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DISCLAIMER

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CHARACTERIZATION OF RADIONUCLIDES IN PUREX WASTE SLUDGES FROM F-AREA HIGH LEVEL WASTE TANKS (U)

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ATTACHMENTS

LIST OF TABLES

Revision Description

Revision	Date	Description
0	6/2000	Initial consolidation of F-Area Tank Farm sludge waste streams.
1	1/2003	Revalidation of F-Area Tank Farm sludge waste streams & update of radionuclide distributions based on current high level waste tank contents and revised SRS Waste Acceptance Criteria (WAC) 2.02 and 3.17 requirements.
2	6/2005	Revalidation of F-Area Tank Farm sludge waste streams & update of radionuclide distributions based on current high level waste tank contents and revised SRS Waste Acceptance Criteria (WAC) 2.02 and 3.17 requirements.

1.0 Background

Characterization of High Level Waste Sludge by the Liquid Waste Disposition Project (LWDP), formerly known as the Concentration Storage and Transfer (CST) Department, is outlined in WSRC-TR-94-0579, *High Level Waste Sludge Characterization in Support of Low Level Waste Certification* (Reference 1). The sludge characterization is based on a series of scaling factors for known sludge-containing waste tanks. Scaling Factors were previously compiled and compared with available sample data in WSRC-TR-94-0562, *Characterization of Radionuclides in HLW Sludge Based on Isotopic Distribution in Irradiated Assemblies* (Reference 2). Quantification of sludge-contaminated waste and application of the scaling factors has been performed on a case-by-case basis since approval of the methodology by the Waste Characterization Board in 1994.

The Waste Characterization System (WCS) was established in 1996 to consolidate waste characterization information. Inventories and compositions of major sludge constituents are based on tank fill histories. Minor constituent inventories are based on compositions developed during DWPF design. Fill histories for each tank are also contained in the WCS (Reference 3). Subsequent analytical data is incorporated into this database as deemed appropriate. Pu-238 and Am-241 inventories for tanks containing Purex Low Activity Waste (LAW) were adjusted in 1999 (Reference 4).

Further examination of historical tank use data contained in Reference 3, tank contents (i.e. high heat or low heat fractions of either Purex or H-Modified waste) and waste age (both in Reference 2) allowed consolidation of sludge in waste tanks to be considered in Revision 1 of this document.

WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 2.02, *Low Level, Hazardous, Mixed and PCB Waste Characterization Requirements*, Revision 8 (Reference 5), allows for consolidation of waste streams when the following two criteria are met:

1. Performance Assessment (PA) radionuclide scaling factors do not vary from the proposed data set scaling factor by more than a factor of 10, and

2. The fractional activity of the predominant radionuclides (predominant radionuclides being those that make up 10% or greater of the activity) in each data set does not vary by more than a factor of 2 from the fractional activity of the same radionuclide in the proposed data set.

This document contains the characterization methodology for sludge-contaminated waste generated from the F-Area Tank Farm, based on process knowledge and available analytical data. In addition, this document contains an evaluation for consolidation of sludge-contaminated waste from multiple HLW tanks in the F-Area Tank Farm. The scaling factors developed in this document supersede those presented in References 1 and 2, and any other previously-developed radionuclide characterizations for F-Area Tank Farm sludge-contaminated waste.

2.0 Introduction

Sludge-contaminated waste consists of waste contaminated with both insoluble species (the sludge fraction) and entrained supernate. The WCS is based on the assumption that approximately 70% of the weight of what is commonly referred to as sludge is interstitial supernate; the remaining approximately 30% consists of the insoluble species (Reference 1).

Development of a method for characterization of sludge–contaminated waste must consider both fractions. Separate waste cuts may contain sludge and supernate fractions in varying proportions due to the nature of the job generating the waste and the variability in waste handling techniques. Development of a distribution representative of all sludge-contaminated waste cuts must allow for varying fractions of sludge and supernate contamination.

This document will develop a radionuclide distribution in accordance with the methodology outlined in WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 2.02, Revision 8 for the sludge fraction of sludge-contaminated waste generated in the F-Area Tank Farm This distribution was based on the assumption that sludge-contaminated waste from F-Area Tank Farm Waste Tanks could be co-mingled, and the actual contamination present on waste in a series of containers from these tanks will be representative of the mean radionuclide distribution. The original characterization was based primarily on process knowledge and fill histories (Reference 6). A single, comprehensive characterization for supernate has been developed previously (Reference 9).

This document also describes the methodology for application of radionuclide distributions representative of the sludge and supernate fractions of sludge-contaminated waste to individual waste packages.

Most of the waste contaminated with sludge from the F-Area Tank Farm will be categorized as Low Level Waste (LLW) and disposed of in the E-area trenches. The waste does, however, have the potential to be categorized as TRU and/or mixed waste. Quantification of hazardous constituents and determination of whether the waste is classified as mixed is dependent on the amount of sludge present on the waste matrix and the nature of the waste matrix, and will be performed on a case-by-case basis. Quantification of radionuclides present in each waste package will be performed as described in Section 5.0.

The radionuclide distribution developed for LLW contaminated with sludge from the F-Area Tank Farm can also be applied to waste classified as transuranic. [Neither WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 3.06, *E-Area TRU Pads Transuranic Waste Acceptance Criteria*, Revision 11, nor Appendix A:23, *TRU Waste Container Characterization Form (OSR 29-90) Instruction* specifies a methodology for determination of the isotopic distribution in TRU Waste; simply that the methodology be documented.]

3.0 Development of a Radionuclide Distribution for Sludge Fraction of Sludge-Contaminated Waste

The development of the radionuclide distribution in this section is performed per guidance outlined in WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 2.02, Revision 8 (Reference 5).

3.1 Determining the Initial List of Radionuclides

WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 2.02, Revision 8, stipulates that the characterization of each package of waste having a total activity greater than 2 nanocuries/gram must consider the potential presence of any radionuclide that meets any one of three criteria:

1. The radionuclide is identified in WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 3.17, *Low Level Waste Acceptance Criteria*, Revision 9 (Reference 7), as being a Performance Assessment (PA) or Safety Authorization (SA) Basis radionuclide for a specific Treatment, Storage or Disposal (TSD) facility. For purposes of this distribution, we will use those PA and SA radionuclides for the EAV.

2. The radionuclide could be present in the waste with a relative activity greater than 1.0% of the total waste stream activity at the time of the characterization.

3. The radionuclide is a detectable transuranic or a fissile radionuclide.

The above criteria are hereafter referred to as “inclusion criteria.”

Based on the three inclusion criteria and available process knowledge, the following list of 40 radionuclides (Table 3.1) will be considered when developing the radionuclide distribution of waste packages contaminated with sludge from the F-Area Tank Farm.

Table 3.1. Radionuclides Important to Characterization of the Sludge Fraction of Sludge-Contaminated Waste				
	Inclusion Criteria			
Radionuclide	PA Limiting	SA Limiting	Potentially Present At >1% Total Activity	Detectable Fissile or TRU Radionuclide
H-3	PA			
C-14	PA			
Ni-59			X	
Co-60			X	
Ni-63			X	
Se-79			X	
Sr-90			X	
Y-90			Daughter of Sr-90	
Nb-94			X	
Tc-99	PA			
Ru-106			X	
Rh-106			Daughter of Ru-106	
Sb-125			X	
Sn-126			X	
I-129	PA			
Cs-134			X	
Cs-135			X	
Cs-137			X	
Ba-137m			Daughter of Cs-137	
Ce-144			X	
Pr-144			Daughter of Ce-144	
Pm-147			X	
Eu-154			X	
Th-232			X	
U-232			X	
U-233				Detectable Fissile
U-234	PA			
U-235				Detectable Fissile
U-236			X	
U-238			X	
Np-237				Detectable TRU
Pu-238				Detectable TRU
Pu-239				Detectable Fissile, TRU
Pu-240				Detectable TRU
Pu-241				Detectable Fissile
Pu-242				Detectable TRU
Am-241				Detectable TRU
Am-242m				Detectable Fissile, TRU
Cm-244			X	
Cm-245				Detectable Fissile, TRU

3.2 Proposed F-Area Tank Farm Tank Groupings

WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 2.02, Revision 8, allows for consolidation of waste streams when the following two criteria are met:

1. Performance Assessment radionuclide scaling factors do not vary from the proposed data set scaling factor by more than a factor of 10, and

2. The fractional activity of the predominant radionuclides (predominant radionuclides being those that make up 10% or greater of the activity) in each data set does not vary by more than a factor of 2 from the fractional activity of the same radionuclide in the proposed data set.

Historical data for tanks under consideration for consolidation are summarized in Table 3.2 (Ref. 8).

Table 3.2. F-Area Tank Farm Sludge Tanks Historical Data

Tank No.	% Purex HHW	% Purex LHW	Avg. Age, PHHW	Avg. Age, PLHW	Tank Use/Notes
1	61	39	41	39	Waste Removal
2	50	50	46	46	Waste Removal
3	50	50	43	43	Waste Removal
4	97	3	31	31	Waste Removal
5	66	34	39	39	Waste Removal
6	100		33		Waste Removal
7		100		37	Waste Removal
8	22	78	35	25	Waste Removal
18		100		30	Waste Removal
19		100		27	Heel; contains zeolite
26		100		15	Evaporator Feed
33	100		16		F Waste Receipt
34	100		17		Storage
47		100		18	Waste Removal

The tanks contain exclusively Purex Waste with varying proportions of Purex High Heat Waste (PHHW) and Purex Low Heat Waste (PLHW) of varying age (15-47 years), and are all utilized for either waste removal, concentrate receipt, or evaporator feed.

Waste Tanks 17 and 20 were formerly used for waste removal and, accordingly, were included in characterization documentation for F-Area Tank Farm sludge-contaminated waste. Tanks 17 and 20 have subsequently been closed and grouted and will, therefore, no longer be used for management of wastes.

Waste Tanks 25, 27, 28, 44, 45 and 46 have not historically been considered sludge tanks. These tanks have been used for receiving material processed through the 2F evaporator. Although they have not received direct transfers of sludge, some sludge may have entered the tanks entrained in concentrated salt solution. These tanks will be characterized under the supernate stream which accounts for 5% sludge carryover.

The grouping of waste tanks per table 3.3 was made based on the following:

- All but one F-Area waste tank were grouped together in waste stream FTK-00002-1. The exception to this grouping was Tank 19. Tank 19 contains spent zeolite resin, which, by virtue of its high concentration of Cs-137, skews the radionuclide distribution for the sludge/zeolite layer. Tank 19

sludge is therefore characterized separately as waste stream FTK-00002-19. Zeolite resin in Tank 19 contains significantly higher Cs-137: Sr-90 ratios than sludge solids.

Table 3.3. F-Area HLW Tank Farm Waste Streams

HLW Tanks	Waste Stream Number
All active FTF Tanks except 19 (1-8, 18, 26, 33, 34, 47)	FTK-00002-1
19	FTK-00002-19

Each tank is considered a waste stream and the radionuclide concentrations for each tank were obtained from decay-corrected data tables in WCS (Attachments 1 and 2; Ref. 8). The concentrations of each radionuclide were used to determine an average concentration for all the tanks (Attachment 3). Consolidated waste stream averages for radionuclide concentration data are conservatively calculated to include only those tanks in the consolidation that contained the particular radionuclide; i.e., zero concentrations were not included in the averages. The average concentrations were used to determine a proposed distribution and scaling factors for each waste stream (Attachment 5).

3.3 Excluding Radionuclides from Consideration

Radionuclides were excluded from the proposed distributions based on WAC 2.02, Revision 8 which states that radionuclides that meet one of the inclusion criteria outlined in Section 3.1 may be excluded from further consideration for a waste stream if one or more of the following conditions exist:

1. There is no reason to expect the radionuclide to be present in the waste stream.

2. For non-SA or -PA radionuclides, or non-detectable fissile or TRU radionuclides, the individual activity contribution is less than 1% of the total radionuclide activity.

The above criteria are hereafter referred to as “exclusion criteria.”

(Note: WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure WAC 2.02, Revision 8, also allows for exclusion from the waste stream distribution of radionuclides whose activities are below specific analytical laboratory Maximum Allowable Lower Limits of Detection [MALLDs]. This exclusion criterion will not be used for this process-knowledge-based characterization of sludge waste streams FTK-00002-1 and -19).

Of the 40 radionuclides listed in Table 3.1, one PA radionuclide (H-3) is excluded because it is not expected to be present in either waste stream; also, one PA radionuclide (U-234), one fissile radionuclide (U-233), one TRU radionuclide (Np-237), and one fissile/TRU radionuclide (Am-242m) are excluded from FTK-00002-19 because they are not expected to be present. Of the radionuclides included because they were expected to be present at more than 1% of total activity, an additional 15 are determined to be present at less than 1% of the total activity in both waste streams. The exclusion results are presented in Attachment 5.

3.4 Development of the Sludge Fraction Distribution

The scaling factors for the PA radionuclides and fractional activity of predominate radionuclides for waste stream FTK-00002-1 are compared to determine if the grouped tanks can be consolidated based on the established criteria. Since waste stream FTK-00002-19 is not being combined with any other tanks, the PA radionuclide scaling factors and fractional activity of predominant radionuclides do not have to be evaluated against the consolidation criteria. The final distribution and scaling factors for FTK-00002-19 are the same as those proposed in Attachment 5.

