WSRC-TR-2000-00249, Rev. 1

Characterization of Radionuclides in H-Modified and Purex Waste Sludges from H-Area High Level Waste Tanks

by

R. F. O'Bryant

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

J. K. Dunaway

DOE Contract No. **DE-AC09-96SR18500**

Keywords: Sludge,
Waste Characterization,
H Tank Farm

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

Retention: Permanent

By

R. F. O'Bryant and J. K. W. Dunaway

Classification: U
Does not Contain UCNI

Paul D. d'Entremont
ADC/RO 12/13/00

Issued: December 2000

APPROVALS

R. F. O'Bryant, CSTE Co-author	Date: 12/13/00
J. K.W. Dunaway, DFM, Co-author	Date: 12/14/00
E. T. Ketusky, Technical Reviewer CSTE	Date: 12/14/2000
D. J. Martin, Manager CSTE Waste Characterization	Date: 12/19/00
D. J. Martin for B. L. Lewis B. L. Lewis, Manager CSTE Support Group	Date: 12/19/00
T. M. Monahon, Manager CSTE	Date: 12/19/00

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1.0 Background

Characterization of High Level Waste Sludge by 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 31 of 34 known sludge-containing waste tanks.

Sludge sampling has been conducted on a very limited basis during development of DWPF design bases. Significant additional sludge samples have not been collected due to high cost and personnel exposure. The limited sets of sample data collected were used as a means of determining if the developed scaling factors were grossly inadequate only, since they were not necessarily representative of the average concentration of radionuclides in the sludge. This comparison is documented in WSRC-TR-94-0562, *Characterization of Radionuclides in HLW Sludge Based on Isotopic Distribution in Irradiated Assemblies* (Reference 2).

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).

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. 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.

Procedure WAC 2.02, *Low Level, Hazardous, Mixed and PCB Waste Characterization Requirements,* Rev. 5 (Reference 5) allows for consolidation of waste streams when the following two criteria are met:

1. 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 H-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 H-Area Tank Farm. The scaling factors developed in this document supercede those presented in References 1 and 2, and any other previously developed radionuclide characterizations for H-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 entrained 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 for the sludge fraction of sludge-contaminated waste stored in the H-Area Tank Farm in accordance with the methodology outlined in WAC 2.02, Rev. 5. A single, comprehensive characterization for supernate has been developed previously (Reference 6).

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 H-Area Tank Farm will be categorized as Low Level Waste (LLW) and disposed of in the E-area Vaults (EAV). 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 H-Area Tank Farm can also be applied to waste classified as transuranic. [Neither WAC 3.06, E-Area TRU Pads Transuranic Waste Acceptance Criteria, Rev. 7 nor Appendix A:23, TRU Waste Container Characterization Form (OSR 29-90) Instructions (Rev. 1, 08/01/00) specifies a methodology for determination of the isotopic distribution in TRU Waste; simply that the methodology be documented.]

WAC 2.02, Rev. 5 allows generators to use scaling factors derived from process knowledge and/or sampling and analysis data to characterize the radionuclide content of the waste. Since the available record of sludge sample data is very limited (primarily due to the logistical difficulties and ALARA considerations associated with sampling the sludge in high level waste tanks), this characterization is based primarily on process knowledge of tank fill histories and compositions developed during limited sludge sampling as reflected in the WCS (Reference 3). However, periodic validation of the distribution developed in this document will be performed as discussed in Section 6.

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 WAC 2.02, *Low Level, Hazardous, Mixed and PCB Waste Characterization Requirements,* Rev. 5 (Reference 5).

3.1 Determining the Initial List of Radionuclides

Procedure WAC 2.02 Rev. 5 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 WAC 3.17 as being a Performance Assessment (PA) or Safety Authorization Basis (SAB) radionuclide for a specific Treatment, Storage or Disposal (TSD) facility (Reference 7). For purposes of this distribution, we will use those PA and SAB 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 33 radionuclides (Table 3.1) will be considered when developing the radionuclide distribution of waste packages contaminated with sludge from the H-Area Tank Farm.

Table 3.1. Radionuclides Important to Characterization of the Sludge Fraction of Sludge-Contaminated Waste				
	Inclusion Criteria			
Radionuclide	PA Limiting	SAB Limiting	Potentially Present At >1% Total Activity	Detectable Fissile or TRU Radionuclide
H-3		SAB		
C-14	PA			
Se-79			X	
Sr-90			X	
Y-90			Daughter of Sr-90	
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	
Pr-144m			Daughter of Ce-144	
Pm-147			X	
Eu-154			X	
U-233				Detectable Fissile
U-234	PA			
U-235				Detectable Fissile
Np-237				Detectable TRU
U-238	PA			
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
Cm-244			X	
Cm-245				Detectable TRU

Scaling factors for radionuclides known to be present in HLW tanks in the H-Area Tank Farms were calculated from decay-corrected concentration data tables in the WCS (Attachment 1).

3.2 Consolidating Sludge from H-Area Tank Farm

WAC 2.02, Rev. 5, 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 reproduced in Table 3.2.

Table 3.2. H-Area Tank Farm Historical Data

Tank No.	% H-Modified HHW	% H-Modified LHW	% Purex HHW	% Purex LHW	Yr. of Waste Rcpt.	Tank Use/Notes
9			50	50	1955	Waste Removal
10	1	1	49	49	56-59	Waste Removal
11	68	17		15	56-59	Waste Removal
12	84		8	8	56-73	Waste Removal
13	1	88		11	56-74	Waste Removal
14	16	25	59		57-65	Waste Removal
15	92	8			60-81	Waste Removal
16						Waste Removal
21		100			76-81	Evaporator Feed from RBOF/RRF, DWPF
22		100			74-84	Evaporator Feed from DWPF/HDB8
23					84	Evaporator Feed from RBOF/RRF
24						Waste Removal, DWPF receipt
29						Concentrate Receipt Tank (CRT)/no documented sludge receipts
30	100				86	Concentrate Receipt Tank
31						CRT/no documented sludge receipts
32	91	9			71-88	Evaporator Feed from Canyon
35	100				77-90	Evaporator Feed from Canyon
36	100				78	Concentrate Receipt Tank
37						CRT/no documented sludge receipts
38						Concentrate Receipt Tank
39	100				82-91	Evaporator Feed from Canyon
41		100			82	Concentrate Receipt Tank
43		100			82-86	Evaporator Feed from RBOF/RRF/DWPF/HDB8

The tanks contain primarily H-Modified Waste (both high- and low-heat) in varying proportions. Tanks containing older sludge also contain Purex Waste (both high- and low-heat) waste. The waste is aged from 8-45 years. The tanks are all utilized for either waste removal, concentrate receipt, or evaporator feed.

The scaling factors for PA radionuclides for each waste stream were then compared to determine what tanks could be consolidated based on whether they were within an order of magnitude from the mean set of scaling factors for those tanks. This comparison results in the following proposed waste streams for the H-Area Tank Farms:

Table 3.3. H-Area HLW Tank Farm Waste Streams

HLW Tanks	Waste Stream Number
9, 10, 13, 14	HTK-00002-9
21- 24, 38, 41, 43	HTK-00002-43
11, 12, 15, 16, 29-32, 35-37, 39	HTK-00002-30

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

- Scaling factors and fractional activity for each grouping were within consolidation criteria set forth in WAC 2.02, Rev. 5. Scaling factors for U-238 in waste streams HTK-00002-43 and HTK-00002-30 were calculated based on tanks which had a higher predominance of this radionuclide.

- Waste tanks containing exclusively H-Modified LHW were grouped together in waste stream HTK-00002-43.

- Waste tanks containing exclusively (or primarily) H-Modified HHW were grouped together in waste stream HTK-00002-30.

- Waste in tanks containing a mixture of H-Modified and Purex waste were in waste stream HTK-00002-9.

- Waste in Tanks 16, 23, 24, 29, 31, 37 and 38 have not historically been considered sludge tanks. Although none of these tanks have received direct transfers of sludge, small amounts of sludge may have entered the tank entrained in salt solution. Suspected sludge-contaminated waste from any of these tanks would likely be similar to tanks with a similar history.

- Tank 23 has received waste from the 242-1H evaporator and 244-245H as well as transfers from Tank 22. This process history is very similar to that of Tank 21. Tank 24 receipts have consisted of concentrated supernate from the 242-1H Evaporator and transfers from Tank 23. Tank 38 has a transfer history similar to Tank 41, with receipts from the 242-16H evaporator and direct transfers from tanks 21, 23 and 24. Sludge contaminated waste from Tanks 23, 24 and 38 will be characterized with Tank 21 waste (Reference 8).

