DOE-RL 2001). When detected results are obtained, evaluation of detection limits is not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the SAP TDLs for nondetected analytes.

The reported MDA was above the TDL for the following COCs:

- Cesium-137 0 of 26
- Europium-152 1 of 26
- Europium-154 2 of 26
- Strontium-90 11 of 26

All missed TDL nondetects in verification samples were less than one-tenth of their associated RAGs. Because the reported values are sufficiently less than the RAGs, the associated data are of sufficient quality for decision-making purposes (DOE-RL 2002). All other nondetected analyses had detection limits below the TDL.

All other parameters meet acceptance criteria.

Precision and Accuracy Evaluation: Analytical accuracy and precision were evaluated by examination of the percent recovery and RPD between the main and duplicate samples. Only the COCs detected at five times the detection limit (or greater) are used for data analysis with respect to accuracy and precision.
All RPDs for laboratory duplicates were within acceptable limits.

B1.4 FIELD QA/QC

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples included one equipment blank (J008D8) from the deep zone. One field duplicate sample (sample J008H6), which was a duplicate of shallow zone sample J008F0, and one field duplicate sample (J008D7), which was a duplicate of deep zone sample J008D1, were also collected. In addition to these, one field split sample (sample J008H7), which was a split of shallow zone sample J008F0, and one split sample (J008D9), which was a split of deep zone sample J008D1, were collected. The main and QA/QC sample results are presented in Appendix A.

B1.4.1 Equipment Blank Samples

One equipment blank sample (J008D8) was collected as part of the QA/QC measures. The blank sample results for this site were less than detection for all COCs.

B1.4.2 Field Duplicate Samples

Duplicate samples were 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 duplicate is evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared.

Based on these criteria, calculation of the RPDs was not required for COCs in the shallow zone. Although calculation of the RPDs was not required, there is a large variability seen in the reported strontium-90 results in the field duplicates. The available data indicate significant localized inhomogeniety in this isotope in these soils.

B1.4.3 Field Split Samples

A split sample was collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPDs of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the TDLs or contract required detection limit for both the main and split sample were compared. Although calculation of the RPDs was not required, there is a large variability seen in the reported results in the field splits.

As was the case for the field duplicates, calculation of the RPDs was not required for COCs in the shallow zone or overburden.

B1.5 SUITABILITY OF DATA

The conclusion of the DQA is that the data are of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and SDG completeness were analyzed to determine if any analytical results should be rejected as a result of QA/QC deficiencies. All COC analytical data were found to be acceptable for decision-making purposes, and the raw data are acceptable for calculating the required statistical values.

B2.0 REFERENCES

BHI, 2000a, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Data Validation Procedure for Chemical Analysis*, BHI-01435, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 2001, *100 Area Remedial Action Sampling and Analysis Plan*, DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2000, *Guidance for Data Quality Assessment*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

Tech Law, 2003a, *Radionuclides (Deep Zone) - Data Package No. H1989-EB (SDG No. H1989)*, Tech Law, Inc., Richland, Washington.

Tech Law, 2003b, *Inorganics (Shallow Zone) - Data Package No. H1997-LLI (SDG No. H1997)*, Tech Law, Inc., Richland, Washington.

Tech Law, 2003c, *Radionuclides (Shallow Zone) - Data Package No. H1997EB (SDG No. H1997)*, Tech Law, Inc., Richland, Washington.

APPENDIX C

RESRAD INPUT PARAMETERS AND CALCULATION BRIEF EXCERPTS

RESRAD INPUT PARAMETERS FOR THE SHALLOW ZONE

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/21/2003 07:28 Page 1
Summary : 116-F-6 Cleanup Verification - Shallow Zone
File : 116f6_shallow.rad

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Summary : 116-F-6 Cleanup Verification - Shallow Zone
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Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
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	Eu-152	2.210E-04	2.210E-04	DCF2(3)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(5)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(6)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(7)
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	Eu-152	6.480E-06	6.480E-06	DCF3(3)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(5)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(6)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(7)
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	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(3,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(3,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(3,3)
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(7,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(7,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(7,3)
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	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(3,2)

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Dose Conversion Factor (and Related) Parameter Summary (continued)
File: HEAST 2001 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(6,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(7,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)

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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)	5.272E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	4.600E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.545E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+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)	7.200E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.500E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	4.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	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	2.670E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Cs-137	5.250E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-152	2.770E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Eu-154	5.770E-02	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Sr-90	9.690E-01	0.000E+00	---	S1(7)
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): Eu-152	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(7)
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

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	8.900E+00	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	2.166E-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	1.000E+03	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.166E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.426E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.323E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.316E-05	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
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)
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

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.264E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.264E+00	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)
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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	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	active

```
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      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:   5272.00 square meters               Co-60       2.670E-02
   Thickness:      4.60 meters                      Cs-137      5.250E-01
 Gover Depth:      0.00 meters                      Eu-152      2.770E-01
                                                    Eu-154      5.770E-02
                                                    Sr-90       9.690E-01
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)
                       ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
    t (years):  0.000E+00  1.000E+00  3.000E+00  7.200E+00  1.500E+01  4.200E+01  1.000E+02  3.000E+02  1.000E+03
     TDOSE(t):  5.794E+00  5.584E+00  5.197E+00  4.500E+00  3.507E+00  1.633E+00  3.776E-01  3.098E-03  1.753E-10
         M(t):  3.862E-01  3.723E-01  3.465E-01  3.000E-01  2.338E-01  1.089E-01  2.518E-02  2.065E-04  1.169E-11
0Maximum TDOSE(t):  5.794E+00 mrem/yr    at t = 0.000E+00 years
```

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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-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.557E-01	0.0441	2.070E-07	0.0000	0.000E+00	0.0000	3.034E-03	0.0005	7.587E-04	0.0001	1.738E-04	0.0000	3.930E-05	0.0000
Cs-137	1.109E+00	0.1915	6.255E-07	0.0000	0.000E+00	0.0000	5.848E-02	0.0101	2.379E-02	0.0041	1.477E-02	0.0026	1.515E-03	0.0003
Eu-152	1.193E+00	0.2059	2.254E-06	0.0000	0.000E+00	0.0000	2.465E-04	0.0000	2.225E-05	0.0000	5.880E-07	0.0000	1.021E-04	0.0000
Eu-154	2.691E-01	0.0464	5.996E-07	0.0000	0.000E+00	0.0000	7.467E-05	0.0000	6.740E-06	0.0000	1.781E-07	0.0000	3.094E-05	0.0000
Sr-90	1.485E-02	0.0026	4.739E-05	0.0000	0.000E+00	0.0000	2.476E+00	0.4274	2.324E-01	0.0401	1.313E-01	0.0227	8.554E-03	0.0015
Total	2.842E+00	0.4905	5.107E-05	0.0000	0.000E+00	0.0000	2.538E+00	0.4381	2.570E-01	0.0444	1.462E-01	0.0252	1.024E-02	0.0018

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-														
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	2.597E-01	0.0448
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	1.208E+00	0.2085
Eu-152	0.000E+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	1.193E+00	0.2060
Eu-154	0.000E+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	2.692E-01	0.0465
Sr-90	0.000E+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	2.863E+00	0.4942
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	5.794E+00	1.0000

0*Sum of all water independent and dependent pathways.

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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-	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	2.242E-01	0.0401	1.815E-07	0.0000	0.000E+00	0.0000	2.659E-03	0.0005	6.651E-04	0.0001	1.524E-04	0.0000	3.445E-05	0.0000
Cs-137	1.084E+00	0.1941	6.110E-07	0.0000	0.000E+00	0.0000	5.714E-02	0.0102	2.324E-02	0.0042	1.443E-02	0.0026	1.480E-03	0.0003
Eu-152	1.132E+00	0.2028	2.140E-06	0.0000	0.000E+00	0.0000	2.340E-04	0.0000	2.112E-05	0.0000	5.582E-07	0.0000	9.696E-05	0.0000
Eu-154	2.487E-01	0.0445	5.541E-07	0.0000	0.000E+00	0.0000	6.901E-05	0.0000	6.229E-06	0.0000	1.646E-07	0.0000	2.860E-05	0.0000
Sr-90	1.449E-02	0.0026	4.625E-05	0.0000	0.000E+00	0.0000	2.417E+00	0.4328	2.269E-01	0.0406	1.281E-01	0.0229	8.349E-03	0.0015
Total	2.704E+00	0.4842	4.974E-05	0.0000	0.000E+00	0.0000	2.477E+00	0.4436	2.508E-01	0.0449	1.427E-01	0.0256	9.990E-03	0.0018

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-	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	2.277E-01	0.0408
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	1.180E+00	0.2113
Eu-152	0.000E+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	1.133E+00	0.2029
Eu-154	0.000E+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	2.488E-01	0.0446
Sr-90	0.000E+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	2.795E+00	0.5005
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	5.584E+00	1.0000

0*Sum of all water independent and dependent pathways.

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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	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.
Co-60	1.722E-01	0.0331	1.394E-07	0.0000	0.000E+00	0.0000	2.043E-03	0.0004	5.110E-04	0.0001	1.171E-04	0.0000	2.647E-05	0.0000
Cs-137	1.034E+00	0.1990	5.832E-07	0.0000	0.000E+00	0.0000	5.453E-02	0.0105	2.218E-02	0.0043	1.378E-02	0.0027	1.413E-03	0.0003
Eu-152	1.020E+00	0.1964	1.928E-06	0.0000	0.000E+00	0.0000	2.108E-04	0.0000	1.903E-05	0.0000	5.030E-07	0.0000	8.738E-05	0.0000
Eu-154	2.124E-01	0.0409	4.733E-07	0.0000	0.000E+00	0.0000	5.894E-05	0.0000	5.321E-06	0.0000	1.406E-07	0.0000	2.443E-05	0.0000
Sr-90	1.381E-02	0.0027	4.406E-05	0.0000	0.000E+00	0.0000	2.303E+00	0.4430	2.161E-01	0.0416	1.221E-01	0.0235	7.954E-03	0.0015
Total	2.453E+00	0.4721	4.719E-05	0.0000	0.000E+00	0.0000	2.359E+00	0.4540	2.388E-01	0.0460	1.360E-01	0.0262	9.505E-03	0.0018

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	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.
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	1.749E-01	0.0337
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	1.126E+00	0.2167
Eu-152	0.000E+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	1.021E+00	0.1964
Eu-154	0.000E+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	2.125E-01	0.0409
Sr-90	0.000E+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	2.663E+00	0.5123
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	5.197E+00	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 7.200E+00 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.
Co-60	9.906E-02	0.0220	8.019E-08	0.0000	0.000E+00	0.0000	1.175E-03	0.0003	2.939E-04	0.0001	6.734E-05	0.0000	1.522E-05	0.0000
Cs-137	9.379E-01	0.2084	5.288E-07	0.0000	0.000E+00	0.0000	4.944E-02	0.0110	2.011E-02	0.0045	1.249E-02	0.0028	1.281E-03	0.0003
Eu-152	8.201E-01	0.1823	1.549E-06	0.0000	0.000E+00	0.0000	1.694E-04	0.0000	1.529E-05	0.0000	4.042E-07	0.0000	7.022E-05	0.0000
Eu-154	1.525E-01	0.0339	3.399E-07	0.0000	0.000E+00	0.0000	4.233E-05	0.0000	3.821E-06	0.0000	1.010E-07	0.0000	1.754E-05	0.0000
Sr-90	1.247E-02	0.0028	3.980E-05	0.0000	0.000E+00	0.0000	2.080E+00	0.4622	1.952E-01	0.0434	1.103E-01	0.0245	7.184E-03	0.0016
Total	2.022E+00	0.4494	4.230E-05	0.0000	0.000E+00	0.0000	2.131E+00	0.4735	2.156E-01	0.0479	1.228E-01	0.0273	8.568E-03	0.0019

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 = 7.200E+00 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.
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	1.006E-01	0.0224
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	1.021E+00	0.2270
Eu-152	0.000E+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	8.203E-01	0.1823
Eu-154	0.000E+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	1.526E-01	0.0339
Sr-90	0.000E+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	2.405E+00	0.5345
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	4.500E+00	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.500E+01 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.
Co-60	3.546E-02	0.0101	2.870E-08	0.0000	0.000E+00	0.0000	4.206E-04	0.0001	1.052E-04	0.0000	2.410E-05	0.0000	5.449E-06	0.0000
Cs-137	7.819E-01	0.2230	4.408E-07	0.0000	0.000E+00	0.0000	4.122E-02	0.0118	1.677E-02	0.0048	1.041E-02	0.0030	1.068E-03	0.0003
Eu-152	5.464E-01	0.1558	1.032E-06	0.0000	0.000E+00	0.0000	1.129E-04	0.0000	1.019E-05	0.0000	2.693E-07	0.0000	4.679E-05	0.0000
Eu-154	8.249E-02	0.0235	1.838E-07	0.0000	0.000E+00	0.0000	2.289E-05	0.0000	2.066E-06	0.0000	5.461E-08	0.0000	9.487E-06	0.0000
Sr-90	1.032E-02	0.0029	3.294E-05	0.0000	0.000E+00	0.0000	1.722E+00	0.4909	1.616E-01	0.0461	9.127E-02	0.0260	5.947E-03	0.0017
Total	1.457E+00	0.4153	3.463E-05	0.0000	0.000E+00	0.0000	1.763E+00	0.5028	1.785E-01	0.0509	1.017E-01	0.0290	7.077E-03	0.0020

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 = 1.500E+01 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.
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	3.601E-02	0.0103
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	8.514E-01	0.2428
Eu-152	0.000E+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	5.466E-01	0.1558
Eu-154	0.000E+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	8.252E-02	0.0235
Sr-90	0.000E+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	1.991E+00	0.5676
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	3.507E+00	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.200E+01 years
0 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	1.012E-03	0.0006	8.192E-10	0.0000	0.000E+00	0.0000	1.201E-05	0.0000	3.002E-06	0.0000	6.880E-07	0.0000	1.555E-07	0.0000
Cs-137	4.166E-01	0.2551	2.349E-07	0.0000	0.000E+00	0.0000	2.196E-02	0.0134	8.932E-03	0.0055	5.548E-03	0.0034	5.690E-04	0.0003
Eu-152	1.340E-01	0.0821	2.532E-07	0.0000	0.000E+00	0.0000	2.769E-05	0.0000	2.499E-06	0.0000	6.606E-08	0.0000	1.147E-05	0.0000
Eu-154	9.821E-03	0.0060	2.188E-08	0.0000	0.000E+00	0.0000	2.725E-06	0.0000	2.460E-07	0.0000	6.502E-09	0.0000	1.129E-06	0.0000
Sr-90	5.366E-03	0.0033	1.712E-05	0.0000	0.000E+00	0.0000	8.948E-01	0.5479	8.399E-02	0.0514	4.744E-02	0.0290	3.091E-03	0.0019
Total	5.668E-01	0.3470	1.763E-05	0.0000	0.000E+00	0.0000	9.168E-01	0.5614	9.293E-02	0.0569	5.299E-02	0.0324	3.673E-03	0.0022

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.200E+01 years
0 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	1.028E-03	0.0006
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	4.536E-01	0.2777
Eu-152	0.000E+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	1.341E-01	0.0821
Eu-154	0.000E+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	9.825E-03	0.0060
Sr-90	0.000E+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	1.035E+00	0.6335
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	1.633E+00	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 116-F-6 Cleanup Verification - Shallow Zone
File : 116f6_shallow.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-	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	4.867E-07	0.0000	3.940E-13	0.0000	0.000E+00	0.0000	5.774E-09	0.0000	1.444E-09	0.0000	3.309E-10	0.0000	7.480E-11	0.0000
Cs-137	1.077E-01	0.2852	6.072E-08	0.0000	0.000E+00	0.0000	5.678E-03	0.0150	2.309E-03	0.0061	1.434E-03	0.0038	1.471E-04	0.0004
Eu-152	6.546E-03	0.0173	1.237E-08	0.0000	0.000E+00	0.0000	1.352E-06	0.0000	1.221E-07	0.0000	3.227E-09	0.0000	5.605E-07	0.0000
Eu-154	1.016E-04	0.0003	2.263E-10	0.0000	0.000E+00	0.0000	2.818E-08	0.0000	2.544E-09	0.0000	6.724E-11	0.0000	1.168E-08	0.0000
Sr-90	1.316E-03	0.0035	4.199E-06	0.0000	0.000E+00	0.0000	2.194E-01	0.5810	2.059E-02	0.0545	1.163E-02	0.0308	7.580E-04	0.0020
Total	1.157E-01	0.3063	4.272E-06	0.0000	0.000E+00	0.0000	2.251E-01	0.5960	2.290E-02	0.0607	1.307E-02	0.0346	9.056E-04	0.0024

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-	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	4.943E-07	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	1.173E-01	0.3106
Eu-152	0.000E+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	6.548E-03	0.0173
Eu-154	0.000E+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	1.016E-04	0.0003
Sr-90	0.000E+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	2.537E-01	0.6718
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	3.776E-01	1.0000

0*Sum of all water independent and dependent pathways.

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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-	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	1.763E-18	0.0000	1.427E-24	0.0000	0.000E+00	0.0000	2.092E-20	0.0000	5.232E-21	0.0000	1.199E-21	0.0000	2.710E-22	0.0000
Cs-137	1.015E-03	0.3277	5.724E-10	0.0000	0.000E+00	0.0000	5.352E-05	0.0173	2.177E-05	0.0070	1.352E-05	0.0044	1.387E-06	0.0004
Eu-152	1.971E-07	0.0001	3.725E-13	0.0000	0.000E+00	0.0000	4.072E-11	0.0000	3.676E-12	0.0000	9.715E-14	0.0000	1.688E-11	0.0000
Eu-154	1.447E-11	0.0000	3.224E-17	0.0000	0.000E+00	0.0000	4.015E-15	0.0000	3.624E-16	0.0000	9.579E-18	0.0000	1.664E-15	0.0000
Sr-90	1.033E-05	0.0033	3.297E-08	0.0000	0.000E+00	0.0000	1.723E-03	0.5561	1.617E-04	0.0522	9.133E-05	0.0295	5.951E-06	0.0019
Total	1.026E-03	0.3311	3.354E-08	0.0000	0.000E+00	0.0000	1.776E-03	0.5734	1.835E-04	0.0592	1.049E-04	0.0338	7.338E-06	0.0024

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-	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	1.791E-18	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	1.105E-03	0.3569
Eu-152	0.000E+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	1.972E-07	0.0001
Eu-154	0.000E+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	1.447E-11	0.0000
Sr-90	0.000E+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	1.992E-03	0.6431
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	3.098E-03	1.0000

0*Sum of all water independent and dependent pathways.

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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
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.
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	8.254E-11	0.4709	4.654E-17	0.0000	0.000E+00	0.0000	4.351E-12	0.0248	1.770E-12	0.0101	1.099E-12	0.0063	1.127E-13	0.0006
Eu-152	2.952E-23	0.0000	8.643E-17	0.0000	0.000E+00	0.0000	2.136E-16	0.0000	1.928E-17	0.0000	5.095E-19	0.0000	8.851E-17	0.0000
Eu-154	0.000E+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
Sr-90	4.430E-13	0.0025	1.414E-15	0.0000	0.000E+00	0.0000	7.387E-11	0.4214	6.934E-12	0.0396	3.917E-12	0.0223	2.552E-13	0.0015
Total	8.298E-11	0.4734	1.547E-15	0.0000	0.000E+00	0.0000	7.823E-11	0.4462	8.704E-12	0.0497	5.016E-12	0.0286	3.680E-13	0.0021

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+03 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.
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	8.987E-11	0.5127
Eu-152	0.000E+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	4.083E-16	0.0000
Eu-154	0.000E+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
Sr-90	0.000E+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	8.542E-11	0.4873
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	1.753E-10	1.0000

0*Sum of all water independent and dependent pathways.