Analysis of proposed waste stream FTK-00002-1 is documented in Attachment 4. In order to meet the first consolidation criteria, each tank PA radionuclide scaling factor (Attachment 3) must be within an order of magnitude (or within a range of 0.1 to 10 times) of the proposed scaling factor. All PA radionuclides in combined waste stream FTK-00002-1 meet this criteria with the exception of C-14 in Tanks 4, 7, 8, 18, 26, and 47, and U-234 in Tank 18, 26, and 33. Since WSRC 1S SRS Waste Acceptance Criteria Manual, Procedure 2.02, Revision 8, allows for exception to the consolidation criteria where it can be shown "that the….reported activity will be greater than if the factors were within the guidelines," the affected tanks can be grouped into this waste stream. For C-14 the scaling factor for Tank 47 will be used because it is conservative compared to the proposed scaling factor. For U-234 the scaling factor for Tank 18 will be used because it is conservative compared to the proposed scaling factor. The conservative scaling factors for C-14 and U-234 will result in a higher reported activity for these radionuclides than if the proposed scaling factor was used..

The second consolidation criterion applies to predominant radionuclides only. Attachment 5 shows there are two predominant radionuclides in proposed waste stream FTK-00002-1, Sr-90 and its daughter Y-90. The fractional activities of Sr-90 and Y-90 vary only slightly within the distribution of sludge except for Tank 18 (Attachment 4). Tank 18 can be grouped into this waste stream using the same exception above. The proposed fractional activity is conservative compared to Tank 18.

Based on the results of this comparison, both consolidation criteria are met for combined waste stream FTK-00002-1, and the sludge fraction of sludge-contaminated waste from tanks in Table 3.3 may be consolidated into two waste streams, FTK-00002-1 and -19; the mean values will include all tanks that contain the specific radionuclide. The radionuclides, concentrations per gallon of sludge, final distribution, and scaling factors (to Sr-90), for FTK-00002-1 and FTK-00002-19 are shown in Attachment 6. These results are also summarized in Table 3.4.

Specific issues related to quantification of sludge-contaminated waste generated from these waste streams are contained in Section 5.

Table 3.4 Radionuclide Scaling Factors and Distribution for F-Area Tank Farm Sludge						
Radio-nuclide	Mean Activity (Ci/gal)		Distribution, Normalized (%)		Mean Scaling Factors (Ci/Ci Sr-90)	
	FTK-00002-		FTK-00002-		FTK-00002-	
	1	19	1	19	1	19
C-14	1.74E-06	4.64E-08	1.21E-06	1.42E-04	3.33E-06	4.20E-06
Sr-90	6.49E+01	1.10E-02	4.50E+01	3.39E+01	1.00E+00	1.00E+00
Y-90	6.49E+01	1.10E-02	4.50E+01	3.39E+01	1.00E+00	1.00E+00
Tc-99	2.27E-02	3.91E-06	1.57E-02	1.20E-02	3.50E-04	3.55E-04
I-129	1.08E-07	1.86E-11	7.49E-08	5.70E-08	1.66E-09	1.68E-09
Cs-137	4.77E+00	7.67E-04	3.30E+00	2.36E+00	7.34E-02	6.95E-02
Ba-137m	4.51E+00	7.26E-04	3.12E+00	2.23E+00	6.94E-02	6.58E-02
Pm-147	4.22E+00		2.92E+00		6.50E-02	
U-233	5.64E-05		3.90E-05		8.68E-07	
U-234	1.25E-04		8.68E-05		3.85E-04	
U-235	1.62E-06	4.53E-09	1.12E-06	1.39E-05	2.50E-08	4.10E-07
Np-237	7.40E-05		5.12E-05		1.14E-06	
Pu-238	6.00E-02	1.70E-03	4.16E-02	5.21E+00	9.24E-04	1.54E-01
Pu-239	2.25E-02	2.43E-04	1.56E-02	7.45E-01	3.47E-04	2.20E-02
Pu-240	4.80E-03	5.42E-05	3.32E-03	1.66E-01	7.39E-05	4.91E-03
Pu-241	8.73E-02	6.31E-03	6.05E-02	1.94E+01	1.34E-03	5.72E-01
Pu-242	8.13E-06	1.12E-07	5.63E-06	3.42E-04	1.25E-07	1.01E-05
Am-241	8.13E-01	7.05E-04	5.63E-01	2.16E+00	1.25E-02	6.39E-02
Am242m	2.93E-04		2.03E-04		4.51E-06	
Cm-245	5.15E-07	6.48E-15	3.57E-07	1.99E-11	7.93E-09	5.87E-13
Total	**1.44E+02**	**3.26E-02**	**1.00E+02**	**1.00E+02**	**2.22E+00**	**2.95E+00**
Total TRU	**9.01E-01**	**2.70E-03**			**1.39E-02**	**2.45E-01**

3.5 Other WAC Criteria

3.5.1 Comparison to Package Guidelines

Most sludge-contaminated waste will be disposed of in the E-Area Slit Trenches and Engineered Trenches (ET). Administrative Waste Package Radiological Concentration Guidelines apply to waste disposed of in the trenches. The guidelines applicable to the ET will be used for comparison since they are the most restrictive of the trench facilities. Low activity waste is defined as waste that will produce less than or equal to 200 mR/hr at 5 cm from an unshielded final disposal container. The average concentration of each PA radionuclide in the F-Area Tank Farm Sludge Waste Streams (Attachment 6) and their corresponding ET limits (Reference 7) are shown in Table 3.5. These values are used to determine the minimum amount of sludge that could be present in a B-25 to fail the ET limit. ET limits are expressed in Ci/ft^3 waste and Ci/90 ft^3 B-25 container. Calculations supporting the comparisons below are in Attachment 8.

Table 3.5. Comparison of Sludge Fraction of Sludge-Contaminated Waste to ET Limits						
	Sludge (Ci/gal)		**ET Limit**		**Gallons of sludge in B-25 to reach ET limit**	
Radio-nuclide	**Stream FTK-00002-1**	**Stream FTK-00002-19**	**Ci/ft^3**	**Ci/B-25**	**Stream FTK-00002-1**	**Stream FTK-00002-19**
	A_1	A_2	B	C=B*90ft^3	D_1=C/A_1	D_2=C/A_2
C-14	1.74E-06	4.64E-08	2.9E-05	2.61E-03	1.50E+03	5.63E+04
Tc-99	2.27E-02	3.91E-06	1.0E-06	9.00E-05	**3.96E-03**	**2.30E+01**
I-129	1.08E-07	1.86E-11	1.7E-09	1.53E-07	1.42E+00	8.23E+03

The most limiting isotope in both waste streams is Tc-99. For waste stream FTK-00002-1, a B-25 will contain a minimum of 3.96E-03 gallons to reach the ET limit. For waste stream FTK-00002-19, a B-25 at the ET limit will contain a minimum of 2.30E+01 gallons. The curie distribution for each waste stream at the ET Limit is shown in Attachment 7. The gallons of sludge from Table 3.5 can be used to calculate the total activity of a B-25 at the ET limit and the minimum weight of a B-25 in order to not be TRU.

Table 3.6 Calculation of Activity in B-25 at the ET Limit			
FTK-00002-	Quantity of Sludge at the ET Limit (gal)	Waste Stream Activity (Ci/gal)	Total Activity in B-25 at ET Limit (Ci)
	A	B	C=A*B
1	3.96E-03	1.44E+02	5.70E-01
19	2.30E+01	3.26E-02	7.50E-01

Table 3.7 Determination of TRU Activity and Minimum TRU Weight at ET Limit				
FTK-00002-	Quantity of Sludge at the ET Limit (gal)	TRU Concentration (Ci/gal)	TRU Activity at ET Limit (Ci)	Minimum Waste Weight @ ET Limit to not be TRU Waste (lbs)
	A	B	C=A*B	D=C/(100nCi/g)/(1E-09nCi/g)/454g/lb
1	3.96E-03	9.01E-01	3.57E-03	78.6
19	2.30E+01	2.70E-03	6.21E-02	1,368

Per Tables 3.6 and 3.7, for waste stream FTK-00002-1, a B-25 with less than 79 lb. of waste and more than 5.70E-01 Ci will fail TRU limits. For waste stream FTK-00002-19, a B-25 with less than 1,370 lbs and more than 7.50E-01 Ci will fail TRU limits. As long as a B-25 is above the calculated minimum weights for the waste stream, the container will reach the ET limit before it reaches the TRU limit. In addition the TRU concentration at the maximum waste weight can also be calculated to ensure a B-25 will not be TRU. The calculation in Attachment 8 shows that a B-25 with FTK-0002-01 waste will contain 1.57E+00 nCi/g TRU and a B-25 with FTK-00002-19 waste will contain 2.73E+01 nCi/g. In practice, very few waste boxes fail TRU limits. Any such box will, upon entry into WITS, be flagged as TRU and not be sent to the ET.

3.5.2 Nuclear Criticality Safety Criteria

Sludge-contaminated LLW from F-Area Tank Farm Waste Streams contains an insignificant quantity of fissionable material to impact nuclear criticality criteria. Calculations supporting this comparison are in Attachment 8. The activities of the fissionable radionuclides at the ET limit are used to calculate the FGE

in Table 3.8 in accordance with Reference 7. The FGE at the ET limit is well below the gram limit for the Engineered Trench. Therefore, a B-25 will reach the ET limit before it reaches the FGE limit.

Table 3.8. Calculation of FGE Equivalent for Sludge Fraction of Sludge-Contaminated Waste

Radio-nuclide	Activity in blended sludge at ET Limit (Ci)	Specific activity (Ci/g)	Maximum mass (grams) in a B-25	Equivalence factor	FGE U-235 (g)
	A	B	C=A/B	D	E=C*D
Waste Stream FTK-00001					
U-233	2.23E-07	9.648E-03	2.31E-05	1.4	3.24E-05
U-235	6.42E-09	2.16E-06	2.97E-03	1.0	2.97E-03
Pu-239	8.92E-05	6.132E-02	1.45E-03	1.6	2.33E-03
Pu-241	3.46E-04	1.034E+02	3.34E-06	3.5	1.17E-05
Am-242m	1.16E-06	9.717E+00	1.19E-07	54.0	6.45E-06
Cm-245	2.04E-09	1.716E-01	1.19E-08	24.0	2.85E-07
Total					5.35E-03
Waste Stream FTK-000019					
U-235	1.04E-07	2.16E-06	4.81E-02	1.0	4.81E-02
Pu-239	5.58E-03	6.132E-02	9.10E-02	1.6	1.46E-01
Pu-241	1.45E-01	1.034E+02	1.40E-03	3.5	4.91E-03
Cm-245	1.49E-13	1.716E-01	8.68E-13	24.0	2.08E-11
Total					1.99E-01

3.6 Documentation of the Sludge Fraction Distribution

Low level waste stream forms for F-Area Tank Farm Waste Streams, FTK-00002-1 and FTK-00002-19, completed electronically, document the distribution from F-Area Tank Farms Waste Streams. For those packages determined to contain sufficient sludge to be determined mixed and/or transuranic, appropriate waste stream forms will be provided for each package.

4.0 Supernate Fraction of Sludge-Contaminated Waste

4.1 Radionuclide Distribution

The radionuclide distribution for the supernate fraction of sludge-contaminated waste has been previously determined and documented. “HLW Supernate Radionuclide Characterization,” WSRC-TR-94-0290, Revision 4, March 2003 (Reference 9), identifies 26 radionuclides present in supernate waste. This waste stream represents a single, comprehensive and conservative characterization/certification for all supernate in both F- and H-Areas. The waste stream consists primarily of Cs-137 and its daughter Ba-137m, which together comprise 94% of the total activity in supernate with approximately 5% consisting of Sr-90 and its daughter Y-90. The twenty-six isotopes determined to be present in supernate waste, their relative activity, and scaling factors (to Cs-137) for this waste stream are reproduced in Table 4.1.

Table 4.1. Validated Radionuclide Distribution and Scaling Factors for HLW Supernate		
Radionuclide	**Normalized Distribution (%)**	**Scaling Factors (Ci/Ci Cs-137)**
H-3	1.59E-01	3.28E-03
C-14	9.44E-05	1.96E-06
Co-60	1.01E+00	2.08E-02
Sr-90	2.29E+00	4.74E-02
Y-90	2.29E+00	4.74E-02
Tc-99	9.60E-03	1.99E-04
I-129	9.94E-06	2.06E-07
Cs-137	4.83E+01	1.00E+00
Ba-137m	4.57E+01	9.46E-01
Pm-147	1.04E-01	2.15E-03
U-233	4.98E-06	1.03E-07
U-234	4.71E-06	9.76E-08
U-235	1.42E-06	2.94E-08
U-238	2.04E-06	4.22E-08
Np-237	2.31E-06	4.78E-08
Pu-238	6.24E-02	1.29E-03
Pu-239	1.30E-03	2.70E-05
Pu-240	2.70E-02	5.58E-04
Pu-241	3.47E-02	7.18E-04
Pu-242	6.41E-04	1.33E-05
Am-241	2.39E-02	4.94E-04
Am-242m	7.39E-04	1.53E-05
Am-243	1.82E-03	3.76E-05
Cm-245	7.49E-06	1.55E-07
Cm-246	2.49E-05	5.15E-07
Cm-247	1.21E-10	2.51E-12
Total	**1.00E+02**	**2.07E+00**

4.2 Other WAC Criteria

Comparison of supernate waste to other WAC requirements has been performed previously (Reference 9). The following determinations were made for supernate waste:

- A B-25 container 90% full (81 ft^3 waste) can contain up to 0.83 gallons of supernate (8.33 Ci Cs-137), before it is expected to exceed the Trench Administrative Waste Package Radiological Concentration Guidelines
- Supernate waste passes the sum of fractions calculation
- Supernate waste contains an insignificant quantity of fissionable material to impact nuclear criticality criteria
- Supernate waste passes TRU limits

4.3 Documentation of Supernate Fraction Distribution

Low Level waste stream form FHW-00001, has previously been submitted for approval to the Solid Waste Division. The distribution is included in Attachment 9 for information, and will be used to document the supernate fraction distribution of sludge waste.