- Tanks 29, 31 and 37 are all used in parallel with Tanks 30 and 36 as concentrate receipt tanks from 3H evaporator. Sludge contaminated waste from Tanks 29, 31 and 37 will be characterized with Tank 30 and 36 waste (Reference 9).

- Tank 16 is currently out of service and has no inventory of sludge or supernate. Residual contamination would be indicative of past operations conducted in this tank, which consisted of receipt of high-heat concentrate waste from the evaporator. Sludge-contaminated waste from this tank will be characterized with tank 30 and 36 waste.

Specific issues related to quantification of sludge-contaminated waste generated from these tanks are contained in Section 5. Analysis of combined waste streams HTK-00002-9, HTK-00002-43 and HTK-00002-30 are documented in Attachment 2. The presence of each PA radionuclide, expressed as a fraction of the mean scaling factor for each tank was calculated. In order to meet the first consolidation criteria, the PA radionuclides must be present within an order of magnitude from the mean, or within a range of 0.1 to 10 times the mean scaling factor. All PA rads in the three combined waste streams meet the first consolidation criteria, with the exception of U-238. The mean scaling factor was re-calculated and re-analyzed after including only those tanks in which U-238 had a higher relative concentration. The PA radionuclides varied from the mean scaling factors by a factor of 0.12 to 3.26.

The second consolidation criterion applies to predominant radionuclides only. There are two predominant radionuclides in this distribution, Sr-90 and its daughter Y-90. The fractional activities of Sr-90 and Y-90 vary only slightly within the distribution of sludge for each of the combined tank streams. The maximum variation from the proposed data set (the mean distribution) is 8.3% in Tank 30 sludge, which is well within a factor of 2, the second criteria for consolidation.

The mean set of scaling factors and comparison of both scaling factors and predominant radionuclides is presented in Attachment 2. Based on the results of this comparison, both consolidation criteria are met for these two combined waste streams, and the sludge fraction of sludge-contaminated waste from tanks in Table 3.3 may be consolidated. The arithmetic mean scaling factors will be used in the remainder of the development of the radionuclide distribution.

3.3 Excluding Radionuclides from Consideration

Under WAC 2.02, Rev. 5, radionuclides that meet one of the inclusion criteria outlined in section 3.1 may be excluded from further consideration 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. Process knowledge shows that the PA radionuclide could not be present in the waste stream at concentrations greater than 1/100th of the Maximum Allowable Lower Limit of Detection (MALLD). For I-129, process knowledge must show that it could not be present in the waste stream above 1.0E-10uCi/g.
3. Historical representative data shows that a non-PA radionuclide is not present in the waste stream, or, if present, has a concentration below the MALLD.

The above criteria are hereafter referred to as "exclusion criteria."

In addition, review of those radionuclides that were initially included only because they were expected to be present at greater than 1% of total activity will be performed. If they are determined not to be present at greater than 1% of total activity, they will also be excluded

Of the 33 radionuclides listed in Table 3.1, one radionuclide (H-3) was excluded because it is not expected to be present in any of the three waste streams. None of the PA radionuclides were excluded. Two additional non-PA radionuclides were excluded (Pu-242 and Cm-245) because they were present at less than the MALLD in some of the waste streams. Pu-242 was excluded from HTK-00002-9, and Cm-245 was excluded from HTK-00002-9 and HTK-00002-43. Of the radionuclides included because they were expected to be present at more than 1% of total activity, an additional 12 are determined to be present at less than 1% of the total activity in all three waste streams. One additional radionuclide (Pm-147) is present at less than 1% in waste stream HTK-00002-9. Three of these radionuclides, however, are retained in one or more of the distributions (Sb-125 in HTK-00002-43, Cm-244 in HTK-00002-30, and Eu-154 in all three) since they are near 1% of total activity. Calculations supporting this determination are summarized in Attachment 3.

Table 3.4. Radionuclides Excluded from Consideration, Sludge Fraction												
	Exclusion Criteria											
	Not Expected			PA Rads <.01 of MALLD			Non-PA <MALLD			Present at <1% (a)		
	HTK-00002-			**HTK-00002-**			**HTK-00002-**			**HTK-00002-**		
Radionuclide	**9**	**43**	**30**	**9**	**43**	**30**	**9**	**43**	**30**	**9**	**43**	**30**
H-3	**X**	**X**	**X**									
C-14												
Se-79										X	X	X
Sr-90												
Y-90												
Tc-99												
Ru-106										X	X	X
Rh-106										X	X	X
Sb-125										X	X(b)	X
Sn-126										X	X	X
I-129												
Cs-134										X	X	X
Cs-135										X	X	X
Cs-137												
Ba-137m												
Ce-144										X	X	X
Pr-144										X	X	X
Pr-144m										X	X	X
Pm-147										X		
Eu-154										X(b)	X(b)	X(b)
U-233												
U-234												
U-235												
Np-237												
U-238												
Pu-238												
Pu-239												
Pu-240												
Pu-241												
Pu-242							X					
Am-241												
Cm-244										X	X	X(b)
Cm-245							X	X				

(a) For those radionuclides included only because they were expected to be present at >1%
(b) Retained in distribution since they are close to 1% total activity
NOTE: Bold = PA Rads

3.4 Development of the Sludge Fraction Distribution

Thirty-three radionuclides were determined to be important to characterization of the sludge in H-Area Tank Farm. A number of these have been excluded per discussion in Section 3.3 above, leaving 19, 21, and 22 radionuclides to be quantified for waste streams HTK-00002-9, -43 and -30, respectively. Mean scaling factors developed previously to determine the compatibility of waste in the tanks have been utilized to create an isotopic distribution for consolidated waste streams. The radionuclides, their corresponding scaling factors (to Sr-90) and fractional activity in the waste stream are summarized in Table 3.5.

Table 3.5. Radionuclide Scaling Factors and Distribution for H-Area Tank Farm Sludge						
Radio-nuclide	Mean Scaling Factors (Ci/Ci Sr-90)			Mean Distribution, Normalized (%)		
	HTK-00002-			HTK-00002-		
	9	43	30	9	43	30
C-14	2.84E-08	1.57E-09	2.35E-08	1.33E-06	7.07E-08	1.05E-06
Sr-90	1.00E+00	1.00E+00	1.00E+00	4.67E+01	4.50E+01	4.48E+01
Y-90	1.00E+00	1.00E+00	1.00E+00	4.67E+01	4.50E+01	4.48E+01
Tc-99	4.44E-04	2.18E-04	2.41E-04	2.08E-02	9.79E-03	1.08E-02
Sb-125		2.26E-03			1.02E-01	
I-129	2.02E-09	7.54E-10	8.39E-10	9.44E-08	3.39E-08	3.76E-08
Cs-137	6.71E-02	5.39E-02	5.45E-02	3.13E+00	2.42E+00	2.44E+00
Ba-137m	6.34E-02	5.10E-02	5.16E-02	2.96E+00	2.29E+00	2.31E+00
Pm-147		6.75E-02	5.02E-02		3.03E+00	2.25E+00
Eu-154	3.37E-03	2.01E-02	1.75E-02	1.58E-01	9.04E-01	7.83E-01
U-233	3.39E-06	5.98E-06	2.14E-06	1.58E-04	2.69E-04	9.58E-05
U-234	4.74E-07	2.76E-06	3.96E-07	2.22E-05	1.24E-04	1.77E-05
U-235	1.94E-08	4.00E-08	6.91E-09	9.05E-07	1.80E-06	3.09E-07
Np-237	2.87E-06	1.62E-06	2.83E-07	1.34E-04	7.28E-05	1.27E-05
U-238	3.90E-07	4.97E-08	2.35E-08	1.82E-05	2.24E-06	1.05E-06
Pu-238	2.36E-03	2.55E-02	3.79E-02	1.10E-01	1.15E+00	1.70E+00
Pu-239	2.21E-04	6.20E-05	3.80E-04	1.03E-02	2.79E-03	1.70E-02
Pu-240	2.21E-04	4.02E-05	2.66E-04	1.03E-02	1.81E-03	1.19E-02
Pu-241	1.45E-04	2.16E-03	1.49E-02	6.80E-03	9.73E-02	6.66E-01
Pu-242		6.73E-08	5.79E-07		3.03E-06	2.59E-05
Am-241	3.12E-03	8.46E-04	1.79E-03	1.46E-01	3.81E-02	8.02E-02
Cm-244			3.17E-03			1.42E-01
Cm-245			2.30E-07			1.03E-05
Total				**1.00E+00**	**1.00E+00**	**1.00E+00**

3.5 Other WAC Criteria

3.5.1 Comparison to Package Guidelines

Most sludge-contaminated waste will be disposed of in the E-Area Vaults. Administrative Waste Package Radiological Concentration Guidelines apply to waste disposed of in the EAV. The guidelines applicable to the Low Activity Waste Vault, that portion of the EAV reserved for Low Activity Waste (LAW) will be used for comparison since they are the most restrictive of the EAV facilities. LAW 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 radionuclide in the H-Area Tank Farm Sludge Waste Streams (Reference 8) and their corresponding LAWV limits are summarized in Table 3.6. LAWV limits are expressed in Ci/ft^3 waste and Ci/90 ft^3 B-25 container.