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Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
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Co-60	Co-60	1.000E+00	9.727E+00	8.527E+00	6.552E+00	3.768E+00	1.349E+00	3.849E-02	1.851E-05	6.708E-17	0.000E+00
0Cs-137	Cs-137	1.000E+00	2.301E+00	2.248E+00	2.145E+00	1.945E+00	1.622E+00	8.640E-01	2.234E-01	2.106E-03	1.712E-10
0Eu-152	Eu-152	7.208E-01	3.105E+00	2.948E+00	2.656E+00	2.135E+00	1.422E+00	3.488E-01	1.704E-02	5.130E-07	7.685E-23
0Eu-152	Eu-152	2.792E-01	1.203E+00	1.142E+00	1.029E+00	8.268E-01	5.509E-01	1.351E-01	6.600E-03	1.987E-07	2.977E-23
Eu-152	Gd-152	2.792E-01	3.819E-17	1.120E-16	2.485E-16	4.929E-16	8.266E-16	1.329E-15	1.484E-15	1.488E-15	1.474E-15
Eu-152	ãDSR(j)		1.203E+00	1.142E+00	1.029E+00	8.268E-01	5.509E-01	1.351E-01	6.600E-03	1.987E-07	1.474E-15
0Eu-154	Eu-154	1.000E+00	4.665E+00	4.312E+00	3.683E+00	2.645E+00	1.430E+00	1.703E-01	1.761E-03	2.509E-10	2.737E-34
0Sr-90	Sr-90	1.000E+00	2.955E+00	2.884E+00	2.748E+00	2.482E+00	2.054E+00	1.068E+00	2.618E-01	2.056E-03	8.816E-11
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*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) 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	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
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Co-60	1.542E+00	1.759E+00	2.289E+00	3.981E+00	1.112E+01	3.897E+02	8.102E+05	*1.131E+15	*1.131E+15
Cs-137	6.519E+00	6.673E+00	6.992E+00	7.711E+00	9.250E+00	1.736E+01	6.715E+01	7.124E+03	8.762E+10
Eu-152	3.482E+00	3.668E+00	4.070E+00	5.065E+00	7.602E+00	3.099E+01	6.345E+02	2.107E+07	*1.765E+14
Eu-154	3.215E+00	3.479E+00	4.073E+00	5.671E+00	1.049E+01	8.809E+01	8.519E+03	5.980E+10	*2.639E+14
Sr-90	5.076E+00	5.201E+00	5.459E+00	6.044E+00	7.302E+00	1.405E+01	5.729E+01	7.297E+03	1.701E+11
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*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 (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
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Co-60	2.670E-02	0.000E+00	9.727E+00	1.542E+00	9.727E+00	1.542E+00
Cs-137	5.250E-01	0.000E+00	2.301E+00	6.519E+00	2.301E+00	6.519E+00
Eu-152	2.770E-01	0.000E+00	4.308E+00	3.482E+00	4.308E+00	3.482E+00
Eu-154	5.770E-02	0.000E+00	4.665E+00	3.215E+00	4.665E+00	3.215E+00
Sr-90	9.690E-01	0.000E+00	2.955E+00	5.076E+00	2.955E+00	5.076E+00
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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
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Co-60	Co-60	1.000E+00	2.597E-01	2.277E-01	1.749E-01	1.006E-01	3.601E-02	1.028E-03	4.943E-07	1.791E-18	0.000E+00
0Cs-137	Cs-137	1.000E+00	1.208E+00	1.180E+00	1.126E+00	1.021E+00	8.514E-01	4.536E-01	1.173E-01	1.105E-03	8.987E-11
0Eu-152	Eu-152	7.208E-01	8.601E-01	8.165E-01	7.358E-01	5.913E-01	3.940E-01	9.663E-02	4.720E-03	1.421E-07	2.129E-23
Eu-152	Eu-152	2.792E-01	3.332E-01	3.163E-01	2.850E-01	2.290E-01	1.526E-01	3.743E-02	1.828E-03	5.505E-08	8.245E-24
Eu-152	äDOSE(j)		1.193E+00	1.133E+00	1.021E+00	8.203E-01	5.466E-01	1.341E-01	6.548E-03	1.972E-07	2.953E-23
0Gd-152	Eu-152	2.792E-01	1.058E-17	3.102E-17	6.884E-17	1.365E-16	2.290E-16	3.682E-16	4.109E-16	4.121E-16	4.083E-16
0Eu-154	Eu-154	1.000E+00	2.692E-01	2.488E-01	2.125E-01	1.526E-01	8.252E-02	9.825E-03	1.016E-04	1.447E-11	0.000E+00
0Sr-90	Sr-90	1.000E+00	2.863E+00	2.795E+00	2.663E+00	2.405E+00	1.991E+00	1.035E+00	2.537E-01	1.992E-03	8.542E-11
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BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Co-60	Co-60	1.000E+00	2.670E-02	2.340E-02	1.798E-02	1.034E-02	3.702E-03	1.057E-04	5.082E-08	1.841E-19	0.000E+00
0Cs-137	Cs-137	1.000E+00	5.250E-01	5.129E-01	4.895E-01	4.438E-01	3.700E-01	1.971E-01	5.097E-02	4.804E-04	3.906E-11
0Eu-152	Eu-152	7.208E-01	1.997E-01	1.895E-01	1.708E-01	1.373E-01	9.145E-02	2.243E-02	1.096E-03	3.299E-08	4.941E-24
Eu-152	Eu-152	2.792E-01	7.734E-02	7.342E-02	6.616E-02	5.317E-02	3.542E-02	8.688E-03	4.244E-04	1.278E-08	1.914E-24
Eu-152	åS(j):		2.770E-01	2.630E-01	2.370E-01	1.904E-01	1.269E-01	3.112E-02	1.520E-03	4.577E-08	6.855E-24
0Gd-152	Eu-152	2.792E-01	0.000E+00	4.837E-16	1.379E-15	2.980E-15	5.167E-15	8.461E-15	9.473E-15	9.500E-15	9.413E-15
0Eu-154	Eu-154	1.000E+00	5.770E-02	5.333E-02	4.555E-02	3.271E-02	1.769E-02	2.106E-03	2.178E-05	3.103E-12	3.386E-36
0Sr-90	Sr-90	1.000E+00	9.690E-01	9.458E-01	9.010E-01	8.138E-01	6.737E-01	3.502E-01	8.586E-02	6.741E-04	2.891E-11
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 2.13 seconds

RESRAD INPUT PARAMETERS FOR THE DEEP ZONE

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Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.rad

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Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
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	Eu-152	2.210E-04	2.210E-04	DCF2(3)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(5)
B-1	Gd-152	2.430E-01	2.430E-01	DCF2(6)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(7)
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	Eu-152	6.480E-06	6.480E-06	DCF3(3)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(5)
D-1	Gd-152	1.610E-04	1.610E-04	DCF3(6)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(7)
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	Eu-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(3,1)
D-34	Eu-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(3,2)
D-34	Eu-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(3,3)
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(5,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(5,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(5,3)
D-34	Gd-152 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Gd-152 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Gd-152 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(6,3)
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(7,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(7,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(7,3)
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	Eu-152 , fish	5.000E+01	5.000E+01	BIOFAC(3,1)
D-5	Eu-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(3,2)

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Dose Conversion Factor (and Related) Parameter Summary (continued)
File: HEAST 2001 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(5,2)
D-5				
D-5	Gd-152 , fish	2.500E+01	2.500E+01	BIOFAC(6,1)
D-5	Gd-152 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5				
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(7,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(7,2)

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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)	5.272E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	8.900E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.545E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	4.000E+00	2.500E+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)	7.200E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.500E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	4.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	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	3.400E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Cs-137	6.080E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Eu-152	7.510E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Eu-154	7.270E-01	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Sr-90	1.280E+01	0.000E+00	---	S1(7)
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): Eu-152	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(7)
R013	Cover depth (m)	4.600E+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)	1.000E-03	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

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(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	1.120E-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	1.000E+03	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.120E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Eu-152				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(3)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.804E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(5)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.804E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCC(7)
R016	Saturated zone (cm**3/g)	2.500E+01	3.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.234E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter Gd-152				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCC(6)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	8.249E+02	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.803E-06	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	not used	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	not used	2.500E-01	---	FOTD

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Shape factor flag, external gamma	not used	1.000E+00	-1 shows non-circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	5.000E+01	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	7.071E+01	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	0.000E+00	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	0.000E+00	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	0.000E+00	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	0.000E+00	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	0.000E+00	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	0.000E+00	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	0.000E+00	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	0.000E+00	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	0.000E+00	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	0.000E+00	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	1.000E+00	1.000E+00	---	FRACA(1)
R017	Ring 2	2.732E-01	2.732E-01	---	FRACA(2)
R017	Ring 3	0.000E+00	0.000E+00	---	FRACA(3)
R017	Ring 4	0.000E+00	0.000E+00	---	FRACA(4)
R017	Ring 5	0.000E+00	0.000E+00	---	FRACA(5)
R017	Ring 6	0.000E+00	0.000E+00	---	FRACA(6)
R017	Ring 7	0.000E+00	0.000E+00	---	FRACA(7)
R017	Ring 8	0.000E+00	0.000E+00	---	FRACA(8)
R017	Ring 9	0.000E+00	0.000E+00	---	FRACA(9)
R017	Ring 10	0.000E+00	0.000E+00	---	FRACA(10)
R017	Ring 11	0.000E+00	0.000E+00	---	FRACA(11)
R017	Ring 12	0.000E+00	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)	not used	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	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.264E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.264E+00	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

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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
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

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Site-Specific Parameter Summary (continued)

0 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	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

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

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	5272.00 square meters	Co-60	3.400E-01
Thickness:	8.90 meters	Cs-137	6.080E+00
Cover Depth:	4.60 meters	Eu-152	7.510E+00
		Eu-154	7.270E-01
		Sr-90	1.280E+01

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 4.000E+00 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.600E-02	4.829E-02	1.086E-01	2.170E-01	3.633E-01	5.236E-01	3.105E-01	7.872E-03	1.219E-09
M(t):	4.000E-03	1.207E-02	2.715E-02	5.426E-02	9.082E-02	1.309E-01	7.763E-02	1.968E-03	3.048E-10

0Maximum TDOSE(t): 5.237E-01 mrem/yr at t = 41.44 ñ 0.08 years
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 = 4.144E+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.
Nuclide														
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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 = 4.144E+01 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.
Nuclide														
Co-60	2.901E-06	0.0000	1.641E-07	0.0000	0.000E+00	0.0000	3.276E-07	0.0000	3.879E-07	0.0000	1.125E-07	0.0000	3.893E-06	0.0000
Cs-137	9.082E-03	0.0173	3.332E-03	0.0064	0.000E+00	0.0000	1.013E-03	0.0019	1.820E-03	0.0035	1.408E-03	0.0027	1.665E-02	0.0318
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	4.138E-01	0.7901	4.892E-03	0.0093	0.000E+00	0.0000	4.982E-02	0.0951	2.237E-02	0.0427	1.616E-02	0.0309	5.070E-01	0.9682
Total	4.229E-01	0.8075	8.223E-03	0.0157	0.000E+00	0.0000	5.084E-02	0.0971	2.419E-02	0.0462	1.757E-02	0.0335	5.237E-01	1.0000

0*Sum of all water independent and dependent pathways.

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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- 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	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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	7.775E-06	0.0005	4.058E-07	0.0000	0.000E+00	0.0000	7.355E-07	0.0000	3.476E-07	0.0000	1.849E-07	0.0000	9.448E-06	0.0006
Cs-137	2.777E-04	0.0174	9.408E-05	0.0059	0.000E+00	0.0000	2.602E-05	0.0016	1.879E-05	0.0012	2.653E-05	0.0017	4.431E-04	0.0277
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	1.313E-02	0.8206	1.489E-04	0.0093	0.000E+00	0.0000	1.445E-03	0.0903	4.248E-04	0.0266	3.987E-04	0.0249	1.555E-02	0.9717
Total	1.342E-02	0.8385	2.434E-04	0.0152	0.000E+00	0.0000	1.472E-03	0.0920	4.440E-04	0.0277	4.254E-04	0.0266	1.600E-02	1.0000

0*Sum of all water independent and dependent pathways.

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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	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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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	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.
Co-60	2.092E-05	0.0004	1.150E-06	0.0000	0.000E+00	0.0000	2.219E-06	0.0000	1.978E-06	0.0000	6.840E-07	0.0000	2.695E-05	0.0006
Cs-137	8.227E-04	0.0170	2.932E-04	0.0061	0.000E+00	0.0000	8.626E-05	0.0018	1.169E-04	0.0024	1.076E-04	0.0022	1.427E-03	0.0295
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	3.872E-02	0.8020	4.507E-04	0.0093	0.000E+00	0.0000	4.510E-03	0.0934	1.764E-03	0.0365	1.384E-03	0.0287	4.683E-02	0.9699
Total	3.957E-02	0.8194	7.450E-04	0.0154	0.000E+00	0.0000	4.598E-03	0.0952	1.883E-03	0.0390	1.493E-03	0.0309	4.829E-02	1.0000

0*Sum of all water independent and dependent pathways.

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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	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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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	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.
Co-60	3.779E-05	0.0003	2.113E-06	0.0000	0.000E+00	0.0000	4.163E-06	0.0000	4.455E-06	0.0000	1.372E-06	0.0000	4.990E-05	0.0005
Cs-137	1.839E-03	0.0169	6.669E-04	0.0061	0.000E+00	0.0000	2.002E-04	0.0018	3.250E-04	0.0030	2.670E-04	0.0025	3.298E-03	0.0304
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	8.634E-02	0.7951	1.014E-03	0.0093	0.000E+00	0.0000	1.026E-02	0.0945	4.369E-03	0.0402	3.256E-03	0.0300	1.052E-01	0.9692
Total	8.821E-02	0.8124	1.683E-03	0.0155	0.000E+00	0.0000	1.046E-02	0.0963	4.698E-03	0.0433	3.524E-03	0.0325	1.086E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.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 = 7.200E+00 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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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 = 7.200E+00 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.
Co-60	4.799E-05	0.0002	2.702E-06	0.0000	0.000E+00	0.0000	5.365E-06	0.0000	6.110E-06	0.0000	1.813E-06	0.0000	6.399E-05	0.0003
Cs-137	3.677E-03	0.0169	1.343E-03	0.0062	0.000E+00	0.0000	4.062E-04	0.0019	7.016E-04	0.0032	5.553E-04	0.0026	6.683E-03	0.0308
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	1.720E-01	0.7924	2.028E-03	0.0093	0.000E+00	0.0000	2.060E-02	0.0949	9.057E-03	0.0417	6.623E-03	0.0305	2.103E-01	0.9689
Total	1.757E-01	0.8096	3.373E-03	0.0155	0.000E+00	0.0000	2.101E-02	0.0968	9.764E-03	0.0450	7.180E-03	0.0331	2.170E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.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 = 1.500E+01 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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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 = 1.500E+01 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.
Co-60	3.467E-05	0.0001	1.958E-06	0.0000	0.000E+00	0.0000	3.900E-06	0.0000	4.551E-06	0.0000	1.331E-06	0.0000	4.642E-05	0.0001
Cs-137	6.184E-03	0.0170	2.265E-03	0.0062	0.000E+00	0.0000	6.874E-04	0.0019	1.216E-03	0.0033	9.490E-04	0.0026	1.130E-02	0.0311
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	2.875E-01	0.7913	3.395E-03	0.0093	0.000E+00	0.0000	3.454E-02	0.0951	1.539E-02	0.0424	1.117E-02	0.0307	3.520E-01	0.9688
Total	2.937E-01	0.8084	5.661E-03	0.0156	0.000E+00	0.0000	3.523E-02	0.0970	1.661E-02	0.0457	1.212E-02	0.0334	3.633E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.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 = 4.200E+01 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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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 = 4.200E+01 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.
Co-60	2.730E-06	0.0000	1.544E-07	0.0000	0.000E+00	0.0000	3.082E-07	0.0000	3.651E-07	0.0000	1.059E-07	0.0000	3.664E-06	0.0000
Cs-137	9.085E-03	0.0174	3.333E-03	0.0064	0.000E+00	0.0000	1.014E-03	0.0019	1.821E-03	0.0035	1.408E-03	0.0027	1.666E-02	0.0318
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	4.137E-01	0.7901	4.891E-03	0.0093	0.000E+00	0.0000	4.982E-02	0.0951	2.237E-02	0.0427	1.616E-02	0.0309	5.070E-01	0.9682
Total	4.228E-01	0.8075	8.224E-03	0.0157	0.000E+00	0.0000	5.083E-02	0.0971	2.419E-02	0.0462	1.757E-02	0.0335	5.236E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.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	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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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	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.
Co-60	3.141E-09	0.0000	1.778E-10	0.0000	0.000E+00	0.0000	3.551E-10	0.0000	4.227E-10	0.0000	1.222E-10	0.0000	4.219E-09	0.0000
Cs-137	5.619E-03	0.0181	2.062E-03	0.0066	0.000E+00	0.0000	6.277E-04	0.0020	1.133E-03	0.0036	8.737E-04	0.0028	1.032E-02	0.0332
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	2.449E-01	0.7888	2.896E-03	0.0093	0.000E+00	0.0000	2.951E-02	0.0950	1.329E-02	0.0428	9.583E-03	0.0309	3.002E-01	0.9668
Total	2.505E-01	0.8069	4.959E-03	0.0160	0.000E+00	0.0000	3.014E-02	0.0971	1.442E-02	0.0464	1.046E-02	0.0337	3.105E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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.
Co-60	3.539E-20	0.0000	2.004E-21	0.0000	0.000E+00	0.0000	4.004E-21	0.0000	4.776E-21	0.0000	1.379E-21	0.0000	4.756E-20	0.0000
Cs-137	1.647E-04	0.0209	6.047E-05	0.0077	0.000E+00	0.0000	1.841E-05	0.0023	3.330E-05	0.0042	2.565E-05	0.0033	3.025E-04	0.0384
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	6.174E-03	0.7844	7.303E-05	0.0093	0.000E+00	0.0000	7.442E-04	0.0945	3.355E-04	0.0426	2.418E-04	0.0307	7.569E-03	0.9616
Total	6.339E-03	0.8053	1.335E-04	0.0170	0.000E+00	0.0000	7.626E-04	0.0969	3.688E-04	0.0468	2.674E-04	0.0340	7.872E-03	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/21/2003 10:09 Page 18
Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.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
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.
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	0.000E+00	0.0000
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	0.000E+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
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	0.000E+00	0.0000

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+03 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.
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	5.113E-11	0.0419	1.878E-11	0.0154	0.000E+00	0.0000	5.717E-12	0.0047	1.035E-11	0.0085	7.968E-12	0.0065	9.394E-11	0.0771
Eu-152	0.000E+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
Eu-154	0.000E+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
Sr-90	9.177E-10	0.7528	1.086E-11	0.0089	0.000E+00	0.0000	1.106E-10	0.0908	4.990E-11	0.0409	3.595E-11	0.0295	1.125E-09	0.9229
Total	9.689E-10	0.7948	2.963E-11	0.0243	0.000E+00	0.0000	1.164E-10	0.0954	6.025E-11	0.0494	4.392E-11	0.0360	1.219E-09	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/21/2003 10:09 Page 19
Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.rad

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Co-60	Co-60	1.000E+00	2.779E-05	7.928E-05	1.468E-04	1.882E-04	1.365E-04	1.078E-05	1.241E-08	1.399E-19	0.000E+00
0Cs-137	Cs-137	1.000E+00	7.288E-05	2.346E-04	5.425E-04	1.099E-03	1.859E-03	2.740E-03	1.697E-03	4.976E-05	1.545E-11
0Eu-152	Eu-152	7.208E-01	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
0Eu-152	Eu-152	2.792E-01	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
Eu-152	Gd-152	2.792E-01	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
Eu-152	äDSR(j)		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
0Eu-154	Eu-154	1.000E+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
0Sr-90	Sr-90	1.000E+00	1.215E-03	3.659E-03	8.221E-03	1.643E-02	2.750E-02	3.961E-02	2.345E-02	5.913E-04	8.790E-11
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 4.000E+00 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Co-60	1.439E+05	5.046E+04	2.726E+04	2.125E+04	2.930E+04	3.712E+05	3.223E+08	*1.131E+15	*1.131E+15
Cs-137	5.488E+04	1.705E+04	7.373E+03	3.639E+03	2.152E+03	1.460E+03	2.358E+03	8.039E+04	2.589E+11
Eu-152	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14	*1.765E+14
Eu-154	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14
Sr-90	3.293E+03	1.093E+03	4.865E+02	2.435E+02	1.455E+02	1.010E+02	1.705E+02	6.764E+03	4.551E+10
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

