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15. Design Verification Required ☐ Yes ☒ No	16. Cost Impact <table border="0"> <tr> <td colspan="2">ENGINEERING</td> <td colspan="2">CONSTRUCTION</td> </tr> <tr> <td>Additional</td> <td>☐ \$</td> <td>Additional</td> <td>☐ \$</td> </tr> <tr> <td>Savings</td> <td>☐ \$</td> <td>Savings</td> <td>☐ \$</td> </tr> </table>		ENGINEERING		CONSTRUCTION		Additional	☐ \$	Additional	☐ \$	Savings	☐ \$	Savings	☐ \$	17. Schedule Impact (days) Improvement ☐ Delay ☐
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SDD/DD ☐ Functional Design Criteria ☐ Operating Specification ☐ Criticality Specification ☐ Conceptual Design Report ☐ Equipment Spec. ☐ Const. Spec. ☐ Procurement Spec. ☐ Vendor Information ☐ OM Manual ☐ FSAR/SAR ☐ Safety Equipment List ☐ Radiation Work Permit ☐ Environmental Impact Statement ☐ Environmental Report ☐ Environmental Permit ☐	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	Seismic/Stress Analysis ☐ Stress/Design Report ☐ Interface Control Drawing ☐ Calibration Procedure ☐ Installation Procedure ☐ Maintenance Procedure ☐ Engineering Procedure ☐ Operating Instruction ☐ Operating Procedure ☐ Operational Safety Requirement ☐ IED Drawing ☐ Cell Arrangement Drawing ☐ Essential Material Specification ☐ Fac. Proc. Samp. Schedule ☐ Inspection Plan ☐ Inventory Adjustment Request ☐	Tank Calibration Manual ☐ Health Physics Procedure ☐ Spares Multiple Unit Listing ☐ Test Procedures/Specification ☐ Component Index ☐ ASME Coded Item ☐ Human Factor Consideration ☐ Computer Software ☐ Electric Circuit Schedule ☐ ICRS Procedure ☐ Process Control Manual/Plan ☐ Process Flow Chart ☐ Purchase Requisition ☐ Ticker File ☐ NONE ☒												
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Excavations in Hanford Ponds, Cribs, or Ditches

G. W. Ryan

Westinghouse Hanford Company, Richland, WA 99352

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Abstract: This document supports the development and presentation of the following accident scenario in the TWRS Final Safety Analysis Report:

Unplanned Excavation/Drilling in Pond/Ditch/Crib.

The calculations needed to quantify the risk associated with this accident scenario are included within.

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Karen H. Roland 9/20/96
Release Approval Date

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EXCAVATIONS IN HANFORD PONDS, CRIBS, OR DITCHES

REVISION 1

**Tank Waste Remediation System Final Safety Analysis Report Project
Safety Analysis & Nuclear Engineering**

NOTE: ACCORDING TO SECTION WP-6.7, REV. 0 OF WHC-CM-6-32, *SAFETY ANALYSIS AND NUCLEAR ENGINEERING WORK PROCEDURES*, CALCULATION NOTES ARE USED TO DOCUMENT THE ORIGINATOR'S ANALYSIS BUT ARE NOT TO BE USED TO AUTHORIZE ACTIVITIES OR JUSTIFY FACILITY MODIFICATIONS, OR CHANGES TO AN AUTHORIZATION BASIS, SAFETY BASIS, OR DESIGN BASIS.

September 1996

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LIST OF TERMS

AED	aerodynamic equivalent diameter
ARF	airborne release fraction
ARR	airborne release rate
CEDE	committed effective dose equivalent
DR	damage ratio
FSAR	final safety analysis report
HEDOP	Hanford Environmental Dose Overview Panel
IVF	information validation form
LPF	leak path factor
MAR	material-at-risk
rem	radiation effective man
RF	respirable fraction
Sv	sievert
TEDE	total effective dose equivalent
TWRS	Tank Waste Remediation System
WHC	Westinghouse Hanford Company

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EXCAVATIONS IN HANFORD PONDS, CRIBS, OR DITCHES

1.0 INTRODUCTION AND PURPOSE

This document supports the development and presentation of the following accident scenario in the TWRS Final Safety Analysis Report (FSAR):

Unplanned Excavation/Drilling in Pond/Ditch/Crib.

ACCIDENT SCENARIO DEVELOPMENT AND DESCRIPTION

Liquid radioactive and toxicologically contaminated wastes produced by Hanford Site facilities and operations have been disposed of in various TWRS ponds, ditches, or cribs located in the 200 East and 200 West Areas. As a result of past waste disposal practices, these TWRS facilities contain large quantities of contaminated soils.

The contaminated soils in ponds, ditches, and cribs normally do not present a hazard because the contaminated soils are buried under a large overburden of uncontaminated soils.

An inadvertent excavation, such as a planned excavation that is performed in the wrong location, or a drilling activity in a pond, ditch, or crib could expose receptors to radioactive or toxicological hazards. The exposure could result from respirable dust particles suspended during and immediately following the unplanned excavation. This accident is considered to possess the potential for significant onsite consequences.

In the unmitigated accident analysis, the crib was postulated to be excavated with a backhoe at a rate of 1 bucket of contaminated soil every 2 minutes for a period of 12 hours. This rate would result in approximately 120 m³ (4,238 ft³) of soil being excavated. Because actual excavation operations are not likely to be performed continuously for 12 hours (1 work shift), this assumption is conservative.

This calculation note treats the contaminated soils in these facilities as if they were near the surface and easily exposed by a casual excavation. The fact is that these soils are buried under a large overburden of uncontaminated soils so that considerable excavation would have to be performed before any contaminated soils would be exposed.

ACCIDENT FREQUENCY DEVELOPMENT

Only prior operational history of the tank farms was considered when a frequency of "anticipated" (1×10^0 to 1×10^{-2} per year) was qualitatively assigned to this unmitigated accident scenario. Numerous entries in the occurrence reporting database demonstrate that planned excavation operations have been performed in unintended areas. Some of these events have resulted in unexpected and uncontrolled personnel exposure from active transfer lines and other subsurface equipment. Planned excavations both by machine (i.e., backhoe) and by hand have occurred in unintended areas.

The consequences associated with this accident scenario are compared to the risk acceptance guidelines for *anticipated* accidents as provided in WHC-CM-4-46, Rev. 1.

2.0 ANALYSIS INPUT

- From an evaluation of the recorded radiological inventories for ditch 216-U-14 and cribs 216-U-16, 216-U-17, and 216-Z-20 (Appendix D), crib 216-Z-20 was identified as having the largest inventory of radioactive contamination (Appendix A). Therefore, to assess the potential unmitigated consequences of an inadvertent excavation in a pond, ditch, or crib an unmitigated accident scenario was developed for crib 216-Z-20. Table 1 lists the main dose contributors and concentrations of the radiological inventory for crib 216-Z-20.

