Tank S-109 Long-Term Human Health Risk Calculations

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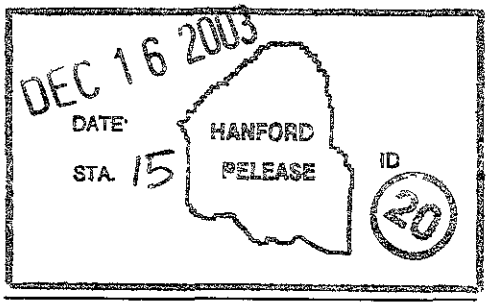
Key Words S-109 Risk Calculation (Calc. No. S-109 F&R-001) in support of F&R Document.

Abstract This document provides Tank S-109 long-term human risks calculations, in support of Functions and Requirements document (RPP-18812) as required by milestone M-45-00 of the Hanford Federal Facility Agreement and Consent Order.



Release Approval Date

Release Stamp

Approved For Public Release

	Calculation Cover Sheet	RPP-19136, Rev 0 Page 1

Calculation No **S-109F&R-001**	Calculation Title **Tank S-109 Long-Term Human Health Risk Calculations**
Revision No **0**	
Project No **CHG 21692/Rel 2/01.01**	Project Title **Tank S-109 Waste Retrieval Functions and Requirements**

Original and Revised Calculation/Analysis Approval

	Rev. 0 Name/Signature/Date	Rev. 1 Name/Signature/Date	Rev. _____ Name/Signature/Date
Originator	Doug Evans 12/9/2003 Doug Evans		
Checked by	Dwayne Crumpler 12/9/2003 Dwayne Crumpler		
Approved by			
Other			

Record of Revision

Revision	Reason for Revision

Affected Documents

Document Number	Document Title	Revision Number
RPP-18812	Tank S-109 Waste Retrieval Functions and Requirements	Rev 0

Calculation Sheet		
Calculation No S-109F&R-001	Rev 0	Title **Tank S-109 Long-Term Human Health Risk Calculations**
Project No CHG 21692/Rel 2/01 01		Title **Tank S-109 Waste Retrieval Functions and Requirements**
Originated by Date 12/9/2003 Doug Evans		Checked by Date 12/9/2003 Dwayne Crumpler

1 0 INTRODUCTION

This calculation was performed to provide a screening-level assessment of long-term human health risk associated with potential leakage that could occur during waste retrieval operations for tank S-109 This calculation supports the development of tank S-109 waste retrieval functions and requirements as documented in RPP-18812

Risks associated with current waste and potential residual waste in tank S-109, as well as risk associated with other S farm tanks, were not of interest and were not evaluated

2 0 CALCULATION METHODOLOGY AND ASSUMPTIONS

The calculation methodology and assumptions followed guidance in RPP-14284 as summarized in the following

- Focuses on potential long-term groundwater pathway human health risk at the tank farm fenceline
- Uses incremental lifetime cancer risk (ILCR) as the risk metric
- Provides ILCR for one indicator contaminant
- Derives effects of contaminant release and transport from previous studies, involves no new contaminant transport analysis
- Uses the best available existing data and information to the maximum extent possible, with little new data generated for the creation of the document

Risk was calculated using the following equation

$$R_i = I_i \times T_i \times d_i \qquad \text{(Equation 1)}$$

Where

i = indicator contaminant
R_i = risk (ILCR)
I_i = inventory (Ci)
T_i = transport transfer function (pCi/L per Ci)
d_i = health effects conversion factor (ILCR per pCi/L)

3 0 CALCULATION

All calculations were performed on an Excel spreadsheet Calculation summary descriptions are provided in the following subsections Calculation details are shown on the attached spreadsheet printouts

Calculation No	Rev	Title
S-109F&R-001	0	**Tank S-109 Long-Term Human Health Risk Calculations**

Project No	Title
CHG 21692/Rel 2/01 01	**Tank S-109 Waste Retrieval Functions and Requirements**