*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 = 41.44 ñ 0.08 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Co-60	3.400E-01	7.18 ñ 0.01	1.882E-04	2.125E+04	1.145E-05	3.493E+05
Cs-137	6.080E+00	42.82 ñ 0.09	2.741E-03	1.459E+03	2.739E-03	1.460E+03
Eu-152	7.510E+00	0.000E+00	0.000E+00	*1.765E+14	0.000E+00	*1.765E+14
Eu-154	7.270E-01	0.000E+00	0.000E+00	*2.639E+14	0.000E+00	*2.639E+14
Sr-90	1.280E+01	41.39 ñ 0.08	3.961E-02	1.010E+02	3.961E-02	1.010E+02
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

*At specific activity limit

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/21/2003 10:09 Page 20
Summary : 116-F-6 Cleanup Verification - Deep Zone File: 116f6_deep.rad

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

DOSE(j,t), mrem/yr

0Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Co-60	Co-60	1.000E+00	9.448E-06	2.695E-05	4.990E-05	6.399E-05	4.642E-05	3.664E-06	4.219E-09	4.756E-20	0.000E+00
0Cs-137	Cs-137	1.000E+00	4.431E-04	1.427E-03	3.298E-03	6.683E-03	1.130E-02	1.666E-02	1.032E-02	3.025E-04	9.394E-11
0Eu-152	Eu-152	7.208E-01	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
Eu-152	Eu-152	2.792E-01	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
Eu-152	äDOSE(j)		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
0Gd-152	Eu-152	2.792E-01	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
0Eu-154	Eu-154	1.000E+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
0Sr-90	Sr-90	1.000E+00	1.555E-02	4.683E-02	1.052E-01	2.103E-01	3.520E-01	5.070E-01	3.002E-01	7.569E-03	1.125E-09
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

S(j,t), pCi/g

0Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	7.200E+00	1.500E+01	4.200E+01	1.000E+02	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ
Co-60	Co-60	1.000E+00	3.400E-01	2.981E-01	2.291E-01	1.318E-01	4.722E-02	1.351E-03	6.540E-07	2.419E-18	0.000E+00
0Cs-137	Cs-137	1.000E+00	6.080E+00	5.940E+00	5.671E+00	5.144E+00	4.292E+00	2.293E+00	5.965E-01	5.741E-03	5.023E-10
0Eu-152	Eu-152	7.208E-01	5.413E+00	5.139E+00	4.631E+00	3.722E+00	2.480E+00	6.088E-01	2.978E-02	9.014E-07	1.375E-22
Eu-152	Eu-152	2.792E-01	2.097E+00	1.990E+00	1.794E+00	1.442E+00	9.608E-01	2.358E-01	1.154E-02	3.492E-07	5.327E-23
Eu-152	äS(j):		7.510E+00	7.129E+00	6.425E+00	5.164E+00	3.441E+00	8.446E-01	4.132E-02	1.251E-06	1.908E-22
0Gd-152	Eu-152	2.792E-01	0.000E+00	1.311E-14	3.738E-14	8.081E-14	1.401E-13	2.295E-13	2.571E-13	2.582E-13	2.569E-13
0Eu-154	Eu-154	1.000E+00	7.270E-01	6.719E-01	5.739E-01	4.122E-01	2.230E-01	2.656E-02	2.751E-04	3.940E-11	4.379E-35
0Sr-90	Sr-90	1.000E+00	1.280E+01	1.250E+01	1.191E+01	1.077E+01	8.927E+00	4.666E+00	1.158E+00	9.481E-03	4.706E-10
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 1.80 seconds

CALCULATION BRIEF EXCERPTS

DISCLAIMER FOR CALCULATIONS

The calculations that are provided in the following appendix are included for reference only. Use of these calculations by persons who do not have access to all of their pertinent factors could lead to incorrect conclusions or assumptions.

Before applying these calculations to work activities or projects outside the context of this report, these calculations must be thoroughly reviewed with appropriate and authorized Hanford Site ERC personnel. Without this review, the ER Project cannot assume any responsibility for the use of these calculations.

CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with BHI-DE-01, *Design Engineering Procedures Manual*, EDPI-4.37-01, "Project Calculations," Bechtel Hanford, Inc., Richland, Washington.

116-F-6 Liquid Waste Trench Sample Variance Calculation, Calculation No. 0100F-CA-V0152, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

116-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design, Calculation No. 0100F-CA-V0159, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation, Calculation No. 0100F-CA-V0141, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

116-F-6 RESRAD Calculation, Calculation No. 0100F-CA-V0143, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

116-F-6 Trench Comparison to Drinking Water Standards, Calculation No. 0100F-CA-V0142, Bechtel Hanford, Inc., Richland, Washington.

NOTE: The calculation briefs referenced in this appendix are kept in the active Environmental Restoration Contractor project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository. Only excerpts of the calculation briefs are included in this appendix.

CALCULATION COVER SHEET

Project Title:	Group 4 Remedial Action	**Job No.**	22192
Area	100F		
Discipline	Environmental	**Calc. No.**	0100F-CA-V0152
Subject	116-F-6 Liquid Waste Trench Sample Variance Calculation		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation X **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calc. Summary - 1 Calculation - 6 Total - 8	3-5-3 M. T. Stankovich	3-5-03 S. W. Callison	3/5/03 J.E. Thomson	for M. A. Buckmaster	3/7/03

SUMMARY OF REVISIONS

Scanned	Rev.	Date	Bar Code No.

* Obtain Calc. No. from DIS.

CALCULATION SHEET

Bechtel Hanford Inc.							
Originator	M. T. Stankovich	Date	3/5/2003	Calc. No.	0100F-CA-V0152	Rev. No.	0
Project	Group 4 Remedial Action	Job No.	22192	Checked	SW Callison	Date	3-5-03
Subject	116-F-6 Liquid Waste Trench Sample Variance Calculation					Sheet No.	1 of 7

Conclusion:
The required number of samples calculated (1 sample) for each decision sub-unit is less than the default number (4 samples) specified in the DOE/RL-96-22, Rev 2. Therefore, the default number of samples will be collected from each shallow zone decision sub-unit.

Problem:
Calculate the number of close out samples required for 116-F-6 Shallow Zone Decision Unit verification sampling as required in "100 Area Remedial Action Sampling and Analysis Plan" (DOE/RL-96-22, Rev 3) and "Instruction Guide for the Remediation of 100 Areas Waste Sites" (0100X-IG-G0001, Rev 3).

Given:
1) Sample locations for the 116-F-6 Shallow Zone are identified on the 116-F-6 Liquid Waste Trench Disposal Shallow & Deep Zone Design, Calculation number 0100F-CA-V0159, Rev. 0.
2) Lookup values from DOE/RL-96-22, Rev 3.
3) Sample Design requirements from DOE/RL-96-22, Rev 3 and 0100X-IG-G0001, Rev 3.

Solution:
Calculation methodology is described in Appendix A of DOE/RL-96-22, Rev 3. Data from attached worksheets are used to calculate the required number of closeout samples. Variance calculation is based on the same three isotopes used to develop the statistical approach in DOE/RL-96-22, Rev 3. The statistical design is based on the premise that these isotopes are the predominant components of the contamination and are representative of the contamination distribution.

Sheet No.	Contents	Topic
1	Calc. Summary	Summary of Calc Brief
2-3	Shallow Zone	Required Number of Samples Calculation
4-5	Shallow Zone Formulas	Formulas
6-7	Shallow Zone Data	Raw Data from Sample Management

CALCULATION SHEET

	Bechtel Hanford Inc.						
Originator	M. T. Stankovich	Date	3/5/2003	Calc. No.	0100F-CA-V0152	Rev. No.	0
Project	Group 4 Remedial Action	Job No.	22192	Checked	SW Callison SWC	Date	3-5-03
Subject	116-F-6 Liquid Waste Trench Sample Variance Calculation					Sheet No.	2 of 7

Statistical Evaluation of Analytical Data

The required number of samples resulting from the calculation is highlighted at the bottom of the page.
Each value is reflective of the specific analyte evaluated.
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of four.
Sample locations are from Calculation 0100F-CA-V0159.
Mean, Standard Deviation, *t*, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: Shallow Zone
Samples values from GEA analysis
Sample Areas A, B, C & D

Sample #	Sample Date	Location	Cobalt-60 pCi/g	Q	Cesium-137 pCi/g	Q	Europium-152 pCi/g	Q
			Constituent					
Look-up Value (HT) ==========>			**1.4**		**6.2**		**3.3**	
J00111	04-Nov-2002	S-A1-2	0.1	U	0.394		0.38	U
J00112	04-Nov-2002	S-A1-3	0.057	U	0.332		0.143	
J00113	04-Nov-2002	S-A1-4	0.089	U	0.558		0.346	
J00114	04-Nov-2002	S-A1-10	0.055	U	0.286		0.2	U
J00115	04-Nov-2002	S-A1-13	0.058	U	0.177		0.15	U
J00116	04-Nov-2002	S-A1-16	0.16	U	0.186		0.269	
J00117	04-Nov-2002	S-A2-3	0.057	U	0.108		0.21	U
J00118	04-Nov-2002	S-A2-6	0.081	U	0.237		0.32	U
J00119	04-Nov-2002	S-A2-7	0.058	U	0.394		0.17	U
J00120	04-Nov-2002	S-A2-10	0.067	U	0.108		0.15	U
J00121	04-Nov-2002	S-A2-14	0.087	U	0.108		0.22	U
J00122	04-Nov-2002	S-A2-15	0.065	U	0.096	U	0.14	U
J00123	04-Nov-2002	S-A3-1	0.071	U	0.1	U	0.22	U
J00124	04-Nov-2002	S-A3-2	0.066	U	0.072	J	0.161	
J00125	04-Nov-2002	S-A3-4	0.06	U	0.067	U	0.14	U
J00126	04-Nov-2002	S-A3-5	0.11	U	0.095	U	0.23	U
J00127	04-Nov-2002	S-A3-9	0.063	U	0.885		0.334	
J00128	04-Nov-2002	S-A3-11	0.12	U	0.11	U	0.22	U
J00129	04-Nov-2002	S-A4-3	0.076	U	1.74		0.635	
J00130	04-Nov-2002	S-A4-4	0.067	U	0.166		0.17	U
J00131	04-Nov-2002	S-A4-7	0.056	U	0.127		0.11	U
J00132	04-Nov-2002	S-A4-9	0.03	U	0.129		0.099	U
J00133	04-Nov-2002	S-A4-12	0.067	U	0.39		0.18	U
J00134	04-Nov-2002	S-A4-13	0.039	U	0.037	U	0.087	U
J00135	05-Nov-2002	S-B5-1	0.063	U	1.16		0.613	
J00136	05-Nov-2002	S-B5-2	0.039	U	0.547		0.293	
J00137	05-Nov-2002	S-B5-5	0.058	U	0.133		0.14	U
J00138	05-Nov-2002	S-B5-7	0.035	U	0.118		0.12	U
J00139	05-Nov-2002	S-B5-13	0.043	U	0.041	U	0.09	U
J00140	05-Nov-2002	S-B5-15	0.11	U	0.084	U	0.15	U
J00141	05-Nov-2002	S-B6-1	0.043	U	0.046	U	0.12	U
J00142	05-Nov-2002	S-B6-10	0.08	U	0.072	U	0.2	U
J00143	05-Nov-2002	S-B6-12	0.06	U	0.234		0.464	
J00144	05-Nov-2002	S-B6-13	0.071	U	0.078	U	0.17	U
J00145	05-Nov-2002	S-B6-15	0.04	U	0.037	U	0.093	U
J00146	05-Nov-2002	S-B6-16	0.027	U	0.053	J	0.068	U
J00147	05-Nov-2002	S-B7-1	0.045	U	0.043	U	0.099	U
J00148	05-Nov-2002	S-B7-3	0.026	U	0.096	J	0.061	U
J00149	05-Nov-2002	S-B7-4	0.035	U	0.113		0.092	J
J00150	05-Nov-2002	S-B7-5	0.081	U	0.1	U	0.14	U
J00151	05-Nov-2002	S-B7-8	0.059	U	0.328		2.84	
J00152	05-Nov-2002	S-B7-11	0.086	U	0.135		0.13	U
J00153	06-Nov-2002	S-B8-2	0.091	U	0.198		0.19	U
J00154	06-Nov-2002	S-B8-3	0.11	U	0.1	U	0.2	U
J00155	06-Nov-2002	S-B8-4	0.066	U	0.086	J	0.16	U
J00156	05-Nov-2002	S-B8-8	0.149		0.836		5.66	
J00157	05-Nov-2002	S-B8-12	0.061	U	0.284		0.163	

Shallow Zone

CALCULATION SHEET

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	3/5/2003	Calc. No.	0100F-CA-V0152	Rev. No.	0
Project	Group 4 Remedial Action	Job No.	22192	Checked	SW Callison SWC	Date	3-5-03
Subject	116-F-6 Liquid Waste Trench Sample Variance Calculation					Sheet No.	3 of 7

64	J00158	05-Nov-2002	S-B8-13	0.068	U	0.076	J	0.13	U
65	J00866	06-Nov-2002	S-C9-3	0.057	U	0.054	U	0.11	U
66	J00867	06-Nov-2002	S-C9-4	0.034	U	0.053	U	0.12	U
67	J00868	06-Nov-2002	S-C9-5	0.058	U	0.052	U	0.12	U
68	J00869	06-Nov-2002	S-C9-10	0.035	U	0.085	J	0.077	U
69	J00870	06-Nov-2002	S-C9-14	0.04	U	0.041	U	0.093	U
70	J00871	06-Nov-2002	S-C9-16	0.089	U	0.085	U	0.2	U
71	J00872	06-Nov-2002	S-C10-3	0.045	U	0.05	U	0.11	U
72	J00873	06-Nov-2002	S-C10-4	0.051	U	0.101		0.11	U
73	J00874	06-Nov-2002	S-C10-8	0.052	U	0.127		0.15	U
74	J00875	06-Nov-2002	S-C10-10	0.054	U	0.179		0.15	U
75	J00876	06-Nov-2002	S-C10-14	0.067	U	0.174		0.191	
76	J00877	06-Nov-2002	S-C10-16	0.058	U	0.482		0.276	
77	J00878	06-Nov-2002	S-C1-2	0.095	U	0.082	J	0.22	U
78	J00879	06-Nov-2002	S-C1-3	0.05	U	0.071	U	0.21	U
79	J00880	06-Nov-2002	S-C1-4	0.058	U	0.161		0.133	
80	J00881	06-Nov-2002	S-C1-1	0.089	U	0.179		0.21	U
81	J00882	06-Nov-2002	S-C1-13	0.047	U	0.132		0.17	U
82	J00883	06-Nov-2002	S-C1-16	0.084	U	0.121		0.23	U
83	J00884	06-Nov-2002	S-C2-3	0.07	U	0.36		0.2	U
84	J00885	06-Nov-2002	S-C2-6	0.073	U	0.192		0.16	U
85	J00886	06-Nov-2002	S-C2-7	0.054	U	0.058	U	0.13	U
86	J00887	06-Nov-2002	S-C2-10	0.048	U	0.448		0.282	
87	J00888	06-Nov-2002	S-C2-14	0.11	U	2.41		1.02	
88	J00889	06-Nov-2002	S-C2-15	0.047	U	0.055	U	0.13	U
89	J00890	07-Nov-2002	S-D3-1	0.11	U	0.443		0.25	U
90	J00891	07-Nov-2002	S-D3-2	0.069	U	0.603		0.323	
91	J00892	07-Nov-2002	S-D3-4	0.098	U	0.689		0.28	U
92	J00893	07-Nov-2002	S-D3-5	0.064	U	0.221		0.176	
93	J00894	07-Nov-2002	S-D3-9	0.082	U	0.555		0.261	
94	J00895	07-Nov-2002	S-D3-11	0.11	U	0.356		0.23	
95	J00896	07-Nov-2002	S-D4-3	0.059	U	0.132		0.13	U
96	J00897	07-Nov-2002	S-D4-4	0.085	U	0.081	U	0.2	U
97	J00898	07-Nov-2002	S-D4-7	0.066	U	0.085	J	0.14	U
98	J00899	07-Nov-2002	S-D4-9	0.062	U	0.07	U	0.15	U
99	J008B0	07-Nov-2002	S-D4-12	0.1	U	0.149		0.177	
100	J008B1	07-Nov-2002	S-D4-13	0.054	U	0.429		0.315	
101	J008B2	07-Nov-2002	S-D5-1	0.093	U	0.103	U	0.19	U
102	J008B3	07-Nov-2002	S-D5-2	0.065	U	0.433		0.29	U
103	J008B4	07-Nov-2002	S-D5-5	0.066	U	0.06	U	0.14	U
104	J008B5	07-Nov-2002	S-D5-7	0.071	U	0.1	U	0.14	U
105	J008B6	07-Nov-2002	S-D5-13	0.031	U	0.055	U	0.098	U
106	J008B7	07-Nov-2002	S-D5-15	0.056	U	0.123		0.135	
107	J008B8	07-Nov-2002	S-D6-1	0.045	U	0.415		0.286	
108	J008B9	07-Nov-2002	S-D6-10	0.053	U	0.194		0.432	
109	J008C0	07-Nov-2002	S-D6-12	0.16	U	0.918		2.3	
110	J008C1	07-Nov-2002	S-D6-13	0.059	U	0.074	J	0.13	U
111	J008C2	07-Nov-2002	S-D6-15	0.11	U	0.12	U	0.21	U
112	J008C3	07-Nov-2002	S-D6-16	0.072	U	0.08	U	0.217	
113	Mean (LV) ==========>			0.07		0.25		0.31	
114	Standard Deviation (S) ==========>			0.03		0.35		0.66	
115	α (5%) ==========>			1.645		1.645		1.645	
116	β (20%) ==========>			0.842		0.842		0.842	
117	**Number of Samples ==========>**			**1**		**1**		**1**	

Bechtel Hanford Inc.

Originator: M. T. Stankovich — Date 03/05/03
Project: Group 4 Remedial Action — Job No. 22192
Subject: 116-F-6 Liquid Waste Trench Sample Variance Calculation

Calc. No. 0100F-CA-V0152
Checked SW Callison SWC

Rev. No.
Date 3-5-03
Sheet No. 2 of 7

Statistical Evaluation of Analytical

The required number of samples resulting from the calculation is highlighted at the bottom of the pa
Each value is reflective of the specific analyte evaluate
The highest value of the three evaluations is used to determine the required number of samples as compared against the default of l
Sample locations are from Calculation0100F-CA-V015!
Mean, Standard Deviation/, and Number of Samples formulas are from DOE/RL-96-22, Appendix A.