Table 1. Radioactive Isotopes and Inventory
Assumed Present in Crib 216-Z-20.

Isotope	Inventory* Bq (Ci)	Concentration Bq(Ci)/m ³ *
Plutonium-239	3.81 E+10 (1.03 E+00)	1.6 E+07 (4.3 E-4)
Plutonium-240	3.81 E+10 (1.03 E+00)	1.6 E+07 (4.3 E-4)
Plutonium-241	8.03 E+10 (2.17 E+00)	3.3 E+07 (9.0 E-4)
Americium-241	3.85 E+10 (1.04 E+00)	1.6 E+07 (4.3 E-4)

*Based on a contaminated soil volume of 2,400 m³
(84,755 ft³) in crib 216-Z-20.
Bq = becquerel.
Ci = curie.

Hanford soils contain a number of non-radiological contaminants such as heavy metals and organic compounds. Concentrations of these substances in the Hanford Site soils are relatively low with concentrations measured the parts per billion to parts per million range. A summary of controlling inorganic and organic contaminant concentrations that were derived from process analytical data (Appendix E) are presented in Table 2 and are considered to bound the toxicological constituents and concentrations in the soils of crib 216-Z-20.

A general description of crib 216-Z-20 is provided in Appendix C.

Table 2. The Toxicological Constituents and Concentrations Assumed Present in Crib 216-Z-20.

Analyte	Average concentration (parts per billion)	Maximum concentration (parts per billion)
Mercury	1.28	20
Lead	28	319
Chromium	54	380
Cyanide	51	246
Hydrazine	59	88
Carbon tetrachloride	4,352	8,700
Cyclohexane	670	900
Tetrachlorethane	410	1,200
Phenol	37	80

- Integrated Atmospheric Coefficients for both onsite and offsite receptors from Van Keuren (1996) are given in Table 3. These values were calculated using the logarithmic interpolation procedure outlined in Van Keuren (1996).

Table 3. Atmospheric Dispersion Coefficients.

Receptor	Integrated X/Q' (s/m^3)
Onsite (12 hour exposure)	5.54×10^{-3}
Offsite (24 hour exposure)	4.62×10^{-6}

- The breathing rates used for the onsite and offsite receptors are $3.3 \times 10^{-4} \text{ m}^3/\text{s}$ and $2.7 \times 10^{-4} \text{ m}^3/\text{s}$, respectively (Van Keuren 1996).
- The volume of contaminated soil in Crib 216-Z-20 is $2,400 \text{ m}^3$ (Appendix B).
- The volume of soil overburden in Crib 216-Z-20 is $60,000 \text{ m}^3$ (Appendix B).
- Bounding airborne release fractions, airborne release rates, and respirable fractions for the suspension of falling powders and resuspension of powders were used in the analysis to bound the suspension of falling soils during the excavation and resuspension of soils subsequent to the excavation, as detailed in Table 4. These values have been extracted from the information contained in DOE-HDBK-3010-94 (specifically cited on pages 4-82 and 4-101).

Table 4. The Respirable Airborne Release Fractions/Rates Used in This Analysis.

DESCRIPTION	AIRBORNE RELEASE FRACTION (ARF) OR AIRBORNE RELEASE RATE (ARR)	RESPIRABLE FRACTION (RF)	ARF (or ARR) x RF
Suspension of Falling Powders	2.0 E-03 (ARF)	0.3	6.0 E-04
Homogeneous Bed of Powder Exposed to Nominal Atmospheric Conditions (< 2 m/s with gusts up to 20 m/s)	4.0 E-05/h (ARR)	1.0	4.0 E-05/h

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3.0 ASSUMPTIONS

- The quantity of excavated material is bounded by a 12 hour excavation (1 shift) by a backhoe. The analysis assumes that the backhoe removes 1 bucket of contaminated soil every 2 minutes. Based on a bucket size of 0.28 m^3 , the rate of excavation is estimated to be $10 \text{ m}^3/\text{hr}$ (Appendix B). This estimate is conservative since it is unlikely the excavation would continue interrupted for the entire shift.
- No credit is taken for the uncontaminated overburden that must be excavated before reaching the contaminated crib soils. This is a conservative assumption since it will decrease the volume of contaminated soils excavated.
- The average concentration of radiological and toxicological inventories in the crib are representative of the excavated material. This may not be the case since only 5% of the crib soils are excavated. Radioactive liquid discharges to cribs, ponds, and ditches are assumed to no longer occur at radioactivity levels which would invalidate source term assumptions made in this analysis.
- It is conservatively assumed that the entire inventory contained in the excavated soils is subject to resuspension for a period of 24 hours from the start of the excavation. This is a very conservative assumption since only the soils near the surface of the soil piles could be resuspended.

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4.0 ANALYTICAL METHODS AND CALCULATIONS

Airborne Source Term Released:

The first step in calculating the dose is to derive the airborne source term, i.e., the amount of airborne radioactive material generated by the accident that is available for transport to the maximum onsite and offsite individuals. As presented in *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE-HDBK-3010-94), the airborne source term is typically estimated by the following formula:

$$\text{Source term (Q)} = \text{MAR} \times \text{DR} \times \text{ARF/ARR} \times \text{RF} \times \text{LPF}$$

where

MAR = material-at-risk

DR = damage ratio

ARF/ARR = airborne release fraction/airborne release rate

RF = respirable fraction

LPF = leak path factor.

The MAR is the amount of material available to be acted on by accident-induced physical stresses such as temperature or pressure. The DR is the fraction of the MAR actually impacted by the accident. An interdependency exists between the MAR and the DR, i.e., if it is predetermined that certain types of material will not be affected by a given accident, that material can be excluded from the MAR. In other words, the DR can be accounted for when defining the MAR.

The ARF is the coefficient used to estimate the amount of material suspended in air by the accident as an aerosol and thus available for transport due to the physical stresses of a specific accident. For mechanisms that continuously act to suspend material (e.g., a spray release), an ARR is required to estimate the potential airborne release from postulated accident conditions.

The RF is the fraction of airborne particles that can be transported through air and inhaled into the pulmonary region of the human respiratory system, and includes particles having a 10- μm aerodynamic equivalent diameter (AED) or less (DOE-HDBK-3010-94). The AED is the diameter of sphere of density (1 g/cm³) that exhibits the same terminal velocity as the particle in question.

The LPF is the fraction of the material in the aerosol transported through some confinement deposition or filtration mechanism. Leak path factors are developed as applicable based upon (1) established relationships among the size of the particulate material, airborne transport mechanisms, and losses by deposition; or (2) specified filtration efficiencies (DOE-HDBK-3010-94).