Table 3.6. Comparison of Sludge Fraction of Sludge-Contaminated Waste to LAWV Limits								
	Sludge (Ci/gal)			LAWV Limit		Gal Sludge in B-25 to Reach LAWV Limit		
Radio-nuclide	Stream HTK-00002-9	Stream HTK-00002-43	Stream HTK-00002-30	Ci/ft^3	Ci/B-25	Stream HTK-00002-9	Stream HTK-00002-43	Stream HTK-00002-30
C-14	5.55E-07	6.40E-09	1.66E-08	2.50E-05	2.25E-03	4.06E+03	3.52E+05	1.35E+03
Tc-99	7.10E-03	1.83E-03	1.70E-02	4.90E-05	4.41E-03	**6.21E-01**	**2.40E+00**	**2.59E-01**
I-129	3.12E-08	6.35E-09	5.92E-08	5.60E-09	5.04E-07	1.62E+01	7.94E+01	8.51E+00
U-234	1.38E-05	2.21E-05	2.87E-05	1.10E-03	9.90E-02	7.18E+03	4.48E+03	3.45E+03
U-238	4.98E-06	1.87E-07	6.55E-07	1.20E-03	1.08E-01	2.17E+04	5.76E+05	1.65E+05

From the container limits, we can calculate the maximum volume of sludge that could be present in a B-25 container while still meeting the LAWV limits. The most limiting isotope in all waste streams is Tc-99, which requires between 0.26 and 2.40 gallons of sludge in a B-25 to meet the LAWV Limit. Sludge in H-Area Tank Farm contains both H-Modified and Purex sludge with an average activity of between 20 and 171 Ci/gallon. Per Table 3.7 below, for waste stream HTK-00002-43 and -30, the limiting amount of sludge would be equivalent to an amount that would exceed the TRU limit and would not be disposed of in the LAWV. For waste stream HTK-00002-9, a box with less than 1,381 lb. of waste and 0.62 gallons or more of sludge will fail TRU limits. 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 LAWV.

Table 3.7. Comparison of Maximum Amount of Sludge Present to Meet LAWV limits to TRU Criteria					
Stream HTK-	Max Gals Sludge per B-25 to meet LAWV criteria	Average Ci/gallon Sludge	Average TRU Ci/Total Ci in sludge	TRU Ci/B-25	TRU nCi/g at max waste weight
00002-9	6.21E-01	36.5	2.77E-03	6.27E-02	28
00002-43	2.40E+00	20.6	1.24E-02	6.16E-01	271
00002-30	2.59E-01	171	2.45E-02	1.08E+00	476

3.5.2 Sum of Fractions Calculation

For acceptance of waste packages sent to the LAWV, the radiological content of the waste package must be compared to the administrative guidelines and shown to satisfy the sum-of-fractions criteria where:

activity concentration of isotope A/limit of isotope A
+ activity concentration of isotope B/limit of isotope B
+ activity concentration of isotope N/limit of isotope N
≤ 1

Table 3.8 calculates the maximum concentration of sludge on sludge-contaminated waste in order for the sum-of-the-fractions criteria to be met.

Table 3.8. Sum-of-Fractions for Sludge Fraction of Sludge-Contaminated Waste

Radio-nuclide	Sludge						Waste		
	Ci/gal			Ci/ft^3			Ci/ft^3		
	9	43	30	9	43	30	9	43	30
C-14	5.55E-07	6.40E-09	1.66E-08	4.15E-06	4.79E-08	1.24E-05	3.68E-09	1.66E-10	4.64E-09
Tc-99	7.10E-03	1.83E-03	1.70E-02	5.13E-02	1.37E-02	1.27E-01	4.71E-05	4.75E-05	4.75E-05
I-129	3.12E-08	6.35E-09	5.92E-08	2.33E-07	4.75E-08	4.43E-07	2.07E-10	1.64E-10	1.65E-10
U-234	1.38E-05	2.21E-05	2.87E-05	1.03E-04	1.65E-04	2.15E-04	9.15E-08	5.72E-07	8.01E-08
U-238	4.98E-06	1.87E-07	6.55E-07	3.72E-05	1.40E-06	4.90E-06	3.30E-08	4.85E-09	1.83E-09

Table 3.8. (cont'd) Sum-of-Fractions for Sludge Fraction of Sludge-Contaminated Waste

Radionuclide	LAWV Limit (Ci/ft^3)	Fraction		
		Waste Stream HTK-00002-		
		9	43	30
C-14	2.50E-05	1.47E-04	4.74E-06	1.32E-04
Tc-99	4.90E-05	9.61E-01	9.69E-01	9.69E-01
I-129	5.60E-09	3.69E-02	2.94E-02	2.95E-02
U-234	1.10E-03	8.32E-05	5.20E-04	7.28E-05
U-238	1.20E-03	2.75E-05	4.04E-06	1.52E-06
Sum-of-Fractions		**9.99E-01**	**9.99E-01**	**9.99E-01**

Tc-99 dominates the sum-of-the-fractions criteria for all waste streams. The criteria are met for a maximum of 0.60, 2.33 and 0.25 gallons of sludge per B-25 for waste streams HTK-00002-9, -43 and -30, respectively. Per Table 3.9 below, for waste streams HTK-00002-43 and HTK-00002-30, the limiting amount of sludge would be equivalent to an amount that would exceed the TRU limit and would not be disposed of in the LAWV. For waste stream HTK-00002-9, a box with less than 1,328 lb. of waste and 0.60 gallons or more of sludge will fail TRU limits. Any such box will, upon entry into WITS, be flagged as TRU and not be sent to the LAWV.

Table 3.9. Comparison of Maximum Amount of Sludge Present to Meet LAWV Sum-of Fraction Limits to TRU Criteria

Stream HTK-	Max Gals Sludge per B-25 to meet Sum of Fractions criteria	Average Ci/gallon Sludge	Average TRU Ci/Total Ci in sludge	TRU Ci/B-25	TRU nCi/g at max waste weight
0002-9	0.60	36.5	2.77E-03	6.03E-02	27
0002-43	2.33	20.6	1.24E-02	5.97E-01	263
0002-30	0.25	171	2.45E-02	1.05E+00	462

3.5.3 Nuclear Criticality Safety Criteria

Sludge-contaminated LLW from H-Area Tank Farm Waste Streams contains an insignificant quantity of fissionable material to impact nuclear criticality criteria. Table 3.10, shows the maximum quantity of sludge that could be placed in a B-25 prior to exceeding the 50 g FGE U-235. This is equivalent to 234, 288, and 46 gallons of sludge in a B-25 for waste streams HTK-00002-9, -43 and -30, respectively, significantly exceeding TRU criteria for a waste box in all cases. Any such box will not be sent to the LAWV for disposal, therefore protecting this requirement.

Table 3.10. Calculation of FGE Equivalent for Sludge Fraction of Sludge-Contaminated Waste