Decision Unit: **Shallow Zone**
Samples values from GEA analysis..
Sample Areas A, B, C, & D

SWC 3-5-03

Sample #	Sample Date	Location	Cobalt-60 pCi/g	Q
Look-up Value===>			~~0.0007~~ 1.4	
='Shallow Zone Data'!B7	='Shallow Zone Data'!C7	='Shallow Zone Data'!D7	='Shallow Zone Data'!E7	
='Shallow Zone Data'!B8	='Shallow Zone Data'!C8	='Shallow Zone Data'!D8	='Shallow Zone Data'!E8	
='Shallow Zone Data'!B9	='Shallow Zone Data'!C9	='Shallow Zone Data'!D9	='Shallow Zone Data'!E9	
='Shallow Zone Data'!B10	='Shallow Zone Data'!C10	='Shallow Zone Data'!D10	='Shallow Zone Data'!E10	
='Shallow Zone Data'!B11	='Shallow Zone Data'!C11	='Shallow Zone Data'!D11	='Shallow Zone Data'!E11	
='Shallow Zone Data'!B12	='Shallow Zone Data'!C12	='Shallow Zone Data'!D12	='Shallow Zone Data'!E12	
='Shallow Zone Data'!B13	='Shallow Zone Data'!C13	='Shallow Zone Data'!D13	='Shallow Zone Data'!E13	
='Shallow Zone Data'!B14	='Shallow Zone Data'!C14	='Shallow Zone Data'!D14	='Shallow Zone Data'!E14	
='Shallow Zone Data'!B15	='Shallow Zone Data'!C15	='Shallow Zone Data'!D15	='Shallow Zone Data'!E15	
='Shallow Zone Data'!B16	='Shallow Zone Data'!C16	='Shallow Zone Data'!D16	='Shallow Zone Data'!E16	
='Shallow Zone Data'!B17	='Shallow Zone Data'!C17	='Shallow Zone Data'!D17	='Shallow Zone Data'!E17	
='Shallow Zone Data'!B18	='Shallow Zone Data'!C18	='Shallow Zone Data'!D18	='Shallow Zone Data'!E18	
='Shallow Zone Data'!B19	='Shallow Zone Data'!C19	='Shallow Zone Data'!D19	='Shallow Zone Data'!E19	
='Shallow Zone Data'!B20	='Shallow Zone Data'!C20	='Shallow Zone Data'!D20	='Shallow Zone Data'!E20	
='Shallow Zone Data'!B21	='Shallow Zone Data'!C21	='Shallow Zone Data'!D21	='Shallow Zone Data'!E21	
='Shallow Zone Data'!B22	='Shallow Zone Data'!C22	='Shallow Zone Data'!D22	='Shallow Zone Data'!E22	
='Shallow Zone Data'!B23	='Shallow Zone Data'!C23	='Shallow Zone Data'!D23	='Shallow Zone Data'!E23	
='Shallow Zone Data'!B24	='Shallow Zone Data'!C24	='Shallow Zone Data'!D24	='Shallow Zone Data'!E24	
='Shallow Zone Data'!B25	='Shallow Zone Data'!C25	='Shallow Zone Data'!D25	='Shallow Zone Data'!E25	
='Shallow Zone Data'!B26	='Shallow Zone Data'!C26	='Shallow Zone Data'!D26	='Shallow Zone Data'!E26	
='Shallow Zone Data'!B27	='Shallow Zone Data'!C27	='Shallow Zone Data'!D27	='Shallow Zone Data'!E27	
='Shallow Zone Data'!B28	='Shallow Zone Data'!C28	='Shallow Zone Data'!D28	='Shallow Zone Data'!E28	
='Shallow Zone Data'!B29	='Shallow Zone Data'!C29	='Shallow Zone Data'!D29	='Shallow Zone Data'!E29	
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='Shallow Zone Data'!B34	='Shallow Zone Data'!C34	='Shallow Zone Data'!D34	='Shallow Zone Data'!E34	
='Shallow Zone Data'!B35	='Shallow Zone Data'!C35	='Shallow Zone Data'!D35	='Shallow Zone Data'!E35	
='Shallow Zone Data'!B36	='Shallow Zone Data'!C36	='Shallow Zone Data'!D36	='Shallow Zone Data'!E36	
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='Shallow Zone Data'!B39	='Shallow Zone Data'!C39	='Shallow Zone Data'!D39	='Shallow Zone Data'!E39	
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='Shallow Zone Data'!B48	='Shallow Zone Data'!C48	='Shallow Zone Data'!D48	='Shallow Zone Data'!E48	
='Shallow Zone Data'!B49	='Shallow Zone Data'!C49	='Shallow Zone Data'!D49	='Shallow Zone Data'!E49	
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='Shallow Zone Data'!B51	='Shallow Zone Data'!C51	='Shallow Zone Data'!D51	='Shallow Zone Data'!E51	
='Shallow Zone Data'!B52	='Shallow Zone Data'!C52	='Shallow Zone Data'!D52	='Shallow Zone Data'!E52	
='Shallow Zone Data'!B53	='Shallow Zone Data'!C53	='Shallow Zone Data'!D53	='Shallow Zone Data'!E53	
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='Shallow Zone Data'!B80	='Shallow Zone Data'!C80	='Shallow Zone Data'!D80	='Shallow Zone Data'!E80	
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='Shallow Zone Data'!B84	='Shallow Zone Data'!C84	='Shallow Zone Data'!D84	='Shallow Zone Data'!E84	
='Shallow Zone Data'!B85	='Shallow Zone Data'!C85	='Shallow Zone Data'!D85	='Shallow Zone Data'!E85	
='Shallow Zone Data'!B86	='Shallow Zone Data'!C86	='Shallow Zone Data'!D86	='Shallow Zone Data'!E86	

SWC 3-5-03

Sample #	Cesium-137 pCi/g	Q
Look-up Value===>	~~0.350~~ 6.2	
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='Shallow Zone Data'!F8	='Shallow Zone Data'!G8	
='Shallow Zone Data'!F9	='Shallow Zone Data'!G9	
='Shallow Zone Data'!F10	='Shallow Zone Data'!G10	
='Shallow Zone Data'!F11	='Shallow Zone Data'!G11	
='Shallow Zone Data'!F12	='Shallow Zone Data'!G12	
='Shallow Zone Data'!F13	='Shallow Zone Data'!G13	
='Shallow Zone Data'!F14	='Shallow Zone Data'!G14	
='Shallow Zone Data'!F15	='Shallow Zone Data'!G15	
='Shallow Zone Data'!F16	='Shallow Zone Data'!G16	
='Shallow Zone Data'!F17	='Shallow Zone Data'!G17	
='Shallow Zone Data'!F18	='Shallow Zone Data'!G18	
='Shallow Zone Data'!F19	='Shallow Zone Data'!G19	
='Shallow Zone Data'!F20	='Shallow Zone Data'!G20	
='Shallow Zone Data'!F21	='Shallow Zone Data'!G21	
='Shallow Zone Data'!F22	='Shallow Zone Data'!G22	
='Shallow Zone Data'!F23	='Shallow Zone Data'!G23	
='Shallow Zone Data'!F24	='Shallow Zone Data'!G24	
='Shallow Zone Data'!F25	='Shallow Zone Data'!G25	
='Shallow Zone Data'!F26	='Shallow Zone Data'!G26	
='Shallow Zone Data'!F27	='Shallow Zone Data'!G27	
='Shallow Zone Data'!F28	='Shallow Zone Data'!G28	
='Shallow Zone Data'!F29	='Shallow Zone Data'!G29	
='Shallow Zone Data'!F30	='Shallow Zone Data'!G30	
='Shallow Zone Data'!F31	='Shallow Zone Data'!G31	
='Shallow Zone Data'!F32	='Shallow Zone Data'!G32	
='Shallow Zone Data'!F33	='Shallow Zone Data'!G33	
='Shallow Zone Data'!F34	='Shallow Zone Data'!G34	
='Shallow Zone Data'!F35	='Shallow Zone Data'!G35	
='Shallow Zone Data'!F36	='Shallow Zone Data'!G36	
='Shallow Zone Data'!F37	='Shallow Zone Data'!G37	
='Shallow Zone Data'!F38	='Shallow Zone Data'!G38	
='Shallow Zone Data'!F39	='Shallow Zone Data'!G39	
='Shallow Zone Data'!F40	='Shallow Zone Data'!G40	
='Shallow Zone Data'!F41	='Shallow Zone Data'!G41	
='Shallow Zone Data'!F42	='Shallow Zone Data'!G42	
='Shallow Zone Data'!F43	='Shallow Zone Data'!G43	
='Shallow Zone Data'!F44	='Shallow Zone Data'!G44	
='Shallow Zone Data'!F45	='Shallow Zone Data'!G45	
='Shallow Zone Data'!F46	='Shallow Zone Data'!G46	
='Shallow Zone Data'!F47	='Shallow Zone Data'!G47	
='Shallow Zone Data'!F48	='Shallow Zone Data'!G48	
='Shallow Zone Data'!F49	='Shallow Zone Data'!G49	
='Shallow Zone Data'!F50	='Shallow Zone Data'!G50	
='Shallow Zone Data'!F51	='Shallow Zone Data'!G51	
='Shallow Zone Data'!F52	='Shallow Zone Data'!G52	
='Shallow Zone Data'!F53	='Shallow Zone Data'!G53	
='Shallow Zone Data'!F54	='Shallow Zone Data'!G54	
='Shallow Zone Data'!F55	='Shallow Zone Data'!G55	
='Shallow Zone Data'!F56	='Shallow Zone Data'!G56	
='Shallow Zone Data'!F57	='Shallow Zone Data'!G57	
='Shallow Zone Data'!F58	='Shallow Zone Data'!G58	
='Shallow Zone Data'!F59	='Shallow Zone Data'!G59	
='Shallow Zone Data'!F60	='Shallow Zone Data'!G60	
='Shallow Zone Data'!F61	='Shallow Zone Data'!G61	
='Shallow Zone Data'!F62	='Shallow Zone Data'!G62	
='Shallow Zone Data'!F63	='Shallow Zone Data'!G63	
='Shallow Zone Data'!F64	='Shallow Zone Data'!G64	
='Shallow Zone Data'!F65	='Shallow Zone Data'!G65	
='Shallow Zone Data'!F66	='Shallow Zone Data'!G66	
='Shallow Zone Data'!F67	='Shallow Zone Data'!G67	
='Shallow Zone Data'!F68	='Shallow Zone Data'!G68	
='Shallow Zone Data'!F69	='Shallow Zone Data'!G69	
='Shallow Zone Data'!F70	='Shallow Zone Data'!G70	
='Shallow Zone Data'!F71	='Shallow Zone Data'!G71	
='Shallow Zone Data'!F72	='Shallow Zone Data'!G72	
='Shallow Zone Data'!F73	='Shallow Zone Data'!G73	
='Shallow Zone Data'!F74	='Shallow Zone Data'!G74	
='Shallow Zone Data'!F75	='Shallow Zone Data'!G75	
='Shallow Zone Data'!F76	='Shallow Zone Data'!G76	
='Shallow Zone Data'!F77	='Shallow Zone Data'!G77	
='Shallow Zone Data'!F78	='Shallow Zone Data'!G78	
='Shallow Zone Data'!F79	='Shallow Zone Data'!G79	
='Shallow Zone Data'!F80	='Shallow Zone Data'!G80	
='Shallow Zone Data'!F81	='Shallow Zone Data'!G81	
='Shallow Zone Data'!F82	='Shallow Zone Data'!G82	
='Shallow Zone Data'!F83	='Shallow Zone Data'!G83	
='Shallow Zone Data'!F84	='Shallow Zone Data'!G84	
='Shallow Zone Data'!F85	='Shallow Zone Data'!G85	
='Shallow Zone Data'!F86	='Shallow Zone Data'!G86	

SWC 3-5-03

Sample #	Europium-152 pCi/g	Q
Look-up Value===>	~~0.0~~ 3.3	
='Shallow Zone Data'!H7	='Shallow Zone Data'!I7	
='Shallow Zone Data'!H8	='Shallow Zone Data'!I8	
='Shallow Zone Data'!H9	='Shallow Zone Data'!I9	
='Shallow Zone Data'!H10	='Shallow Zone Data'!I10	
='Shallow Zone Data'!H11	='Shallow Zone Data'!I11	
='Shallow Zone Data'!H12	='Shallow Zone Data'!I12	
='Shallow Zone Data'!H13	='Shallow Zone Data'!I13	
='Shallow Zone Data'!H14	='Shallow Zone Data'!I14	
='Shallow Zone Data'!H15	='Shallow Zone Data'!I15	
='Shallow Zone Data'!H16	='Shallow Zone Data'!I16	
='Shallow Zone Data'!H17	='Shallow Zone Data'!I17	
='Shallow Zone Data'!H18	='Shallow Zone Data'!I18	
='Shallow Zone Data'!H19	='Shallow Zone Data'!I19	
='Shallow Zone Data'!H20	='Shallow Zone Data'!I20	
='Shallow Zone Data'!H21	='Shallow Zone Data'!I21	
='Shallow Zone Data'!H22	='Shallow Zone Data'!I22	
='Shallow Zone Data'!H23	='Shallow Zone Data'!I23	
='Shallow Zone Data'!H24	='Shallow Zone Data'!I24	
='Shallow Zone Data'!H25	='Shallow Zone Data'!I25	
='Shallow Zone Data'!H26	='Shallow Zone Data'!I26	
='Shallow Zone Data'!H27	='Shallow Zone Data'!I27	
='Shallow Zone Data'!H28	='Shallow Zone Data'!I28	
='Shallow Zone Data'!H29	='Shallow Zone Data'!I29	
='Shallow Zone Data'!H30	='Shallow Zone Data'!I30	
='Shallow Zone Data'!H31	='Shallow Zone Data'!I31	
='Shallow Zone Data'!H32	='Shallow Zone Data'!I32	
='Shallow Zone Data'!H33	='Shallow Zone Data'!I33	
='Shallow Zone Data'!H34	='Shallow Zone Data'!I34	
='Shallow Zone Data'!H35	='Shallow Zone Data'!I35	
='Shallow Zone Data'!H36	='Shallow Zone Data'!I36	
='Shallow Zone Data'!H37	='Shallow Zone Data'!I37	
='Shallow Zone Data'!H38	='Shallow Zone Data'!I38	
='Shallow Zone Data'!H39	='Shallow Zone Data'!I39	
='Shallow Zone Data'!H40	='Shallow Zone Data'!I40	
='Shallow Zone Data'!H41	='Shallow Zone Data'!I41	
='Shallow Zone Data'!H42	='Shallow Zone Data'!I42	
='Shallow Zone Data'!H43	='Shallow Zone Data'!I43	
='Shallow Zone Data'!H44	='Shallow Zone Data'!I44	
='Shallow Zone Data'!H45	='Shallow Zone Data'!I45	
='Shallow Zone Data'!H46	='Shallow Zone Data'!I46	
='Shallow Zone Data'!H47	='Shallow Zone Data'!I47	
='Shallow Zone Data'!H48	='Shallow Zone Data'!I48	
='Shallow Zone Data'!H49	='Shallow Zone Data'!I49	
='Shallow Zone Data'!H50	='Shallow Zone Data'!I50	
='Shallow Zone Data'!H51	='Shallow Zone Data'!I51	
='Shallow Zone Data'!H52	='Shallow Zone Data'!I52	
='Shallow Zone Data'!H53	='Shallow Zone Data'!I53	
='Shallow Zone Data'!H54	='Shallow Zone Data'!I54	
='Shallow Zone Data'!H55	='Shallow Zone Data'!I55	
='Shallow Zone Data'!H56	='Shallow Zone Data'!I56	
='Shallow Zone Data'!H57	='Shallow Zone Data'!I57	
='Shallow Zone Data'!H58	='Shallow Zone Data'!I58	
='Shallow Zone Data'!H59	='Shallow Zone Data'!I59	
='Shallow Zone Data'!H60	='Shallow Zone Data'!I60	
='Shallow Zone Data'!H61	='Shallow Zone Data'!I61	
='Shallow Zone Data'!H62	='Shallow Zone Data'!I62	
='Shallow Zone Data'!H63	='Shallow Zone Data'!I63	
='Shallow Zone Data'!H64	='Shallow Zone Data'!I64	
='Shallow Zone Data'!H65	='Shallow Zone Data'!I65	
='Shallow Zone Data'!H66	='Shallow Zone Data'!I66	
='Shallow Zone Data'!H67	='Shallow Zone Data'!I67	
='Shallow Zone Data'!H68	='Shallow Zone Data'!I68	
='Shallow Zone Data'!H69	='Shallow Zone Data'!I69	
='Shallow Zone Data'!H70	='Shallow Zone Data'!I70	
='Shallow Zone Data'!H71	='Shallow Zone Data'!I71	
='Shallow Zone Data'!H72	='Shallow Zone Data'!I72	
='Shallow Zone Data'!H73	='Shallow Zone Data'!I73	
='Shallow Zone Data'!H74	='Shallow Zone Data'!I74	
='Shallow Zone Data'!H75	='Shallow Zone Data'!I75	
='Shallow Zone Data'!H76	='Shallow Zone Data'!I76	
='Shallow Zone Data'!H77	='Shallow Zone Data'!I77	
='Shallow Zone Data'!H78	='Shallow Zone Data'!I78	
='Shallow Zone Data'!H79	='Shallow Zone Data'!I79	
='Shallow Zone Data'!H80	='Shallow Zone Data'!I80	
='Shallow Zone Data'!H81	='Shallow Zone Data'!I81	
='Shallow Zone Data'!H82	='Shallow Zone Data'!I82	
='Shallow Zone Data'!H83	='Shallow Zone Data'!I83	
='Shallow Zone Data'!H84	='Shallow Zone Data'!I84	
='Shallow Zone Data'!H85	='Shallow Zone Data'!I85	
='Shallow Zone Data'!H86	='Shallow Zone Data'!I86	

Sample #	Q
='Shallow Zone Data'!J7	
='Shallow Zone Data'!J8	
='Shallow Zone Data'!J9	
='Shallow Zone Data'!J10	
='Shallow Zone Data'!J11	
='Shallow Zone Data'!J12	
='Shallow Zone Data'!J13	
='Shallow Zone Data'!J14	
='Shallow Zone Data'!J15	
='Shallow Zone Data'!J16	
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='Shallow Zone Data'!J18	
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='Shallow Zone Data'!J77	
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='Shallow Zone Data'!J79	
='Shallow Zone Data'!J80	
='Shallow Zone Data'!J81	
='Shallow Zone Data'!J82	
='Shallow Zone Data'!J83	
='Shallow Zone Data'!J84	
='Shallow Zone Data'!J85	
='Shallow Zone Data'!J86	

Shallow Zone Formulas

ATTACHMENT 1

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date 03/05/03	Calc. No.	0100F-CA-V0152	Rev. No. 0
Project	Group 4 Remedial Action	Job No. 22192	Checked	SWCallison SWC	Date 3-5-03
Subject	116-F-6 Liquid Waste Trench Sample Variance Calculation				Sheet No. 5 of 7