5.0 Quantification

5.1 Quantification of Sludge and Supernate Fractions

Quantification of radionuclides in sludge-contaminated waste requires quantification of both the supernate and sludge fractions in each waste cut. Independent quantification of Sr-90, indicative of the sludge fraction, and Cs-137, indicative of the supernate fraction, is important for accurate characterization of sludge-contaminated waste. Both the sludge and supernate fractions and their scaling ratios to Sr-90 and Cs-137, respectively, are reproduced in Attachment 8.

Scaling factors for the sludge fraction are tied to Sr-90. Although Sr-90 is present in the supernate fraction, it comprises less than 3% of total activity in the supernate fraction. For this reason, all Sr-90 identified in the sludge-contaminated waste will be attributed to the sludge fraction. Scaling ratios developed for the sludge fraction will be applied to the Sr-90 identified in sludge-contaminated waste.

Scaling factors for the supernate fraction are tied to Cs-137. Although Cs-137 is present in the sludge fraction, it typically comprises less than 5% of total activity in the sludge fraction (as is the case for waste streams FTK-00002-1 and FTK-00002-19). Similarly, 94% of the activity in the supernate is from Cs-137 and its daughter Ba-137m. Application of the radionuclide distributions of waste streams FTK-00002-1 and -19 to quantification of waste from individual waste tanks will be performed on a case-by-case basis, based on available activity data and process knowledge.

The two fractions of sludge-contaminated waste will be manifested separately. The total calculated curies attributed to each stream will be entered into two separate waste streams in WITS, representing the sludge and supernate fractions, respectively. The two waste streams will be combined in WITS to create a single manifest.

5.2 Quantification of Job Control Waste and other Compactable Sludge-Contaminated Waste

The relative ease with which gamma radiation from Cs-137 is detected makes estimation of the curie content of the supernate fraction of waste straightforward. Dose-to-curie methodologies for quantification of Cs-137 on waste containers have been developed and are currently in use (References 10 and 11).

Sr-90, a low-energy beta emitter, is not easily measured. Although a Beta Screening Tool (BST) has been developed as an improved alternative method for providing a dose associated with Sr-90 (Reference 12), the BST methodology has not yet been implemented for waste quantification purposes. Until such time as the BST is field implemented, the actual quantity of Sr-90 present in the sludge fraction must be estimated by some other means.

The most conservative approach in quantification of a waste cut is to assume that all measured Cs-137 is attributed to both supernate and sludge fractions. For the sludge fraction, the known Sr-90 to Cs-137 ratio is utilized to estimate the maximum Sr-90 that could be present on the waste cut. This approach results in double-manifesting of the Cs-137, over-manifesting of virtually all of the remaining radionuclides, and significantly over-estimating the sludge fraction.

It is preferable, therefore, to determine an appropriate split of the measured Cs-137 that can be attributed to the supernate and sludge fractions. In determining the appropriate split between these fractions, one must consider the effects of overestimating one fraction or the other. Over-estimating the sludge fraction will result in

- under-manifesting of radionuclides attributed to supernate only (in this waste stream, the only radionuclide fitting this description is tritium, a PA radionuclide, present at 0.2% of total supernate activity), and

- over-manifesting of transuranics (a higher level of transuranics are present in sludge).

Over-estimating the supernate fraction will result in under-manifesting of radionuclides present in the sludge fraction only.

Determination of the split of Cs-137 contributed from the sludge and supernate fractions will be performed on a case-by-case basis for F-Area high level waste packages.

5.3 Quantification of Non-Compactable Sludge-Contaminated Waste

Estimation of the quantity of Cs-137 present on non-compactable waste, such as equipment or HEPA filters, is performed on a case-by-case basis. This is done by individual Dose-to-Curie runs, which take into account the specific geometry of the waste (Reference 13).

Application of BST methodology to non-compactable waste to determine the amount of Sr-90 present is not appropriate since the waste itself shields beta radiation and would result in unrealistically low measured values. Estimation of Sr-90 present in cuts of non-compactable waste will be performed by estimation of the amount of Cs-137 attributed to the sludge fraction in combination with the known relationship between Sr-90 and Cs-137. This will be performed on a case-by-case basis.

6.0 Periodic Validation

Provisions of Procedure WAC 2.02, Revision 7 (Reference 5), require generators of routine wastes, including sludge-contaminated waste, to review and confirm the certification of each waste stream at least every two years. However, validation of the supernate fraction is performed on a five year frequency.

Sludge sampling has been conducted on a very limited basis during development of DWPF design bases. Only limited additional sludge samples have been collected to date due to high cost and personnel exposure. For this reason, future validation performed of the sludge fraction will utilize process knowledge and analytical data as available.

7.0 References

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Attachment 1

WCS Tank Data
Reference Date: December 22, 2004

Attachment 1
WCS1.5 Tank Data
Reference Date: 12/22/04
'WG17\WCS1.5PROD\WCS1.5\T-TankData'

Tank	Total Waste Volume (gal)	Sludge Volume (gal)	Sludge Interstitial Fraction (vol. frac.)	Salt Volume (gal)	Dry Salt Bulk Sp.G.	Estimated Salt Dry Wt. (kg)	Salt Interstitial Fraction (vol. frac.)	Free Supernate Volume (gal)	Interstitial Sludge Supernate Volume (gal)	Interstitial Salt Supernate Volume (gal)	Total Supernate Volume (gal)	Sp.G.	Organic Resin Volume (gal)	Organic Resin Sp.G.	Est. Organic Resin Weight (kg)	Misc. Zeolite Volume (gal)	Zeolite Sp.G.	Est. Zeolite Mass (kg)	Sand Weight (kg)	Coal Weight (kg)	Grout Volume (gal)	Current Level (in)	Sludge Depth (in)	Salt Depth (in)	Free Supernate Depth (in)	Total Supernate Depth (in)	Supernate Concentration (Ci/gal)	Solids Concentration (Ci/gal)	Free Liquid In Tank?	Dry Tank?	Filled To AB Limit For H2 Calculations?	Organic Tank?	Tank Farm Tank?	Total Vapor Space for Empty Tank (gal)
1	505957	7046	0.7	479941	1.45	2634245	0.22	18970	4932.2	105587	129489	1.525	0	0.761	0	0	0.761	0	0	0	0	186.7	3	177	7	48	38.58	209.52	0	0	Y	0	Y	793411
2	540374	4065	0.7	536038	1.45	2942144	0.22	271	2845.5	117928	121045	1.52	0	0.761	0	0	0.761	0	0	0	0	199.4	2	198	0.1	45	14.31	51.053	0	0	Y	0	Y	793411
3	540645	4065	0.7	536038	1.45	2942144	0.22	542	2845.5	117928	121316	1.525	0	0.761	0	0	0.761	0	0	0	0	199.5	2	198	0.2	45	14.51	47.719	0	0	Y	0	Y	793411
4	462326	127099	0.7	33875	1.45	185929	0.22	301352	88969.3	7452.5	397774	1.323	0	0.761	0	0	0.761	0	0	0	0	170.6	47	13	111	147	17.12	79.231	Y	0	Y	0	Y	793411
5	42276	33875	0.56	0	1.45	0	0.22	8401	18970	0	27371	1.283	0	0.761	0	0	0.761	0	0	0	0	15.6	13	0	3.1	10	3.508	173.08	Y	0	Y	0	Y	793411
6	280756	24932	0.7	0	1.45	0	0.22	255824	17452.4	0	273276	1.142	0	0.761	0	0	0.761	0	0	0	0	103.6	9	0	94	101	0.071	267.96	Y	0	Y	0	Y	793411
7	302707	19707.5	0.7	0	1.45	0	0.22	283000	13795.3	0	296795	1.113	0	0.761	0	0	0.761	0	4545	3178	0	111.7	7	0	104	110	1.575	23.994	Y	0	Y	0	Y	793411
8	11382	4100	0.7	0	1.45	0	0.22	7282	2870	0	10152	1.129	0	0.761	0	0	0.761	0	0	0	0	4.2	2	0	2.7	3.7	1.353	17.768	Y	0	Y	0	Y	793411
9	543626	2710	0.7	533870	1.45	2930244	0.22	7046	1897	117451	126394	1.41	0	0.761	0	0	0.761	0	0	0	0	200.6	1	197	2.6	47	14.03	74.121	0	0	Y	0	Y	793411
10	192410	2710	0.7	211380	1.45	1160198	0.22	0	1897	46504	48400.6	1.307	0	0.761	0	0	0.761	0	0	0	0	71	1	78	0	18	2.448	8.7959	0	0	Y	0	Y	793411
11	32520	32520	0.7	0	1.45	0	0.22	0	22764	0	22764	1.117	0	0.761	0	0	0.761	0	0	0	0	12	12	0	0	8.4	0.035	122.01	Y	0	Y	0	Y	793411
12	173711	143000	0.53	75790	1.45	415987	0.22	0	0	0	0	1.525	0	0.761	0	0	0.761	0	0	0	0	64.1	53	28	0	0	0	118.69	0	Y	Y	0	Y	793411
13	830550	252000	0.7	0	1.45	0	0.22	578550	176400	0	754950	1.409	0	0.761	0	0	0.761	0	0	0	0	237.3	72	0	165	216	30.38	89.684	Y	0	Y	0	Y	1121357
14	173950	28000	0.7	129500	1.45	710785	0.22	16450	19600	28490	64540	1.4	0	0.761	0	0	0.761	0	0	0	0	49.7	8	37	4.7	18	32.51	44.097	0	0	Y	0	Y	1121357
15	213500	213500	0.48	102480	1.45	562480	0.22	0	0	0	0	1.266	0	0.761	0	0	0.761	0	0	0	0	61	61	29	0	0	0	70.812	0	Y	Y	0	Y	1121357
16	0	0	0.7	0	1.45	0	0.22	0	0	0	0	0	0	0.761	0	0	0.761	0	0	0	0	0	0	0	0	0	0	0	0	0	Y	Y	0	Y	1121357
17	0	0	0.7	0	1.45	0	0.22	0	0	0	0	0	0	0.761	0	0	0.761	0	0	0	1300000	0	0	0	0	0	0	0	0	Y	Y	0	Y	1703024
18	8496	4300	0.7	0	1.45	0	0.22	4196	3010	0	7206	1.183	0	0.761	0	0	0.761	0	0	0	0	2.4	1	0	1.2	2	0.038	6.3551	Y	0	Y	0	Y	1703024
19	15576	15000	0.7	0	1.45	0	0.22	576	10500	0	11076	1.183	0	0.761	0	12440	0.761	35835	0	0	0	4.4	4	0	0.2	3.1	0.038	0.0676	Y	0	Y	0	Y	1703024
20	0	0	0.7	0	1.45	0	0.022	0	0	0	0	0	0	0.761	0	0	0.761	0	0	0	1300000	0	0	0	0	0	0	0	0	Y	Y	0	Y	1703024
21	706230	6088.8	0.7	0	1.45	0	0.22	700141	4262.16	0	704403	1.019	0	0.761	0	0	0.761	0	0	0	0	199.5	2	0	198	199	0.007	19.932	Y	0	Y	0	Y	1703024
22	822696	9982.8	0.7	0	1.45	0	0.22	812713	6987.96	0	819701	1.027	0	0.761	0	0	0.761	0	0	0	0	232.4	3	0	230	232	0.003	23.068	Y	0	Y	0	Y	1703024
23	1E+06	56109	0.7	0	1.45	0	0.22	1E+06	39276.3	0	1294029	1.021	0	0.761	0	0	0.761	0	0	0	0	370.3	16	0	354	366	4E-04	0.0152	Y	0	Y	0	Y	1703024
24	1E+06	3540	0.7	0	1.45	0	0.22	1E+06	2478	0	1217052	0	0	0.761	0	4000	0.761	11522	0	0	0	344.1	1	0	343	344	0.003	0.0028	Y	0	Y	0	Y	1703024
25	1E+06	0	0.7	1098630	1.45	6030034	0.22	162162	0	241699	403861	1.406	0	0.761	0	1050	0.761	3025	0	0	0	359.2	0	313	46	115	6.886	6.3353	Y	0	Y	0	Y	1373238
26	1E+06	259319	0.7	0	1.45	0	0.22	986731	181523	0	1168254	1.359	0	0.761	0	0	0.761	0	0	0	0	355	74	0	281	333	15.02	15.691	Y	0	Y	Y	Y	1373238
27	1E+06	3861	0.7	600315	1.45	3294942	0.22	641874	2702.7	132069	776646	1.447	0	0.761	0	4990	0.761	14374	0	0	0	355	1	171	183	221	15.75	14.492	Y	0	Y	0	Y	1373238
28	1E+06	0	0.7	1029834	1.45	5652434	0.22	187083	0	226563	413646	1.46	0	0.761	0	0	0.761	0	0	0	0	346.7	0	293	53	118	8.71	8.0133	Y	0	Y	0	Y	1373238
29	1E+06	0	0.7	1023165	1.45	5615830	0.22	167076	0	225096	392172	1.26	0	0.761	0	0	0.761	0	0	0	0	339.1	0	292	48	112	1.94	1.785	Y	0	Y	0	Y	1373238
30	1E+06	631.8	0.7	249631	1.45	1370147	0.22	914706	442.26	54919	970067	1.523	0	0.761	0	0	0.761	0	0	0	0	331.9	0	71	261	276	20.84	161.87	Y	0	Y	0	Y	1373238
31	1E+06	0	0.7	1146717	1.45	6293968	0.22	115830	0	252278	368108	1.47	0	0.761	0	0	0.761	0	0	0	0	359.7	0	327	33	105	22.1	20.33	Y	0	Y	0	Y	1373238
32	968760	98455.5	0.7	0	1.45	0	0.22	870305	68918.9	0	939223	1.498	0	0.761	0	6700	0.761	19300	0	0	0	276	28	0	248	268	16.86	231.38	Y	0	Y	0	Y	1373238
33	1E+06	84240	0.7	293787	1.45	1612504	0.22	794313	58968	64633	917914	1.407	0	0.761	0	0	0.761	0	0	0	0	334	24	84	226	262	6.153	231.92	Y	0	Y	Y	Y	1373238
34	621270	20182.5	0.7	191295	1.45	1049958	0.22	409793	14127.8	42085	466005	1.24	0	0.761	0	0	0.761	0	0	0	0	177	6	55	117	133	5.725	867.93	Y	0	Y	0	Y	1373238
35	1E+06	63180	0.7	0	1.45	0	0.22	982449	44226	0	1026675	1.319	0	0.761	0	0	0.761	0	0	0	0	297.9	18	0	280	293	7.885	316.64	Y	0	Y	0	Y	1373238
36	1E+06	186.03	0.7	1035264	1.45	5682238	0.22	219375	130.221	227758	447263	1.47	0	0.761	0	0	0.761	0	0	0	0	357.5	0	295	63	127	40.69	151.7	Y	0	Y	0	Y	1373238
37	1E+06	0	0.7	1112670	1.45	6107095	0.22	157950	0	244787	402737	1.545	0	0.761	0	0	0.761	0	0	0	0	362	0	317	45	115	18.53	17.047	Y	0	Y	0	Y	1373238
38	1E+06	0	0.7	828009	1.45	4544681	0.22	442611	0	182162	624773	1.377	0	0.761	0	0	0.761	0	0	0	0	362	0	236	126	178	0.916	0.8429	Y	0	Y	0	Y	1373238
39	777465	103545	0.7	0	1.45	0	0.22	673920	72481.5	0	746402	1.28	0	0.761	0	0	0.761	0	0	0	0	221.5	30	0	192	213	2.191	268.35	Y	0	Y	0	Y	1373238
40	767637	504914	0.7	0	1.45	0	0.22	262724	353439	0	616163	1.042	0	0.761	0	0	0.761	0	0	0	0	218.7	##	0	75	176	0.173	18.152	Y	0	Y	0	Y	1373238
41	1E+06	2667.6	0.7	1219163	1.45	6691604	0.22	0	1867.32	268216	270083	1.395	0	0.761	0	0	0.761	0	0	0	0	344.4	1	347	0	77	1.876	11.906	Y	0	Y	0	Y	1373238
42	1E+06	17550	0.8	0	1.45	0	0.22	1E+06	14040	0	1268514	1.305	0	0.761	0	765	0.761	2204	0	0	0	362.4	5	0	357	361	18.84	55.704	Y	0	Y	0	Y	1373238
43	1E+06	239312	0.7	0	1.45	0	0.22	1E+06	167518	0	1174256	1.305	0	0.761	0	0	0.761	0	0	0	0	355	68	0	287	335	0.414	20.484	Y	0	Y	Y	Y	1373238
44	1E+06	0	0.7	1003018	1.45	5505248	0.22	263390	0	220664	484054	1.52	0	0.761	0	0	0.761	0	0	0	0	360.8	0	286	75	138	10.32	9.4977	Y	0	Y	0	Y	1373238
45	1E+06	0	0.7	1104808	1.45	6063941	0.22	177395	0	243058	420453	1.49	0	0.761	0	0	0.761	0	0	0	0	365.3	0	315	51	120	9.762	8.9814	Y	0	Y	0	Y	1373238
46	1E+06	0	0.7	865180	1.45	4748700	0.22	407897	0	190340	598237	1.581	0	0.761	0	0	0.761	0	0	0	0	362.7	0	246	116	170	14.64	13.467	Y	0	Y	0	Y	1373238
47	1E+06	0	0.7	1082905	1.45	5943726	0.22	159635	0	238239	397874	1.333	0	0.761	0	0	0.761	0	0	0	0	354	0	309	45	113	2.712	2.4953	Y	0	Y	0	Y	1373238
48	241137	0	0.7	0	1.45	0	0.22	241137	0	0	241137	1.188	0	0.761	0	0	0.761	0	0	0	0	68.7	0	0	69	69	0.139	0.1275	Y	0	Y	0	Y	1373238
49	784836	0	0.7	299	1.45	1641.12	0.22	784537	0	65.78	784603	1.512	0	0.761	0	0	0.761	0	0	0	0	223.6	0	0.1	224	224	1.351	1.2427	Y	0	Y	0	Y	1373238
50	350298	0	0.7	0	1.45	0	0.22	350298	0	0	350298	1.177	0	0.761	0	0	0.761	0	0	0	0	99.8	0	0	100	100	4E-05	4E-05	Y	0	Y	0	Y	1373238
51	581607	89434.8	0.8	0	1.45	0	0.22	492172	71547.8	0	563720	1.373	0	0.761	0	4335	0.761	12487	0	0	0	165.7	25	0	140	161	0.969	84.117	Y	0	Y	0	Y	1373238