Originated by	Checked by
Date 12/9/2003 Doug Evans	Date 12/9/2003 Dwayne Crumpler

3 1 Indicator Contaminant

Technetium-99 was selected as the tank S-109 indicator contaminant based on a tank-specific screening analysis (see attached Excel calculation spreadsheet) The screening criterion used was the calculated product of the residual waste inventories from DOE/ORP-2003-02 and the ILCR conversion factors from HNF-SD-WM-TI-707

Results indicate technetium-99 would contribute approximately 81% (industrial scenario) to 94% (residential scenario) of the total long-term groundwater pathway ILCR for tank S-109

3 2 Tc-99 Inventory Estimation

Potential tank S-109 retrieval leakage inventory was of interest and was evaluated. Tank S-109 inventories associated with current tank waste and potential residual waste were not of interest and were not evaluated Tank S-109 is classified as a sound tank and has no past leak inventory Inventories for other S farm tanks were not of interest and were not evaluated

The standard inventory data source for retrieval functions and requirements documents (DOE/ORP-2003-02) does not directly provide retrieval leak inventory estimates DOE/ORP-2003-02 (Section 6 4 2) recommends retrieval leak inventories be calculated by assuming the waste concentrations of leaks during retrieval would be the same as the waste concentrations in the final residuals Accordingly, tank S-109 retrieval leak fluid concentrations were assumed to have the same waste composition as the final tank residuals given in Table A 2 of DOE/ORP-2003-02 (see attached Excel calculation spreadsheet)

Table A 2 of DOE/ORP-2003-02 provides different final residual data sets for different assumed retrieval methods For this evaluation the inventory value used was taken from either the Selected Phase Retention or Hanford Tank Waste Operation Simulator (HTWOS) modeling data set, which ever was larger For tank S-109 this was the HTWOS modeling data set (see attached Excel calculation spreadsheet)

The tank S-109 retrieval leak inventory (in Ci) was calculated as the product of the leak fluid concentration and the assumed leak volume (see attached Excel calculation spreadsheet) A leak volume of 8,000 gal was used for informational purposes only

3 3 Transport Transfer Function

Contaminant transport calculations were not performed Rather, per guidance in RPP-14284 the effects of contaminant release and transport were taken from previous studies that are the most relevant to the case being studied For tank S-109, this was the vadose zone field investigation work for Waste Management Area S-SX (RPP-7884)

RPP-7884 provides data based on analysis of existing S tank farm vadose zone contamination (past leaks) These data are therefore considered an appropriate basis for deriving an ex-tank waste (retrieval leaks, past leaks) transfer function for use with tank S-109 An in-tank waste (residual waste) transfer function was not of interest and was not calculated The ex-tank function was calculated by dividing the reported peak Tc-99 groundwater concentration at the S tank farm fenceline by the reported Tc-99 inventory released at the source (see attached Excel calculation spreadsheet) The transfer function is in units of pCi/L per Ci

3 4 Health Effects Conversion Factors

Health effects conversion factors were taken from tables in HNF-SD-WM-TI-707, Rev 3 Conversion factor units are cancer morbidity risk per unit Tc-99 concentration in groundwater (risk per pCi/L) The exposure scenarios used were industrial and residential (see attached Excel calculation spreadsheet)

4 0 RESULTS

Results were calculated and presented on a plot showing ILCR vs Tc-99 Ci (see attached Excel calculation spreadsheet) Two sloped lines representing the industrial and residential scenarios were plotted The lines were constructed by using Equation 1 and extrapolating the transport transfer function over a range of Tc-99 inventory values for the industrial and residential scenarios A vertical dashed line was then added for the estimated Tc-99 inventory associated with a potential tank S-109 retrieval leak

5 0 REFERENCES

DOE/ORP-2003-02, 2003, *Inventory and Source Term Data Package*, Rev 0, U S Department of Energy, Richland, Washington

HNF-SD-WM-TI-707, 2003, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment*, Rev 3, U S Department of Energy, Richland, Washington