Radio-nuclide	Activity in blended waste (Ci/gal)	Maximum Gallons of sludge in a B-25 to meet FGE Equivalent	Maximum Curies Sludge in a B-25	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	F	G=E*F
Waste Stream HTK-00002-9							
U-233	0	234	0	9.648E-03	0	1.4	0
U-235	3.02E-07	234	7.07E-05	2.16E-06	3.27E+01	1.0	3.27E+01
Pu-239	2.78E-03	234	6.51E-01	6.134E-02	1.06E+01	1.6	1.70E+01
Pu-241	3.82E-03	234	8.94E-01	1.034E+02	8.65E-03	3.5	3.03E-02
Am-242m	5.78E-05	234	1.35E-02	9.717E+00	1.39E-03	54.0	7.51E-02
Cm-243	0	234	0	5.253E+01	0	7.8	0
Cm-245	7.29E-09	234	1.71E-06	1.716E-01	9.95E-06	24.0	2.39E-04
Cm-247	0	234	0	9.396E-05	0	1.6	0
Cf-249	0	234	0	4.078E+00	0	70.0	0
Cf-251	0	234	0	1.582E+00	0	140.0	0
Waste Stream HTK-00002-43							
U-233	0	288	0	9.648E-03	0	1.4	0
U-235	3.18E-07	288	9.17E-05	2.16E-06	4.25E+01	1.0	4.25E+01
Pu-239	9.36E-04	288	2.70E-01	6.134E-02	4.41E+00	1.6	7.05E+00
Pu-241	3.58E-02	288	1.03E+01	1.034E+02	1.00E-01	3.5	3.50E-01
Am-242m	7.74E-06	288	2.23E-03	9.717E+00	2.30E-04	54.0	1.24E-02
Cm-243	0	288	0	5.253E+01	0	7.8	0
Cm-245	6.51E-09	288	1.88E-06	1.716E-01	1.09E-05	24.0	2.62E-04
Cm-247	0	288	0	9.396E-05	0	1.6	0
Cf-249	0	288	0	4.078E+00	0	70.0	0
Cf-251	0	288	0	1.582E+00	0	140.0	0
Waste Stream HTK-00002-30							
U-233	0	46	0	9.648E-03	0	1.4	0
U-235	4.98E-07	46	2.27E-05	2.16E-06	1.05E+01	1.0	1.05E+01
Pu-239	3.11E-02	46	1.42E+00	6.134E-02	2.32E+01	1.6	3.71E+01
Pu-241	1.35E+00	46	6.19E+01	1.034E+02	5.98E-01	3.5	2.09E+00
Am-242m	1.06E-04	46	4.83E-03	9.717E+00	4.97E-04	54.0	2.68E-02
Cm-243	0	46	0	5.253E+01	0	7.8	0
Cm-245	2.37E-05	46	1.08E-03	1.716E-01	6.32E-03	24.0	1.52E-01
Cm-247	0	46	0	9.396E-05	0	1.6	0
Cf-249	0	46	0	4.078E+00	0	70.0	0
Cf-251	0	46	0	1.582E+00	0	140.0	0

3.5.4 Class C Waste Determination

The sludge fraction of sludge-contaminated LLW disposed at the LAWV does not exceed Class C waste criteria. Table 3.11 includes the Class C radionuclide criteria (10 CFR 61.55, Table 1) along with the LAWV and ILV radionuclide criteria. The data indicates that the current LAWV and ILV radionuclide criteria are much more restrictive than the 10 CFR 61 criteria for Class C waste for C-14, Tc-99 and I-129.

Table 3.11. Class C Waste Analysis for Sludge Fraction of Sludge-Contaminated Waste

Radionuclide	Class C (Ci/ft^3)	WAC 3.17 for LAWV (Ci/ft^3)	WAC 3.17 for ILV (Ci/ft^3)
C-14	2.27E-01	2.5E-05	1.4E-04
Sr-90	1.98E+02	See discussion below	
Tc-99	8.50E-02	4.9E-05	N/A
I-129	2.27E-03	5.6E-09	1.4E-08
Cs-137	1.3E+02	See discussion below	
	Class C (nanocurie/g)		
Alpha	1.00E+02	See discussion below	
Pu-241	3.50E+03	See discussion below	
Cm-242	2.00E+04	See discussion below	

Sr-90 – In order to exceed the class C limit of 198 Ci/ft3 for Sr-90, between 236 and 2,000 gallons of sludge would need to be present in a B-25 container. At known concentrations of transuranic isotopes, these same containers would well exceed the TRU limit of 100 nCi/g, containing between 10,000 and 88,000 nCi/g TRU isotopes, and would not be permitted in the LAWV.

Cs-137 – In order to exceed the class C limit of 130 Ci/ft3 for Cs-137, between 285 and 2,420 gallons of sludge would need to be present in a B-25 container. At known concentrations of transuranic isotopes, these same containers would well exceed the TRU limit of 100 nCi/g, containing between 12,700 and 108,000 nCi/g TRU isotopes, and would not be permitted in the LAWV.

Alpha – The alpha criteria is identical to the restriction on the disposal of TRU waste in the waste acceptance criteria.

Pu-241 – Pu-241 can be between 5 and 28% of the total plutonium activity in this waste stream (see Table 3.12 below). This means that between 12,600 and 71,000 nCi/gram of total plutonium activity (including both alpha and beta-emitting Pu isotopes) could be present before the 3500 nCi/g Pu-241 criteria would be exceeded. Subtracting the beta-emitting Pu-241 activity results in a maximum of between 9,100 and 67,500 nCi/gram of alpha-emitting plutonium isotopes that would be present in the waste at this level. This level of alpha-emitters exceeds the criteria for TRU waste, and would not be permitted in the LAWV. Therefore, any waste box meeting the TRU limit will also satisfy the Class C Waste criteria for Pu-241 in the LAWV.

Table 3.12. Comparison of Maximum Amount of Sludge Present to Pu-241 Class C Waste Analysis

Stream HTK-	% of Total Pu Activity in Pu-241	Total Pu activity required before Pu-241 Criteria exceeded, nCi/g	Remaining alpha-emitting Pu isotopes, nCi/g
0002-9	4.93	71,000	67,500
0002-43	7.78	45,000	41,500
0002-30	27.8	12,600	9,100

Cm-242 – Cm-242 is not expected in HLW sludge based on knowledge of the processes that have generated the waste.

3.6 Documentation of the Sludge Fraction Distribution

Low level waste stream forms for H-Area Tank Farm Waste Streams, HTK-00002-9, HTK-00002-43 and HTK-00002-30, included as Attachment 4, document the distribution from H-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, Rev. 3, April 19, 1999, (Reference 6) identifies 14 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 97% of the total activity in supernate. The fourteen 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 below.

Table 4.1. Validated Radionuclide Distribution and Scaling Factors for HLW Supernate

Radionuclide	Normalized Distribution (%)	Scaling Factors (Ci/Ci Cs-137)
H-3	2.0E-01	4.0E-03
Co-60	1.7E+00	3.4E-02
Sr-90	4.7E-02	9.3E-04
Tc-99	9.1E-03	1.8E-04
I-129	1.1E-05	2.1E-07
Cs-137	5.0E+01	1.0E+00
Ba-137m	4.7E+01	9.4E-01
U-233	2.6E-04	5.2E-06
U-234	7.1E-05	1.4E-06
Pu-238	2.5E-01	5.0E-03
Pu-239	2.9E-03	5.9E-05
Pu-240	1.3E-03	2.6E-05
Pu-241	1.9E-01	3.8E-03
Am-241	1.8E-02	3.5E-04
Total	**1.0E+02**	

4.2 Other WAC Criteria

Comparison of supernate waste to other WAC requirements has been performed previously (Reference 6). The following determinations were made for supernate waste:

- A B-25 container 90% full (81 ft^3 waste) can contain up to 0.36 gallons of supernate (1.8 Ci Cs-137), approximately 50-200 times the estimate of supernate expected in a typical B-25 before it is expected to exceed the LAWV 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 does not exceed Class C waste criteria

4.3 Documentation of Supernate Fraction Distribution

Low Level waste stream form HTK-00001, previously submitted for approval to the Solid Waste Division, and included in Attachment 5 for information, 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 primarily Cs-137, indicative of the supernate fraction, is key to 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 6.

Scaling factors for the sludge fraction are tied to Sr-90. Although Sr-90 is present in the supernate fraction, it comprises less than 1% 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 HTK-00002-9, -30 and -43). For this reason, all Cs-137 identified in sludge-contaminated waste for these waste streams will be attributed to the supernate fraction. Scaling ratios developed for supernate will be applied to the Cs-137 to determine the supernate radionuclides.

The two fractions of sludge-contaminated waste will be manifested separately. The dose of Cs-137 and Sr-90 will be entered into two separate waste streams in WITS, representing the sludge and supernate fractions, respectively, which will calculate curies attributed to each radionuclide identified in the respective distributions. 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. Special consideration will be given to tanks that have been or are currently considered dry sludge tanks (Tanks 5 and 6), those that are closed (Tank 17 and 20), and those that are undergoing waste removal activities (Tanks 8, 18 and 19) to adequately quantify the split of Cs-137 between sludge and supernate fractions.

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 waste 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, Rev. 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. Since samples of supernate are routinely pulled and analyzed, data is readily available for periodic validation of the supernate fraction.

Sludge sampling has been conducted on a very limited basis during development of DWPF design bases. Additional sludge samples have not been collected to date due to high cost and personnel exposure. For this reason, future validation performed of the sludge fraction will likely be performed to available smear data.

7.0 References

1. D'Entremont, P. D., "HLW Sludge Characterization in Support of Low Level Waste Certification (U)," WSRC-TR-94-0579, Rev. 1., December 15, 1994.

2. Georgeton, G. K. and J. R. Hester., "Characterization of Radionuclides in HLW Sludge Based on Isotopic Distribution in Irradiated Assemblies (U)," WSRC-TR-94-0562, Rev. 1., January 27, 1995.