Material at Risk (MAR) and Damage Ratio (DR)

The excavation in cribs, ditches, or ponds accident analysis was conducted by using an accident scenario that bounds the material at risk in any excavation in one of these areas. The accident scenario postulates an excavation in 216-Z-20 crib by a backhoe. The backhoe excavates 1 bucket of contaminated soil every 2 minutes for a period of 12 hours resulting in approximately 120 m³ being excavated. Therefore, the total MAR is 120 m³.

Since all of the excavated soils are assumed to come from the crib and not the overburden, DR = 1.

Airborne Release Fraction (ARF), Respirable Fraction (RF), and Leak Path Factor (LPF)

In the above scenario, release and dispersion of airborne soil particles results from the successive dumping of contaminated soils and from the resuspension of contaminated soils by the wind. The ARF x RF for falling powders from Table 4 is used to calculate the airborne source term for the dumping of crib soils and the ARF x RF for the resuspension of loose powders from Table 4 is used for the resuspension of soils by the wind. Once the soils are aerosolized by the free fall spill or resuspended by the wind, they are dispersed directly to the atmosphere, LPF = 1.

Calculation of the Airborne Source Term Released in this Accident Scenario

Crib soils are excavated and dumped for 12 hours. Therefore, the airborne source term in m³ for the dumping of soils is:

$$\begin{aligned} Q_{\text{dumping}} &= \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF} \\ &= (120 \text{ m}^3) \cdot (1) \cdot (2.0 \times 10^{-3}) \cdot (0.3) \cdot (1) \\ Q_{\text{dumping}} &= 7.20 \times 10^{-2} \text{ m}^3 \end{aligned}$$

The airborne resuspension source term for an onsite receptor is:

$$\begin{aligned} Q_{\text{resuspension}} &= (60 \text{ m}^3) \cdot (1) \cdot (4.0 \times 10^{-5}/\text{h}) \cdot (1) \cdot (1) \cdot (12 \text{ h}) \\ Q_{\text{resuspension}} &= 2.88 \times 10^{-2} \text{ m}^3 \end{aligned}$$

It should be noted here that 60 m³ is used in the calculation of the onsite soil resuspension source term since 120 m³ of material is not present and available for resuspension during the entire 12 hour time period. Since the excavation rate is considered linear, integrating the amount excavated over the 12 hour period results in 60 m³ available for resuspension to the onsite receptor.

Therefore, for the onsite receptor the total airborne source term material released is:

$$\begin{aligned} Q_{\text{onsite}} &= Q_{\text{dumping}} + Q_{\text{resuspension}} \\ &= 7.20 \times 10^{-2} \text{ m}^3 + 2.88 \times 10^{-2} \text{ m}^3 \end{aligned}$$

$$Q_{\text{onsite}} = 1.01 \times 10^{-1} \text{ m}^3$$

The airborne resuspension source term for an offsite receptor is a total of the amount resuspended from the total material at risk (120 m^3) for 12 hours following the excavation and the amount resuspended during the excavation (i.e., $Q_{\text{resuspension (onsite)}}$):

$$Q_{\text{resuspension}} = (120 \text{ m}^3) \cdot (1) \cdot (4.0 \times 10^{-5} / \text{h}) \cdot (1) \cdot (1) \cdot (12 \text{ h}) + Q_{\text{resuspension (onsite)}}$$

$$Q_{\text{resuspension}} = 8.64 \times 10^{-2} \text{ m}^3$$

Therefore, for the offsite receptor the total airborne source term material released is:

$$\begin{aligned} Q_{\text{offsite}} &= Q_{\text{dumping}} + Q_{\text{resuspension}} \\ &= 7.20 \times 10^{-2} \text{ m}^3 + 8.64 \times 10^{-2} \text{ m}^3 \end{aligned}$$

$$Q_{\text{offsite}} = 1.58 \times 10^{-1} \text{ m}^3$$

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5.0 RADIOLOGICAL DOSE CONSEQUENCE ANALYSIS

Given an airborne source term, the doses from the inhalation and ingestion pathways are calculated by the following formulas:

Inhalation:

$$D_{inh}(Sv) = Q(m^3) \times \frac{X}{Q'} \left(\frac{s}{m^3} \right) \times R \left(\frac{m^3}{s} \right) \times UD_{inh} \left(\frac{Sv}{m^3} \right)$$

where

D_{inh} = dose due to inhalation (Sv)

Q = respirable source term (m^3), from Section 4.0

X/Q' = atmospheric dispersion coefficient (s/m^3), from Table 3

R = breathing rate, from Section 2.0

UD_{inh} = inhalation unit dose (Sv/m^3 , calculated below)

The inhalation dose calculated is the 50-year committed effective dose equivalent (CEDE) defined as the dose received by the individual during a 50-year period following the uptake. For the maximum onsite individual, this dose must be combined with that due to external exposure (if any) to yield the TEDE. In this analysis, there is insignificant external exposure.

Calculation of the Unit Doses for Source Term in this Scenario

An approximate unit dose per m^3 for excavated soils can be calculated using the expression:

$$Unit\ Dose = \frac{1}{V_{soil}} \sum C_i DCF_i$$

Where

V_{soil} = Volume of contaminated soil in crib (m^3)

C_i = Crib inventory of radioactive isotope i (Bq)

DCF_i = Dose conversion factors (Sv/Bq), (EPA 1988)

Using the isotopic concentrations from Table 1 and dose conversion factors (EPA 1988), Table 5 is constructed.

Table 5. The Total Radiological Dose From Contaminated Soil in Crib 216-Z-20.

Isotope	Inventory (Bq) ^{a,b}	Dose factor (Sv/Bq) ^c	Dose (Sv) ^{d,e}
Plutonium-239	3.81 E+10	1.16 E-04	4.42 E+06
Plutonium-240	3.81 E+10	1.16 E-04	4.42 E+06
Plutonium-241	8.03 E+10	2.23 E-06	1.79 E+05
Americium-241	3.85 E+10	1.20 E-04	4.62 E+06
Total			1.37 E+07

^aBased on a contaminated soil volume of 2,400 m³ (84,755 ft³) in crib 216-Z-20.

^bTo convert becquerels to curies, multiply by 2.7 x 10⁻¹¹.

^cValues taken from EPA-520/1-88-020, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11, U.S. Environmental Protection Agency, Washington, D.C.

^dTo convert sieverts to rem, multiply by 100.

^eDose calculated by multiplying the inventory by the dose factor.

Bq = becquerel.

Sv = sievert.

Therefore, with V_{soil} = 2,400 m³ the Unit Dose is calculated to be:

$$\text{Unit Dose} = 1.37 \times 10^7 \text{ Sv} / 2,400 \text{ m}^3$$

$$\text{Unit Dose} = 5.71 \times 10^3 \text{ Sv/m}^3$$

The calculation of the Unit Dose (i.e., 5.71 x 10³ Sv/m³) is consistent with the inventory and concentration comparison/evaluation shown in Appendix A.