RPP-7884, 2002, *Field Investigation Report for Waste Management Area S-SX*, Rev 0, CH2M HILL Hanford Group, Inc , Richland, Washington

RPP-14284, 2003, *Contents of Risk Assessments to Support the Retrieval and Closure of Tanks for the Washington State Department of Ecology*, Rev 0, CH2M HILL Hanford Group, Inc , Richland, Washington

RPP-18812, 2003, *Tank S-109 Waste Retrieval Functions and Requirements*, Rev 0, CH2M HILL Hanford Group, Inc , Richland, Washington

Indicator Contaminant Screening Analysis

Radionuclide Groundwater Unit Risk Factors (risk per pCi/L)

Nuclide	HSRAM Industrial[a]	HSRAM Residential[b]	HSRAM Agricultural[c]
C-14	7.77E-09	5.61E-08	2.39E-07
Se-79	3.66E-08	1.88E-07	4.10E-07
Tc-99	1.38E-08	3.36E-07	4.72E-07
I-129	7.42E-07	3.84E-06	1.96E-05

[a]Source = HNF-SD-WM-TI-707, Rev. 3, Table 22, column labeled "20-Year Total"
[b]Source = HNF-SD-WM-TI-707, Rev. 3, Table 26, column labeled "Inland Resident"
[c]Source = HNF-SD-WM-TI-707, Rev. 3, Table 28, column labeled "Inland Resident"

Carcinogenic Chemical Groundwater Unit Risk Factors (risk per mg/L)

Chemical	HSRAM Industrial[a]	HSRAM Residential[b]	HSRAM Agricultural[c]
Arsenic	4.31E-01	7.25E-01	7.26E-01
Beryllium	2.37E-01	3.91E-01	3.91E-01
Cadmium	1.78E-01	2.93E-01	2.93E-01
Cobalt	2.77E-01	4.56E-01	4.56E-01
Chromium VI	2.70E-05	6.00E-05	6.00E-05

[a]Source = HNF-SD-WM-TI-707, Rev. 3, Table 23
[b]Source = HNF-SD-WM-TI-707, Rev. 3, Table 27, column labeled "Well Water Only"
[c]Source = HNF-SD-WM-TI-707, Rev. 3, Table 29, column labeled "Well Water Only"

Calculation of Contaminant Specific "Potential ILCR" Values and Relative Contributions to Total "Potential ILCR"

Tank S-109

Contaminant	Inventory in 360 ft³ of Residual Waste[a]		Potential ILCR (URF * Inventory)			Relative Contribution (% of Total Rads + Chems)			Relative Contribution (% of Total Rads)		
	Units	C-103	Industrial	Residential	Agricultural	Industrial	Residential	Agricultural	Industrial	Residential	Agricultural
C-14	pCi	9.99E+10	7.76E+02	5.61E+03	2.39E+04	8.94	3.26	8.82	9.53	3.28	8.86
Se-79	pCi	1.34E+09	4.88E+01	2.51E+02	5.48E+02	0.56	0.15	0.20	0.60	0.15	0.20
Tc-99	pCi	4.81E+11	6.63E+03	1.62E+05	2.27E+05	76.40	93.84	83.83	81.44	94.49	84.20
I-129	pCi	9.25E+08	6.87E+02	3.55E+03	1.81E+04	7.91	2.06	6.70	8.43	2.08	6.73
Arsenic	mg	NR	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA
Beryllium	mg	NR	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA
Cadmium	mg	NR	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA
Cobalt	mg	NR	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA	NA
Chromium VI	mg	1.99E+07	5.37E+02	1.19E+03	1.19E+03	6.19	0.69	0.44	NA	NA	NA
Total			8.68E+03	1.72E+05	2.71E+05	100.00	100.00	100.00	100.00	100.00	100.00

[a]Source = DOE/ORP-2003-02, Table A.2, value shown is from either the Selected Phase Retention or HTWOS Modeling data set, which ever is larger

References

HNF-SD-WM-TI-707, 2003, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment*, Rev. 3, U.S. Department of Energy, Richland, Washington, July 2003.
DOE/ORP-2003-02, 2003, *Inventory and Source Term Data Package*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington, April 2003.