3. Hester, J. R., "High Level Waste Characterization System," WSRC-TR-96-0264, December 1996.

4. Hester, J. R., "Correction of Am-241 Inventories and Adjustment of PUREX Low Heat Waste Pu-238 Inventories in the Waste Characterization System (WCS)," HLW-STE-99-0207, June 3, 1999.

5. Procedure 2.02, "Low Level, Hazardous, TRU, Mixed, and PCB Waste Characterization Requirements," WSRC 1S Savannah River Site Waste Acceptance Criteria Manual, Rev. 5, Savannah River Site, June 15, 2000.

6. Ketusky, E. T. and R. F. O'Bryant, "HLW Supernate Radionuclide Characterization," WSRC-TR-94-0290, Rev. 3, April 19, 1999.

7. Procedure 3.17, "Low Level Radioactive Waste Acceptance Criteria," WSRC 1S Savannah River Site Waste Acceptance Manual, Rev. 4, Savannah River Site, October 2, 2000

8. Dunaway, J. K. W., "Justification for Using Sludge Waste Characterization HTK-00002-43 for Sludge Waste From HLW Tank 24," HLW-STE-99-0156, May 6, 1999.

9. Dunaway, J. K. W., "Justification for Using Sludge Waste Characterization HTK-00002-30 for Sludge Waste From HLW Tanks 29, 31 and 37," HLW-STE-99-0143, May 6, 1999.

10. Jamison, M. E., "Characterization of Non-Routine Low-Level Waste from High Level Waste Activities (U)," WSRC-TR-95-0069, March 13, 1995

11. Hunt, P. D., "Dose-to-Curie Calculations," ESH-HPT-99-0019, Rev. 1, March 2, 1999.

12. Ross, R. H., E. T. Ketusky, and R. Petras, "HLW Characterization in Support of Low Level Waste Certification: HLW Sludge Beta Screening Tool," WSRC-TR-97-0555, Rev. 1, October 8, 1998.

13. SRS-DTC™ 3.1, WMG Inc., 16 Bank Street, Peekskill, NY 10556

Attachment 1

Calculation of Scaling Factors from WCS Concentration Data

Attachment 1. H-Area Tank Farm Calculation of Scaling Factors from WCS Concentration Data

WCS Reference Data: 4/17/00

Tank	C-14	Co-60	Ni-59	Se-79	Sr-90	Y-90	Tc-99	Ru-106	Rh-106	Sb-125	Sn-126	I-129	Cs-134	Cs-135	Cs-137	Ba-137m	Ce-144	Pr-144	Pm-147
Concentration (Ci/gal)																			
9	7.72E-07	7.09E-03	9.09E-04	6.22E-04	2.17E+01	2.17E+01	1.08E-02	2.50E-11	2.50E-11	3.22E-04	1.16E-03	5.13E-08	2.32E-07	7.21E-06	1.53E+00	1.45E+00	1.00E-14	1.00E-14	4.33E-03
10	8.10E-08	8.43E-04	9.53E-05	6.49E-05	2.31E+00	2.31E+00	1.12E-03	4.87E-12	4.87E-12	4.06E-05	1.20E-04	5.32E-09	4.10E-08	7.51E-07	1.63E-01	1.54E-01	2.88E-15	2.88E-15	5.56E-04
13	1.31E-06	4.59E-02	1.25E-03	7.70E-04	3.66E+01	3.66E+01	1.32E-02	7.27E-08	7.27E-08	2.05E-03	1.01E-03	5.28E-08	8.12E-05	8.80E-06	2.20E+00	2.08E+00	4.17E-09	4.17E-09	4.90E-02
14	5.58E-08	4.26E-03	2.86E-04	1.95E-04	7.70E+00	7.70E+00	3.36E-03	8.20E-11	8.20E-11	1.96E-04	3.27E-04	1.52E-08	8.54E-07	2.25E-06	5.16E-01	4.88E-01	4.34E-13	4.34E-13	3.00E-03
Average	5.55E-07	1.45E-02	6.34E-04	4.13E-04	1.71E+01	1.71E+01	7.10E-03	1.82E-08	1.82E-08	6.52E-04	6.54E-04	3.12E-08	2.06E-05	4.75E-06	1.10E+00	1.04E+00	1.04E-09	1.04E-09	1.42E-02
21	6.40E-09	1.86E-02	7.40E-05	5.58E-05	4.07E+00	4.07E+00	9.45E-04	4.48E-06	4.48E-06	3.26E-03	5.11E-05	3.27E-09	3.13E-04	6.31E-07	2.20E-01	2.08E-01	1.19E-06	1.19E-06	9.07E-02
22		2.41E-02	1.02E-04	7.88E-05	5.73E+00	5.73E+00	1.33E-03	3.60E-06	3.60E-06	3.77E-03	7.21E-05	4.62E-09	3.35E-04	8.91E-07	3.10E-01	2.94E-01	8.33E-07	8.33E-07	1.04E-01
43		1.87E-01	2.46E-04	1.91E-04	1.71E+01	1.71E+01	3.22E-03	7.27E-03	7.27E-03	9.11E-02	1.74E-04	1.12E-08	1.80E-02	2.15E-06	9.16E-01	8.67E-01	1.79E-02	1.79E-02	2.77E+00
Average	6.40E-09	7.66E-02	1.40E-04	1.08E-04	8.97E+00	8.97E+00	1.83E-03	2.43E-03	2.43E-03	3.27E-02	9.91E-05	6.35E-09	6.21E-03	1.23E-06	4.82E-01	4.56E-01	5.98E-03	5.98E-03	9.89E-01
11	1.13E-06	1.30E-01	1.17E-03	6.46E-04	4.11E+01	4.11E+01	1.10E-02	5.14E-06	5.14E-06	1.04E-02	5.92E-04	3.79E-08	7.24E-04	7.32E-06	2.25E+00	2.13E+00	1.32E-06	1.32E-06	2.77E-01
12	1.46E-06	1.04E-01	1.61E-03	9.09E-04	5.11E+01	5.11E+01	1.54E-02	1.86E-07	1.86E-07	4.83E-03	9.32E-04	5.58E-08	2.22E-04	1.03E-05	2.87E+00	2.71E+00	9.49E-09	9.49E-09	1.22E-01
15	1.10E-06	6.50E-02	1.22E-03	6.74E-04	3.73E+01	3.73E+01	1.14E-02	2.42E-07	2.42E-07	2.59E-03	6.17E-04	3.95E-08	1.16E-04	7.63E-06	2.06E+00	1.94E+00	5.30E-08	5.30E-08	6.54E-02
30	1.56E-06	1.24E+00	1.71E-03	9.42E-04	8.61E+01	8.61E+01	1.60E-02	1.18E-02	1.18E-02	4.48E-01	8.62E-04	5.52E-08	7.89E-02	1.07E-05	4.62E+00	4.37E+00	1.18E-02	1.18E-02	1.35E+01
32	1.34E-06	3.73E-01	1.48E-03	8.16E-04	5.91E+01	5.91E+01	1.38E-02	2.04E-03	2.04E-03	8.24E-02	7.47E-04	4.78E-08	1.28E-02	9.24E-06	3.21E+00	3.04E+00	2.38E-03	2.38E-03	2.43E+00
35	3.20E-06	1.25E+00	3.52E-03	1.93E-03	1.53E+02	1.53E+02	3.28E-02	9.05E-03	9.05E-03	2.91E-01	1.77E-03	1.13E-07	4.45E-02	2.19E-05	8.27E+00	7.82E+00	1.45E-02	1.45E-02	8.57E+00
36	1.56E-06	4.43E-01	1.71E-03	9.42E-04	7.12E+01	7.12E+01	1.60E-02	5.76E-05	5.76E-05	6.13E-02	8.62E-04	5.52E-08	5.67E-03	1.07E-05	3.86E+00	3.65E+00	1.12E-05	1.12E-05	1.70E+00
39	1.95E-06	1.25E+00	2.14E-03	1.18E-03	1.03E+02	1.03E+02	1.99E-02	1.14E-02	1.14E-02	3.90E-01	1.08E-03	6.90E-08	6.45E-02	1.33E-05	5.54E+00	5.24E+00	1.94E-02	1.94E-02	1.16E+01
Average	1.66E-06	6.07E-01	1.82E-03	1.00E-03	7.52E+01	7.52E+01	1.70E-02	4.29E-03	4.29E-03	1.61E-01	9.32E-04	5.92E-08	2.59E-02	1.14E-05	4.08E+00	3.86E+00	6.01E-03	6.01E-03	4.79E+00