86	='Shallow Zone Data'!B87	='Shallow Zone Data'!C87	='Shallow Zone Data'!D87	='Shallow Zone Data'!E87	='Shallow Zone Data'!F87	='Shallow Zone Data'!G87	='Shallow Zone Data'!H87	='Shallow Zone Data'!I87	='Shallow Zone Data'!J87
87	='Shallow Zone Data'!B88	='Shallow Zone Data'!C88	='Shallow Zone Data'!D88	='Shallow Zone Data'!E88	='Shallow Zone Data'!F88	='Shallow Zone Data'!G88	='Shallow Zone Data'!H88	='Shallow Zone Data'!I88	='Shallow Zone Data'!J88
88	='Shallow Zone Data'!B89	='Shallow Zone Data'!C89	='Shallow Zone Data'!D89	='Shallow Zone Data'!E89	='Shallow Zone Data'!F89	='Shallow Zone Data'!G89	='Shallow Zone Data'!H89	='Shallow Zone Data'!I89	='Shallow Zone Data'!J89
89	='Shallow Zone Data'!B90	='Shallow Zone Data'!C90	='Shallow Zone Data'!D90	='Shallow Zone Data'!E90	='Shallow Zone Data'!F90	='Shallow Zone Data'!G90	='Shallow Zone Data'!H90	='Shallow Zone Data'!I90	='Shallow Zone Data'!J90
90	='Shallow Zone Data'!B91	='Shallow Zone Data'!C91	='Shallow Zone Data'!D91	='Shallow Zone Data'!E91	='Shallow Zone Data'!F91	='Shallow Zone Data'!G91	='Shallow Zone Data'!H91	='Shallow Zone Data'!I91	='Shallow Zone Data'!J91
91	='Shallow Zone Data'!B92	='Shallow Zone Data'!C92	='Shallow Zone Data'!D92	='Shallow Zone Data'!E92	='Shallow Zone Data'!F92	='Shallow Zone Data'!G92	='Shallow Zone Data'!H92	='Shallow Zone Data'!I92	='Shallow Zone Data'!J92
92	='Shallow Zone Data'!B93	='Shallow Zone Data'!C93	='Shallow Zone Data'!D93	='Shallow Zone Data'!E93	='Shallow Zone Data'!F93	='Shallow Zone Data'!G93	='Shallow Zone Data'!H93	='Shallow Zone Data'!I93	='Shallow Zone Data'!J93
93	='Shallow Zone Data'!B94	='Shallow Zone Data'!C94	='Shallow Zone Data'!D94	='Shallow Zone Data'!E94	='Shallow Zone Data'!F94	='Shallow Zone Data'!G94	='Shallow Zone Data'!H94	='Shallow Zone Data'!I94	='Shallow Zone Data'!J94
94	='Shallow Zone Data'!B95	='Shallow Zone Data'!C95	='Shallow Zone Data'!D95	='Shallow Zone Data'!E95	='Shallow Zone Data'!F95	='Shallow Zone Data'!G95	='Shallow Zone Data'!H95	='Shallow Zone Data'!I95	='Shallow Zone Data'!J95
95	='Shallow Zone Data'!B96	='Shallow Zone Data'!C96	='Shallow Zone Data'!D96	='Shallow Zone Data'!E96	='Shallow Zone Data'!F96	='Shallow Zone Data'!G96	='Shallow Zone Data'!H96	='Shallow Zone Data'!I96	='Shallow Zone Data'!J96
96	='Shallow Zone Data'!B97	='Shallow Zone Data'!C97	='Shallow Zone Data'!D97	='Shallow Zone Data'!E97	='Shallow Zone Data'!F97	='Shallow Zone Data'!G97	='Shallow Zone Data'!H97	='Shallow Zone Data'!I97	='Shallow Zone Data'!J97
97	='Shallow Zone Data'!B98	='Shallow Zone Data'!C98	='Shallow Zone Data'!D98	='Shallow Zone Data'!E98	='Shallow Zone Data'!F98	='Shallow Zone Data'!G98	='Shallow Zone Data'!H98	='Shallow Zone Data'!I98	='Shallow Zone Data'!J98
98	='Shallow Zone Data'!B99	='Shallow Zone Data'!C99	='Shallow Zone Data'!D99	='Shallow Zone Data'!E99	='Shallow Zone Data'!F99	='Shallow Zone Data'!G99	='Shallow Zone Data'!H99	='Shallow Zone Data'!I99	='Shallow Zone Data'!J99
99	='Shallow Zone Data'!B100	='Shallow Zone Data'!C100	='Shallow Zone Data'!D100	='Shallow Zone Data'!E100	='Shallow Zone Data'!F100	='Shallow Zone Data'!G100	='Shallow Zone Data'!H100	='Shallow Zone Data'!I100	='Shallow Zone Data'!J100
100	='Shallow Zone Data'!B101	='Shallow Zone Data'!C101	='Shallow Zone Data'!D101	='Shallow Zone Data'!E101	='Shallow Zone Data'!F101	='Shallow Zone Data'!G101	='Shallow Zone Data'!H101	='Shallow Zone Data'!I101	='Shallow Zone Data'!J101
101	='Shallow Zone Data'!B102	='Shallow Zone Data'!C102	='Shallow Zone Data'!D102	='Shallow Zone Data'!E102	='Shallow Zone Data'!F102	='Shallow Zone Data'!G102	='Shallow Zone Data'!H102	='Shallow Zone Data'!I102	='Shallow Zone Data'!J102
102	='Shallow Zone Data'!B103	='Shallow Zone Data'!C103	='Shallow Zone Data'!D103	='Shallow Zone Data'!E103	='Shallow Zone Data'!F103	='Shallow Zone Data'!G103	='Shallow Zone Data'!H103	='Shallow Zone Data'!I103	='Shallow Zone Data'!J103
103	Mean (LV) ==========			=AVERAGE(E23:E119)		=AVERAGE(G23:G119)		=AVERAGE(I23:I119)	
104	Standard Deviation (S) ==========			=STDEV(E23:E119)		=STDEV(G23:G119)		=STDEV(I23:I119)	
105	u (5%) ==========			1.645		1.645		1.645	
106	β (20%) ==========			0.842		0.842		0.842	
107	Number of Samples ==========			=ROUNDUP((1.645+0.842)^2/(((E120-E22)/E121)^2),0)		=ROUNDUP((1.645+0.842)^2/(((G120-G22)/G121)^2)		=ROUNDUP((1.645+0.842)^2/(((I120-I22)/I121)^2),0)	

ATTACHMENT 3

Bechtel Hanford Inc.

Originator M. T. Stankovich Date 3/5/2003 Calc. No. 0100F-CA-V0152 Rev. No. 0
Project Group 4 Remedial Action Job No. 22192 Checked SW Callison Date 3-5-03
Subject 116-F-6 Liquid Waste Trench Sample Variance Calculation Sheet No. 6 of 7

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
1	J00111	11/4/2002	S-A1-2	0.1	U	0.394		0.38	U
2	J00112	11/4/2002	S-A1-3	0.057	U	0.332		0.143	
3	J00113	11/4/2002	S-A1-4	0.089	U	0.558		0.346	
4	J00114	11/4/2002	S-A1-10	0.055	U	0.286		0.2	U
5	J00115	11/4/2002	S-A1-13	0.058	U	0.177		0.15	U
6	J00116	11/4/2002	S-A1-16	0.16	U	0.186		0.269	
7	J00117	11/4/2002	S-A2-3	0.057	U	0.108		0.21	U
8	J00118	11/4/2002	S-A2-6	0.081	U	0.237		0.32	U
9	J00119	11/4/2002	S-A2-7	0.058	U	0.394		0.17	U
10	J00120	11/4/2002	S-A2-10	0.067	U	0.108		0.15	U
11	J00121	11/4/2002	S-A2-14	0.087	U	0.108		0.22	U
12	J00122	11/4/2002	S-A2-15	0.065	U	0.096	U	0.14	U
13	J00123	11/4/2002	S-A3-1	0.071	U	0.1	U	0.22	U
14	J00124	11/4/2002	S-A3-2	0.066	U	0.072	J	0.161	
15	J00125	11/4/2002	S-A3-4	0.06	U	0.067	U	0.14	U
16	J00126	11/4/2002	S-A3-5	0.11	U	0.095	U	0.23	U
17	J00127	11/4/2002	S-A3-9	0.063	U	0.885		0.334	
18	J00128	11/4/2002	S-A3-11	0.12	U	0.11	U	0.22	U
19	J00129	11/4/2002	S-A4-3	0.076	U	1.74		0.635	
20	J00130	11/4/2002	S-A4-4	0.067	U	0.166		0.17	U
21	J00131	11/4/2002	S-A4-7	0.056	U	0.127		0.11	U
22	J00132	11/4/2002	S-A4-9	0.03	U	0.129		0.099	U
23	J00133	11/4/2002	S-A4-12	0.067	U	0.39		0.18	U
24	J00134	11/4/2002	S-A4-13	0.039	U	0.037	U	0.087	U
25	J00135	11/5/2002	S-B5-1	0.063	U	1.16		0.613	
26	J00136	11/5/2002	S-B5-2	0.039	U	0.547		0.293	
27	J00137	11/5/2002	S-B5-5	0.058	U	0.133		0.14	U
28	J00138	11/5/2002	S-B5-7	0.035	U	0.118		0.12	U
29	J00139	11/5/2002	S-B5-13	0.043	U	0.041	U	0.09	U
30	J00140	11/5/2002	S-B5-15	0.11	U	0.084	U	0.15	U
31	J00141	11/5/2002	S-B6-1	0.043	U	0.046	U	0.12	U
32	J00142	11/5/2002	S-B6-10	0.08	U	0.072	U	0.2	U
33	J00143	11/5/2002	S-B6-12	0.06	U	0.234		0.464	
34	J00144	11/5/2002	S-B6-13	0.071	U	0.078	U	0.17	U
35	J00145	11/5/2002	S-B6-15	0.04	U	0.037	U	0.093	U
36	J00146	11/5/2002	S-B6-16	0.027	U	0.053	J	0.068	U
37	J00147	11/5/2002	S-B7-1	0.045	U	0.043	U	0.099	U
38	J00148	11/5/2002	S-B7-3	0.026	U	0.096	J	0.061	U
39	J00149	11/5/2002	S-B7-4	0.035	U	0.113		0.092	J
40	J00150	11/5/2002	S-B7-5	0.081	U	0.1	U	0.14	U
41	J00151	11/5/2002	S-B7-8	0.059	U	0.328		2.84	
42	J00152	11/5/2002	S-B7-11	0.086	U	0.135		0.13	U
43	J00153	11/6/2002	S-B8-2	0.091	U	0.198		0.19	U
44	J00154	11/6/2002	S-B8-3	0.11	U	0.1	U	0.2	U
45	J00155	11/6/2002	S-B8-4	0.066	U	0.086	J	0.16	U
46	J00156	11/5/2002	S-B8-8	0.149		0.836		5.66	
47	J00157	11/5/2002	S-B8-12	0.061	U	0.284		0.163	
48	J00158	11/5/2002	S-B8-13	0.068	U	0.076	J	0.13	U
49	J00866	11/6/2002	S-C9-3	0.057	U	0.054	U	0.11	U
50	J00867	11/6/2002	S-C9-4	0.034	U	0.053	U	0.12	U

ATTACHMENT 3

Bechtel Hanford Inc.

Originator	M. T. Stankovich	Date	3/5/2003	Calc. No.	0100F-CA-V0152	Rev. No.	0
Project	Group 4 Remedial Action	Job No.	22192	Checked	SW Gallison	Date	3-5-03
Subject	116-F-6 Liquid Waste Trench Sample Variance Calculation					Sheet No.	7 of 7

	samp_num	samp_date_time	Sample Node	Co60	Q	Cs137	Q	Eu152	Q
51	J00868	11/6/2002	S-C9-5	0.058	U	0.052	U	0.12	U
52	J00869	11/6/2002	S-C9-10	0.035	U	0.085	J	0.077	U
53	J00870	11/6/2002	S-C9-14	0.04	U	0.041	U	0.093	U
54	J00871	11/6/2002	S-C9-16	0.089	U	0.085	U	0.2	U
55	J00872	11/6/2002	S-C10-3	0.045	U	0.05	U	0.11	U
56	J00873	11/6/2002	S-C10-4	0.051	U	0.101		0.11	U
57	J00874	11/6/2002	S-C10-8	0.052	U	0.127		0.15	U
58	J00875	11/6/2002	S-C10-10	0.054	U	0.179		0.15	U
59	J00876	11/6/2002	S-C10-14	0.067	U	0.174		0.191	
60	J00877	11/6/2002	S-C10-16	0.058	U	0.482		0.276	
61	J00878	11/6/2002	S-C1-2	0.095	U	0.082	J	0.22	U
62	J00879	11/6/2002	S-C1-3	0.05	U	0.071	U	0.21	U
63	J00880	11/6/2002	S-C1-4	0.058	U	0.161		0.133	
64	J00881	11/6/2002	S-C1-1	0.089	U	0.179		0.21	U
65	J00882	11/6/2002	S-C1-13	0.047	U	0.132		0.17	U
66	J00883	11/6/2002	S-C1-16	0.084	U	0.121		0.23	U
67	J00884	11/6/2002	S-C2-3	0.07	U	0.36		0.2	U
68	J00885	11/6/2002	S-C2-6	0.073	U	0.192		0.16	U
69	J00886	11/6/2002	S-C2-7	0.054	U	0.058	U	0.13	U
70	J00887	11/6/2002	S-C2-10	0.048	U	0.448		0.282	
71	J00888	11/6/2002	S-C2-14	0.11	U	2.41		1.02	
72	J00889	11/6/2002	S-C2-15	0.047	U	0.055	U	0.13	U
73	J00890	11/7/2002	S-D3-1	0.11	U	0.443		0.25	U
74	J00891	11/7/2002	S-D3-2	0.069	U	0.603		0.323	
75	J00892	11/7/2002	S-D3-4	0.098	U	0.689		0.28	U
76	J00893	11/7/2002	S-D3-5	0.064	U	0.221		0.176	
77	J00894	11/7/2002	S-D3-9	0.082	U	0.555		0.261	
78	J00895	11/7/2002	S-D3-11	0.11	U	0.356		0.23	
79	J00896	11/7/2002	S-D4-3	0.059	U	0.132		0.13	U
80	J00897	11/7/2002	S-D4-4	0.085	U	0.081	U	0.2	U
81	J00898	11/7/2002	S-D4-7	0.066	U	0.085	J	0.14	U
82	J00899	11/7/2002	S-D4-9	0.062	U	0.07	U	0.15	U
83	J008B0	11/7/2002	S-D4-12	0.1	U	0.149		0.177	
84	J008B1	11/7/2002	S-D4-13	0.054	U	0.429		0.315	
85	J008B2	11/7/2002	S-D5-1	0.093	U	0.103	U	0.19	U
86	J008B3	11/7/2002	S-D5-2	0.065	U	0.433		0.29	U
87	J008B4	11/7/2002	S-D5-5	0.066	U	0.06	U	0.14	U
88	J008B5	11/7/2002	S-D5-7	0.071	U	0.1	U	0.14	U
89	J008B6	11/7/2002	S-D5-13	0.031	U	0.055	U	0.098	U
90	J008B7	11/7/2002	S-D5-15	0.056	U	0.123		0.135	
91	J008B8	11/7/2002	S-D6-1	0.045	U	0.415		0.286	
92	J008B9	11/7/2002	S-D6-10	0.053	U	0.194		0.432	
93	J008C0	11/7/2002	S-D6-12	0.16	U	0.918		2.3	
94	J008C1	11/7/2002	S-D6-13	0.059	U	0.074	J	0.13	U
95	J008C2	11/7/2002	S-D6-15	0.11	U	0.12	U	0.21	U
96	J008C3	11/7/2002	S-D6-16	0.072	U	0.08	U	0.217	

CALCULATION COVER SHEET

Project Title:	**116-F-6 Liquid Waste Disposal Trench Shallow & Deep Zone Design**	**Job No.**	**22192**
Area	**100-F**		
Discipline	**Environmental Engineering**	**Calc. No.**	**0100F-CA-V0159**
Subject	**116-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design**		
Computer Program	**Excel**	**Program No.**	**Excel 97**

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sht Calc = 2 Shts Attach1 = 1 Sht Attach2 = 1 Sht Attach 3 = 2 Shts Total = 7 Shts	G. Cruz 2/6/03	C.A. Bentz 2/6/03	M.T. Stankovich 2/13/03	M.A. Buckmaster 2/14/03	2/14/03

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

January 2003

DE01-437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator G. Cruz **Date** 12/6/2002 **Calc. No.** 0100F-CA-V0159 **Rev. No.** 6

Project 116-F-6 Liquid Waste Disposal Trench Shallow & Deep Zone Design **Job No.** 22192 **Checked** CAB **Date** 12/11/02

Subject 116-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design **Sheet No.**

Problem: Calculate and display required sampling nodes in concurrence with 100 Area SAP DOE/RL-96-22 Rev. 3 for verification and closure.

Given:
-SAP (DOE/RL-96-22 Rev. 3) and IG (0100X-IG-G0001 Rev. 3) requirements
-Shallow Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 1 of 2, CAD file 1F:110502E, 116-F-6 Shallow Zone Sampling Plan)
-Deep Zone Sampling Area (Surface area of each zone determined from CAD program, Attachment 3, Sht 2 of 2, CAD file 1F:110502F, 116-F-6 Deep Zone Sampling Plan)

SAP and IG Requirements:
-Develop a 16 node sampling grid for the sampling area
Shallow Zone -Use appendix A of the IG to determine which six of the sixteen will be sampled to collect HPGe and clean up verification samples

Determination of Shallow Zone Sampling Grid:

Shallow Zone Sampling Grid Area determined from Table 5-1, IG
Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	3337.91 m^2
Area of Decision Subunits (total area 4 subunit)	834.47 m^2
Decision Subunit divided into 4 Sampling Areas:	208.61 m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	13.03 m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)
See Attachment 3, Sht 1 of 2, 116-F-6 Shallow Zone Sampling Plan, for Sample Location Table

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator	G. Cruz	**Date**	12/6/2002	**Calc. No.**	0100F-CA-V0159	**Rev. No.**	0
Project	116-F-6 Liquid Waste Disposal Trench Shallow & Deep Zone Design	**Job No.**	22192	**Checked**	CAB	**Date**	12/11/02
Subject	116-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design					**Sheet No.**	

Determination of Deep Zone Sampling Grid:

Deep Zone Sampling Grid Area determined from Table 5-1, IG
Attachment 2, Number of Decision Subunits Based on Area (Converted to Sq Meters)

Total Area:	1934.35	m^2
Area of Decision Subunits (total area 2 subunits)	967.17	m^2
Decision Subunits divided into 3 Sampling Areas:	322.39	m^2
Sampling Areas divided into a 16 node grid (node numbers 1-16):	20.14	m^2

Nodes to be Sampled (as determined from Attachment 1, Table A-1, Sample Grid Point Lookup Table)

See Attachment 3, Sht 2 of 2, 116-F-6 Deep Zone Sampling Plan,
for Sample Location Table

Bechtel Hanford, Inc.

Originator	G. Cruz	Date	12/6/2002	Calc. No.	0100F-CA-V0159	Rev. No.	6
Project	116-F-6 Liquid Waste Disposal Trench Shallow & Deep Zone Design	Job No.	22192	Checked	GB	Date	12/11/02
Subject	116-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design			Sheet No			

ATTACHMENT 1

Sample Grid Point Lookup Table.

Default Plan	Sampling Area 1	Sampling Area 2	Sampling Area 3	Sampling Area 4	Sampling Area 5	Sampling Area 6	Sampling Area 7	Sampling Area 8	Sampling Area 9	Sampling Area 10
HPGe/Closeout	3	6	1	4	5	1	3	3	4	16
HPGe/Closeout	4	7	11	3	15	15	5	13	10	10
HPGe/Closeout	16	3	2	7	7	10	11	4	3	14
HPGe/Closeout	10	15	4	12	1	13	4	8	16	4
HPGe	2	14	5	9	13	12	8	2	14	8
HPGe	13	10	9	13	2	16	1	12	5	3
Not Sampling	6	1	10	8	14	4	16	5	8	6
Not Sampling	1	9	13	1	10	5	12	1	1	15
Not Sampling	9	12	7	5	6	2	6	7	15	9
Not Sampling	15	16	15	14	16	6	2	15	11	1
Not Sampling	8	13	8	10	12	11	13	14	2	12
Not Sampling	5	2	3	11	4	3	9	10	7	11
Not Sampling	7	11	14	15	11	14	14	6	13	2
Not Sampling	11	4	6	2	9	7	7	11	9	7
Not Sampling	12	8	16	16	3	8	15	9	6	13
Not Sampling	14	5	12	6	8	9	10	16	12	5

** **Note:** Grid nodes for each sampling area in each waste site should be numbered consistently, e.g., begin numbering the nodes in the northwesternmost node. Then number consecutively left to right as shown in Fig. 5-1 of this IG

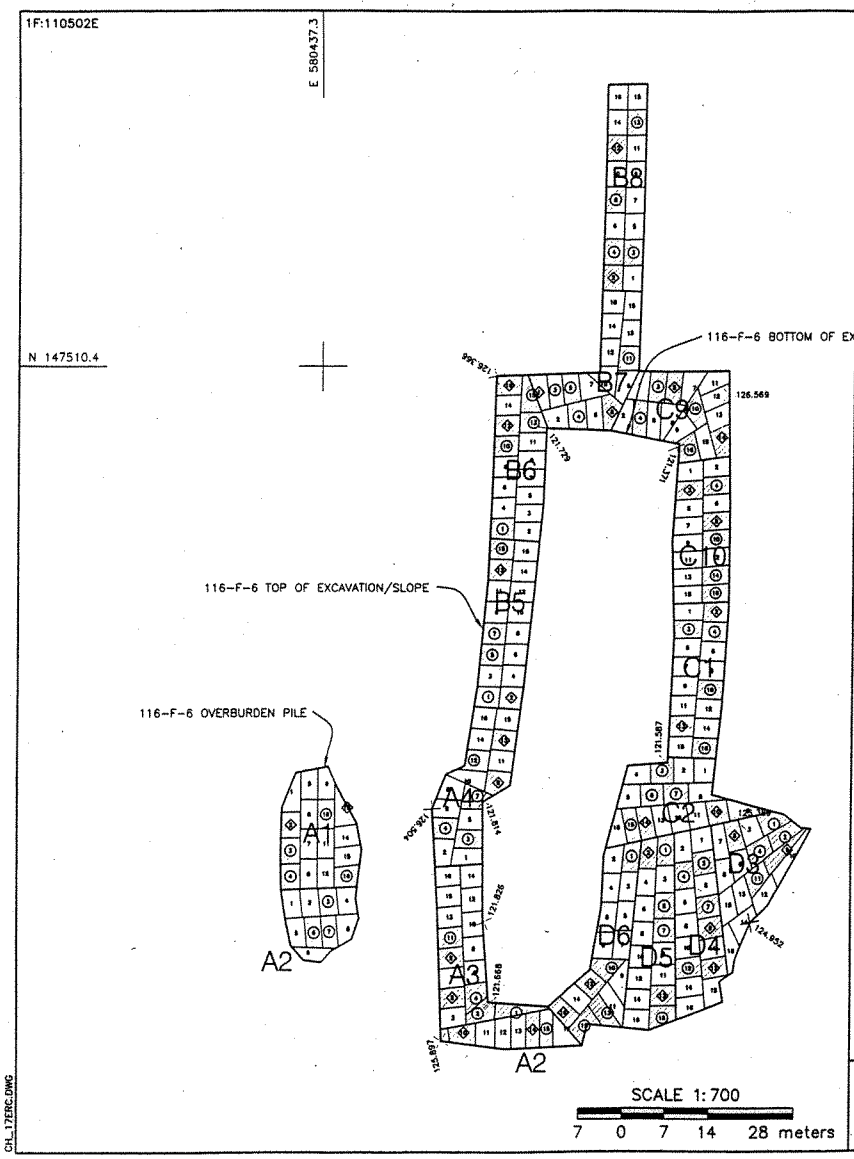
Bechtel Hanford, Inc.