Modified from Table A.2, DOE/RL-2003-02, *Inventory and Source Term Data Package* (April 2003)

SUMMARY OF FINAL INVENTORY ESTIMATES
Based on 10.2 kL (360 ft3) remaining (30 ft3 in 200 series tanks)

Tank	Current Tank Radionuclide Inventory Based on BBI (Ci)	Current Tank Chemical Inventory Based on BBI (kg)	Estimate at Closure Based on selected phase Retention						
			Total Ci	Total kg	129I	14C	79Se	99Tc	Cr
241-S-109	2.45E+05	2.88E+06	2.17E+04	7.81E+03	3.18E-04	2.37E-02	5.04E-04	1.66E-01	5.97E+01

Tank	Current Tank Radionuclide Inventory Based on BBI (Ci)	Current Tank Chemical Inventory Based on BBI (kg)	Estimate at Closure Based on HTWOS Modeling						
			Total Ci	Total kg	129I	14C	79Se	99Tc	Cr
241-S-109	2.45E+05	2.88E+06	3.75E+02	4.41E+03	9.25E-04	9.99E-02	1.34E-03	4.81E-01	8.24E+00

Retrieval Leakage Inventory

The tank S-109 Tc-99 retrieval leak inventory is developed below based on the data and recommendations in DOE/ORP-2003-02 by assuming the waste composition of leaks during retrieval would be the same as the waste concentrations in the final residuals. The waste concentrations in final residuals are taken from either the Selected Phase Retention or Hanford Tank Waste Operation Simulator (HTWOS) modeling data set from Table A.2 of DOE/ORP-2003-02, which ever is larger. The tank S-109 Tc-99 retrieval leak inventory is then calculated as the product of the concentration and the assumed leak volume (8,000 gal for purposes of this evaluation).

Tank	Tc-99 Residual Waste Inventory in 360 ft³ (2,700 gal) Residual Waste (Ci)[a]		Tc-99 Concentration in Retrieval Leakage Fluid (Ci/gal)[b]	Assumed Retrieval Leak Volume (gal)	Tc-99 Inventory in Retrieval Leakage (Ci)
	Selected Phase Retention	HTWOS Modeling			
241-S-109	1.66E-01	4.81E-01	1.78E-04	8.00E+03	1.42E+00

[a]Source = DOE/ORP-2003-02, Table A.2 (different values shown correspond to different retrieval technology assumptions)

[b]Calculated as residual waste inventory (larger of two values shown) divided by residual waste volume

Transport Transfer Function Based on Data From *Field Investigation Report for Waste Management Area S-SX* (RPP-7884)		
Ex-Tank Waste (Past Leaks and Retrieval Leaks) =	3.57E+04	pCi/L per Ci Tc-99
Peak Tc-99 groundwater concentration at fenceline from S-104 past leak (RPP-7884, Table E. 14, cross-sect S-CC') =	1.38E+05	pCi/L
Tc-99 inventory in S-104 past leak (RPP-7884, Table 3.4) =	3.87	Ci
In-Tank Waste (Residual Waste) =	N/A	pCi/L per Ci Tc-99
In-tank transfer function not needed for tank S-109 evaluation		

Data for ILCR vs. Tc-99 Ci Plot

Radionuclide Groundwater Unit Risk Factors From *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (HNF-SD-WM-TI-707)

Nuclide	HSRAM Industrial (Risk per pCi/L)[a]	HSRAM Residential (Risk per pCi/L)[b]
C-14	7.77E-09	5.61E-08
Se-79	3.65E-08	1.88E-07
Tc-99	1.38E-08	3.36E-07
I-129	7.42E-07	3.84E-06

[a]Source = HNF-SD-WM-TI-707, Rev. 3, Table 22, column labeled "20-Year Total"
[b]Source = HNF-SD-WM-TI-707, Rev. 3, Table 26, column labeled "Inland Resident"