Radiological Inhalation Dose Consequence

$$D_{\text{onsite}} = 1.01 \times 10^{-1} \text{ m}^3 \times 5.54 \times 10^{-3} \frac{\text{S}}{\text{m}^3} \times 3.3 \times 10^{-4} \frac{\text{m}^3}{\text{S}} \times 5.71 \times 10^3 \frac{\text{Sv}}{\text{m}^3}$$

$$= 1.05 \times 10^{-3} \text{ Sv} \text{ (} 1.05 \times 10^{-1} \text{ rem)}$$

$$D_{\text{offsite}} = 1.58 \times 10^{-1} \text{ m}^3 \times 4.62 \times 10^{-6} \frac{\text{S}}{\text{m}^3} \times 2.7 \times 10^{-4} \frac{\text{m}^3}{\text{S}} \times 5.71 \times 10^3 \frac{\text{Sv}}{\text{m}^3}$$

$$= 1.13 \times 10^{-6} \text{ Sv} \text{ (} 1.13 \times 10^{-4} \text{ rem)}$$

6.0 TOXICOLOGICAL EXPOSURE CONSEQUENCE ANALYSIS

Toxic chemicals, as presented in Table 2, are present in Hanford Soils in the concentration range of parts-per-million (ppm) to parts-per-billion (ppb). Airborne concentrations of these chemicals due to excavation would be at most in the parts-per-million range at the location of the onsite receptor (i.e., 328 ft [100 m]). The toxicological exposure consequences due to an excavation of the pond/crib/ditch soils are therefore considered negligible and have not been quantified in this analysis.

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7.0 ANALYSIS RESULTS

The radiological dose consequence results, as shown in Table 6, are well within risk evaluation guidelines for both onsite and offsite receptors at a frequency of *anticipated*.

Table 6. Radiological Dose and Toxicological Exposure Consequences for Excavations in Hanford Ponds, Cribs, or Ditches.

Unmitigated Accident Frequency: Anticipated				
Consequences: The calculated radiological dose consequences are within the risk guidelines for an anticipated event.				
Receptor/ Hazard	Calculated Dose/Exposure	Risk Guidelines		
		Anticipated	Unlikely	Extremely Unlikely
Offsite/ Radiological	1.13×10^{-4} rem	0.1 rem	0.5 rem	4 rem
Onsite/ Radiological	0.11 rem	0.5 rem	5 rem	10 rem
Offsite/ Toxicological	Negligible	1	1	1
Onsite/ Toxicological	Negligible	1	1	1

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8.0 CONCLUSIONS

The calculated radiological dose consequences of an excavation in a pond, crib, or ditch are well within the risk evaluation guidelines. The toxic chemical exposure consequences are negligible due to the low concentrations of chemicals in the soil. Therefore, this accident does not pose a significant risk and will not require implementation of any safety significant controls.

The calculated results can be affected by an increase in the amount of material excavated, a change in the radioactive inventory, or by the use of a more conservative value of the airborne release fraction/rate. However, since the calculated onsite dose is only 20% of the risk evaluation guideline value, even a substantial increase in these factors will not have a significant impact on the results.

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9.0 REFERENCES

- DOE/RL-88-30, 1988, *Hanford Site Waste Management Units Report*, Rev. 4, U. S. Department of Energy, Richland, Washington.
- EPA 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, EPA-520/1-88-020, Federal Guidance Report No. 11, U.S. Environmental Protection Agency, Washington, DC.
- Van Keuren, J. C., 1996, WHC-SD-WM-SARR-016, Rev. 2, *Tank Waste Compositions and Atmospheric Dispersion Coefficients for use in ASA Consequence Assessments*, Westinghouse Hanford Company, Richland, Washington.
- DOE-HDBK-3010-94, 1994, "DOE Handbook Airborne Release Fractions/Rates and Restorable Fraction for Nonreactor Nuclear Facilities," U.S. Department of Energy, Richland, Washington.
- R. R. Lehrscha1, 1992, *Safety Assessment for Environmental Investigations and Site Characterizations, Volume 2 - Aggregate Safety Assessment for Shallow/Near Surface Activities*, WHC-SD-EN-SAD-016, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Waste Information Data System (WIDS): A database containing information about existing waste sites. Hard copy information from this database is provided in Appendix D.
- WHC 1991, *Safety Analysis Manual*, WHC-CM-4-46, Section 4.0, Rev. 1, November 15, 1991, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A
RADIOLOGICAL INVENTORY AND CONCENTRATION COMPARISON/EVALUATION

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NOTES REGARDING THE DEVELOPMENT OF UNIT DOSES IN THE FOLLOWING TABLE

GENERAL: The inventories for radionuclides which were reported as "less than" values in the *Cumulative Decayed Inventory Reports* in Appendix D were conservatively assumed to be equal to the "less than" values.

There are several radionuclides in the *Cumulative Decayed Inventory Reports* in Appendix D that are not included in the calculations in Appendix A, however, they have negligible impact on the unit dose values because of their low total activities.

SPECIFIC: The U-gross value (6.39×10^{-2} Ci) from Appendix D was used in Appendix A calculations for the U-233 value for crib 216-U-14 instead of the U-233 value from Appendix D (6.6×10^{-16} Ci).

The U-233 value from Appendix D for crib 216-U-17 was used for U-234 in Appendix A calculations.

The U-gross value (1.14×10^{-3} Ci) from Appendix D for crib 216-U-17 was used in Appendix A calculations for the Pu-238 value since no Pu-238 value was available from Appendix D.

Divide	by	Multiply	by	to get
		Cl	3.70E+10	Bq
Bq	2400 m ³	result	Dose Factor	Sv/m ³