Originator G. Cruz Date 12/6/2002 Calc. No. 0100F-CA-V0159 Rev. No. 0
Project 116-F-6 Liquid Waste Disposal Trench Shallow & Deep Zone Design Job No. 22192 Checked CAB Date 12/11/02
Subject 116-F-6 Liquid Waste Disposal Trench Shallow & Deep Sampling Design Sheet No.

ATTACHMENT 2

Number of Decision Subunits Based on Area.

Area of Primary Decision Unit (m2)	Number of Subunits
<1,394	1
>1,394 to <2,326	2
>2,326 to <3,256	3
>3,256 to <4,186	4
>4,186 to <9,303	2
>9,303 to <13,024	3
>13,024 to <16,745	4
>16,745 to <20,466	5
>20,466	ROUNDa (Area/3,720)
a ROUND is an integer rounding function.	



Attachment 3 Sheet No. 1 of 2
Originator G.C.R. Date 12/4/02
Chk'd By CAB Date 12/11/02
Calc. No. 01001-CA-V0159 Rev. No. 0

NOTES

1. SHALLOW ZONE NODE AREAS ARE APPROXIMATELY 13.03 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE SHALLOW ZONE CONSISTS OF SAMPLING AREAS A1, A2, A3 & A4 WITHIN DECISION SUBUNIT 1. SAMPLING AREAS B5, B6, B7, & B8 WITHIN DECISION SUBUNIT 2. SAMPLING AREAS C9, C10, C1, & C2 WITHIN DECISION SUBUNIT 3. SAMPLING AREAS D3, D4, D5, & D6 WITHIN DECISION SUBUNIT 4.
4. ALL ELEVATIONS SHOWN ARE REFERENCED DATUM NGVD29 CONVERSION TO NAVD88 + 1.031 METERS.

LEGEND

(B) GAMMA ENERGY ANALYSIS & CLOSEOUT VERIFICATION SAMPLING NODE

(B) GAMMA ENERGY ANALYSIS SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	S-A1-2	147436.41	580432.47
		S-A1-3	147432.30	580432.44
		S-A1-4	147428.24	580432.47
		S-A1-10	147438.12	580438.19
		S-A1-13	147439.17	580441.62
		S-A1-16	147428.27	580441.60
	A2	S-A2-3	147424.23	580438.60
		S-A2-6	147419.37	580436.23
		S-A2-7	147419.52	580438.75
		S-A2-10	147403.43	580460.42
		S-A2-14	147403.92	580471.71
		S-A2-15	147404.01	580473.97
	A3	S-A3-1	147406.59	580469.01
		S-A3-2	147406.51	580462.70
		S-A3-4	147408.93	580462.43
		S-A3-5	147409.01	580458.55
		S-A3-9	147415.36	580458.32
		S-A3-11	147418.57	580458.21
	A4	S-A4-3	147434.15	580461.03
		S-A4-4	147435.87	580457.34
		S-A4-7	147441.03	580462.52
		S-A4-9	147443.19	580465.87
		S-A4-12	147448.77	580461.92
		S-A4-13	147449.95	580468.80
2	B5	S-B5-1	147456.98	580464.11
		S-B5-2	147456.82	580467.92
		S-B5-5	147463.76	580464.74
		S-B5-7	147467.21	580465.06
		S-B5-13	147477.57	580466.03
		S-B5-15	147481.01	580466.19
	B6	S-B6-1	147484.22	580466.30
		S-B6-10	147497.74	580468.89
		S-B6-12	147501.02	580467.02
		S-B6-13	147501.47	580471.23
		S-B6-15	147505.85	580470.97
		S-B6-16	147507.43	580467.26
	B7	S-B7-1	147508.35	580472.02
		S-B7-3	147506.66	580474.70
		S-B7-4	147502.35	580478.61
		S-B7-5	147506.99	580477.24
		S-B7-6	147503.06	580483.99
		S-B7-11	147511.61	580486.61
	B8	S-B8-2	147524.55	580484.02
		S-B8-3	147528.59	580487.24
		S-B8-4	147528.67	580484.09
		S-B8-8	147536.94	580484.31
		S-B8-12	147545.21	580484.53
		S-B8-13	147549.36	580487.78

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
3	C9	S-C9-3	147507.16	580481.41
		S-C9-4	147502.11	580488.55
		S-C9-5	147507.03	580493.98
		S-C9-10	147503.86	580497.31
		S-C9-14	147499.12	580501.89
		S-C9-16	147497.08	580498.53
	C10	S-C10-3	147490.49	580498.47
		S-C10-4	147491.29	580500.85
		S-C10-8	147485.42	580500.88
		S-C10-10	147482.49	580500.88
		S-C10-14	147476.62	580500.81
		S-C10-16	147473.71	580500.80
	C1	S-C1-2	147470.68	580500.98
		S-C1-3	147467.53	580498.49
		S-C1-4	147467.42	580500.67
		S-C1-10	147458.02	580500.03
		S-C1-13	147452.14	580495.57
		S-C1-16	147448.58	580499.24
	C2	S-C2-3	147444.95	580492.50
		S-C2-6	147441.01	580490.91
		S-C2-7	147441.22	580494.74
		S-C2-10	147438.39	580501.30
		S-C2-14	147436.64	580499.89
		S-C2-15	147436.28	580487.51
4	D3	S-D3-1	147436.40	580510.75
		S-D3-2	147434.32	580512.57
		S-D3-4	147432.06	580508.49
		S-D3-5	147434.58	580504.31
		S-D3-9	147432.28	580512.94
		S-D3-11	147427.72	580508.13
	D4	S-D4-3	147430.20	580499.27
		S-D4-4	147428.02	580496.08
		S-D4-7	147423.25	580500.02
		S-D4-9	147419.95	580500.37
		S-D4-12	147413.56	580496.85
		S-D4-13	147413.82	580501.05
	D5	S-D5-1	147432.26	580493.13
		S-D5-2	147431.82	580490.42
		S-D5-5	147423.38	580493.02
		S-D5-7	147419.49	580492.97
		S-D5-13	147409.14	580492.83
		S-D5-15	147405.64	580492.77
	D6	S-D6-1	147431.27	580487.86
		S-D6-10	147413.58	580484.52
		S-D6-12	147411.05	580481.07
		S-D6-13	147406.43	580483.89
		S-D6-15	147404.41	580480.16
		S-D6-16	147406.59	580476.71

ATTACHMENT 3

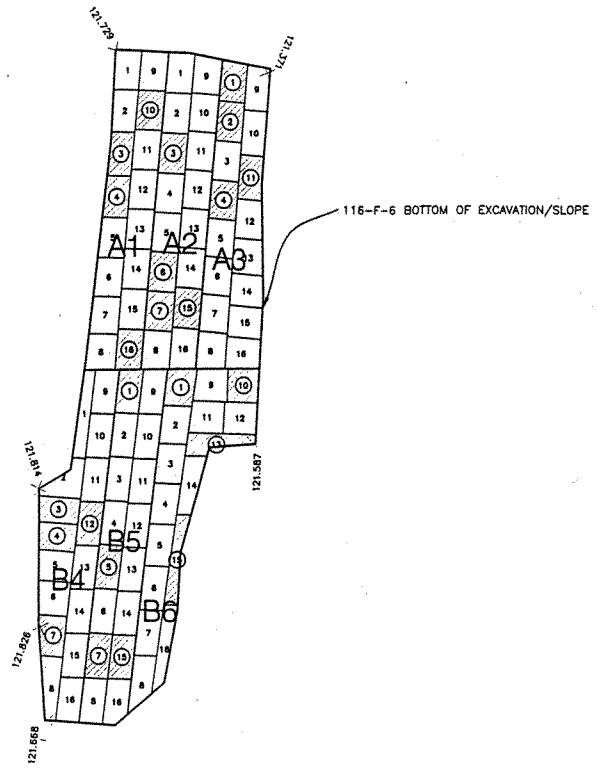
U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 F AREA
100 AREA REMEDIAL DESIGN
116-F-6 SHALLOW ZONE
SAMPLING PLAN

1F:110502F

E 580437.3

N 147510.4



SCALE 1:600

6 0 6 12 24 meters

NOTES

1. DEEP ZONE NODE AREAS ARE APPROXIMATELY 20.14 SQUARE METERS.
2. SAMPLES ARE TAKEN FROM THE APPROXIMATE CENTER OF EACH NODE.
3. THE DEEP ZONE CONSISTS OF SAMPLING AREAS A1, A2, & A3 WITHIN DECISION SUBUNIT 1. SAMPLING AREAS B4, B5, & B6 WITHIN DECISION SUBUNIT 2.
4. ALL ELEVATIONS SHOWN ARE REFERENCED DATUM NGVD29 CONVERSION TO NAVD88 + 1.031 METERS.

LEGEND

GAMMA ENERGY ANALYSIS & CLOSEOUT VERIFICATION SAMPLING NODE

GAMMA ENERGY ANALYSIS SAMPLING NODE

SAMPLE LOCATION TABLE

DECISION SUBUNIT	SAMPLING AREA	SAMPLE NODE	NORTHING	EASTING
1	A1	D-A1-3	147468.07	580474.34
		D-A1-4	147460.14	580473.82
		D-A1-10	147462.14	580478.34
		D-A1-16	147459.12	580475.79
	A2	D-A2-3	147466.16	580481.83
		D-A2-6	147469.77	580480.33
		D-A2-7	147464.40	580479.94
		D-A2-15	147464.82	580483.70
	A3	D-A3-1	147468.06	580489.58
		D-A3-2	147460.57	580489.28
		D-A3-4	147479.72	580488.53
		D-A3-11	147482.86	580492.27
2	B4	D-B4-3	147437.27	580466.09
		D-B4-4	147433.60	580465.90
		D-B4-7	147419.87	580465.47
		D-B4-12	147435.25	580470.46
	B5	D-B5-1	147453.46	580475.91
		D-B5-5	147429.27	580473.17
		D-B5-7	147417.04	580471.81
		D-B5-15	147416.99	580475.11
	B6	D-B6-1	147454.01	580482.82
		D-B6-10	147454.33	580491.60
		D-B6-13	147446.15	580487.88
		D-B6-15	147430.26	580482.66

Attachment 3 Sheet No. 2 of 2
Originator G. CRIN Date 12/5/02
Chk'd By RAB Date 12/11/02
Calc. No. 0100F-CA-V0159 Rev. No. 0

ATTACHMENT 3

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 F AREA
100 AREA REMEDIAL DESIGN
116-F-6 DEEP ZONE
SAMPLING PLAN

CH_17ERC.DWG

CALCULATION COVER SHEET

Project Title:	116-F-6 Cleanup Verification	**Job No.**	22192
Area	100-F		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0141
Subject	116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

* **Committed Calculation** ☒ **Preliminary** ☐ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 5 Total = 6	Bill Hudson 3/5/03 Bill Hudson	J.E. Thomson 3/5/03 J.E. Thomson JB Miley 3/6/03 T.B. Miley	K Cook 3/6/03 K.E. Cook	M.A. Buckmaster	3/7/03

SUMMARY OF REVISIONS

* Obtain calc no. from DIS

Nov-98

DE01-437.03

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator	Bill Hudson BH	**Date**	3/5/03	**Calc. No.** 0100F-CA-V0141		**Rev. No.**	0
Project	116-F-6 Cleanup Verification	**Job No.**	22192	**Checked** J.E. Thomson		**Date**	3/5/03
				T.B. Miley JBM			3/5/03
Subject	116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation					**Sheet No.**	1 of 5

Purpose:
Calculate the 95% UCL to evaluate compliance with cleanup standards for the 116-F-6 Trench. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes (shallow zone only), WAC 173-340 (Model Toxics Control Act (MTCA)) 3-part test, if required (all nonradionuclide analytes), and the relative percent difference (RPD) for each contaminant of concern (COC).

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Page 2 of 5: Calculation Sheet Summary (Page 2)
Page 3 of 5: Shallow Zone Data
Page 4 of 5: Deep Zone Data
Page 5 of 5: Split -Dup Analysis

Given/References:

1) Sample Results
2) Lookup values from Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) (DOE-RL 2002). All lookup values and RAGs are taken from RDR/RAWP unless otherwise specified.
3) DOE-RL, 2001, 100 Area Remedial Action Sampling and Analysis Plan (SAP), DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2002, Remedial Design Report/Remedial Action Work Plan for the 100 Area, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) BHI, 1999, Instruction Guide for the Remediation of the 100-BC-1, 100-DR-1, and 100-HR-1 Waste Sites, 0100X-IG-G0001, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.
6) Model Toxics Control Act, Washington Administrative Code-173-340, and Statistical Guidance for Ecology Site Managers, Ecology Pub. #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).
8) EPA, 1994, WSEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA 540/R-94/013.
9) Ecology, 2001 Model Toxic Control Act Cleanup Levels and Risk Calculations (CLARC III) Update, Publication #940145, Washington State Department of Ecology, Olympia, Washington.

Solution:
Calculation methodology is described in Ecology Pub. #92-54 and below. Use data from attached worksheets to calculate the 95% upper confidence limit (UCL) for each analyte, calculate carcinogenic risk, perform the WAC 173-340 3-part test for nonradionuclides, and calculate an RPD for each COC as indicated.

Calculation Description:
The subject calculations were performed on data from soil verification samples from waste site 116-F-6 Trench. The data were entered into an EXCEL 97 spreadsheet and calculations performed by utilizing 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 is documented by this calculation. Split and duplicate RPD results are used in evaluation of data quality and are presented in the Cleanup Verfication Package (CVP) for this site.

Methodology:
The statistical value calculated to evaluate the effectiveness of cleanup was the 95% UCL. For nonradioactive analytes with > 50% of the data below detection limits, the maximum value for the sample data was used instead of the 95% UCL. All nonradionuclide (e.g., metals) data reported as being below detection limits were set to one-half the detection limit value for calculation of the statistics (Ecology, 1993). For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimal 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.

The estimated hazard quotient (for applicable nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 B non-carcinogenic cleanup limit. The nonradionuclide carcinogenic risk, above background, is determined by dividing the statistical value by the WAC 173-340 B carcinogenic cleanup limit and then multiplying by 10^{-6}. For data sets where all values are below detection, neither of these calculations are required. For noncarcinogenic nonradionuclide COCs, only the estimated fraction of risk computation must be performed.

The WAC 173-340 3-part test determines if:
1) the statistical value exceeds the most stringent cleanup limit for each non-radionuclide COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each non-radionuclide COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each non-radionuclide COC.

The 3-part test is performed for nonradionuclide analytes found in shallow zone and deep zone soil.

The RPD is performed when both the main value and, either the duplicate or split values 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. These detection limit requirements are located in Table II-2 of the SAP, DOE/RL-96-22, where they are referred to as the RDL. 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

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	Bill Hudson BH	**Date**	3/5/03	**Calc. No.**	0100F-CA-V0141
Project	116-F-6 Cleanup Verification	**Job No.**	22192	**Checked by:**	J.E. Thomson JET
Subject	116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation				T.B. Miley TBM

Rev. No.: 0
Date 3/5/03
3/5/03
Sheet No.: 3 of 5

116-F-6 Trench Shallow Zone Data

Sampling Area	HEIS Number	Sample Date	Cs-137 pCi/g	Q	MDA	Co-60 pCi/g	Q	MDA	Eu-152 pCi/g	Q	MDA	Eu-154 pCi/g	Q	MDA	Sr-90* pCi/g	Q	MDA	Cr+6 mg/kg	Q	PQL
SA1	J008F0	25-Nov-2002	3.13E-01		4.30E-02	4.20E-02	U	4.20E-02	1.60E-01		1.00E-01	1.30E-01	U	1.30E-01	1.58E+00		2.30E-01	4.10E-01	U	4.10E-01
Duplicate of J008F0	J008H6	25-Nov-2002	3.28E-01		3.30E-02	3.30E-02	U	3.30E-02	1.65E-01		6.60E-02	1.20E-01	U	1.20E-01	2.61E-01		2.20E-01	4.10E-01	U	4.10E-01
SA2	J008F1	25-Nov-2002	5.21E-01		3.20E-02	3.40E-02	U	3.40E-02	2.56E-01		6.60E-02	1.10E-01	U	1.10E-01	6.70E-02	U	3.10E-01	4.10E-01	U	4.10E-01
SA3	J008F2	25-Nov-2002	1.83E-01		2.80E-02	3.40E-02	U	3.40E-02	1.40E-01		7.70E-02	1.20E-01	U	1.20E-01	4.60E-02	U	2.80E-01	4.20E-01	U	4.20E-01
SA4	J008F3	25-Nov-2002	1.31E+00		3.60E-02	3.40E-02	U	3.40E-02	4.45E-01		6.70E-02	9.40E-02	U	9.40E-02	3.88E-01		2.20E-01	4.40E-01	U	4.40E-01
SB5	J008F4	25-Nov-2002	1.24E-01		4.00E-02	3.20E-02	U	3.20E-02	1.30E-01		6.10E-02	1.10E-01	U	1.10E-01	1.06E-01	U	2.70E-01	4.90E-01		4.20E-01
SB6*	J008F5 and J00FF0*	25-Nov-2002 and 06-Jan-2003*	5.00E-02	U	5.00E-02	2.80E-02	U	2.80E-02	6.50E-02	U	6.50E-02	9.80E-02	U	9.80E-02	1.60E-02	U	2.10E-01	4.20E-01	U	4.20E-01
SB7	J008F6	25-Nov-2002	7.00E-02		1.90E-02	2.60E-02	U	2.60E-02	6.00E-02	U	6.00E-02	8.60E-02	U	8.60E-02	7.90E-02	U	1.80E-01	4.10E-01	U	4.10E-01
SB8	J008F7	25-Nov-2002	1.05E-01		2.70E-02	3.20E-02	U	3.20E-02	1.20E-01	U	1.20E-01	1.10E-01	U	1.10E-01	-1.50E-02	U	2.70E-01	4.20E-01	U	4.20E-01
SC9	J008F8	25-Nov-2002	3.70E-02	U	3.70E-02	3.20E-02	U	3.20E-02	7.40E-02	U	7.40E-02	1.00E-01	U	1.00E-01	-9.00E-02	U	2.80E-01	4.10E-01	U	4.10E-01
SC10	J008F9	25-Nov-2002	3.50E-01		2.90E-02	3.00E-02	U	3.00E-02	1.97E-01		7.20E-02	1.00E-01	U	1.00E-01	8.20E-02	U	2.90E-01	4.10E-01	U	4.10E-01
SC1	J008H0	25-Nov-2002	1.68E-01		2.90E-02	3.50E-02	U	3.50E-02	1.38E-01		6.50E-02	1.10E-01	U	1.10E-01	4.14E+00		2.20E-01	4.20E-01	U	4.20E-01
SC2	J008H1	25-Nov-2002	1.31E+00		4.20E-02	8.30E-02		4.90E-02	6.31E-01		1.00E-01	1.50E-01	U	1.50E-01	1.70E+00		2.30E-01	5.30E-01		4.10E-01
SD3*	J008H2 and J00FF1*	25-Nov-2002 and 06-Jan-2003*	6.26E-01		3.20E-02	3.50E-02	U	3.50E-02	3.02E-01		7.90E-02	1.20E-01	U	1.20E-01	8.60E-02	U	2.20E-01	4.10E-01	U	4.10E-01
SD4	J008H3	25-Nov-2002	1.92E-01		3.80E-02	4.00E-02	U	4.00E-02	1.99E-01		8.70E-02	1.40E-01	U	1.40E-01	9.30E-02	U	2.70E-01	4.30E-01	U	4.30E-01
SD5	J008H4	25-Nov-2002	1.53E-01		1.10E-02	1.00E-02	U	1.00E-02	1.27E-01		1.90E-02	3.40E-02	U	3.40E-02	1.37E-01	U	2.30E-01	4.10E-01	U	4.10E-01
SD6	J008H5	25-Nov-2002	2.37E-01		1.30E-02	2.00E-02	U	2.00E-02	4.27E-01		2.50E-02	3.90E-02	U	3.90E-02	7.22E-01		2.50E-01	4.10E-01	U	4.10E-01