Attachment 2

WCS Sludge Inventory
Reference Date: December 22, 2004

Attachment 2
WCS Sludge Inventory
Reference Date: 12/22/04
'WG17\WCS1.5PROD\WCS1.5\
T-SldgInv'

Tank	H-3 (Ci)	C-14 (Ci)	Co-60 (Ci)	Ni-59 (Ci)	Ni-63 (Ci)	Se-79 (Ci)	Sr-90 (Ci)	Y-90 (Ci)	Nb-94 (Ci)	Tc-99 (Ci)	Ru-106 (Ci)	Rh-106 (Ci)	Sb-125 (Ci)	Sn-126 (Ci)	I-129 (Ci)	Cs-134 (Ci)	Cs-135 (Ci)	Cs-137 (Ci)	Ba-137m (Ci)	Ce-144 (Ci)	Pr-144 (Ci)
1		1.28E-02	2.19E+02	2.34E+01		1.63E+01	5.71E+05	5.71E+05		2.81E+02	6.44E-06	6.44E-06	1.42E+01	3.02E+01	1.34E-03	1.37E-02	1.88E-01	4.04E+04	3.83E+04	7.20E-09	7.20E-09
2		2.86E-03	1.42E+01	3.37E+00		2.31E+00	7.17E+04	7.17E+04		3.99E+01	3.93E-09	3.93E-09	3.66E-01	4.29E+00	1.90E-04	1.80E-04	2.67E-02	5.11E+03	4.84E+03	5.95E-13	5.95E-13
3		2.48E-03	1.62E+01	2.92E+00		2.00E+00	6.50E+04	6.50E+04		3.46E+01	2.64E-08	2.64E-08	5.65E-01	3.72E+00	1.65E-04	3.51E-04	2.31E-02	4.62E+03	4.37E+03	9.87E-12	9.87E-12
4		3.34E-03	5.08E+03	1.18E+02		8.47E+01	3.74E+06	3.74E+06		1.46E+03	3.09E-01	3.09E-01	1.77E+03	1.58E+02	6.98E-03	5.48E+00	9.81E-01	2.61E+05	2.47E+05	6.02E-03	6.02E-03
5		4.45E-02	1.46E+03	1.01E+02		7.07E+01	2.69E+06	2.69E+06		1.22E+03	2.80E-04	2.80E-04	1.43E+02	1.31E+02	5.82E-03	1.85E-01	8.18E-01	1.89E+05	1.79E+05	5.91E-07	5.91E-07
6			2.41E+03	1.04E+02		7.45E+01	3.11E+06	3.11E+06		1.29E+03	2.01E-03	2.01E-03	3.26E+02	1.39E+02	6.14E-03	5.18E-01	8.63E-01	2.18E+05	2.06E+05	7.84E-06	7.84E-06
7		3.97E-02	1.20E+02	9.35E+00		5.25E+00	1.95E+05	1.95E+05		9.13E+01	8.51E-04	8.51E-04	1.95E+01	9.70E+00	4.30E-04	3.99E-02	6.04E-02	2.58E+04	2.44E+04	1.54E-05	1.54E-05
8		3.15E-03	3.15E+01	1.18E+00		7.31E-01	3.14E+04	3.14E+04		1.26E+01	3.17E-04	3.17E-04	6.51E+00	1.36E+00	6.02E-05	1.42E-02	8.46E-03	2.20E+03	2.08E+03	5.78E-06	5.78E-06
9		3.09E-03	1.53E+01	3.64E+00		2.49E+00	7.73E+04	7.73E+04		4.31E+01	4.16E-09	4.16E-09	3.92E-01	4.63E+00	2.05E-04	1.92E-04	2.88E-02	5.51E+03	5.21E+03	6.25E-13	6.25E-13
10		3.24E-04	1.82E+00	3.81E-01		2.60E-01	8.26E+03	8.26E+03		4.49E+00	8.08E-10	8.08E-10	4.94E-02	4.78E-01	2.13E-05	3.40E-05	3.01E-03	5.85E+02	5.53E+02	1.80E-13	1.80E-13
11		5.67E-02	3.51E+03	5.85E+01		3.23E+01	1.83E+06	1.83E+06		5.48E+02	1.07E-02	1.07E-02	1.58E+02	2.96E+01	1.90E-03	7.51E+00	3.66E-01	1.01E+05	9.55E+04	1.03E-03	1.03E-03
12		2.53E-01	9.78E+03	2.80E+02		1.58E+02	7.91E+06	7.91E+06		2.68E+03	1.34E-03	1.34E-03	2.56E+02	1.62E+02	9.69E-03	8.00E+00	1.79E+00	4.47E+05	4.23E+05	2.57E-05	2.57E-05
13		2.92E-01	5.53E+03	2.78E+02		1.72E+02	7.28E+06	7.28E+06		2.93E+03	6.73E-04	6.73E-04	1.39E+02	2.25E+02	1.18E-02	3.75E+00	1.96E+00	4.40E+05	4.16E+05	1.45E-05	1.45E-05
14		1.51E-03	6.22E+01	7.72E+00		5.26E+00	1.86E+05	1.86E+05		9.06E+01	9.20E-08	9.20E-08	1.61E+00	8.82E+00	4.09E-04	4.78E-03	6.06E-02	1.25E+04	1.18E+04	1.83E-10	1.83E-10
15		2.34E-01	7.50E+03	2.60E+02		1.44E+02	7.10E+06	7.10E+06		2.44E+03	2.15E-03	2.15E-03	1.68E+02	1.32E+02	8.43E-03	5.13E+00	1.63E+00	3.94E+05	3.73E+05	1.77E-04	1.77E-04
16																					
17		3.42E-03	8.65E-01	2.01E-01		1.66E-02	7.46E+02	7.46E+02		2.89E-01	8.65E-06	8.65E-06	1.99E-01	3.09E-02	1.37E-06	4.55E-04	1.93E-04	5.21E+01	4.93E+01	9.49E-08	9.49E-08
18		3.81E-03	9.01E-01	2.24E-01		5.03E-02	1.40E+03	1.40E+03		1.46E+00	9.35E-06	9.35E-06	2.08E-01	3.45E-02	1.53E-06	4.81E-04	2.15E-04	1.22E+04	1.15E+04	1.02E-07	1.02E-07
19		6.95E-04	2.43E-01	4.09E-02		3.38E-03	1.66E+02	1.66E+02		5.87E-02	1.82E-06	1.82E-06	6.08E-02	6.29E-03	2.79E-07	1.38E-04	3.92E-05	1.15E+01	1.09E+01	1.35E-08	1.35E-08
20																					
21		3.01E-03	1.41E+02	1.04E+00		7.82E-01	5.48E+04	5.48E+04		1.34E+01	2.17E-01	2.17E-01	1.40E+01	7.15E-01	4.82E-05	1.38E+00	8.84E-03	3.10E+03	2.93E+03	3.09E-01	2.59E-04
22			2.74E+02	2.13E+00		1.66E+00	1.07E+05	1.07E+05		2.80E+01	3.14E-03	3.14E-03	2.41E+01	1.51E+00	9.70E-05	1.46E+00	1.87E-02	5.85E+03	5.54E+03	2.73E-04	2.73E-04
23			3.90E-01													1.26E-02		4.27E+02	4.03E+02		
24																					
25																					
26		6.13E-01	1.14E+03	3.60E+01		2.98E+00	1.96E+05	1.96E+05		5.17E+01	8.34E+01	8.34E+01	1.62E+03	5.53E+00	2.45E-04	1.32E+01	3.45E-02	1.34E+04	1.27E+04	3.90E+01	3.90E+01
27																					
28																					
29																					
30		7.80E-04	3.35E+02	8.56E-01		4.71E-01	3.84E+04	3.84E+04		7.98E+00	2.45E-01	2.45E-01	6.82E+01	4.31E-01	2.76E-05	8.18E+00	5.33E-03	2.08E+03	1.96E+03	9.20E-02	9.20E-02
31													0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
32		2.45E-01	3.69E+04	2.71E+02		1.49E+02	9.65E+06	9.65E+06		2.53E+03	1.55E+01	1.55E+01	4.59E+03	1.37E+02	8.75E-03	4.85E+02	1.69E+00	5.28E+05	4.99E+05	6.79E+00	6.79E+00
33		1.25E-01	5.45E+04	1.70E+02		1.17E+02	7.98E+06	7.98E+06		2.03E+03	5.11E+03	5.11E+03	9.37E+04	2.18E+02	9.67E-03	8.43E+02	1.36E+00	5.45E+05	5.15E+05	1.84E+03	1.84E+03
34			3.61E+04	1.71E+02		1.23E+02	7.71E+06	7.71E+06		2.12E+03	3.44E+02	3.44E+02	3.85E+04	2.28E+02	1.01E-02	2.46E+02	1.42E+00	5.28E+05	5.00E+05	5.16E+01	5.16E+01
35		2.07E-01	4.36E+04	2.27E+02		1.25E+02	8.81E+06	8.81E+06		2.12E+03	2.43E+01	2.43E+01	5.73E+03	1.14E+02	7.32E-03	5.96E+02	1.41E+00	4.80E+05	4.54E+05	1.46E+01	1.46E+01
36		2.34E-04	3.59E+01	2.57E-01		1.41E-01	9.53E+03	9.53E+03		2.39E+00	3.59E-04	3.59E-04	2.80E+00	1.29E-01	8.28E-06	1.76E-01	1.60E-03	5.20E+02	4.92E+02	2.62E-05	2.62E-05
37																					
38																					
39		2.35E-01	1.21E+05	2.59E+02		1.43E+02	1.17E+07	1.17E+07		2.42E+03	2.31E+03	2.31E+03	3.89E+04	1.31E+02	8.36E-03	7.25E+03	1.62E+00	6.34E+05	6.00E+05	4.23E+03	4.23E+03
40		8.46E-01	3.12E+03	1.93E+02		1.05E+02	4.14E+06	4.09E+06		1.81E+03	3.30E+00	2.19E-02	4.30E+02	1.85E+02	8.38E-03	3.36E+00	1.21E+00	2.92E+05	2.74E+05	1.52E+00	7.28E-04
41			5.32E+01	2.21E-01		1.71E-01	1.26E+04	1.26E+04		2.90E+00	4.19E-03	4.19E-03	7.91E+00	1.57E-01	1.00E-05	6.57E-01	1.94E-03	6.80E+02	6.43E+02	6.17E-04	6.17E-04
42		2.57E-02	3.58E+02	1.15E+01		5.97E+00	3.00E+05	3.00E+05		1.01E+02	1.34E-03	1.34E-03	1.38E+01	5.54E+00	3.52E-04	6.25E-01	6.77E-02	1.67E+04	1.58E+04	1.29E-04	1.29E-04
43		2.11E-02	2.16E+04	3.80E+01		2.43E+01	2.07E+06	2.07E+06		4.11E+02	1.38E+02	1.38E+02	6.93E+03	2.22E+01	1.42E-03	1.11E+03	2.75E-01	1.12E+05	1.06E+05	1.37E+02	1.37E+02
44																					
45																					
46																					
47		4.37E-01	5.73E+02	2.57E+01		2.12E+00	1.32E+05	1.32E+05		3.68E+01	1.51E+00	1.51E+00	5.09E+02	3.94E+00	1.75E-04	2.76E+00	2.46E-02	9.07E+03	8.58E+03	1.14E-01	1.14E-01
48																					
49																					
50																					
51		1.28E-01	6.53E+03	1.11E+02		6.14E+01	3.43E+06	3.43E+06		1.04E+03	1.81E-01	2.20E-02	3.01E+02	5.90E+01	3.67E-03	1.45E+01	6.96E-01	1.91E+05	1.81E+05	7.49E-02	2.20E-03