Isotope	Crib Inventory 216-Z-20		Ditch Inventory 216-U-14		Crib Inventory 216-U-16		Crib Inventory 216-U-17		Dose Factor Sv/Bq	Dose (Sv/m ³)			
	Cl	Bq	Cl	Bq	Cl	Bq	Cl	Bq		Z-20	U-14	U-16	U-17
Co60	2.99E-03	1.11E+08	4.96E-04	1.84E+07	0	0.00E+00	0.00E+00	0.00E+00	5.91E-08	2.72E-03	4.52E-04	0.00E+00	0.00E+00
Se79	1.63E-07	6.03E+03	1.87E-06	6.92E+04	6.56E-09	2.43E+02	0.00E+00	0.00E+00	2.66E-09	6.68E-09	7.67E-08	2.69E-10	0.00E+00
Sr90	9.22E-02	3.41E+09	5.88E-02	2.18E+09	8.17E-03	3.02E+08	5.70E-06	2.11E+05	6.47E-08	9.20E-02	5.87E-02	8.15E-03	5.69E-06
Y90	8.86E-02	3.28E+09	5.77E-02	2.13E+09	8.18E-03	3.03E+08	0.00E+00	0.00E+00	2.28E-09	3.11E-03	2.03E-03	2.88E-04	0.00E+00
Zr93	2.11E-06	7.81E+04	2.41E-05	8.92E+05	8.48E-08	3.14E+03	0.00E+00	0.00E+00	6.39E-09	2.08E-07	2.37E-06	8.35E-09	0.00E+00
Tc99	9.39E-06	3.47E+05	1.72E-01	6.36E+09	3.77E-07	1.39E+04	1.26E-03	4.66E+07	2.77E-10	4.01E-08	7.35E-04	1.61E-09	5.38E-06
Ru106	5.16E-06	1.91E+05	4.44E-12	1.64E-01	5.16E-07	1.91E+04	0.00E+00	0.00E+00	1.29E-07	1.03E-05	8.83E-12	1.03E-06	0.00E+00
Rh108	5.16E-06	1.91E+05	4.44E-12	1.64E-01	5.16E-07	1.91E+04	0.00E+00	0.00E+00	5.77E-11	4.59E-09	3.95E-15	4.59E-10	0.00E+00
Pd107	2.77E-08	1.02E+03	3.16E-07	1.17E+04	1.11E-09	4.11E+01	0.00E+00	0.00E+00	6.94E-11	2.96E-11	3.38E-10	1.19E-12	0.00E+00
Cd113m	9.29E-10	3.44E+01	4.22E-09	1.56E+02	3.76E-11	1.39E+00	0.00E+00	0.00E+00	4.51E-07	6.46E-09	2.93E-08	2.61E-10	0.00E+00
Sn121m	9.13E-06	3.38E+05	5.01E-05	1.85E+06	3.85E-07	1.42E+04	0.00E+00	0.00E+00	1.76E-09	2.48E-07	1.36E-06	1.04E-08	0.00E+00
Sn126	3.62E-07	1.34E+04	4.13E-06	1.53E+05	1.45E-08	5.37E+02	0.00E+00	0.00E+00	2.69E-08	1.50E-07	1.71E-06	6.01E-09	0.00E+00
Sb125	5.61E-05	2.08E+06	0	0.00E+00	3.56E-06	1.32E+05	0.00E+00	0.00E+00	3.30E-09	2.85E-06	0.00E+00	1.81E-07	0.00E+00
Sb126	5.06E-08	1.87E+03	5.79E-07	2.14E+04	2.03E-09	7.51E+01	0.00E+00	0.00E+00	3.17E-09	2.47E-09	2.83E-08	9.92E-11	0.00E+00
Sb126m	3.62E-07	1.34E+04	4.13E-06	1.53E+05	1.45E-08	5.37E+02	0.00E+00	0.00E+00	4.69E-08	2.62E-07	2.99E-06	1.05E-08	0.00E+00
Te125m	1.37E-05	5.07E+05	2.38E-16	8.81E-06	8.68E-07	3.21E+04	0.00E+00	0.00E+00	1.97E-09	4.16E-07	7.23E-18	2.64E-08	0.00E+00
Cs134	1.12E-05	4.14E+05	1.86E-08	6.88E+02	8.31E-07	3.07E+04	0.00E+00	0.00E+00	1.25E-08	2.16E-06	3.58E-09	1.60E-07	0.00E+00
Cs135	1.88E-07	6.96E+03	2.15E-06	7.96E+04	7.56E-09	2.80E+02	0.00E+00	0.00E+00	1.23E-09	3.56E-09	4.08E-08	1.43E-10	0.00E+00
Sc137	1.10E-01	4.07E+09	6.30E-02	2.33E+09	1.47E-02	5.44E+08	0.00E+00	0.00E+00	8.63E-09	1.46E-02	8.38E-03	1.96E-03	0.00E+00
Ba137m	1.03E-01	3.81E+09	5.32E-02	1.97E+09	1.39E-02	5.14E+08	0.00E+00	0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pm147	4.25E-03	1.57E+08	4.68E-05	1.73E+06	2.74E-04	1.01E+07	0.00E+00	0.00E+00	1.01E-07	6.62E-03	7.29E-05	4.27E-04	0.00E+00
Sm151	5.64E-04	2.09E+07	5.22E-03	1.93E+08	2.30E-05	8.51E+05	0.00E+00	0.00E+00	8.10E-09	7.04E-05	6.52E-04	2.87E-06	0.00E+00
Eu152	4.26E-07	1.58E+04	1.06E-06	3.92E+04	1.90E-08	7.03E+02	0.00E+00	0.00E+00	5.97E-08	3.92E-07	9.76E-07	1.75E-08	0.00E+00
Eu154	4.30E-05	1.59E+06	1.56E-04	5.77E+06	1.87E-06	6.92E+04	0.00E+00	0.00E+00	7.73E-08	5.12E-05	1.86E-04	2.23E-06	0.00E+00
Eu155	2.41E-05	8.92E+05	1.27E-08	4.70E+02	1.97E-06	7.29E+04	0.00E+00	0.00E+00	1.12E-08	4.16E-06	2.19E-09	3.40E-07	0.00E+00
Bi214	1.05E-15	3.89E-05	1.92E-10	7.10E+00	5.75E-11	2.13E+00	6.05E-12	2.24E-01	1.46E-04	2.36E-12	4.32E-07	1.29E-07	1.36E-08
Pb214	1.05E-15	3.89E-05	1.92E-10	7.10E+00	5.75E-11	2.13E+00	6.05E-12	2.24E-01	2.11E-09	3.42E-17	6.25E-12	1.87E-12	1.97E-13
Ra226	1.06E-15	3.92E-05	1.93E-10	7.14E+00	5.76E-11	2.13E+00	6.05E-12	2.24E-01	2.32E-06	3.79E-14	6.90E-09	2.06E-09	2.16E-10

Isotope	Crib Inventory 216-Z-20		Ditch Inventory 216-U-14		Crib Inventory 216-U-16		Crib Inventory 216-U-17		Dose Factor Sv/Bq	Dose (Sv/m ³)			
	Cl	Bq	Cl	Bq	Cl	Bq	Cl	Bq		Z-20	U-14	U-16	U-17
U233	2.92E-12	1.08E-01	6.39E-02	2.36E+09	6.63E-13	2.45E-02	1.51E-16	5.59E-06	3.66E-05	1.65E-09	3.61E+01	3.74E-10	8.52E-14
U234	2.63E-07	9.73E+03		0.00E+00		0.00E+00		0.00E+00	3.58E-05	1.45E-04	0.00E+00	0.00E+00	0.00E+00
U235	1.01E-08	3.74E+02	6.30E-13	2.33E-02	4.44E-10	1.64E+01	1.46E-13	5.40E-03	1.97E-06	3.07E-07	1.91E-11	1.35E-08	4.43E-12
Pu238	2.30E-02	8.51E+08		0.00E+00		0.00E+00	1.14E-03	4.22E+07	1.06E-04	3.76E+01	0.00E+00	0.00E+00	1.86E+00
Pu239	1.03E+00	3.81E+10	8.00E-05	2.96E+06	4.50E-02	1.67E+09	1.48E-05	5.48E+05	1.16E-04	1.84E+03	1.43E-01	8.05E+01	2.65E-02
Pu240	1.03E+00	3.81E+10	8.00E-05	2.96E+06	4.50E-02	1.67E+09	1.48E-05	5.48E+05	1.16E-04	1.84E+03	1.43E-01	8.05E+01	2.65E-02
Pu241	2.17E+00	8.03E+10		0.00E+00		0.00E+00		0.00E+00	2.23E-06	7.46E+01	0.00E+00	0.00E+00	0.00E+00
Am241	1.04E+00	3.85E+10	2.88E-04	1.07E+07	2.31E-01	8.55E+09	7.85E-05	2.90E+06	1.20E-04	1.92E+03	5.33E-01	4.27E+02	1.45E-01
Am242m	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00	1.15E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am243	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00	1.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm242	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00	4.67E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm244	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00	6.70E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ULD										5.72E+03	3.69E+01	5.88E+02	2.06E+00