Tank	C-14	Co-60	Ni-59	Se-79	Sr-90	Y-90	Tc-99	Ru-106	Rh-106	Sb-125	Sn-126	I-129	Cs-134	Cs-135	Cs-137	Ba-137m	Ce-144	Pr-144	Pm-147
Scaling Factors																			
9	3.56E-08	3.27E-04	4.20E-05	2.87E-05	1.00E+00	1.00E+00	4.97E-04	1.16E-12	1.16E-12	1.48E-05	5.34E-05	2.37E-09	1.07E-08	3.33E-07	7.08E-02	6.70E-02	4.62E-16	4.62E-16	2.00E-04
10	3.50E-08	3.64E-04	4.12E-05	2.81E-05	1.00E+00	1.00E+00	4.85E-04	2.10E-12	2.10E-12	1.75E-05	5.17E-05	2.30E-09	1.77E-08	3.25E-07	7.04E-02	6.66E-02	1.25E-15	1.25E-15	2.40E-04
13	3.58E-08	1.25E-03	3.40E-05	2.10E-05	1.00E+00	1.00E+00	3.60E-04	1.99E-09	1.99E-09	5.60E-05	2.76E-05	1.44E-09	2.22E-06	2.41E-07	6.00E-02	5.68E-02	1.14E-10	1.14E-10	1.34E-03
14	7.24E-09	5.54E-04	3.71E-05	2.53E-05	1.00E+00	1.00E+00	4.36E-04	1.07E-11	1.07E-11	2.55E-05	4.24E-05	1.97E-09	1.11E-07	2.92E-07	6.70E-02	6.34E-02	5.64E-14	5.64E-14	3.90E-04
Average	2.84E-08	6.25E-04	3.86E-05	2.58E-05	1.00E+00	1.00E+00	4.44E-04	5.00E-10	5.00E-10	2.85E-05	4.38E-05	2.02E-09	5.90E-07	2.97E-07	6.71E-02	6.34E-02	2.85E-11	2.85E-11	5.42E-04
21	1.57E-09	4.56E-03	1.82E-05	1.37E-05	1.00E+00	1.00E+00	2.32E-04	1.10E-06	1.10E-06	8.00E-04	1.25E-05	8.04E-10	7.70E-05	1.55E-07	5.41E-02	5.12E-02	2.92E-07	2.92E-07	2.23E-02
22		4.21E-03	1.77E-05	1.38E-05	1.00E+00	1.00E+00	2.33E-04	6.27E-07	6.27E-07	6.58E-04	1.26E-05	8.06E-10	5.84E-05	1.55E-07	5.41E-02	5.12E-02	1.45E-07	1.45E-07	1.81E-02
43		1.09E-02	1.43E-05	1.11E-05	1.00E+00	1.00E+00	1.88E-04	4.24E-04	4.24E-04	5.32E-03	1.02E-05	6.52E-10	1.05E-03	1.26E-07	5.35E-02	5.06E-02	1.05E-03	1.05E-03	1.62E-01
Average	1.57E-09	6.57E-03	1.67E-05	1.29E-05	1.00E+00	1.00E+00	2.18E-04	1.42E-04	1.42E-04	2.26E-03	1.18E-05	7.54E-10	3.95E-04	1.45E-07	5.39E-02	5.10E-02	3.49E-04	3.49E-04	6.75E-02
11	2.76E-08	3.16E-03	2.85E-05	1.57E-05	1.00E+00	1.00E+00	2.67E-04	1.25E-07	1.25E-07	2.52E-04	1.44E-05	9.23E-10	1.76E-05	1.78E-07	5.47E-02	5.18E-02	3.21E-08	3.21E-08	6.74E-03
12	2.86E-08	2.04E-03	3.16E-05	1.78E-05	1.00E+00	1.00E+00	3.02E-04	3.64E-09	3.64E-09	9.46E-05	1.83E-05	1.09E-09	4.35E-06	2.02E-07	5.61E-02	5.31E-02	1.86E-10	1.86E-10	2.39E-03
15	2.94E-08	1.75E-03	3.27E-05	1.81E-05	1.00E+00	1.00E+00	3.06E-04	6.50E-09	6.50E-09	6.95E-05	1.65E-05	1.06E-09	3.11E-06	2.05E-07	5.51E-02	5.22E-02	1.42E-09	1.42E-09	1.76E-03
30	1.81E-08	1.44E-02	1.99E-05	1.09E-05	1.00E+00	1.00E+00	1.85E-04	1.37E-04	1.37E-04	5.20E-03	1.00E-05	6.41E-10	9.16E-04	1.24E-07	5.36E-02	5.08E-02	1.37E-04	1.37E-04	1.57E-01
32	2.27E-08	6.31E-03	2.50E-05	1.38E-05	1.00E+00	1.00E+00	2.34E-04	3.45E-05	3.45E-05	1.39E-03	1.26E-05	8.09E-10	2.16E-04	1.56E-07	5.43E-02	5.14E-02	4.03E-05	4.03E-05	4.10E-02
35	2.10E-08	8.17E-03	2.30E-05	1.27E-05	1.00E+00	1.00E+00	2.14E-04	5.92E-05	5.92E-05	1.91E-03	1.16E-05	7.41E-10	2.91E-04	1.43E-07	5.41E-02	5.12E-02	9.51E-05	9.51E-05	5.61E-02
36	2.19E-08	6.22E-03	2.40E-05	1.32E-05	1.00E+00	1.00E+00	2.24E-04	8.09E-07	8.09E-07	8.60E-04	1.21E-05	7.75E-10	7.96E-05	1.50E-07	5.42E-02	5.13E-02	1.57E-07	1.57E-07	2.39E-02
39	1.89E-08	1.21E-02	2.07E-05	1.14E-05	1.00E+00	1.00E+00	1.93E-04	1.10E-04	1.10E-04	3.79E-03	1.04E-05	6.69E-10	6.26E-04	1.29E-07	5.38E-02	5.09E-02	1.88E-04	1.88E-04	1.13E-01
Average	2.35E-08	6.77E-03	2.57E-05	1.42E-05	1.00E+00	1.00E+00	2.41E-04	4.27E-05	4.27E-05	1.69E-03	1.32E-05	8.39E-10	2.69E-04	1.61E-07	5.45E-02	5.16E-02	5.76E-05	5.76E-05	5.02E-02

Attachment 1. H-Area Tank Farm Calculation of Scaling Factors from WCS Concentration Data