Attachment 2
WCS Sludge Inventory
Reference Date: 12/22/04
'WG17\WCS1.5PROD\WCS1.5\
T-SldgInv'

Tank	Pm-147 (Ci)	Eu-154 (Ci)	Th-232 (Ci)	U-232 (Ci)	U-233 (Ci)	U-234 (Ci)	U-235 (Ci)	U-236 (Ci)	U-238 (Ci)	Np-237 (Ci)	Pu-238 (Ci)	Pu-239 (Ci)	Pu-240 (Ci)	Pu-241 (Ci)	Pu-242 (Ci)	Ingrown Am-241 (Ci)	Am-241 (Ci)	Am-242m (Ci)	Cm-244 (Ci)	Cm-245 (Ci)
1	1.97E+02	9.88E+02		1.24E-02			1.76E-02		4.39E-01	6.41E-01	5.19E+02	1.33E+02	2.97E+01	1.66E+02	6.12E-03	4.12E+01	2.10E+03	2.64E+00	3.89E-01	4.62E-07
2	4.69E+00	9.07E+01		1.69E-03			8.12E-04		2.02E-02	2.12E-01	1.38E+02	1.98E+01	4.42E+00	1.89E+01	9.08E-04	6.09E+00	2.95E+02	3.65E-01	4.53E-02	6.55E-08
3	7.45E+00	9.18E+01		1.49E-03			2.03E-03		5.06E-02	3.78E-01	1.66E+02	2.38E+01	5.31E+00	2.73E+01	1.09E-03	7.41E+00	2.57E+02	3.19E-01	4.22E-02	5.67E-08
4	2.86E+04	1.17E+04		7.01E-02			7.77E-02		3.34E+00	2.98E+00	6.05E+02	5.98E+02	1.34E+02	1.15E+03	2.75E-02	1.79E+02	1.16E+04	1.43E+01	1.59E+04	6.90E-01
5	2.07E+03	5.55E+03		5.57E-02			1.05E-01		2.48E+00	4.19E+00	2.89E+03	4.82E+02	1.15E+02	7.84E+02	3.40E-02	1.75E+02	9.19E+03	1.16E+01	1.92E+00	2.01E-06
6	4.84E+03	7.76E+03		6.05E-02			6.65E-02		2.49E+00	8.63E-01		2.55E+02	8.84E+01	1.01E+03	1.74E-01	1.77E+02	9.84E+03	1.25E+01	1.38E+03	2.12E-06
7	2.97E+02	4.08E+02		4.41E-03	7.96E-01	5.39E-01	2.33E-02	7.43E-03	6.58E-01	4.35E-01	1.18E+03	3.01E+02	6.99E+01	5.88E+02	3.37E-01	6.36E+01	7.55E+02	8.24E-01	5.33E+02	8.89E-03
8	1.00E+02	8.73E+01		6.31E-04			1.49E-03		6.84E-02	3.11E-02	1.24E+02	1.95E+01	4.60E+00	4.45E+01	5.80E-03	4.87E+00	1.05E+02	1.21E-01	1.83E+02	3.35E-03
9	5.03E+00	9.76E+01		1.82E-03			1.18E-03		2.94E-02	2.01E-01	4.37E+01	6.24E+00	1.39E+00	5.89E+00	2.87E-04	1.91E+00	3.19E+02	3.94E-01	4.88E-02	7.07E-08
10	6.45E-01	1.16E+01		1.88E-04			2.28E-04		5.69E-03	4.35E-02	2.21E+01	3.16E+00	7.06E-01	3.19E+00	1.45E-04	9.84E-01	3.30E+01	4.08E-02	6.62E-03	2.98E-07
11	4.02E+03	1.79E+04	5.11E-03	5.81E-05	7.29E-01	5.99E-01	1.13E-02	9.25E-02	2.09E-02	3.95E-01	5.37E+04	5.32E+02	3.34E+02	1.94E+04	7.11E-01	2.20E+03	2.53E+03	2.99E+00	3.00E+02	1.94E-03
12	6.16E+03	6.00E+04	1.36E+00	1.37E-02	3.83E+01	3.58E+00	6.74E-02	2.84E-01	6.79E-01	7.94E+00	1.39E+05	2.32E+03	1.28E+03	3.31E+04	1.85E+00	4.59E+03	1.33E+04	1.58E+01	2.16E+03	8.38E-03
13	3.17E+03	3.94E+04	1.98E-01	5.42E-02	4.06E+01	5.73E+00	1.57E-01	5.91E-01	1.83E+00	1.47E+01	5.46E+04	1.46E+03	6.03E+02	1.08E+04	4.00E-01	2.27E+03	1.65E+04	1.98E+01	2.56E+03	5.98E-03
14	2.35E+01	4.44E+02	1.06E-02	3.15E-03	3.74E-01	5.13E-02	4.15E-03	4.41E-03	7.91E-02	5.48E-01	2.46E+02	6.04E+01	1.95E+01	1.00E+02	3.57E-03	2.47E+01	6.26E+02	7.71E-01	4.25E-01	6.11E-05
15	4.05E+03	5.08E+04	1.13E+00		1.39E+01	3.79E+00	6.12E-02	3.59E-01	1.40E-03	3.55E+00	5.71E+04	1.22E+03	5.90E+02	1.25E+04	4.45E-01	2.60E+03	1.12E+04	1.30E+01	8.83E+02	8.64E-03
16																				
17	3.09E+00	2.25E+00		4.78E-05			3.29E-04		2.04E-02		8.38E+01	1.20E+01	3.17E+00	3.98E+01	4.55E-03	4.95E+00	1.65E-01		5.75E+01	4.77E-10
18	3.23E+00	2.37E+00		5.28E-05	7.96E-01	5.39E-01	7.19E-03	7.43E-03	1.84E-01	8.43E-02	6.97E+01	1.32E+02	2.97E+01	2.66E+02	3.13E-01	8.67E+00	7.23E+01		4.83E+01	5.32E-10
19	9.47E-01	5.77E-01		1.01E-05			6.80E-05		6.21E-03		2.55E+01	3.64E+00	8.13E-01	9.46E+01	1.67E-03	1.06E+01			1.34E-04	9.71E-11
20																				
21	3.63E+03	6.80E+02	5.67E-06		1.79E-01	1.91E-01	3.03E-03	3.50E-02	1.79E-02	1.58E-01	9.54E+02	1.40E+01	4.76E+00	8.39E+01	5.33E-04	2.81E+00	5.66E+01	3.98E-01	1.38E+02	1.81E-02
22	6.34E+02	1.38E+03			1.07E+00	3.86E-01	5.91E-03	6.36E-02	1.31E-01	2.35E-01	1.60E+03						9.37E+01	1.13E-01	1.00E+00	9.94E-05
23																				
24																				
25																				
26	2.95E+04	1.36E+03		9.97E-03	2.60E-08	8.55E-08	2.53E-02	3.17E-03	3.01E+00	7.85E-03	1.76E+04	2.51E+03	5.61E+02	1.32E+04	1.12E-01	5.66E+02			1.89E-01	8.55E-08
27																				
28																				
29																				
30	1.96E+03	8.20E+02				1.83E-02	3.25E-04	3.37E-03	1.20E-05	8.25E-03	3.53E+03	3.06E+01	2.20E+01	2.30E+03	5.26E-02	1.08E+02	3.81E+01	4.71E-02	4.11E-01	2.83E-05
31																				
32	1.29E+05	1.30E+05				2.77E+00	3.97E-02	6.22E-01	1.86E-02	1.15E+00	4.04E+05	3.53E+03	2.62E+03	1.83E+05	5.53E+00	1.49E+04	1.19E+04	1.42E+01	9.09E+01	8.97E-03
33	1.73E+06	5.98E+04		1.17E-01	5.39E-07	1.11E-02	2.09E-01	1.16E-01	3.02E+01	9.48E+00	1.55E+04	8.44E+03	1.48E+03	4.47E+04	8.57E-02	5.05E+02	1.58E+04	2.15E+01	7.93E+00	3.33E-06
34	6.81E+05	4.80E+04		1.17E-01			1.14E-01		8.05E+00	6.22E+00	0.00E+00	1.30E+03	2.91E+02	6.12E+03	6.03E-02	3.12E+02	1.50E+05	2.23E+01	7.31E+00	3.49E-06
35	1.61E+05	1.39E+05				2.72E+00	4.72E-02	8.02E-01	2.79E-02	9.83E-01	4.08E+05	3.29E+03	2.52E+03	1.99E+05	5.66E+00	1.45E+04	1.00E+04	1.22E+01	8.68E+01	7.51E-03
36	7.42E+01	1.33E+02				7.26E-03	1.41E-04	2.56E-03	4.60E-05	2.03E-03	6.31E+02	4.90E+00	3.90E+00	2.60E+02	8.42E-03	2.18E+01	1.13E+01	1.36E-02	9.13E-02	8.49E-06
37																				
38																				
39	1.17E+06	2.66E+05				1.00E+01	1.41E-01	1.72E+00	3.36E-02	6.13E+00	6.24E+05	7.29E+03	4.67E+03	5.58E+05	1.03E+01	2.08E+04	1.15E+04	1.43E+01	1.27E+02	8.57E-03
40	6.97E+03	1.62E+04	6.52E-02	8.14E-02	2.37E+00	2.13E+00	3.41E-01	4.50E-01	1.06E+01	3.69E+01	3.81E+04	1.09E+04	4.11E+03	6.18E+04	2.26E+00	1.40E+03	1.46E+04	3.17E+01	1.32E+05	1.47E+01
41	2.17E+02	2.10E+02				1.23E-02	1.43E-04	3.54E-03	9.78E-06	3.69E-02	2.02E+02						9.78E+00	1.19E-02	1.26E-01	1.03E-05
42	3.42E+02	2.28E+03	4.36E-02	2.30E-04	6.14E-01	2.26E-01	5.33E-03	3.02E-02	9.35E-02	1.86E-01	3.03E+03	1.05E+02	3.76E+01	6.54E+02	3.44E-02	1.23E+02	4.52E+02	5.26E-01	2.41E+02	3.54E-04
43	2.06E+05	4.98E+04				3.41E+00	3.06E-01	6.49E-01	3.82E-03	3.63E+00	8.28E+04	3.26E+02	2.75E+02	7.19E+04	4.06E+00	1.03E+03	1.70E+03	2.11E+00	2.28E+01	1.46E-03
44																				
45																				
46																				
47	8.83E+03	7.96E+02		6.95E-03			1.86E-02		1.48E+00		1.58E+04	2.26E+03	5.06E+02	1.00E+04	1.04E-01	5.61E+02			1.23E-01	6.09E-08
48																				
49																				
50																				
51	7.65E+03	3.32E+04	1.17E-02	2.50E-03	1.39E+00	1.16E+00	3.27E-02	1.86E-01	3.56E-01	9.79E-01	9.80E+04	1.43E+03	7.91E+02	3.82E+04	1.37E+00	4.00E+03	5.01E+03	6.68E+00	6.71E+03	7.47E-01