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APPENDIX B
INFORMATION VALIDATION FORM

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Information Validation Form

Tracking # RDG.2

Name of Originator 1 Ronald D. Graves	Organization or Team 2 WSRC FSAR TEAM	Date 3 4/29/96
<p>Statement of Problem: This accident involves the inadvertent excavation of a crib, ditch, or pond. The main uncertainties in the analysis is the material at risk (MAR) and the concentration of radionuclides and nonradiological chemical in the excavated soil.</p> <p>(1) It is assumed that the quantity of material excavated is bounded by an excavation by a backhoe that excavates 1 bucket, approximately 0.28 m³ every 2 minutes (10 m³/hr. is used in the analysis). The excavation last one 12 hour shift.</p> <p>(2) The radiological concentration in the excavated soil is bounded the radiological concentration in BY Cribs as represented by soils under 200-BP-1 crib.</p> <p>(3) It is assumed that the toxilogical source term is bounded by the summary of controlling inorganic and organic compound found in Hanford soils (See attachment 1) provided by Environmental Engineering.</p> <p>(3) The density of the excavated soils is 1.6 g/cm³.</p>		
4 Alternatives		Consequences to Alternatives
5		6
Decision Reached		Basis for Decision
7		8
Date Requested 9	Sent To 10	Date Requested By 5/6/96
<p>Response #1 Responses to the statement problems are: 1) Agree. 2) The 200-BP-1 crib doesn't belong to TWRS, use the 216-Z- 20 crib. Use a volume of 2400 cubic meters and an over-burden of 60,000 cubic meters. 3) Was not able to find different data, use attachment 1 as the bounding case. 4) Use a density of 1.4 grams per cubic centimeter.</p>		
12 Response #2		
13		
Attachments (List)		References (List)
14		15

Responder #1 Name and Signature		Responder #2 Name and Signature
16 Lankford Ruffin <i>S. Ruffin</i> 5-9-96		17
POC:	Filed:	Routed:
Further Action Required (i.e., RML, Senior Management Attention, etc.)		
18		

Attachment 1

Analyte	Average Concentration (p/b)	Maximum Concentration (p/b)
Mercury	1.21	20
Lead	28	319
Chromium	54	380
Cyanide	51	246
Hydrazine	59	88
Carbon tetrachloride	4,352	8,700
Cyclohexane	670	900
Tetrachlorethane	410	1,200
Phenol	37	80

APPENDIX C
GENERAL DESCRIPTION OF CRIB 216-Z-20

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UNIT NAME: 216-Z-20
UNIT TYPE: Crib
WASTE CATEGORY: Low-Level Waste

OPERABLE UNIT: 200-UP-2
SMU: Yes
UNIT STATUS: Active
START DATE: September 24, 1981

COORDINATES: N37830 W76523, N39280 W76130 (centerline)

WASTE TYPES AND AMOUNTS: The site has been receiving cooling water, steam condensate, storm sewer, building drains, HEDL RADTU cooling water, and chemical drains waste from the 234-5Z Building; cooling water steam condensate and laboratory drains from the 231-Z Building; and miscellaneous drains waste from 291-Z, 232-Z, and 236-Z buildings. The unit will also receive wastes from 2736-Z Building, which is now under construction (Project 8-246).

SITE DESCRIPTION: The structure has varied depths of 9 to 29 ft below ground surface. Three 6-in. perforated PVC distribution pipes are located 3.5 ft apart along the length to within 1 ft of the south end, where the pipes are capped. A set of 3 risers stem from the distribution pipes, rising to 1.5 ft above grade at 4 locations throughout the unit. ~57,150 cu ft of 0.5-in. to 2.5-in. gravel fill is backfilled over with soil. The side slope is 1:2.

KNOWN RELEASES: On February 2, 1986, a release of 0.02 uCi/L alpha (amount unknown) occurred to this unit from 234-5Z Building tank leakage. On December 20, 1984, a release of 107 uCi/L unknown radionuclides (amount unknown) occurred to this unit from 234-5Z Building tank leakage. This unit received a spill of 7,594 lb of nitric acid on September 26, 1984.

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APPENDIX D
CUMULATIVE DECAYED INVENTORY REPORT INFORMATION

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CUMULATIVE DECAYED INVENTORY REPORT

05/06/96

13:11

Site # 176: 216-Z-20 CRIB
 Active from 09/24/81 to 12/31/94
 Cumulative Waste Volume 4.45E+09 Liters
 Radionuclides decayed to 12/31/94

	Isotope	Half-life	Curies
1.	Co-60	5.27 Years	<2.98E-03
2.	Se-79	6.5E+4 Years	1.63E-07
3.	Sr-90	29.12 Years	9.22E-02
4.	Y-90	65 Hours	<8.86E-02
5.	Zr-93	5E+6 Years	2.11E-06
6.	Tc-99	2.13E+5 Years	9.39E-06
7.	Ru-106	368 Days	<5.16E-06
8.	Rh-106	30 Seconds	<5.16E-06
9.	Pd-107	7E+6 Years	2.77E-08
10.	Cd-113M	5.1 Years	9.29E-10
11.	Sn-121M	27.5 Hours	9.13E-06
12.	Sn-126	70 Minutes	3.62E-07
13.	Sb-125	2.8 Years	5.61E-05
14.	Sb-126	9 Hours	5.06E-08
15.	Sb-126M	19 Minutes	3.62E-07
16.	Te-125M	58 Days	1.37E-05
17.	Cs-134	2.1 Years	1.12E-05
18.	Cs-135	2.9E+6 Years	1.88E-07
19.	Cs-137	30 Years	1.10E-01
20.	Ba-137M	2.6 Minutes	<1.03E-01
21.	Pm-147	2.6 Years	4.25E-03
22.	Sm-151	70 Years	5.64E-04
23.	Eu-152	13.3 Years	4.26E-07
24.	Eu-154	8.8 Years	4.30E-05
25.	Eu-155	4.96 Years	2.41E-05
26.	B1-214	19.9 Minutes	1.05E-15
27.	Pb-214	26.8 Minutes	1.05E-15
28.	Ra-226	1,600 Years	1.06E-15
29.	U-233	1.62E+5 Years	2.92E-12
30.	U-234	2.45E+5 Years	2.63E-07
31.	U-235	7.04E+8 Years	1.01E-08
32.	Pu-238	87.8 Years	2.30E-02
33.	Pu-239/40	24,131 Years*	2.06E+00
34.	Pu-241	14.4 Years	2.17E+00
35.	Am-241	432 Years	1.04E+00
36.	Total α	n/a	2.25E+00
37.	Total β	n/a	4.15E-01

* The half-life shown for Total Uranium is the half-life of U-238. The half-life shown for mixed Plutonium-239/40 is the half-life of Pu-239.