*These sampling areas in the shallow zone were resampled on the indicated dates following additional remediation, and reanalyzed for the indicated CC

Statistical Computation Input Data

Composite Point	HEIS Number	Sample Date	Cs-137 pCi/g	Co-60 pCi/g	Eu-152 pCi/g	Eu-154 pCi/g	Sr-90* pCi/g	Cr+6 mg/kg
SA1	J008F0/J008H6	25-Nov-2002	3.21E-01	1.88E-02	1.63E-01	6.25E-02	9.21E-01	2.05E-01
SA2	J008F1	25-Nov-2002	5.21E-01	1.70E-02	2.56E-01	5.50E-02	6.70E-02	2.05E-01
SA3	J008F2	25-Nov-2002	1.83E-01	1.70E-02	1.40E-01	6.00E-02	4.60E-02	2.10E-01
SA4	J008F3	25-Nov-2002	1.31E+00	1.70E-02	4.45E-01	4.70E-02	3.88E-01	2.20E-01
SB5	J008F4	25-Nov-2002	1.24E-01	1.60E-02	1.30E-01	5.50E-02	1.06E-01	4.90E-01
SB6	J008F5	25-Nov-2002	2.50E-02	1.40E-02	3.25E-02	4.90E-02	1.60E-02	2.10E-01
SB7	J008F6	25-Nov-2002	7.00E-02	1.30E-02	3.00E-02	4.30E-02	7.90E-02	2.05E-01
SB8	J008F7	25-Nov-2002	1.05E-01	1.60E-02	6.00E-02	5.50E-02	-1.50E-02	2.10E-01
SC9	J008F8	25-Nov-2002	1.85E-02	1.60E-02	3.70E-02	5.00E-02	-9.00E-02	2.05E-01
SC10	J008F9	25-Nov-2002	3.50E-01	1.50E-02	1.97E-01	5.00E-02	8.20E-02	2.05E-01
SC1	J008H0	25-Nov-2002	1.68E-01	1.75E-02	1.38E-01	5.50E-02	4.14E+00	2.10E-01
SC2	J008H1	25-Nov-2002	1.31E+00	8.30E-02	6.31E-01	7.50E-02	1.70E+00	5.30E-01
SD3	J008H2	25-Nov-2002	6.26E-01	1.75E-02	3.02E-01	6.00E-02	8.60E-02	2.05E-01
SD4	J008H3	25-Nov-2002	1.92E-01	2.00E-02	1.99E-01	7.00E-02	9.30E-02	2.15E-01
SD5	J008H4	25-Nov-2002	1.53E-01	5.00E-03	1.27E-01	1.70E-02	1.37E-01	2.05E-01
SD6	J008H5	25-Nov-2002	2.37E-01	1.00E-02	4.27E-01	1.95E-02	7.22E-01	2.05E-01

Statistical Computations

	Cs-137	Co-60	Eu-152	Eu-154	Sr-90*	Cr+6
Statistical value based on	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	>50% Below Detection. Default to Maximum Value
N	16	16	16	16	16	16
% < Detection limit	13%	94%	25%	100%	69%	88%
mean	3.57E-01	1.95E-02	2.07E-01	5.14E-02	5.30E-01	2.46E-01
st. dev.	4.08E-01	1.73E-02	1.70E-01	1.53E-02	1.07E+00	1.03E-01
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	5.25E-01	2.67E-02	2.77E-01	5.77E-02	9.69E-01	2.88E-01
max value	1.31E+00	8.30E-02	6.31E-01	1.50E-01	4.14E+00	5.30E-01
Statistical value	5.25E-01	2.67E-02	2.77E-01	5.77E-02	9.69E-01	5.30E-01
Background	NA	NA	NA	NA	NA	NA
Statistical value above background	5.25E-01	2.67E-02	2.77E-01	5.77E-02	9.69E-01	5.30E-01
Lookup Value - 15 mrem/yr for rad	6.2	1.4	3.3	3.0	4.5	

Most Stringent Cleanup Limit for nonradionuclide and RAG Type	2.0 River Protection
WAC 173-340 3-PART TEST	
95% UCL > Cleanup Limit?	NO
> 10% above Cleanup Limit?	NO
Any sample > 2X Cleanup Limit?	NO
EXCESS RISK EVALUATION	
WAC 173-340 B Non-Carcinogenic Cleanup:	400
Hazard quotient for each nonradionuclide:	1.33E-03
WAC 173-340 B Carcinogenic Cleanup:	2.1
Excess risk for each carcinogenic	2.52E-07

NON-RAD SUMMARY

WAC 173-340 3-Part-Test Compliance:	YES
Nonrad noncarcinogenic sum of quotients:	1.33E-03
Nonrad carcinogenic risk:	2.52E-07

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	Bill Hudson BH	Date 3/5/03	Calc. No.:	0100F-CA-V0141	Rev. No.: 0
Project	116-F-6 Cleanup Verification	Job No.: 22192	Checked by:	J.E. Thomson	Date 3/5/03
Subject	116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation			T.B. Miley JBM	3/5/03
					Sheet No.: 4 of 5

116-F-2 Trench Deep Zone Data

Sample Area	HEIS Number	Sample Date	Cs-137 pCi/g	Cs-137 Q	Cs-137 MDA	Co-60 pCi/g	Co-60 Q	Co-60 MDA	Eu-152 pCi/g	Eu-152 Q	Eu-152 MDA	Eu-154 pCi/g	Eu-154 Q	Eu-154 MDA	Sr-90 pCi/g	Sr-90 Q	Sr-90 MDA	Cr^{+6} mgkg	Cr^{+6} Q	Cr^{+6} PQL
DA1	J008D1	21-Nov-2002	6.90E-02		3.40E-02	2.90E-02	U	2.90E-02	1.36E-01		6.50E-02	1.10E-01	U	1.10E-01	3.18E+01		3.30E-01	7.10E-01		4.10E-01
Duplicate of J008D1	J008D7	21-Nov-2002	9.50E-02		5.40E-02	5.50E-02	U	5.50E-02	1.80E-01	U	1.80E-01	1.80E-01	U	1.80E-01	8.71E-01		2.20E-01	6.00E-01		4.10E-01
DA2	J008D2	21-Nov-2002	4.77E-01		3.10E-02	3.90E-02		2.90E-02	1.12E+00		5.40E-02	1.06E-01		6.50E-02	1.83E+01		3.00E-01	6.80E-01		4.20E-01
DA3	J008D3	21-Nov-2002	1.66E-01		6.20E-02	5.30E-02	U	5.30E-02	6.90E-01		1.10E-01	2.00E-01	U	2.00E-01	1.94E+00		2.50E-01	1.70E+00		4.20E-01
DB4	J008D4	21-Nov-2002	4.46E-01		3.80E-02	3.80E-02	U	3.80E-02	3.40E-01		7.30E-02	1.30E-01	U	1.30E-01	2.32E+00		2.30E-01	4.20E-01	U	4.20E-01
DB5	J008D5	21-Nov-2002	3.80E+00		9.30E-02	4.61E-01		5.80E-02	8.51E+00		1.60E-01	7.74E-01		2.20E-01	1.97E+00		2.50E-01	4.10E-01	U	4.10E-01
DB6	J008D6	21-Nov-2002	1.22E+01		8.60E-02	5.14E-01		4.90E-02	1.27E+01		1.60E-01	1.24E+00		1.70E-01	5.17E+00		2.20E-01	1.70E+00		4.20E-01

Statistical Computation Input Data

Sample Point	HEIS Number	Sample Date	Cs-137 pCi/g	Co-60 pCi/g	Eu-152 pCi/g	Eu-154 pCi/g	Sr-90 pCi/g	Cr+6 mg/kg
DA1	J008D1/J008D7	21-Nov-2002	8.20E-02	2.10E-02	1.13E-01	7.25E-02	1.63E+01	6.55E-01
DA2	J008D2	21-Nov-2002	4.77E-01	3.90E-02	1.12E+00	1.06E-01	1.83E+01	6.80E-01
DA3	J008D3	21-Nov-2002	1.66E-01	2.65E-02	6.90E-01	1.00E-01	1.94E+00	1.70E+00
DB4	J008D4	21-Nov-2002	4.46E-01	1.90E-02	3.40E-01	6.50E-02	2.32E+00	2.10E-01
DB5	J008D5	21-Nov-2002	3.80E+00	4.61E-01	8.51E+00	7.74E-01	1.97E+00	2.05E-01
DB6	J008D6	21-Nov-2002	1.22E+01	5.14E-01	1.27E+01	1.24E+00	5.17E+00	1.70E+00

Statistical Computations

	Cs-137	Co-60	Eu-152	Eu-154	Sr-90	Cr+6
Statistical value based on	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Radionuclide data set. Use nonparametric z-stat	Small data set. Use nonparametric z-stat
N	6	6	6	6	6	6
% < Detection limit	0%	50%	0%	50%	0%	33%
mean	2.86E+00	1.80E-01	3.91E+00	3.93E-01	7.67E+00	8.58E-01
st. dev.	4.79E+00	2.39E-01	5.36E+00	4.98E-01	7.59E+00	6.84E-01
Z-statistic	1.645	1.645	1.645	1.645	1.645	1.645
95%UCL on mean	6.08E+00	3.40E-01	7.51E+00	7.27E-01	1.28E+01	1.32E+00
max value	1.22E+01	5.14E-01	1.27E+01	1.24E+00	3.18E+01	1.70E+00
Statistical value	6.08E+00	3.40E-01	7.51E+00	7.27E-01	1.28E+01	1.32E+00
Background	NA	NA	NA	NA	NA	NA
Statistical value above background	6.08E+00	3.40E-01	7.51E+00	7.27E-01	1.28E+01	1.32E+00
Lookup Value - 15 mrem/yr for rad	6.2	1.4	3.3	3.0	4.5	

Most Stringent Cleanup Limit for nonradionuclide and RAG Type	2.0 River Protection
WAC 173-340 3-PART TEST	
95% UCL > Cleanup Limit?	NO
> 10% above Cleanup Limit?	NO
Any sample > 2X Cleanup Limit?	NO
EXCESS RISK EVALUATION	
WAC 173-340 B Non-Carcinogenic Cleanup:	400
Hazard quotient for each nonradionuclide:	3.29E-03
WAC 173-340 B Carcinogenic Cleanup:	2.1
Excess risk for each carcinogenic	6.27E-07
NON-RAD SUMMARY	
WAC 173-340 3-Part-Test Compliance:	YES
Nonrad noncarcinogenic sum of quotients:	3.29E-03
Nonrad carcinogenic risk:	6.27E-07

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator: Bill Hudson BH
Project: 116-F-6 Cleanup Verification
Subject: 116-F-6, 1608-F Liquid Waste Disposal Trench Cleanup Verification 95% UCL Calculation

Date: 3/5/03
Job No.: 22192

Calc. No.: 0100F-CA-V0141
Checked by: J.E. Thomson
T.B. Miley TBM

Rev. No.: 0
Date: 3/5/03 3/5/03
Sheet No.: 5 of 5

Trench Split/Duplicate Analysis:

Sample Area	HEIS Number	Cs-137 pCi/g	Q	MDA	Co-60 pCi/g	Q	MDA	Eu-152 pCi/g	Q	MDA	Eu-154 pCi/g	Q	MDA	Sr-90 pCi/g	Q	MDA	Cr^{+6} mg/kg	Q	PQL
Trench Shallow Zone Results:																			
SA1	J008F0	3.13E-01		4.30E-02	4.20E-02	U	4.20E-02	1.60E-01		1.00E-01	1.30E-01	U	1.30E-01	1.58E+00		2.30E-01	4.10E-01	U	4.20E-01
Duplicate of J008F0	J008H6	3.28E-01		3.30E-02	3.30E-02	U	3.30E-02	1.65E-01		6.60E-02	1.20E-01	U	1.20E-01	2.61E-01		2.20E-01	4.10E-01	U	4.10E-01
Split of J008F0	J008H7	2.97E-01		1.81E-02	3.11E-02	U	2.46E-02	4.58E-02	U	6.49E-02	2.14E-02	U	6.25E-02	2.25E-01		1.40E-01	0.00E+00		3.50E-01
Trench Deep Zone Results:																			
DA1	J008D1	6.90E-02		3.40E-02	2.90E-02	U	2.90E-02	1.36E-01		6.50E-02	1.10E-01	U	1.10E-01	3.18E+01		3.30E-01	7.10E-01		4.00E-01
Duplicate of J008D1	J008D7	9.50E-02		5.40E-02	5.50E-02	U	5.50E-02	1.80E-01	U	1.80E-01	1.80E-01	U	1.80E-01	8.71E-01		2.20E-01	6.00E-01		4.00E-01
Split of J008D1	J008D9	5.62E-02		4.71E-02	8.35E-03	U	5.02E-02	5.54E-02	U	1.22E-01	1.90E-02	U	1.63E-01	1.74E+00		1.57E-01	4.98E-01		8.00E-02

Trench Shallow Zone Analysis:

	(TDL)	0.1	0.05	0.1	0.1	1.0	0.5
Duplicate Analysis	Both> MDA?	Yes (continue)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?	No-Stop (acceptable)		No-Stop (acceptable)		No-Stop (acceptable)	
	RPD						
Split Analysis	Both> MDA?	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	No-Stop (acceptable)
	Both >5xTDL?	No-Stop (acceptable)				No-Stop (acceptable)	
	RPD						

Trench Deep Zone Analysis:

Duplicate Analysis	Both> MDA?	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)				No-Stop (acceptable)	No-Stop (acceptable)
	RPD						
Split Analysis	Both> MDA?	Yes (continue)	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)				No-Stop (acceptable)	No-Stop (acceptable)
	RPD						

CALCULATION COVER SHEET

Project Title 116-F-6 Cleanup Verification **Job No.** 22192
Area 100 Area; 100-FR-1 Operable Unit
Discipline Environmental ***Calc. No.** 0100F-CA-V0143
Subject 116-F-6 RESRAD Calculation
Computer Program RESRAD **Program No.** Version 6.21

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 5 pg Attm. 1 - 1 pg Attm. 2 - 20 pg Attm. 3 - 29 pg Attm. 4 - 10 pg Attm. 2 - 20 pg Attm. 3 - 20 pg Attm. 4 - 10 pg Total – 116 pages	B. Hudson BHudson 2/24/03	S. W. Clark S.W. Clark 2/24/03	K. E. Cook KECook 2/24/03	M.A. Buckmaster 2/27/03	2/27/03

SUMMARY OF REVISION

*Obtain Calc. No. from DIS
DE01-437.03

January 2003

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	B. Hudson	Date:	2-24-03	Calc. No.:	0100F-CA-V0143	Rev.:	0
Project:	116-F-6 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	2/24/03
Subject:	116-F-6 Cleanup Verification RESRAD Calculation					Sheet No. 1 of 5	

PROBLEM STATEMENT:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in the vadose zone soil at the 116-F-6 Liquid Waste Disposal Trench remediation site over a period of 1,000 years.

REFERENCES:

1) Cleanup verification data from *116-F-6 Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0141, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) Radioactive and nonradioactive contaminants of concern from the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP), DOE/RL-96-22, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington. For the purpose of these RESRAD calculations, the radioactive contaminants of concern (COCs) are cobalt-60, cesium-137, europium-152, europium-154, and strontium-90. Hexavalent chromium is the only nonradionuclide COC.
4) RESidual RADioactivity (RESRAD) computer code, version 6.21, 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.

SOLUTION:

1) Separate RESRAD runs were performed for the relevant vadose zone soil horizons (shallow zone and deep zone). Table 1 shows the elevations (NAVD'88) and dimensions of each soil horizon. The shallow zone was chosen as the sidewalls of the excavation to 4.6 m deep (from the backfill reference elevation of 127.5 m to an elevation of 122.9 m). The deep zone is the remaining portion of the vadose zone from 4.6 m below ground surface to groundwater (elevation 114.0 m). The total-plan view area of the excavation was used to conservatively estimate the site area input parameter for each soil horizon. Attachment 1 shows the dimensions of each soil horizon and the contaminant pathways considered for dose, risk, and groundwater protection.

   Input factors for each run are shown in the "Summary" section of the RESRAD "Part I: Mixture Sums and Single Radionuclide Guidelines" printouts in the Attachments to this Calculation Summary.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	B. Hudson	Date:	2-24-03	Calc. No.:	0100F-CA-V0143	Rev.:	0
Project:	116-F-6 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	2/24/03
Subject:	116-F-6 Cleanup Verification RESRAD Calculation					Sheet No. 2 of 5	

Table 1. Dimensions and Elevations of 116-F-6 Soil Horizons

RESRAD Run #	Vadose Zone Horizon	Upper Elevation (m)	Lower Elevation (m)	Thickness (m)
1-Radionuclides	Shallow Zone	127.5	122.9	4.6
2-Radionuclides	Deep Zone	122.9	114.0	8.9

2) The year where the peak dose (or concentration) occurs from each individual COC and layer is determined by a preliminary run. This year is then added for all horizons for the final RESRAD runs. For the direct exposure pathways (i.e., soil ingestion and inhalation and external radiation), the peak year occurred at year 0 (the present, year 2003). For the water dependent pathways (i.e., drinking water and food ingestion) the peak years were year 7.2 for cobalt-60 and year 42 for cesium-137 and strontium-90. The 7.2 and 42-year time periods were included in all of the RESRAD runs.

METHODOLOGY:

1) Runs of RESRAD Version 6.21 were completed for the vadose zone using the radionuclide concentrations shown in Table 2. RESRAD numerical output reports for dose, risk, and concentration for the shallow and deep zones are presented in the Attachments to this Calculation Summary. Shallow and deep zone concentrations of hexavalent chromium are included in Table 2 for evaluation of their potential to affect groundwater or the Columbia River. However, the concentrations of hexavalent chromium are less than the remedial action goals (RAGs) from the RDR/RAWP so no evaluation is necessary.

Table 2. Cleanup Verification Data Set

Radionuclide COCs	Shallow Zone[a]	Deep Zone[a]
	Radionuclide Activity, pCi/g	
Cs-137	5.25E-01	6.08E+00
Co-60	2.67E-02	3.40E-01
Eu-152	2.77E-01	7.51E+00
Eu-154	5.77E-02 (U)	7.27E-01
Sr-90	9.69E-01	1.28E+01
Nonradionuclide COCs	**Nonradionuclide Concentration, mg/kg**	
Cr (VI)	5.30E-01[b]	1.32E+00[b]

[a] The Shallow Zone and Deep Zone concentrations are from the *116-F-6 Cleanup Verification 95% UCL Calculation*, Calculation No. 0100F-CA-V0141, Rev. 0.
[b] Value was not input into RESRAD because the concentration is below RAGs, below Hanford Site background, below Washington State background, or because the analyte was not detected in cleanup verification samples at the indicated PQLs.
(U) = All analytical results for the data set were below laboratory detection limits.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	B. Hudson	Date:	7.24.03	Calc. No.:	0100F-CA-V0143	Rev.:	0
Project:	116-F-6 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	7/24/03
Subject:	116-F-6 Cleanup Verification RESRAD Calculation					Sheet No. 3 of 5	

RESULTS:

1) Radionuclide "All Pathways" Dose Rate:

1) The "all pathways" (maximum) dose rates are shown in Table 3. The maximum total all pathways dose rate of 5.81 mrem/yr occurs at year zero (2003) (principally from the shallow zone). The maximum deep zone dose rate of 5.24 x 10^{-1} mrem/yr occurs in year 42.