Attachment 3

Calculation of Sludge Concentration Averages and Scaling Factors from WCS Concentration Data

Attachment 3

F Tank Farm

Calculation of Sludge Concentration Averages and Scaling Factors from WCS Concentration Data

Reference Date: 12/22/04

'WG17\WCS1.5PROD\WCS1.5\T-SldgConc'

Tank	H-3	C-14	Co-60	Ni-59	Ni-63	Se-79	Sr-90	Y-90	Nb-94	Tc-99	Ru-106	Rh-106	Sb-125	Sn-126	I-129	Cs-134
	Concentration (Ci/gal)															
1		1.81E-06	3.11E-02	3.32E-03		2.31E-03	8.11E+01	8.11E+01		3.99E-02	9.14E-10	9.14E-10	2.01E-03	4.29E-03	1.90E-07	1.94E-06
2		7.04E-07	3.50E-03	8.29E-04		5.68E-04	1.76E+01	1.76E+01		9.82E-03	9.67E-13	9.67E-13	8.99E-05	1.06E-03	4.68E-08	4.42E-08
3		6.10E-07	3.99E-03	7.18E-04		4.91E-04	1.60E+01	1.60E+01		8.50E-03	6.50E-12	6.50E-12	1.39E-04	9.14E-04	4.05E-08	8.64E-08
4		2.63E-08	4.00E-02	9.32E-04		6.66E-04	2.94E+01	2.94E+01		1.15E-02	2.43E-06	2.43E-06	1.40E-02	1.24E-03	5.49E-08	4.31E-05
5		1.31E-06	4.32E-02	2.98E-03		2.09E-03	7.94E+01	7.94E+01		3.61E-02	8.27E-09	8.27E-09	4.22E-03	3.88E-03	1.72E-07	5.45E-06
6			9.66E-02	4.17E-03		2.99E-03	1.25E+02	1.25E+02		5.17E-02	8.05E-08	8.05E-08	1.31E-02	5.56E-03	2.46E-07	2.08E-05
7		2.02E-06	6.09E-03	4.74E-04		2.66E-04	9.88E+00	9.88E+00		4.63E-03	4.32E-08	4.32E-08	9.88E-04	4.92E-04	2.18E-08	2.02E-06
8		7.68E-07	7.68E-03	2.89E-04		1.78E-04	7.65E+00	7.65E+00		3.08E-03	7.74E-08	7.74E-08	1.59E-03	3.31E-04	1.47E-08	3.45E-06
18		8.86E-07	2.10E-04	5.21E-05		1.17E-05	3.26E-01	3.26E-01		3.40E-04	2.17E-09	2.17E-09	4.83E-05	8.01E-06	3.55E-10	1.12E-07
26		2.36E-06	4.41E-03	1.39E-04		1.15E-05	7.56E-01	7.56E-01		1.99E-04	3.22E-04	3.22E-04	6.26E-03	2.13E-05	9.46E-10	5.11E-05
33		1.48E-06	6.47E-01	2.02E-03		1.39E-03	9.47E+01	9.47E+01		2.41E-02	6.06E-02	6.06E-02	1.11E+00	2.59E-03	1.15E-07	1.00E-02
34			1.79E+00	8.50E-03		6.08E-03	3.82E+02	3.82E+02		1.05E-01	1.71E-02	1.71E-02	1.91E+00	1.13E-02	5.01E-07	1.22E-02
47		1.74E-06	2.19E-03	1.02E-04		8.47E-06	5.23E-01	5.23E-01		1.47E-04	4.79E-06	4.79E-06	1.87E-03	1.57E-05	6.98E-10	9.85E-06
Average		1.25E-06	2.06E-01	1.89E-03		1.31E-03	6.49E+01	6.49E+01		2.27E-02	6.00E-03	6.00E-03	2.36E-01	2.44E-03	1.08E-07	1.72E-03
		1.74E-06	(*Tank 47 only))													
19		4.64E-08	1.62E-05	2.73E-06		2.26E-07	1.10E-02	1.10E-02		3.91E-06	1.21E-10	1.21E-10	4.06E-06	4.19E-07	1.86E-11	9.22E-09

	Scaling Factors (Ci/Ci Sr-90)															
1		2.24E-08								4.92E-04					2.35E-09	
2		3.99E-08								5.57E-04					2.65E-09	
3		3.81E-08								5.31E-04					2.53E-09	
4		8.92E-10								3.92E-04					1.87E-09	
5		1.65E-08								4.55E-04					2.17E-09	
6										4.14E-04					1.97E-09	
7		2.04E-07								4.69E-04					2.21E-09	
8		1.00E-07								4.03E-04					1.92E-09	
18		2.72E-06								1.04E-03					1.09E-09	
26		3.13E-06								2.64E-04					1.25E-09	
33		1.56E-08								2.54E-04					1.21E-09	
34										2.75E-04					1.31E-09	
47		3.33E-06								2.81E-04					1.33E-09	
		3.33E-06	(*Tank 47 only)													
19		4.20E-06								3.55E-04					1.68E-09	8.36E-07

F Tank Farm

Calculation of Sludge Concentration Averages and Scaling Factors from WCS Concentration Data

Reference Date: 12/22/04

'WG17\WCS1.5PROD\WCS1.5\T-SldgConc'

Tank	Cs-135	Cs-137	Ba-137m	Ce-144	Pr-144	Pm-147	Eu-154	Th-232	U-232	U-233	U-234	U-235	U-236	U-238	Np-237	Pu-238
Concentration (Ci/gal)																
1	2.67E-05	5.74E+00	5.43E+00	1.02E-12	1.02E-12	2.80E-02	1.40E-01		1.76E-06			2.50E-06		6.23E-05	9.09E-05	7.37E-02
2	6.57E-06	1.26E+00	1.19E+00	1.46E-16	1.46E-16	1.15E-03	2.23E-02		4.16E-07			2.00E-07		4.98E-06	5.21E-05	3.40E-02
3	5.69E-06	1.14E+00	1.08E+00	2.43E-15	2.43E-15	1.83E-03	2.26E-02		3.67E-07			4.99E-07		1.24E-05	9.30E-05	4.09E-02
4	7.71E-06	2.06E+00	1.94E+00	4.73E-08	4.73E-08	2.25E-01	9.24E-02		5.51E-07			6.11E-07		2.63E-05	2.35E-05	4.76E-03
5	2.42E-05	5.59E+00	5.29E+00	1.74E-11	1.74E-11	6.10E-02	1.64E-01		1.64E-06			3.09E-06		7.32E-05	1.24E-04	8.53E-02
6	3.46E-05	8.75E+00	8.28E+00	3.15E-10	3.15E-10	1.94E-01	3.11E-01		2.43E-06			2.67E-06		9.97E-05	3.46E-05	
7	3.06E-06	1.31E+00	1.24E+00	7.82E-10	7.82E-10	1.51E-02	2.07E-02		2.24E-07	4.04E-05	2.73E-05	1.18E-06	3.77E-07	3.34E-05	2.21E-05	5.97E-02
8	2.06E-06	5.36E-01	5.07E-01	1.41E-09	1.41E-09	2.45E-02	2.13E-02		1.54E-07			3.63E-07		1.67E-05	7.57E-06	3.04E-02
18	5.00E-08	2.84E+00	2.68E+00	2.38E-11	2.38E-11	7.52E-04	5.52E-04		1.23E-08	1.85E-04	1.25E-04	1.67E-06	1.73E-06	4.28E-05	1.96E-05	1.62E-02
26	1.33E-07	5.17E-02	4.89E-02	1.51E-04	1.51E-04	1.14E-01	5.23E-03		3.84E-08	1.00E-13	3.30E-13	9.74E-08	1.22E-08	1.16E-05	3.03E-08	6.77E-02
33	1.61E-05	6.47E+00	6.12E+00	2.18E-02	2.18E-02	2.05E+01	7.10E-01		1.39E-06	6.40E-12	1.32E-07	2.48E-06	1.37E-06	3.58E-04	1.13E-04	1.84E-01
34	7.04E-05	2.62E+01	2.48E+01	2.56E-03	2.56E-03	3.37E+01	2.38E+00		5.80E-06			5.65E-06		3.99E-04	3.08E-04	
47	9.82E-08	3.59E-02	3.40E-02	3.38E-07	3.38E-07	3.23E-02	3.10E-03		2.77E-08			7.52E-08		5.95E-06		6.35E-02
Average	1.52E-05	4.77E+00	4.51E+00	1.89E-03	1.89E-03	4.22E+00	2.99E-01		1.14E-06	5.64E-05	3.82E-05	1.62E-06	8.72E-07	8.82E-05	7.40E-05	6.00E-02
											1.25E-04	(*only Tank 18)				
19	2.61E-09	7.67E-04	7.26E-04	9.00E-13	9.00E-13	6.31E-05	3.85E-05		6.72E-10			4.53E-09		4.14E-07		1.70E-03

Scaling Factors (Ci/Ci Sr-90)																
1																
2																
3																
4																
5																
6																
7											2.77E-06					
8																
18											3.85E-04					
26											4.36E-13					
33											1.39E-09					
34																
47											0.00E+00					
											3.85E-04	(*only Tank 18)				
19																

Attachment 3

F Tank Farm

Calculation of Sludge Concentration Averages and Scaling Factors from WCS Concentration Data

Reference Date: 12/22/04

'WG17\WCS1.5PROD\WCS1.5\T-SldgConc'

Tank	Pu-239	Pu-240	Pu-241	Pu-242	Ingrown Am-241	Am-241	Am-242m	Cm-244	Cm-245	Total	TRU	Fractional Activity of Predominant Radionuclides	
Concentration (Ci/gal)												Sr-90/Total	Y-90/Total
1	1.89E-02	4.22E-03	2.36E-02	8.68E-07	5.85E-03	2.98E-01	3.74E-04	5.53E-05	6.55E-11	1.74E+02		4.66E-01	4.66E-01
2	4.86E-03	1.09E-03	4.64E-03	2.23E-07	1.50E-03	7.27E-02	8.98E-05	1.11E-05	1.61E-11	3.79E+01		4.66E-01	4.66E-01
3	5.85E-03	1.31E-03	6.72E-03	2.69E-07	1.82E-03	6.31E-02	7.84E-05	1.04E-05	1.40E-11	3.44E+01		4.65E-01	4.65E-01
4	4.70E-03	1.05E-03	9.04E-03	2.16E-07	1.41E-03	9.11E-02	1.13E-04	1.25E-01	5.43E-06	6.35E+01		4.64E-01	4.64E-01
5	1.42E-02	3.40E-03	2.32E-02	1.00E-06	5.15E-03	2.71E-01	3.43E-04	5.66E-05	5.92E-11	1.70E+02		4.66E-01	4.66E-01
6	1.02E-02	3.55E-03	4.05E-02	6.98E-06	7.10E-03	3.95E-01	5.02E-04	5.53E-02	8.49E-11	2.68E+02		4.66E-01	4.66E-01
7	1.53E-02	3.55E-03	2.98E-02	1.71E-05	3.23E-03	3.83E-02	4.18E-05	2.70E-02	4.51E-07	2.25E+01		4.38E-01	4.38E-01
8	4.76E-03	1.12E-03	1.09E-02	1.41E-06	1.19E-03	2.56E-02	2.94E-05	4.46E-02	8.18E-07	1.65E+01		4.63E-01	4.63E-01
18	3.07E-02	6.91E-03	6.19E-02	7.28E-05	2.02E-03	1.68E-02		1.12E-02	1.24E-13	6.32E+00		5.15E-02	5.15E-02
26	9.67E-03	2.16E-03	5.09E-02	4.34E-07	2.18E-03			7.29E-07	3.30E-13	1.88E+00		4.03E-01	4.03E-01
33	1.00E-01	1.76E-02	5.31E-01	1.02E-06	5.99E-03	1.88E-01	2.55E-04	9.41E-05	3.96E-11	2.26E+02		4.19E-01	4.19E-01
34	6.44E-02	1.44E-02	3.03E-01	2.99E-06	1.54E-02	7.44E+00	1.10E-03	3.62E-04	1.73E-10	8.63E+02		4.43E-01	4.43E-01
	9.13E-03	2.04E-03	3.97E-02	4.20E-07	2.29E-03			4.86E-07	2.43E-13	1.27E+00		4.11E-01	4.11E-01
Average	2.25E-02	4.80E-03	8.73E-02	8.13E-06	4.24E-03	8.09E-01	2.93E-04	2.03E-02	5.15E-07	1.45E+02	9.01E-01		
19	2.43E-04	5.42E-05	6.31E-03	1.12E-07	7.05E-04			8.96E-09	6.48E-15	3.27E-02	2.70E-03		