+^ [&100^] (10U^] (s0p12.00h10.0v0s0b3T^ [&a12L^ [&16D

05/06/96

CUMULATIVE DECAYED INVENTORY REPORT

13:10

Site # 157: 216-U-16 CR1B
 Active from 09/01/84 to 02/28/85
 Cumulative Waste Volume 4.09E+08 Liters
 Radionuclides decayed to 12/31/94

	Isotope	HalfLife	Curies
	-----	-----	-----
1.	Se-79	6.5E+4 Years	<6.56E-09
2.	Sr-90	29.12 Years	<8.17E-03
3.	Y-90	65 Hours	<8.18E-03
4.	Zr-93	5E+6 Years	<8.48E-08
5.	Tc-99	2.13E+5 Years	<3.77E-07
6.	Ru-106	368 Days	<5.16E-07
7.	Rh-106	30 Seconds	<5.16E-07
8.	Pd-107	7E+6 Years	<1.11E-09
9.	Ag-110	24.5 Seconds	<5.71E-15
10.	Ag-110M	270 Days	<4.30E-13
11.	Cd-113M	5.1 Years	<3.76E-11
12.	Sn-119M	245 Days	<5.71E-13
13.	Sn-121M	27.5 Hours	<3.85E-07
14.	Sn-126	70 Minutes	<1.45E-08
15.	Sb-125	2.8 Years	<3.56E-06
16.	Sb-126	9 Hours	<2.03E-09
17.	Sb-126M	19 Minutes	<1.45E-08
18.	Te-125M	58 Days	<8.68E-07
19.	Te-127	9.3 Hours	<3.10E-18
20.	Te-127M	113 Days	<3.16E-18
21.	Cs-134	2.1 Years	<8.31E-07
22.	Cs-135	2.9E+6 Years	<7.56E-09
23.	Cs-137	30 Years	1.47E-02
24.	Ba-137M	2.6 Minutes	1.39E-02
25.	Ce-144	284 Days	<2.27E-07
26.	Pr-144	17 Minutes	<3.24E-09
27.	Pm-147	2.6 Years	<2.74E-04
28.	Sm-151	70 Years	<2.30E-05
29.	Eu-152	13.3 Years	<1.90E-08
30.	Eu-154	8.8 Years	<1.87E-06
31.	Eu-155	4.96 Years	<1.97E-06
32.	Bi-212	60.55 Minutes	1.37E-18
33.	Bi-214	19.9 Minutes	5.75E-11
34.	Pb-212	10.64 Hours	1.37E-18
35.	Pb-214	26.8 Minutes	5.75E-11
36.	Po-216	0.15 Seconds	1.37E-18
37.	Rn-220	55.6 Seconds	1.37E-18
38.	Ra-224	3.66 Days	1.37E-18
39.	Ra-226	1,600 Years	5.76E-11
40.	Ac-228	6.13 Hours	1.23E-17
41.	Th-232	1.41E+10 Years	1.23E-15
42.	U (Gross)	4.5E+9 Years*	5.91E-03
43.	U-233	1.62E+5 Years	6.63E-13
44.	U-235	7.04E+8 Years	4.44E-10
45.	Pu-239/40	24,131 Years*	9.02E-02

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CUMULATIVE DECAYED INVENTORY REPORT

Page 2

Site # 157: 216-U-16 CRIB

	Isotope	Half-life	Curies
	-----	-----	-----
46.	Am-241	432 Years	<2.31E-01
47.	Total α	n/a	7.39E-03
48.	Total β	n/a	5.15E-02

* The half-life shown for Total Uranium is the half-life of U-238. The half-life shown for mixed Plutonium-239/40 is the half-life of Pu-239.

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CUMULATIVE DECAYED INVENTORY REPORT

13:10

Site # 158: 216-U-17 CRIB
 Active from 01/31/88 to 12/31/94
 Cumulative Waste Volume 5.90E+06 Liters
 Radionuclides decayed to 12/31/94

	Isotope	Half-life	Curies
	-----	-----	-----
1.	H-3	12.3 Years	6.37E+01
2.	Sr-90	29.12 Years	5.70E-06
3.	Tc-99	2.13E+5 Years	1.26E-03
4.	Bi-214	19.9 Minutes	6.05E-12
5.	Pb-214	26.8 Minutes	6.05E-12
6.	Ra-226	1,600 Years	6.05E-12
7.	Ac-228	6.13 Hours	2.24E-18
8.	Th-232	1.41E+10 Years	1.29E-16
9.	U (Gross)	4.5E+9 Years*	1.14E-03
10.	U-233	1.62E+5 Years	1.51E-16
11.	U-235	7.04E+8 Years	1.46E-13
12.	Pu-239/40	24,131 Years*	<2.96E-05
13.	Am-241	432 Years	7.85E-05
14.	Total α	n/a	5.77E-04
15.	Total β	n/a	6.83E-03

* The half-life shown for Total Uranium is the half-life of U-238. The half-life shown for mixed Plutonium-239/40 is the half-life of Pu-239.