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

RESRAD Run #	Vadose Zone Horizons	"All Pathways" Dose Contributions in mrem/yr at Each Time Slice (yr)								
		0	1	3	7.2	15	42	100	300	1000
1	Shallow Zone	5.79E+00	5.58E+00	5.20E+00	4.50E+00	3.51E+00	1.63E+00	3.78E-01	3.10E-03	1.75E-10
2	Deep Zone	1.60E-02	4.83E-02	1.09E-01	2.17E-01	3.63E-01	5.24E-01	3.11E-01	7.87E-03	1.22E-09
Total All Pathways Dose Rate (mrem/yr)		5.81E+00	5.63E+00	5.31E+00	4.72E+00	3.87E+00	2.15E+00	6.89E-01	1.10E-02	1.39E-09

2) Radionuclide Excess Cancer Risk

The radionuclide excess cancer risk results are shown on Table 4. The maximum risk (8.13 x 10^{-5}) occurs at year 0 and is primarily from shallow zone soils.

Table 4. Radionuclide Excess Cancer Risk

RESRAD Run #	Vadose Zone Horizons	Excess Cancer Risk at Each Time Slice (yr)								
		0	1	3	7.2	15	42	100	300	1000
1	Shallow Zone	7.64E-05	7.39E-05	6.93E-05	6.08E-05	2.56E-06	2.30E-05	5.41E-06	4.49E-08	2.62E-15
2	Deep Zone	4.94E-06	5.19E-06	5.65E-06	6.43E-06	7.38E-06	7.59E-06	3.91E-06	9.17E-08	1.38E-14
Total Excess Cancer Risk		8.13E-05	7.91E-05	7.49E-05	6.72E-05	9.94E-06	3.06E-05	9.32E-06	1.37E-07	1.64E-14

3) Radionuclide Groundwater Protection

The radionuclide concentrations in groundwater calculated by the RESRAD model are summarized in Table 5. Only concentrations are presented here. Cobalt-60, cesium-137, and strontium-90 were calculated to reach groundwater in the 1,000 years of the RESRAD model run for the vadose zone. These radionuclide contaminants reach groundwater at concentrations below the RAGs.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

Originator:	B. Hudson	Date:	2-24-03	Calc. No.:	0100F-CA-V0143	Rev.:	0
Project:	116-F-6 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark	Date:	2/24/03
Subject:	116-F-6 Cleanup Verification RESRAD Calculation					Sheet No. 4 of 5	

Table 5. RESRAD Estimated Groundwater (Well Water) Concentrations.

Radio-nuclide	Vadose Zone Horizon	Groundwater Concentration in pCi/L at Each Time Slice (yr)									RAG from RDR (pCi/L)
		0	1	3	7.2	15	42	100	300	1000	
Cs-137	SZ	0	0	0	0	0	0	0	0	0	60
	DZ	0	1.53E-02	4.38E-02	9.54E-02	1.66E-01	2.49E-01	1.55E-01	4.56E-03	1.42E-09	
	Total	0	1.53E-02	4.38E-02	9.54E-02	1.66E-01	2.49E-01	1.55E-01	4.56E-03	1.42E-09	
Co-60	SZ	0	0	0	0	0	0	0	0	0	100
	DZ	0	7.67E-04	1.77E-03	2.45E-03	1.83E-03	1.48E-04	1.70E-07	1.92E-18	0	
	Total	0	7.67E-04	1.77E-03	2.45E-03	1.83E-03	1.48E-04	1.70E-07	1.92E-18	0	
Eu-152	SZ	0	0	0	0	0	0	0	0	0	200
	DZ	0	0	0	0	0	0	0	0	0	
	Total	0	0	0	0	0	0	0	0	0	
Eu-154	SZ	0	0	0	0	0	0	0	0	0	60
	DZ	0	0	0	0	0	0	0	0	0	
	Total	0	0	0	0	0	0	0	0	0	
Sr-90	SZ	0	0	0	0	0	0	0	0	0	8
	DZ	0	2.35E-01	6.72E-01	1.46E+00	2.52E+00	3.71E+00	2.21E+00	5.59E-02	8.32E-09	
	Total	0	2.35E-01	6.72E-01	1.46E+00	2.52E+00	3.71E+00	2.21E+00	5.59E-02	8.32E-09	

4) Nonradionuclide Groundwater Protection

The nonradionuclide COC associated with this site, hexavalent chromium, is present at concentrations below the applicable RAGs for direct exposure and groundwater protection.

CONCLUSIONS:

- The maximum total dose rate for the 116-F-6 Trench site is 5.81 mrem/yr and occurs at year zero (year 2003). Maximum total dose rate at year 2018 is 3.87 mrem/yr. Maximum total dose rate after 1,000 years is 1.39×10^{-9} mrem/yr.
- The dominant pathways for the dose rate at the year of maximum dose are direct external exposure and plant ingestion.
- The primary radionuclide contributing to the dose rate at the year of maximum dose is strontium-90 from the plant ingestion pathway.
- None of the 116-F-6 site COCs are projected to exceed remedial action goals (RAGs) within the 1,000 years of the RESRAD evaluation.
- Maximum total excess lifetime cancer risk (8.13×10^{-5}) occurs at year zero and is primarily contributed from the shallow zone. Maximum total excess lifetime cancer risk at year 2018 is 9.94×10^{-6}. Maximum total excess lifetime cancer risk after 1,000 years is 1.64×10^{-14}.
- Of the contaminants of concern, cobalt-60, cesium-137, and strontium-90 are calculated to reach groundwater within the 1,000 years of the RESRAD model run. These radionuclides reach groundwater at concentrations significantly below the RAGs.

Bechtel Hanford, Inc. **CALCULATION SUMMARY**

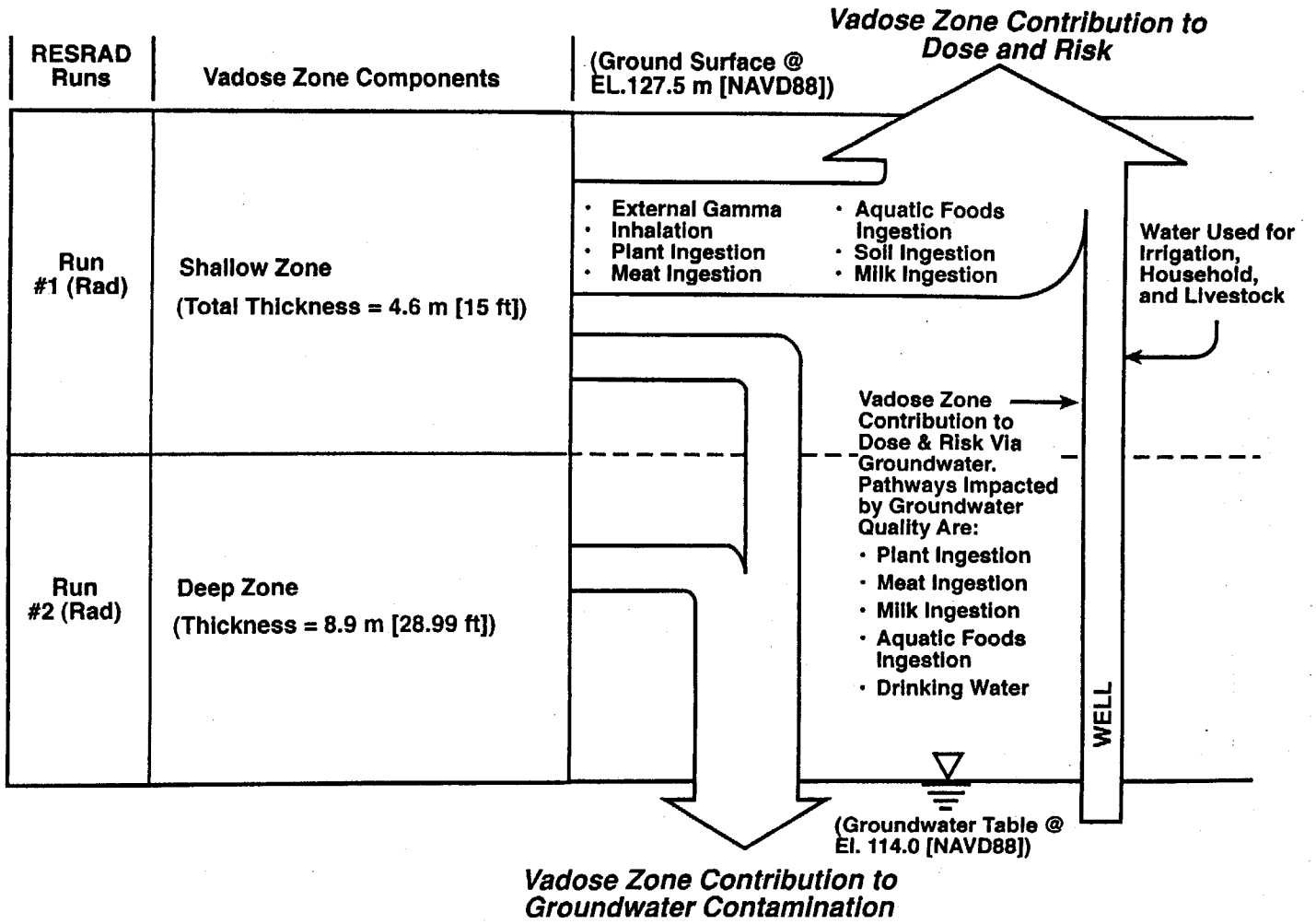
Originator:	B. Hudson BH	Date:	2-24-03	Calc. No.:	0100F-CA-V0143	Rev.:	0
Project:	116-F-6 Cleanup Verification	Job No:	22192	Checked:	S. W. Clark SWC	Date:	2/24/03
Subject:	116-F-6 Cleanup Verification RESRAD Calculation					Sheet No. 5 of 5	

ATTACHMENTS:

1. Graphic showing 116-F-6 Cleanup Verification Model (1 page)
2. RESRAD Output: 116-F-6 – Shallow Zone (Run #1), Part I: Mixture Sums and Single Radionuclide Guidelines (20 pages)
3. RESRAD Output: 116-F-6 – Shallow Zone (Run #1), Part III: Intake Quantities and Health Risk Factors (29 pages)
4. RESRAD Output: 116-F-6 – Shallow Zone (Run #1), Part IV: Concentration of Radionuclides (10 pages)
5. RESRAD Output: 116-F-6 – Deep Zone (Run #2), Part I: Mixture Sums and Single Radionuclide Guidelines (20 pages)
6. RESRAD Output: 116-F-6 – Deep Zone (Run #2), Part III: Intake Quantities and Health Risk Factors (20 pages)
7. RESRAD Output: 116-F-6 – Deep Zone (Run #2), Part IV: Concentration of Radionuclides (10 pages)

ATTACHMENT 1

116-F-6 Cleanup Verification Model



Attachment 1 Sheet No. 1 of 1
Originator B. Hudson Date 2-21-03
Chk'd By S. W. Clark Date 3/5/03
Calc. No. 0100F-CA-V0143 Rev. No. 0

CALCULATION COVER SHEET

Project Title:	116-F-6 Site Closeout	**Job No.**	22192
Area	100-F Area		
Discipline	Environmental	***Calc. No.**	0100F-CA-V0142
Subject	116-F-6 Trench Comparison to Drinking Water Standards		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation X **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Total - 4	Bill Hudson Bill Hudson 2/24/03	S. W. Clark S W Clark 2/24/03	K. E. Cook KE Cook 2/26/03	M. A. Buckmaster 2/27/03	2/27/03

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

January 2003

Bechtel Hanford, Inc. CALCULATION SHEET

Originator	Bill Hudson	Date	2/24/03	Calc. No.	0100F-CA-V0142	Rev. No.	0
Project	116-F-6 Site Closeout	Job No.	22192	Checked	S. W. Clark	Date	3/24/03
Subject	116-F-6 Trench Comparison to Drinking Water Standards					Sheet No.	1 of 3

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to MCLs . Compare beta/gamma emitter dose contribution to the maximum allowable dose of 4 mrem/yr (National Primary Drinking Water Regulations, 40 CFR Part 141, Subpart B, 141.16), as calculated using NBS Handbook 69 individual organ-dose calulation methodology and EPA-570/9-76-003 total organ-dose calulation methodology.

Table of Contents:
1. Calculation Summary
2. Comparison to MCLs
3. Cumulative Dose Comparison

Given/References:
1) RESRAD derived groundwater radionuclide concentrations from Calculation 0100F-CA-V0143.

2) Radionuclide concentrations in water corresponding to 4 mrem/year (C4 mrem/yr) from Calculation 0100X-CA-V0025 or as determined from references in item 5.

3) MCLs summarized in Table 2-3 of: DOE, 2001, Remedial Design Report/Remedial Action Work Plan for the 100 Area (RDR/RAWP), DOE/RL-96-17, Rev. 3, U.S. Department of Energy, Richland Operations office, Richland, WA.

4) Maximum allowable gross particle activity (alpha emitters) and maximum allowable dose (beta/gamma emitters) from: 40 CFR 141, "National Primary Drinking Water Regulation," *Code of Federal Regulations*, as amended.

5) Individual organ-dose caclulation methodology from: NBS 1963, *Maximum Permissible Body Burdens and Maximum Permissible Concetrations of Radionuclides in Air or Water for Occupational Exposure*, NBS Handbook 69, as amended, U.S. Department of Commerce, Washington D.C., and *National Interim Primary Drinking Water Regulations*, EPA-570/9-76-003, U.S. Environmental Protection Agency, Office of Water Supply, Washington D.C.

Solution:
1. The site data for the calculation are the groundwater concentrations for the COCs (daughter products are not considered) over time from the RESRAD groundwater (GW) concentration file.

2. If the site conceptual model breaks the contamination into multiple layers with differing concentrations, then the GW concentrations from the various model runs are added (for each time interval) to provide the concentration data for comparison to the individual MCLs and the dose calculation for the beta and gamma emitters.

3. Compare the summed concentrations for each radionuclide to the GW MCL given in the RDR/RAWP, Table 2-3. .

4. The cumulative dose for each organ for all beta and gamma emitting COCs (Co-60, Cs-137, Eu-152, Eu-154, and Sr-90) at time t is calculated separately using the corresponding to 4 mRem/year dose (C4) and the sum of fractions equation shown below (from EPA-570/9-76-003). The organs for which doses need to be computed are total body, bone, liver and gastrointestinal tract [lower large intestine] (GI(LLI)). The individual organ doses are compared to 4 mrem/yr.

Doseorgan x (t) = [ConcA(t)/C4A(x) + ConcB(t)/C4B(x) + ...] x (4 mrem/yr)

where:
Doseorgan x (t) is the total dose to organ x in mrem/yr
ConcA(t) is the concentration of isotope A at time t in pCi/L
C4A(x) is the 4 mrem/yr dose equivalent concentration for organ x of isotope A at time t in pCi/L
If the dose for organ x < 4 mrem/yr, then the standard is met.

Conclusions:
The summed concentrations for each radionuclide are less than the GW MCL given in the Soil Screening Guidance for Radionuclides: User's Guide.

The cumulative dose for each total body, bone, liver and gastrointestinal tract for all beta and gamma emitting COCs is less than 4 mrem/yr (using EPA-570/9-76-003 total dose calculation methodology).

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator Bill Hudson BH **Date** 2-24-03
Project 116-F-6 Site Closeout **Job** 22192
Subject 116-F-6 Trench Comparison to Drinking Water Standards

Calc. No. 0100F-CA-V0142
Checked S. W. Clark

Rev. No. 0
Date 3/24/02
Sheet No. 2 of 3

Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modelling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	7.2	15	42	100	300	1000	MCL	Exceeds MCL?	Peak Conc.	Year of Peak
Cs-137	0	1.52E-02	4.38E-02	9.54E-03	1.66E-01	2.49E-01	1.55E-01	4.56E-03	1.42E-09	60	No	2.49E-01	42
Co-60	0	7.67E-04	1.77E-03	2.45E-03	1.83E-03	1.48E-04	1.70E-07	1.92E-18	0.00E+00	100	No	2.45E-03	7.2
Eu-152	0	0	0	0	0	0	0	0	0	200	No	0	0
Eu-154	0	0	0	0	0	0	0	0	0	60	No	0	0
Sr-90	0	2.35E-01	6.72E-01	1.46E+00	2.52E+00	3.71E+00	2.28E+00	5.59E-02	8.32E-09	8	No	3.71	42

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator: Bill Hudson
Project: 116-F-6 Site Closeout
Subject: 116-F-6 Trench Comparison to Drinking Water Standards

Date: 2-24-03
Job: 22192

Calc. No. 0100F-CA-V0142
Checked: S. W. Clark

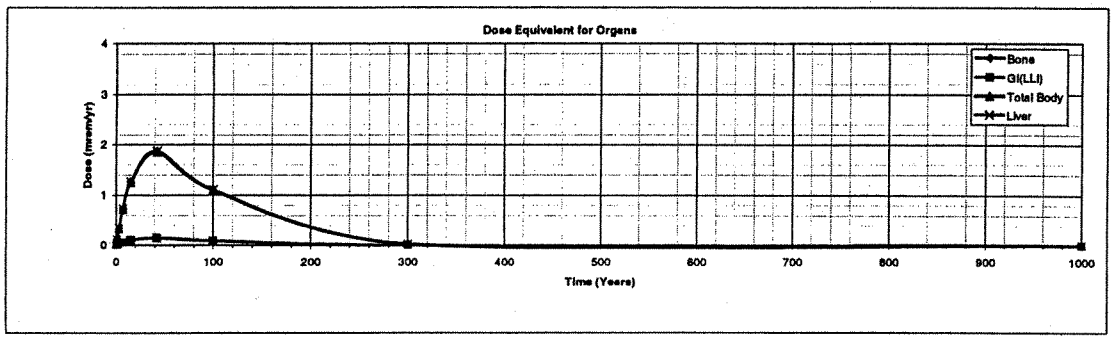
Rev. No. 0
Date: 3/27/03
Sheet No. 3 of 3

Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modelling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	7.2	15	42	100	300	1000	Organ	C_4	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Cs-137	0	1.53E-02	4.38E-02	9.54E-02	1.66E-01	2.49E-01	1.55E-01	4.56E-03	1.42E-09	Bone	80	No	2.49E-01	42
										GI(LLI)	2,000	No		
										Total Body	200	No		
										Liver	60	No		
Co-60	0	7.67E-04	1.77E-03	2.45E-03	1.83E-03	1.48E-04	1.70E-07	1.92E-18	0.00E+00	GI(LLI)	100	No	2.45E-03	7.2
										Total Body	900	No		
										Liver	3,000	No		
Eu-152	0	0	0	0	0	0	0	0	0	Bone	30,000	No	0	0
										GI(LLI)	200	No		
										Total Body	200,000	No		
										Liver	100,000	No		
Eu-154	0	0	0	0	0	0	0	0	0	Bone	5,000	No	0	0
										GI(LLI)	60	No		
										Total Body	70,000	No		
										Liver	60,000	No		
Sr-90	0	2.35E-01	6.72E-01	1.46E+00	2.52E+00	3.71E+00	2.21E+00	5.59E-02	8.32E-09	Bone	8	No	3.71	42
										GI(LLI)	100	No		
										Total Body	8	No		

Cumulative dose for each organ (with time)

Organ	Time (years) 0	1	3	7.2	15	42	100	300	1000	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Bone	0.00E+00	1.18E-01	3.38E-01	7.35E-01	1.27E+00	1.87E+00	1.11E+00	2.82E-02	4.23E-09	No	1.87E+00	42
GI(LLI)	0.00E+00	9.46E-03	2.70E-02	5.87E-02	1.01E-01	1.49E-01	8.87E-02	2.25E-03	3.36E-10	No	1.49E-01	42
Total Body	0.00E+00	1.18E-01	3.37E-01	7.32E-01	1.26E+00	1.86E+00	1.11E+00	2.80E-02	4.19E-09	No	1.86E+00	42
Liver	0.00E+00	1.19E-01	3.39E-01	7.36E-01	1.27E+00	1.87E+00	1.12E+00	2.83E-02	4.25E-09	No	1.87E+00	42



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