	ILCR (Linear extrapolation using above transfer functions)			
Tc-99 Inventory (Ci)	In Tank Industrial	Ex Tank Industrial	In Tank Residential	Ex Tank Residential
0.001	N/A	4.92E-07	N/A	1.20E-05
0.01	N/A	4.92E-06	N/A	1.20E-04
0.1	N/A	4.92E-05	N/A	1.20E-03
1	N/A	4.92E-04	N/A	1.20E-02
10	N/A	4.92E-03	N/A	1.20E-01
100	N/A	4.92E-02	N/A	1.20E+00
1000	N/A	4.92E-01	N/A	1.20E+01

Tank S-109 Tc-99 Ci in 8,000 gal Retrieval Leak from Tank S-109			
	Tc99 Ci	Residential ILCR	Industrial ILCR
	1.42E+00	1.00E-06	
	1.42E+00	1.71E-02	7.01E-04

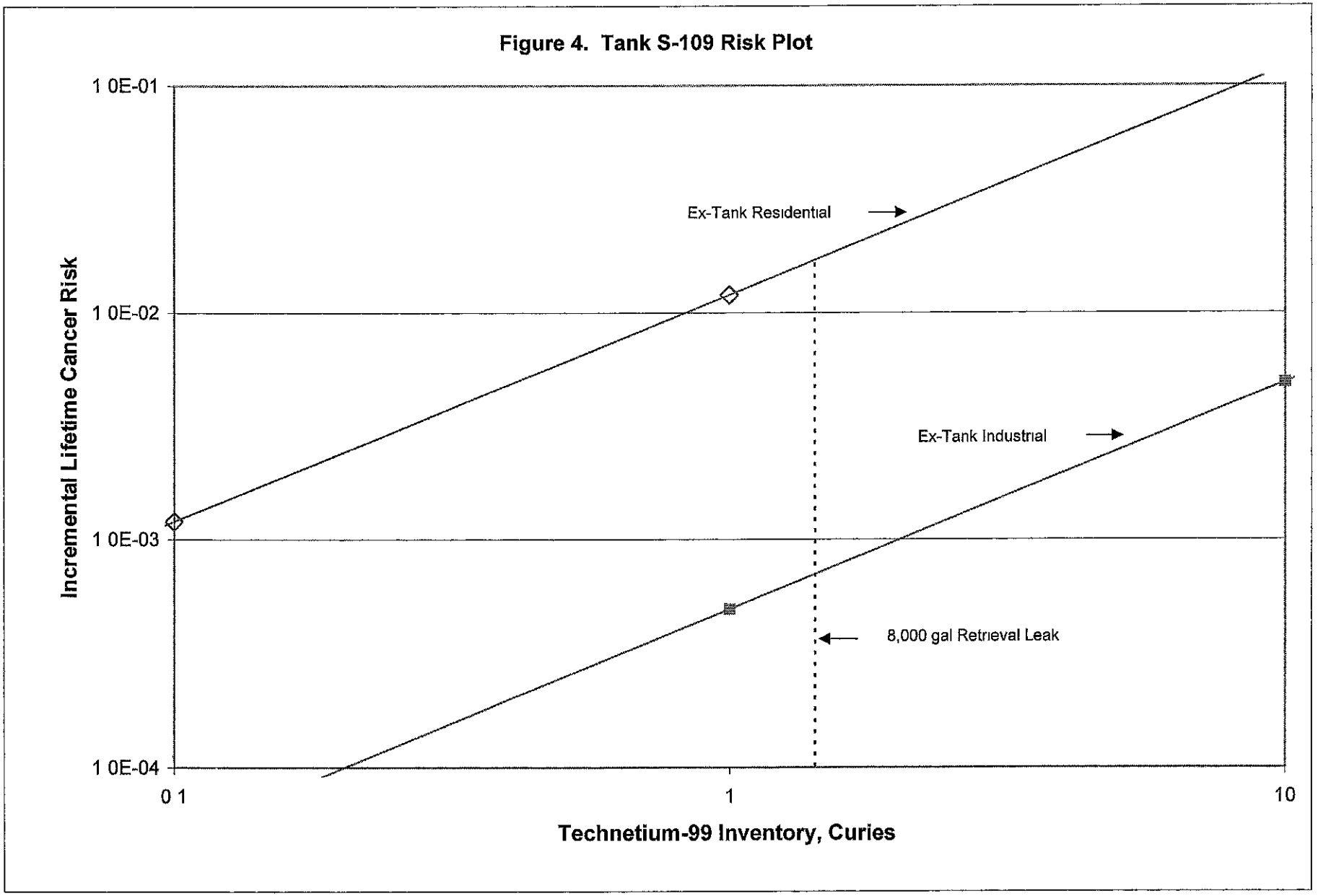


Figure 4. Tank S-109 Risk Plot
1 0E-01
1 0E-02
1 0E-03
1 0E-04
Incremental Lifetime Cancer Risk
Ex-Tank Residential
Ex-Tank Industrial
8,000 gal Retrieval Leak
0 1
1
10
Technetium-99 Inventory, Curies

SPREADSHEET VERIFICATION FORM

1 SVF Page 1C
RPP-19136, Rev 0

2 **Spreadsheet Owner, Organization, MSIN, & Phone No.**	D Evans, CEES (contractor), 946-7111
3. **Spreadsheet File Name, Rev. No./Version No.**	F&R Risk Calcs, S109, Rev2.xls
4. **Location of Spreadsheet** (Identify where the spreadsheet file is located by checking the boxes to the right If "Other," provide description of where it is located)	**Personal Computer** ☐ **CD** ☐ **Network Drive** ☐ **Path** **Other** ☒ **Description** CEES (contractor)
5. **Function and Purpose of Spreadsheet** (Provide a brief description of the purpose of the spreadsheet)	Tank S-109 Long-Term Human Health Risk Calcs
6 **Scope of Verification** (Indicate scope of verification by checking box to right If "Other" provide description of scope)	**All Formulas in Spreadsheet** ☐ **Input Data only** ☐ **Formulas and Input Data** ☒ **Formula Changes** ☐ **Other** ☐ **Description**