WCS Reference Data: 4/17/00

Tank	Eu-154	Th-232	U-232	U-233	U-234	U-235	U-236	U-238	Np-237	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Ingrown Am-241	Am-241	Am-242m	Cm-244	Cm-245	Total	TRU
Concentration (Ci/gal)																					
9	3.53E-02		4.77E-07			2.95E-07		7.35E-06	5.03E-05	1.09E-02	1.56E-03	3.48E-04	2.83E-04	7.17E-08	7.12E-05	8.03E-02	1.01E-04	1.46E-05	1.77E-11	4.65E+01	
10	4.18E-03		4.92E-08			5.71E-08		1.42E-06	1.09E-05	5.53E-03	7.90E-04	1.76E-04	1.61E-04	3.63E-08	3.84E-05	8.32E-03	1.04E-05	1.98E-06	7.44E-11	4.96E+00	
13	2.55E-01	8.89E-07	2.54E-07	1.82E-04	2.57E-05	7.02E-07	2.65E-06	8.21E-06	6.61E-05	2.05E-01	6.54E-03	2.70E-03	1.39E-02	1.79E-06	2.19E-03	7.43E-02	9.09E-05	2.24E-04	2.68E-08	7.81E+01	
14	2.38E-02	3.92E-07	1.22E-07	1.38E-05	1.90E-06	1.54E-07	1.63E-07	2.93E-06	2.03E-05	7.27E-03	2.24E-03	7.23E-04	9.13E-04	1.32E-07	1.73E-04	2.33E-02	2.92E-05	1.88E-05	2.26E-09	1.65E+01	
Average	7.96E-02	6.40E-07	2.26E-07	9.79E-05	1.38E-05	3.02E-07	1.41E-06	4.98E-06	3.69E-05	5.73E-02	2.78E-03	9.88E-04	3.82E-03	5.09E-07	6.18E-04	4.66E-02	5.78E-05	6.47E-05	7.29E-09	3.65E+01	
21	6.94E-02	4.05E-10		1.24E-05	1.22E-05	1.68E-07	2.50E-06	1.14E-07	7.51E-06	6.08E-02	7.82E-05	4.53E-05	7.49E-04	3.81E-08	5.77E-05	3.27E-03	3.98E-06	4.08E-05	3.35E-09	8.81E+00	
22	9.48E-02			5.12E-05	1.84E-05	2.81E-07	3.03E-06	4.09E-07	1.12E-05	6.87E-02						4.49E-03	5.47E-06	5.72E-05	4.73E-09	1.24E+01	
43	4.58E-01				3.56E-05	5.04E-07	8.28E-06	3.85E-08	1.82E-05	8.50E-01	1.79E-03	1.19E-03	7.09E-02	2.14E-06	3.27E-03	1.10E-02	1.38E-05	1.93E-04	1.14E-08	4.05E+01	
Average	2.07E-01	4.05E-10		3.18E-05	2.21E-05	3.18E-07	4.60E-06	1.87E-07	1.23E-05	3.27E-01	9.36E-04	6.16E-04	3.58E-02	1.09E-06	1.66E-03	6.26E-03	7.74E-06	9.71E-05	6.51E-09	2.06E+01	
11	5.17E-01	1.02E-07	1.22E-09	1.46E-05	1.20E-05	2.26E-07	1.85E-06	4.19E-07	7.90E-06	9.48E-01	1.06E-02	6.67E-03	1.85E-01	1.42E-05	1.51E-02	5.09E-02	6.11E-05	3.82E-04	3.88E-08	8.87E+01	
12	5.00E-01	7.83E-06	8.28E-08	2.20E-04	2.06E-05	3.88E-07	1.64E-06	3.91E-06	4.57E-05	6.93E-01	1.33E-02	7.37E-03	7.83E-02	1.06E-05	7.81E-03	7.72E-02	9.27E-05	4.22E-04	4.82E-08	1.09E+02	
15	3.44E-01	5.32E-06		6.50E-05	1.78E-05	2.87E-07	1.68E-06	6.57E-09	1.66E-05	2.21E-01	5.70E-03	2.76E-03	1.71E-02	2.08E-06	2.62E-03	5.28E-02	6.23E-05	3.20E-04	4.05E-08	7.93E+01	
30	2.37E+00				3.66E-05	6.49E-07	6.75E-06	2.41E-08	1.65E-05	6.88E+00	6.13E-02	4.40E-02	3.93E+00	1.05E-04	1.21E-01	7.67E-02	9.62E-05	9.83E-04	5.66E-08	2.10E+02	
32	1.02E+00				1.52E-05	2.17E-07	3.40E-06	1.02E-07	6.27E-06	2.02E+00	1.93E-02	1.43E-02	6.33E-01	3.02E-05	3.37E-02	6.53E-02	7.96E-05	5.94E-04	4.90E-08	1.31E+02	
35	3.10E+00				4.21E-05	7.31E-07	1.24E-05	4.32E-07	1.52E-05	5.87E+00	5.10E-02	3.90E-02	2.03E+00	8.76E-05	1.01E-01	1.56E-01	1.92E-04	1.61E-03	1.16E-07	3.43E+02	
36	1.28E+00				4.84E-05	9.37E-07	1.71E-05	3.07E-07	1.35E-05	3.85E+00	3.27E-02	2.60E-02	1.01E+00	5.61E-05	6.10E-02	7.58E-02	9.29E-05	7.28E-04	5.66E-08	1.58E+02	
39	2.59E+00				3.73E-05	5.47E-07	8.80E-06	4.14E-08	1.49E-05	5.57E+00	5.52E-02	3.84E-02	2.95E+00	9.57E-05	1.09E-01	9.64E-02	1.68E-04	2.61E+00	1.89E-04	2.44E+02	
Average	1.47E+00	4.42E-06	4.20E-08	1.00E-04	2.87E-05	4.98E-07	6.70E-06	6.55E-07	1.71E-05	3.26E+00	3.11E-02	2.23E-02	1.35E+00	5.02E-05	5.64E-02	8.14E-02	1.06E-04	3.27E-01	2.37E-05	1.71E+02	
Scaling Factors																					TRU
9	1.63E-03		2.20E-08			1.36E-08		3.39E-07	2.32E-06	5.04E-04	7.20E-05	1.61E-05	1.31E-05	3.31E-09	3.29E-06	3.71E-03	4.64E-06	6.74E-07	8.16E-13		
10	1.81E-03		2.13E-08			2.47E-08		6.15E-07	4.71E-06	2.39E-03	3.41E-04	7.63E-05	6.95E-05	1.57E-08	1.66E-05	3.60E-03	4.51E-06	8.55E-07	3.22E-11		
13	6.98E-03	2.43E-08	6.95E-09	4.98E-06	7.02E-07	1.92E-08	7.24E-08	2.24E-07	1.81E-06	5.61E-03	1.79E-04	7.39E-05	3.81E-04	4.90E-08	5.98E-05	2.03E-03	2.49E-06	6.11E-06	7.33E-10		
14	3.09E-03	5.09E-08	1.59E-08	1.80E-06	2.47E-07	2.00E-08	2.12E-08	3.80E-07	2.63E-06	9.44E-04	2.91E-04	9.39E-05	1.19E-04	1.72E-08	2.25E-05	3.03E-03	3.79E-06	2.44E-06	2.94E-10		
Average	3.37E-03	3.76E-08	1.65E-08	3.39E-06	4.74E-07	1.94E-08	4.68E-08	3.90E-07	2.87E-06	2.36E-03	2.21E-04	2.21E-04	1.45E-04	2.13E-08	2.55E-05	3.09E-03	3.86E-06	2.52E-06	2.65E-10	2.14E+00	5.93E-03
21	1.71E-02	9.95E-11		3.04E-06	3.00E-06	4.14E-08	6.14E-07	2.80E-08	1.85E-06	1.49E-02	1.92E-05	1.11E-05	1.84E-04	9.35E-09	1.42E-05	8.04E-04	9.78E-07	1.00E-05	8.24E-10		
22	1.65E-02			8.93E-06	3.21E-06	4.91E-08	5.28E-07	7.14E-08	1.95E-06	1.20E-02						7.84E-04	9.55E-07	9.99E-06	8.25E-10		
43	2.67E-02				2.08E-06	2.95E-08	4.84E-07	2.25E-09	1.06E-06	4.96E-02	1.05E-04	6.93E-05	4.14E-03	1.25E-07	1.91E-04	6.43E-04	8.04E-07	1.13E-05	6.68E-10		
Average	2.01E-02	9.95E-11		5.98E-06	2.76E-06	4.00E-08	5.42E-07	3.39E-08	1.62E-06	2.55E-02	6.20E-05	4.02E-05	2.16E-03	6.73E-08	1.03E-04	7.44E-04	9.12E-07	1.04E-05	7.72E-10	2.23E+00	2.65E-02
11	1.26E-02	2.49E-09	2.96E-11	3.55E-07	2.92E-07	5.50E-09	4.51E-08	1.02E-08	1.92E-07	2.31E-02	2.59E-04	1.62E-04	4.52E-03	3.46E-07	3.68E-04	1.24E-03	1.49E-06	9.29E-06	9.45E-10		
12	9.78E-03	1.53E-07	1.62E-09	4.32E-06	4.04E-07	7.61E-09	3.20E-08	7.66E-08	8.95E-07	1.36E-02	2.61E-04	1.44E-04	1.53E-03	2.09E-07	1.53E-04	1.51E-03	1.82E-06	8.26E-06	9.44E-10		
15	9.24E-03	1.43E-07		1.74E-06	4.77E-07	7.69E-09	4.51E-08	1.76E-10	4.47E-07	5.93E-03	1.53E-04	7.41E-05	4.60E-04	5.59E-08	7.04E-05	1.42E-03	1.67E-06	8.59E-06	1.09E-09		
30	2.75E-02				4.24E-07	7.54E-09	7.83E-08	2.79E-10	1.91E-07	7.99E-02	7.11E-04	5.10E-04	4.56E-02	1.22E-06	1.41E-03	8.90E-04	1.12E-06	1.14E-05	6.57E-10		
32	1.73E-02				2.56E-07	3.67E-09	5.75E-08	1.72E-09	1.06E-07	3.41E-02	3.27E-04	2.42E-04	1.07E-02	5.11E-07	5.69E-04	1.10E-03	1.35E-06	1.01E-05	8.29E-10		
35	2.03E-02				2.75E-07	4.78E-09	8.13E-08	2.82E-09	9.95E-08	3.84E-02	3.33E-04	2.55E-04	1.33E-02	5.73E-07	6.60E-04	1.02E-03	1.26E-06	1.05E-05	7.60E-10		
36	1.80E-02				6.80E-07	1.32E-08	2.40E-07	4.31E-09	1.90E-07	5.41E-02	4.59E-04	3.65E-04	1.42E-02	7.89E-07	8.57E-04	1.06E-03	1.30E-06	1.02E-05	7.95E-10		
39	2.52E-02				3.62E-07	5.30E-09	8.54E-08	4.02E-10	1.44E-07	5.41E-02	5.36E-04	3.72E-04	2.86E-02	9.28E-07	1.06E-03	9.35E-04	1.63E-06	2.53E-02	1.84E-06		
Average	1.75E-02	9.95E-08	8.26E-10	2.14E-06	3.96E-07	6.91E-09	8.31E-08	1.21E-08	2.83E-07	3.79E-02	3.80E-04	2.66E-04	1.49E-02	5.79E-07	6.43E-04	1.15E-03	1.45E-06	3.17E-03	2.30E-07	2.24E+00	4.03E-02