Scaling Factors (Ci/Ci Sr-90)											
1											
2											
3											
4											
5											
6											
7											
8											
18											
26											
33											
34											
47											
19											0.00E+00

WSRC-TR-2000-00215
Revision 2
Data obtained: 2/3/05

Attachment 4

Comparison of F-Area Tank Farm Sludge Scaling Factors and Predominant Radionuclides for Consolidation

Attachment 4

Comparison of F Area Tank Farm Sludge Scaling Factors and Predominant Radionuclides for Consolidation

			Comparison of Tank Scaling Factors to Proposed Scaling Factors							
		Proposed Scaling Factor for C-14	Acceptable Range	Proposed Scaling Factor for Tc-99	Acceptable Range	Proposed Scaling Factor for I-129	Acceptable Range	Proposed Scaling Factor for U-234	Acceptable Range
		1.92E-08	1.92E-10 to 1.92E-07	3.50E-04	3.50E-05 to 3.50E-03	1.66E-09	1.66E-10 to 1.66E-08	5.88E-07	5.88E-08 to 5.8E-06
Tank	H-3	C-14	Within Range?	Tc-99	Within Range?	I-129	Within Range?	U-234	Within Range?
1		2.24E-08	Y	4.92E-04	Y	2.35E-09	Y		
2		3.99E-08	Y	5.57E-04	Y	2.65E-09	Y		
3		3.81E-08	Y	5.31E-04	Y	2.53E-09	Y		
4		8.92E-10	**N**	3.92E-04	Y	1.87E-09	Y		
5		1.65E-08	Y	4.55E-04	Y	2.17E-09	Y		
6				4.14E-04	Y	1.97E-09	Y		
7		2.04E-07	**N**	4.69E-04	Y	2.21E-09	Y	2.77E-06	Y
8		1.00E-07	**N**	4.03E-04	Y	1.92E-09	Y		
18		2.72E-06	**N**	1.04E-03	Y	1.09E-09	Y	**3.85E-04**	**N**
26		3.13E-06	**N**	2.64E-04	Y	1.25E-09	Y	4.36E-13	**N**
33		1.56E-08	Y	2.54E-04	Y	1.21E-09	Y	1.39E-09	**N**
34				2.75E-04	Y	1.31E-09	Y		
47		**3.33E-06**	**N**	2.81E-04	Y	1.33E-09	Y		
Most Conservative Scaling Factor		**3.33E-06**						**3.85E-04**	

Fractional activity (from Att. 3)															
Isotope	**Tank 1**	**Tank 2**	**Tank 3**	**Tank 4**	**Tank 5**	**Tank 6**	**Tank 7**	**Tank 8**	**Tank 18**	**Tank 26**	**Tank 33**	**Tank 34**	**Tank 47**	**Proposed Fractional Activity***	**Acceptable Range**
Sr-90	4.66E-01	4.66E-01	4.65E-01	4.64E-01	4.66E-01	4.66E-01	4.38E-01	4.63E-01	5.15E-02	4.03E-01	4.19E-01	4.43E-01	4.11E-01	4.50E-01	0.225 to 0.90
Y-90	4.66E-01	4.66E-01	4.65E-01	4.64E-01	4.66E-01	4.66E-01	4.38E-01	4.63E-01	5.15E-02	4.03E-01	4.19E-01	4.43E-01	4.11E-01	4.50E-01	0.225 to 0.90
Within Range?	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y		

* mean is conservative for Tk 18 which falls outside the range

Attachment 5

F-Area Tank Farm Sludge Waste Streams Exclusion Criteria

					Proposed Distribution for Waste Stream FTK-00002-1			
Isotope	**Average Concentration (Ci/gal)**	**Distribution (%)**	**<1% of dist?**	**Not Expected**	RADs remaining after excl criteria	Average Concentration (Ci/gal)	Proposed Normalized Distribution (Ci %)	Proposed Scaling Factors
Waste Stream FTK-00002-1								
H-3				x				
C-14	1.25E-06	8.59E-07			**C-14**	1.25E-06	8.64E-07	1.92E-08
Co-60	2.06E-01	1.42E-01	yes					
Ni-59	1.89E-03	1.30E-03	yes					
Ni-63				x				
Se-79	1.31E-03	9.04E-04	yes					
Sr-90	6.49E+01	4.47E+01	no		Sr-90	6.49E+01	4.50E+01	
Y-90	6.49E+01	4.47E+01	no		Y-90	6.49E+01	4.50E+01	
Nb-94				x				
Tc-99	2.27E-02	1.56E-02			**Tc-99**	2.27E-02	1.57E-02	3.50E-04
Ru-106	6.00E-03	4.13E-03	yes					
Rh-106	6.00E-03	4.13E-03	yes					
Sb-125	2.36E-01	1.62E-01	yes					
Sn-126	2.44E-03	1.68E-03	yes					
I-129	1.08E-07	7.45E-08			**I-129**	1.08E-07	7.49E-08	1.66E-09
Cs-134	1.72E-03	1.18E-03	yes					
Cs-135	1.52E-05	1.05E-05	yes					
Cs-137	4.77E+00	3.28E+00	no		Cs-137	4.77E+00	3.30E+00	
Ba-137m	4.51E+00	3.11E+00	no		Ba-137m	4.51E+00	3.12E+00	
Ce-144	1.89E-03	1.30E-03	yes					
Pr-144	1.89E-03	1.30E-03	yes					
Pm-147	4.22E+00	2.91E+00	no		Pm-147	4.22E+00	2.92E+00	
Eu-154	2.99E-01	2.06E-01	yes					
Th-232				x				
U-232	1.14E-06	7.85E-07	yes					
U-233	5.64E-05	3.88E-05			U-233	5.64E-05	3.90E-05	
U-234	3.82E-05	2.63E-05			**U-234**	3.82E-05	2.65E-05	5.88E-07
U-235	1.62E-06	1.12E-06			U-235	1.62E-06	1.12E-06	
U-236	8.72E-07	6.01E-07	yes					
U-238	8.82E-05	6.08E-05	yes					
Np-237	7.40E-05	5.10E-05			Np-237	7.40E-05	5.12E-05	
Pu-238	6.00E-02	4.13E-02			Pu-238	6.00E-02	4.16E-02	
Pu-239	2.25E-02	1.55E-02			Pu-239	2.25E-02	1.56E-02	
Pu-240	4.80E-03	3.31E-03			Pu-240	4.80E-03	3.32E-03	
Pu-241	8.73E-02	6.01E-02			Pu-241	8.73E-02	6.05E-02	
Pu-242	8.13E-06	5.60E-06			Pu-242	8.13E-06	5.63E-06	
Am-241	8.13E-01	5.60E-01			Am-241	8.13E-01	5.63E-01	
Am-242m	2.93E-04	2.02E-04			Am-242m	2.93E-04	2.03E-04	
Cm-244	2.03E-02	1.40E-02	yes					
Cm-245	5.15E-07	3.55E-07			Cm-245	5.15E-07	3.57E-07	
Total	1.45E+02	1.00E+02			Total	1.44E+02	1.00E+02	

Bold = PA radionuclides

					Proposed Distribution for Waste Stream FTK-00002-19			
Isotope	**Average Concentration (Ci/gal)**	**Distribution (%)**	**<1% of dist?(a)**	**Not Expected**	RADs remaining after excl criteria	Average Concentration (Ci/gal)	Proposed Normalized Distribution (Ci%)	Proposed Scaling Factors
Waste Stream FTK-00002-19								
H-3				x				
C-14	4.64E-08	1.42E-04			**C-14**	4.64E-08	1.42E-04	4.20E-06
Co-60	1.62E-05	4.96E-02	yes					
Ni-59	2.73E-06	8.34E-03	yes					
Ni-63				x				
Se-79	2.26E-07	6.90E-04	yes					
Sr-90	1.10E-02	3.37E+01	no		Sr-90	1.10E-02	3.39E+01	
Y-90	1.10E-02	3.37E+01	no		Y-90	1.10E-02	3.39E+01	
Nb-94				x				
Tc-99	3.91E-06	1.20E-02			**Tc-99**	3.91E-06	1.20E-02	3.55E-04
Ru-106	1.21E-10	3.70E-07	yes					
Rh-106	1.21E-10	3.70E-07	yes					
Sb-125	4.06E-06	1.24E-02	yes					
Sn-126	4.19E-07	1.28E-03	yes					
I-129	1.86E-11	5.68E-08			**I-129**	1.86E-11	5.70E-08	1.68E-09
Cs-134	9.22E-09	2.82E-05	yes					
Cs-135	2.61E-09	7.99E-06	yes					
Cs-137	7.67E-04	2.35E+00	no		Cs-137	7.67E-04	2.36E+00	
Ba-137m	7.26E-04	2.22E+00	no		Ba-137m	7.26E-04	2.23E+00	
Ce-144	9.00E-13	2.75E-09	yes					
Pr-144	9.00E-13	2.75E-09	yes					
Pm-147	6.31E-05	1.93E-01	yes					
Eu-154	3.85E-05	1.18E-01	yes					
Th-232				x				
U-232	6.72E-10	2.05E-06	yes					
U-233				x				
U-234				x				
U-235	4.53E-09	1.39E-05			U-235	4.53E-09	1.39E-05	
U-236				x				
U-238	4.14E-07	1.27E-03	yes					
Np-237				x				
Pu-238	1.70E-03	5.19E+00			Pu-238	1.70E-03	5.21E+00	
Pu-239	2.43E-04	7.42E-01			Pu-239	2.43E-04	7.45E-01	
Pu-240	5.42E-05	1.66E-01			Pu-240	5.42E-05	1.66E-01	
Pu-241	6.31E-03	1.93E+01			Pu-241	6.31E-03	1.94E+01	
Pu-242	1.12E-07	3.41E-04			Pu-242	1.12E-07	3.42E-04	
Am-241	7.05E-04	2.16E+00			Am-241	7.05E-04	2.16E+00	
Am-242m				x				
Cm-244	8.96E-09	2.74E-05	yes					
Cm-245	6.48E-15	1.98E-11			Cm-245	6.48E-15	1.99E-11	
Total	3.27E-02	1.00E+02			Total	3.26E-02	1.00E+02	

Bold = PA radionuclides

Attachment 6

F Area Tank Farm Sludge Distributions and Scaling Factors

		Final Distribution	
Isotope	Average Concentration (Ci/gal)	**Distribution (Ci%)**	**Scaling Factors**
Waste Stream FTK-00002-1			
C-14[a]	1.74E-06	1.21E-06	3.33E-06
Sr-90	6.49E+01	4.50E+01	1.00E+00
Y-90	6.49E+01	4.50E+01	1.00E+00
Tc-99	2.27E-02	1.57E-02	3.50E-04
I-129	1.08E-07	7.49E-08	1.66E-09
Cs-137	4.77E+00	3.30E+00	7.34E-02
Ba-137m	4.51E+00	3.12E+00	6.94E-02
Pm-147	4.22E+00	2.92E+00	6.50E-02
U-233	5.64E-05	3.90E-05	8.68E-07
U-234[b]	1.25E-04	8.68E-05	3.85E-04
U-235	1.62E-06	1.12E-06	2.50E-08
Np-237	7.40E-05	5.12E-05	1.14E-06
Pu-238	6.00E-02	4.16E-02	9.24E-04
Pu-239	2.25E-02	1.56E-02	3.47E-04
Pu-240	4.80E-03	3.32E-03	7.39E-05
Pu-241	8.73E-02	6.05E-02	1.34E-03
Pu-242	8.13E-06	5.63E-06	1.25E-07
Am-241	8.13E-01	5.63E-01	1.25E-02
Am-242m	2.93E-04	2.03E-04	4.51E-06
Cm-245	5.15E-07	3.57E-07	7.93E-09
Total	1.44E+02	1.00E+02	2.22E+00
Total TRU Concentration	9.01E-01		
TRU Scaling Factor			1.39E-02

(a) Average concentration for C-14 includes only Tank 47 per Attachment 4 evaluation.
(b) Average concentration for U-234 includes only Tank 18 per Attachment 4 evaluation.