7 **Method of Verification** (Provide brief description of the method used to verify the spreadsheet Note multiple methods may be used to verify different parts of a spreadsheet)

- Verified formulas used are correct for intended purpose of calculations
- Performed hand calc to verify values returned by formulas are correct (initial cell only for repeating formulas)
- Verified correct repetition used for repeating formulas
- Verified correct cell references used in cells with input data

8. **Verification Documentation** (Provide description of where verification documentation may be located The verification documentation should include a description of all unique intended formulae together with evidence that the interpretation of the formulae in the spreadsheet is correct and that the spreadsheet returns correct results)	**Attached** ☐	**No of Pages**
	Electronic Information File ☐	**Ref**
	Engineering Document ☐	**Ref**

9 **Approvals**	Name	Signature	Date
Spreadsheet Owner	D Evans	Dana Evans	12/9/2003
Spreadsheet Verifier	D. Crumpler	Dwayne Crumpler	12/9/2003
Owner's Manager			

Figure 4 Subcontractor Calculation Review Checklist.

Page 1 of 1

Subject: RPP-19136

The subject document has been reviewed by the undersigned.
The checker reviewed and verified the following items as applicable

Documents Reviewed TANK S-109 LONG-TERM HUMAN HEALTH RISK CALCULATIONS

Analysis Performed By COLUMBIA ENERGY AND ENVIROMENTAL SERVICES (CEES)

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- CONTRACTOR INTERNAL SPREADSHEET VERIFICATION/REVIEW METHODS ARE CONSISTANT WITH THOSE REQUIRED BY CHEM HILL PROCEDURES.

Checker (printed name, signature, and date) SE CARLSON Steven E Carlson 12/15/2003

Organizational Manager (printed name, signature and date) Warren T. Thompson
W. T. Thompson 12/16/2003