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CUMULATIVE DECAYED INVENTORY REPORT

13:09

Site # 155: 216-U-14 DITCH (In CWM, 216-U-10)
Active from 03/01/52 to 12/31/94
Cumulative Waste Volume 1.22E+09 Liters
Radionuclides decayed to 12/31/94

	Isotope	Half-life	Curies
1.	H-3	12.3 Years	2.60E+00
2.	Co-60	5.27 Years	<4.96E-04
3.	Se-79	6.5E+4 Years	1.87E-06
4.	Sr-90	29.12 Years	5.88E-02
5.	Y-90	65 Hours	<5.77E-02
6.	Zr-93	~5E+6 Years	2.41E-05
7.	Tc-99	2.13E+5 Years	1.72E-01
8.	Ru-106	368 Days	4.44E-12
9.	Rh-106	30 Seconds	4.44E-12
10.	Pd-107	7E+6 Years	3.16E-07
11.	Cd-113M	5.1 Years	4.22E-09
12.	Sn-121M	27.5 Hours	5.01E-05
13.	Sn-126	70 Minutes	4.13E-06
14.	Sb-126	9 Hours	5.79E-07
15.	Sb-126M	19 Minutes	4.13E-06
16.	Te-125M	58 Days	2.38E-16
17.	Cs-134	2.1 Years	1.86E-08
18.	Cs-135	2.9E+6 Years	2.15E-06
19.	Cs-137	30 Years	6.30E-02
20.	Ba-137M	2.6 Minutes	5.32E-02
21.	Ce-144	284 Days	1.51E-15
22.	Pr-144	17 Minutes	2.16E-17
23.	Pm-147	2.6 Years	4.68E-05
24.	Sm-151	70 Years	5.22E-03
25.	Eu-152	13.3 Years	1.06E-06
26.	Eu-154	8.8 Years	1.56E-04
27.	Eu-155	4.96 Years	1.27E-08
28.	Tl-208	3.1 Minutes	2.92E-18
29.	Bi-212	60.55 Minutes	8.11E-18
30.	Bi-214	19.9 Minutes	1.92E-10
31.	Pb-212	10.64 Hours	8.11E-18
32.	Pb-214	26.8 Minutes	1.92E-10
33.	Po-212	3.1E-7 Seconds	5.20E-18
34.	Po-216	0.15 Seconds	8.11E-18
35.	Rn-220	55.6 Seconds	8.11E-18
36.	Ra-224	3.66 Days	8.11E-18
37.	Ra-226	1,600 Years	1.93E-10
38.	Ac-228	6.13 Hours	7.27E-17
39.	Th-232	1.41E+10 Years	4.12E-15
40.	U (Gross)	4.5E+9 Years*	6.39E-02
41.	U-233	1.62E+5 Years	6.60E-16
42.	U-235	7.04E+8 Years	6.30E-13
43.	Pu-239/40	24,131 Years*	1.60E-04
44.	Am-241	432 Years	2.88E-04
45.	Total α	n/a	3.11E-02

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CUMULATIVE DECAYED INVENTORY REPORT

Page 2

Site # 155: 216-U-14 DITCH (In CWM, 216-U-10)

Isotope	Half-life	Curies
46. Total β	n/a	2.45E-01

- The half-life shown for Total Uranium is the half-life of U-238. The half-life shown for mixed Plutonium-239/40 is the half-life of Pu-239.

APPENDIX E

HAZARDOUS ORGANIC AND INORGANIC SUBSTANCES ANTICIPATED IN HANFORD SOILS

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WHC-SD-EN-SAO-016, REV 0-C
VOLUME 2Table 2. Hazardous Organic and Inorganic Substances
Anticipated in Hanford Soils.

Analyte	Average concentration p/b	Maximum concentration p/b
Mercury	1.28	20
Lead	28	319
Chromium	54	380
Cyanide	51	246
Hydrazine	59	88
Carbon tetrachloride	4,352	8,700
Cyclohexane	670	900
Tetrachloroethane	410	1,200
Phenol	37	80

For most of the shallow/near surface sampling activities, the potential hazard inventory consists of the material sample volume that in most cases is less than one L. The methods (e.g., hand tools) used to obtain these samples generally do not provide sufficient energy for generating a source term to uninjured individuals.

Excluding mechanized excavation sampling, mechanisms for generating a source term are not available in the shallow/near surface sampling activities. In the case of mechanized soil sampling, where there are relatively large volumes of dirt [$>1 \text{ m}^3$ (0.3 ft^3)], potentially contaminated soil can be brought to the surface, and exposure to wind or other dispersal mechanisms can occur. Any mechanized soil gas sampling could potentially result in small concentrations of CCl_4 vapors being released at the work site. The worst case concentrations of 25,000 p/m (under static well conditions) CCl_4 detected has been at the 216-Z Grib sites in the 200 West Area.

The shallow/near surface sampling activities can be segregated into five categories:

1. Nonintrusive/nonaccumulative (soil gas sampling, radiological surveys, etc.). Based on the lack of a material hazard, the activities fitting this description are excluded from safety review requirements.
2. Intrusive/accumulative sampling (mechanized or nonmechanized), where no contaminants are anticipated. Based on the lack of a material hazard, the activities fitting this description are excluded from safety review requirements.
3. Nonmechanized intrusive/accumulative sampling where the small volumes (measured in L) of accumulated material exceed the release criteria provided in WHC-CM-4-10, Section 11.4.5.

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APPENDIX F
PEER REVIEW AND HEDOP REVIEW CHECKLISTS

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CHECKLIST FOR PEER REVIEW

Document Reviewed: "Excavations in Hanford Ponds, Cribbs, or Ditches," WHC-SD-WM-CN-053, Rev. 1, 9/96, by Grant Ryan.

Scope of Review: Entire Document.

Yes	No	NA	
☒	☐	☐	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐	Problem completely defined.
☒	☐	☐	Accident scenarios developed in a clear and logical manner.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☐	☐	☒	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☒	☐	☐	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☐	☐	☒	Software input correct and consistent with document reviewed.
☐	☐	☒	Software output consistent with input and with results reported in document reviewed.
☒	☐	☐	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.
☐	☐	☒	Format consistent with appropriate NRC Regulatory Guide or other standards
☐	☐	☒	Review calculations, comments, and/or notes are attached.
☒	☐	☐	Document approved.

Anthony V. Savino *Av Savino*
 Reviewer (Printed Name and Signature)

9/20/96
 Date

HEDOP REVIEW CHECKLIST
for
Radiological and Nonradiological Release Calculations

Document reviewed (include title or description of calculation, document number, author, and date, as applicable):

WHC-SD-WM-CN-053, Rev. 1, *Excavations in Hanford Ponds, Cribs, or Ditches.*

Submitted by: Grant W. Ryan

Date Submitted: 9/19/96

Scope of Review: Radiological Dose and Toxicological Exposure Calculations.

YES NO* N/A

☐	☐	☐	1. A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
☐	☐	☐	2. Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
☐	☐	☐	3. HEDOP-approved code(s) were used.
☐	☐	☐	4. Receptor locations were selected according to HEDOP recommendations.
☐	☐	☐	5. All applicable environmental pathways and code options were included and are appropriate for the calculations.
☐	☐	☐	6. Hanford site data were used.
☐	☐	☐	7. Model adjustments external to the computer program were justified and performed correctly.
☐	☐	☐	8. The analysis is consistent with HEDOP recommendations.
☐	☐	☐	9. Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
☐	☐		10. Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.

* All "NO" responses must be explained and use of nonstandard methods justified.

A. V. Savino / Anthony J. Savino

9/20/96

HEDOP-Approved Reviewer (Printed Name and Signature)

Date

COMMENTS (add additional signed and dated pages if necessary):