		Final Distribution	
Isotope	Average Concentration (Ci/gal)	**Distribution (Ci%)**	**Scaling Factors**
Waste Stream FTK-00002-19			
C-14	4.64E-08	1.42E-04	4.20E-06
Sr-90	1.10E-02	3.39E+01	1.00E+00
Y-90	1.10E-02	3.39E+01	1.00E+00
Tc-99	3.91E-06	1.20E-02	3.55E-04
I-129	1.86E-11	5.70E-08	1.68E-09
Cs-137	7.67E-04	2.36E+00	6.95E-02
Ba-137m	7.26E-04	2.23E+00	6.58E-02
U-235	4.53E-09	1.39E-05	4.10E-07
Pu-238	1.70E-03	5.21E+00	1.54E-01
Pu-239	2.43E-04	7.45E-01	2.20E-02
Pu-240	5.42E-05	1.66E-01	4.91E-03
Pu-241	6.31E-03	1.94E+01	5.72E-01
Pu-242	1.12E-07	3.42E-04	1.01E-05
Am-241	7.05E-04	2.16E+00	6.39E-02
Cm-245	6.48E-15	1.99E-11	5.87E-13
Total	3.26E-02	1.00E+02	2.95E+00
Total TRU Concentration	2.70E-03		
TRU Scaling Factor			2.45E-01

Attachment 7

F Area Tank Farm Sludge Stream Activity at the Engineered Trench Limit

Bounding Quantity of Sludge at ET Limit = 3.96E-03 gal.			
Isotope	**Concentration (Ci/gal)**	**Normalized Distribution (%)**	**Quantity of Isotope in B-25 at ET Limit (Ci)**
		Conc/TTL Conc.	B*3.96E-03
Waste Stream FTK-00002-1			
C-14[a]	1.74E-06	1.21E-06	6.90E-09
Sr-90	6.49E+01	4.50E+01	2.57E-01
Y-90	6.49E+01	4.50E+01	2.57E-01
Tc-99	2.27E-02	1.57E-02	8.99E-05
I-129	1.08E-07	7.49E-08	4.28E-10
Cs-137	4.77E+00	3.30E+00	1.89E-02
Ba-137m	4.51E+00	3.12E+00	1.79E-02
Pm-147	4.22E+00	2.92E+00	1.67E-02
U-233	5.64E-05	3.90E-05	2.23E-07
U-234[b]	1.25E-04	8.68E-05	4.96E-07
U-235	1.62E-06	1.12E-06	6.42E-09
Np-237	7.40E-05	5.12E-05	2.93E-07
Pu-238	6.00E-02	4.16E-02	2.38E-04
Pu-239	2.25E-02	1.56E-02	8.92E-05
Pu-240	4.80E-03	3.32E-03	1.90E-05
Pu-241	8.73E-02	6.05E-02	3.46E-04
Pu-242	8.13E-06	5.63E-06	3.22E-08
Am-241	8.13E-01	5.63E-01	3.22E-03
Am-242m	2.93E-04	2.03E-04	1.16E-06
Cm-245	5.15E-07	3.57E-07	2.04E-09
Total	1.44E+02	1.00E+02	5.72E-01
Total TRU	9.01E-01		**3.57E-03**

(a) Concentration and scaling factor for C-14 include only Tank 47 per Attachment 4 evaluation.
(b) Average concentration and scaling factor for U-234 includes only Tank 18 per Attachment 4 evaluation.

Bounding Quantity of Sludge at ET Limit = 2.30E+01 gal.			
Isotope	**Concentration (Ci/gal)**	**Distribution (%)**	**Quantity of Isotope for B-25 at ET Limit (Ci)**
		Conc/TTL Conc.	B*2.30E+01
Waste Stream FTK-00002-19			
C-14	4.64E-08	1.42E-04	1.07E-06
Sr-90	1.10E-02	3.39E+01	2.54E-01
Y-90	1.10E-02	3.39E+01	2.54E-01
Tc-99	3.91E-06	1.20E-02	9.00E-05
I-129	1.86E-11	5.70E-08	4.27E-10
Cs-137	7.67E-04	2.36E+00	1.77E-02
Ba-137m	7.26E-04	2.23E+00	1.67E-02
U-235	4.53E-09	1.39E-05	1.04E-07
Pu-238	1.70E-03	5.21E+00	3.91E-02
Pu-239	2.43E-04	7.45E-01	5.58E-03
Pu-240	5.42E-05	1.66E-01	1.25E-03
Pu-241	6.31E-03	1.94E+01	1.45E-01
Pu-242	1.12E-07	3.42E-04	2.57E-06
Am-241	7.05E-04	2.16E+00	1.62E-02
Cm-245	6.48E-15	1.99E-11	1.49E-13
Total	3.26E-02	1.00E+02	7.49E-01
Total TRU	2.70E-03		**6.21E-02**

Attachment 8

Comparison of F-Area Sludge Waste against WAC 3.17, Rev. 9, Requirements

Comparison Against WAC 3.17, Rev. 9, Requirements - Waste Stream FTK-00002-1

Comparison to Package Guidelines (Section 3.5.1)

Isotope	Isotope Average Ci/gal	ET limit ci/ft3	ET Limit in B-25 Ci	Quantity of isotope in B-25 to reach ET Limit gal	Total Activity in B-25 at ET Limit Ci	TRU Activity at ET Limit Ci	TRU Concentration At Max. Waste Weight (5000 lbs) at ET Limit nCi/g	Min. Waste Weight at ET Limit to not be TRU lbs.
			D=C*90	E=D/B	F=E12*G15	G=E12*H19	I=G12*1E+09/(5000*454)	J=G12*1E+09/(454*100)
H-3		1.2E-05	1.08E-03					
C-14	1.74E-06	2.9E-05	2.61E-03	1.50E+03				
Tc-99	2.27E-02	1.0E-06	9.00E-05	**3.96E-03**	**5.72E-01**	**3.57E-03**	**1.57E+00**	**78.65**
I-129	1.08E-07	1.7E-09	1.53E-07	1.42E+00				

Sum of Fractions Calculation (Section 3.5.2)

Concentration, blended waste (from Att. 6) 1.44E+02 Ci/gal

Isotope	Isotope Average Ci/gal	Ci/ft3 sludge C=B*7.48	Ci/ft3 waste D=C*EC27	ET limit ci/ft3	Fraction
H-3				1.2E-05	
C-14	1.74E-06	1.30E-05	7.67E-11	2.9E-05	2.65E-06
Tc-99	2.27E-02	1.70E-01	1.00E-06	1.0E-06	1.00E+00
I-129	1.08E-07	8.09E-07	4.76E-12	1.7E-09	2.80E-03
ft3 sludge/ft3 waste = E12/7.48/90 =		5.89E-06		Total	**1.00E+00**
ft3 sludge/B-25 = C27*90 =		5.30E-04			

TRU Curies/Total Curies = 6.24E-03

Total TRU = **9.01E-01** Ci/gal

Np-237	7.40E-05
Pu-238	6.00E-02
Pu-239	2.25E-02
Pu-240	4.80E-03
Pu-242	8.13E-06
Ingrown Am-241	4.24E-03
Am-241	8.09E-01
Am-242m	2.93E-04
Cm-245	5.15E-07

Nuclear Criticality Safety Criteria (Section 3.5.3)

	Specific Activity Ci/g	Activity at ET Limit Ci	Mass (g) C/B	Equiv Factor	FGE (g) E*D	Total Activity at FGE Limit (Ci) F12*50/F45
U-233	9.648E-03	2.23E-07	2.31E-05	1.4	3.24E-05	
U-235	2.160E-06	6.42E-09	2.97E-03	1.0	2.97E-03	
Pu-239	6.132E-02	8.92E-05	1.45E-03	1.6	2.33E-03	
Pu-241	1.034E+02	3.46E-04	3.34E-06	3.5	1.17E-05	
Am-242m	9.717E+00	1.16E-06	1.19E-07	54.0	6.45E-06	
Cm-245	1.716E-01	2.04E-09	1.19E-08	24.0	2.85E-07	
Total				Total	**5.35E-03**	**5.34E+03**

Comparison Against WAC 3.17, Rev. 9, Requirements - Waste Stream FTK-00002-19

Comparison to Package Guidelines (Section 3.5.1)

Isotope	Isotope Average Ci/gal	ET limit ci/ft3	ET Limit in B-25 Ci	Amount of isotope in B-25 to reach ET Limit gal	Total Activity in B-25 at ET Limit Ci	TRU Activity Ci	TRU Concentration At Max. Waste Weight (5000 lbs) at ET Limit nCi/g	Min. Waste Weight at ET Limit to not be TRU lbs.
			D=C*90	E=D/B	F=E59*G62	G=E59*H66	I=G59*1E+09/(5000*454)	J=G59*1E+09/(454*100)
H-3		1.2E-05	1.1E-03					
C-14	4.64E-08	2.9E-05	2.6E-03	5.63E+04				
Tc-99	3.91E-06	1.0E-06	9.0E-05	**2.30E+01**	**7.52E-01**	**6.21E-02**	**2.73E+01**	**1.37E+03**
I-129	1.86E-11	1.7E-09	1.5E-07	8.24E+03				

Sum of Fractions Calculation (Section 3.5.2)

Concentration, blended waste (from Att. 6) **3.27E-02** Ci/gal

Isotope	Isotope Average Ci/gal	Ci/ft3 sludge	Ci/ft3 waste	ET limit ci/ft3	Fraction
H-3				1.2E-05	
C-14	4.64E-08	3.47E-07	1.18E-08	2.9E-05	4.08E-04
Tc-99	3.91E-06	2.93E-05	1.00E-06	1.0E-06	1.00E+00
I-129	1.86E-11	1.39E-10	4.75E-12	1.7E-09	2.79E-03
ft3 sludge/ft3 waste = E59/7.48/90 =		3.41E-02		Total	**1.00E+00**
ft3 sludge/B-25 = C74*90 =		3.07E+00			

TRU Curies/Total Curies = **8.26E-02**

Total TRU = 2.70E-03 Ci/gal

Np-237	0.00E+00
Pu-238	1.70E-03
Pu-239	2.43E-04
Pu-240	5.42E-05
Pu-242	1.12E-07
Ingrown Am-241	7.05E-04
Cm-244	8.96E-09
Cm-245	6.48E-15

Nuclear Criticality Safety Criteria (Section 3.5.3)

	Specific Activity Ci/g	Activity at ET Limit Ci	Mass (g) C/B	Equiv Factor	FGE (g) E*D	Total Activity at FGE Limit (Ci) F12*50/F45
U-233	9.648E-03			1.4		
U-235	2.160E-06	1.04E-07	4.81E-02	1.0	4.81E-02	
Pu-239	6.132E-02	5.58E-03	9.10E-02	1.6	1.46E-01	
Pu-241	1.034E+02	1.45E-01	1.40E-03	3.5	4.91E-03	
Am-242m	9.717E+00			54.0		
Cm-245	1.716E-01	1.49E-13	8.68E-13	24.0	2.08E-11	
				Total	**1.99E-01**	**1.89E+02**

Attachment 9

F-Area Tank Farm Sludge Waste Streams, Sludge and Supernate Fractions Activity Distributions

Attachment 9
F-Area Tank Farm Sludge Waste Streams
Sludge and Supernate Fractions Activity Distributions

SLUDGE FRACTION		
Radionuclide	**Normalized Distribution (%)**	**Scaling Factors Ci/Ci Sr-90**
FTK-00002-1		
H-3		
C-14	1.21E-06	3.33E-06
Sr-90	4.50E+01	1.00E+00
Y-90	4.50E+01	1.00E+00
Tc-99	1.57E-02	3.50E-04
I-129	7.49E-08	1.66E-09
Cs-137	3.30E+00	7.34E-02
Ba-137m	3.12E+00	6.94E-02
Pm-147	2.92E+00	6.50E-02
U-233	3.90E-05	8.68E-07
U-234	8.68E-05	3.85E-04
U-235	1.12E-06	2.50E-08
Np-237	5.12E-05	1.14E-06
Pu-238	4.16E-02	9.24E-04
Pu-239	1.56E-02	3.47E-04
Pu-240	3.32E-03	7.39E-05
Pu-241	6.05E-02	1.34E-03
Pu-242	5.63E-06	1.25E-07
Am-241	5.63E-01	1.25E-02
Am-242m	2.03E-04	4.51E-06
Cm-245	3.57E-07	7.93E-09
Total	1.00E+02	2.22E+00
FTK-00002-19		
H-3		
C-14	1.42E-04	4.20E-06
Sr-90	3.39E+01	1.00E+00
Y-90	3.39E+01	1.00E+00
Tc-99	1.20E-02	3.55E-04
I-129	5.70E-08	1.68E-09
Cs-137	2.36E+00	6.95E-02
Ba-137m	2.23E+00	6.58E-02
U-235	1.39E-05	4.10E-07
Pu-238	5.21E+00	1.54E-01
Pu-239	7.45E-01	2.20E-02
Pu-240	1.66E-01	4.91E-03
Pu-241	1.94E+01	5.72E-01
Pu-242	3.42E-04	1.01E-05
Am-241	2.16E+00	6.39E-02
Cm-245	1.99E-11	5.87E-13
Total	1.00E+02	2.95E+00

SUPERNATE FRACTION		
Radionuclide	**Normalized Distribution (%)**	**Scaling Factors Ci/Ci Cs-137**
FHW-00001		
H-3	1.59E-01	3.28E-03
C-14	9.44E-05	1.96E-06
Co-60	1.01E+00	2.08E-02
Sr-90	2.29E+00	4.74E-02
Y-90	2.29E+00	4.74E-02
Tc-99	9.60E-03	1.99E-04
I-129	9.94E-06	2.06E-07
Cs-137	4.83E+01	1.00E+00
Ba-137m	4.57E+01	9.46E-01
Pm-147	1.04E-01	2.15E-03
U-233	4.98E-06	1.03E-07
U-234	4.71E-06	9.76E-08
U-235	1.42E-06	2.94E-08
U-238	2.04E-06	4.22E-08
Np-237	2.31E-06	4.78E-08
Pu-238	6.24E-02	1.29E-03
Pu-239	1.30E-03	2.70E-05
Pu-240	2.70E-02	5.58E-04
Pu-241	3.47E-02	7.18E-04
Pu-242	6.41E-04	1.33E-05
Am-241	2.39E-02	4.94E-04
Am-242m	7.39E-04	1.53E-05
Am-243	1.82E-03	3.76E-05
Cm-245	7.49E-06	1.55E-07
Cm-246	2.49E-05	5.15E-07
Cm-247	1.21E-10	2.51E-12
Total	1.00E+02	2.07E+00