Attachment 2

Comparison of H-Area Tank Farm Sludge Scaling Factors for Consolidation

Attachment 2. Comparison of H-Area Tank Farm Sludge Scaling Factors for Consolidation

	Sludge Scaling Factors (Ci/Ci Sr-90)					PA Rads, Fraction of Mean Scaling Factor (allowable fraction = 0.1-10.0)			
Isotope	**Tank 9**	**Tank 10**	**Tank 13**	**Tank 14**	**Mean Ci/Ci Sr-90**	**Tank 9**	**Tank 10**	**Tank 13**	**Tank 14**
C-14	3.56E-08	3.50E-08	3.58E-08	7.24E-09	2.84E-08	1.25	1.23	1.26	0.25
Tc-99	4.97E-04	4.85E-04	3.60E-04	4.36E-04	4.44E-04	1.12	1.09	0.81	0.98
I-129	2.37E-09	2.30E-09	1.44E-09	1.97E-09	2.02E-09	1.17	1.14	0.71	0.97
U-234			7.02E-07	2.47E-07	4.74E-07			1.48	0.52
U-238	3.39E-07	6.15E-07	2.24E-07	3.80E-07	3.90E-07	0.87	1.58	0.58	0.98

	Fractional Activity					Predominant Rads, Variation from Mean Fractional Activity (allowable variation = 100%)			
Isotope	**Tank 9**	**Tank 10**	**Tank 13**	**Tank 14**	**Mean**	**Tank 9**	**Tank 10**	**Tank 13**	**Tank 14**
Sr-90	4.66E-01	4.66E-01	4.68E-01	4.67E-01	4.67E-01	-0.2%	-0.2%	0.3%	0.1%
Y-90	4.66E-01	4.66E-01	4.68E-01	4.67E-01	4.67E-01	-0.2%	-0.2%	0.3%	0.1%

	Sludge Scaling Factors (Ci/Ci Sr-90)				PA Rads, Fraction of Mean Scaling Factor (allowable fraction = 0.1-10.0)		
Isotope	**Tank 21**	**Tank 22**	**Tank 43**	**Mean Ci/Ci Sr-90**	**Tank 21**	**Tank 22**	**Tank 43**
C-14	1.57E-09			1.57E-09	1.00		
Tc-99	2.32E-04	2.33E-04	1.88E-04	2.18E-04	1.07	1.07	0.86
I-129	8.04E-10	8.06E-10	6.52E-10	7.54E-10	1.07	1.07	0.86
U-234	3.00E-06	3.21E-06	2.08E-06	2.76E-06	1.09	1.16	0.75
U-238	2.80E-08	7.14E-08	2.25E-09	3.39E-08	0.83	2.11	**0.07**
				4.97E-08	0.56	1.44	

	Fractional Activity				Predominant Rads, Variation from Mean Fractional Activity (allowable variation = 100%)		
Isotope	**Tank 21**	**Tank 22**	**Tank 43**	**Mean**	**Tank 21**	**Tank 22**	**Tank 43**
Sr-90	4.62E-01	4.63E-01	4.22E-01	4.49E-01	2.8%	3.2%	-6.0%
Y-90	4.62E-01	4.63E-01	4.22E-01	4.49E-01	2.8%	3.2%	-6.0%

	Sludge Scaling Factors (Ci/Ci Sr-90)									PA Rads, Fraction of Mean Scaling Factor (allowable fraction = 0.1-10.0)							
Isotope	**Tank 11**	**Tank 12**	**Tank 15**	**Tank 30**	**Tank 32**	**Tank 35**	**Tank 36**	**Tank 39**	**Mean Ci/Ci Sr-90**	**Tank 11**	**Tank 12**	**Tank 15**	**Tank 30**	**Tank 32**	**Tank 35**	**Tank 36**	**Tank 39**
C-14	2.76E-08	2.86E-08	2.94E-08	1.81E-08	2.27E-08	2.10E-08	2.19E-08	1.89E-08	2.35E-08	1.17	1.22	1.25	0.77	0.96	0.89	0.93	0.80
Tc-99	2.67E-04	3.02E-04	3.06E-04	1.85E-04	2.34E-04	2.14E-04	2.24E-04	1.93E-04	2.41E-04	1.11	1.26	1.27	0.77	0.97	0.89	0.93	0.80
I-129	9.23E-10	1.09E-09	1.06E-09	6.41E-10	8.09E-10	7.41E-10	7.75E-10	6.69E-10	8.39E-10	1.10	1.30	1.26	0.76	0.96	0.88	0.92	0.80
U-234	2.92E-07	4.04E-07	4.77E-07	4.24E-07	2.56E-07	2.75E-07	6.80E-07	3.62E-07	3.96E-07	0.74	1.02	1.20	1.07	0.65	0.69	1.72	0.91
U-238	1.02E-08	7.66E-08	1.76E-10	2.79E-10	1.72E-09	2.82E-09	4.31E-09	4.02E-10	1.21E-08	0.85	6.35	**0.01**	**0.02**	0.14	0.23	0.36	**0.03**
									2.35E-08	0.43	3.26				0.12	0.18	

	Fractional Activity									Predominant Rads, Variation from Mean Fractional Activity (allowable variation = 100%)							
Isotope	**Tank 11**	**Tank 12**	**Tank 15**	**Tank 30**	**Tank 32**	**Tank 35**	**Tank 36**	**Tank 39**	**Mean**	**Tank 11**	**Tank 12**	**Tank 15**	**Tank 30**	**Tank 32**	**Tank 35**	**Tank 36**	**Tank 39**
Sr-90	4.63E-01	4.67E-01	4.70E-01	4.10E-01	4.51E-01	4.45E-01	4.49E-01	4.22E-01	4.47E-01	3.6%	4.5%	5.1%	-8.3%	0.8%	-0.4%	0.5%	-5.7%
Y-90	4.63E-01	4.67E-01	4.70E-01	4.10E-01	4.51E-01	4.45E-01	4.49E-01	4.22E-01	4.47E-01	3.6%	4.5%	5.1%	-8.3%	0.8%	-0.4%	0.5%	-5.7%

Attachment 3

H-Area Tank Farm Sludge Waste Streams Exclusion Criteria

Attachment 3. H-Area Tank Farm Sludge Waste Streams
Exclusion Criteria

Bold = PA radionuclides

(a) for those radionuclides included only because they were expected to be present at greater than 1%

(b) retained in distribution since they are close to 1% of total activity

max rad constituents in sludge on weight basis = 0.2%

nonrad constituents in sludge on weight basis=99.8%

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					Comparison to MALLD								Distribution		
Isotope	Mean Ci/Ci Sr-90	Mean Distribution	<1% of Dist?(a)	Not Expected	Specific Activity, Ci isotope per g isotope	g isotope per Ci Sr-90	Mean Ci isotope per g sludge	Mean uCi isotope per g sludge	MALLD, uCi/g	1/100 MALLD, uCi/g	PA Rads in sludge <1/100 MALLD?	Non-PA <MALLD?	RADs Remaining after Exclusion Criteria	Fractional Distribution (percent)	Re-normalized Distribution
H-3	0.00E+00	0.00E+00		x	9.22E+05	0.00E+00	0.00E+00	0.00E+00	1.00E-04	1.00E-06		yes			
C-14	2.84E-08	1.33E-06			4.46E+00	6.37E-09	4.68E-13	4.68E-07	1.00E-05	1.00E-07	no	NA	**C-14**	1.33E-06	1.33E-06
Se-79	2.58E-05	1.20E-03	yes		6.96E-02	3.70E-04	4.24E-10	4.24E-04							
Sr-90	1.00E+00	4.67E+01	no		1.39E+02	7.19E-03	1.64E-05	1.64E+01	1.00E-04	1.00E-06		no	Sr-90	4.67E+01	4.67E+01
Y-90	1.00E+00	4.67E+01	no		5.44E+05	1.84E-06	1.64E-05	1.64E+01	1.00E-04	1.00E-06		no	Y-90	4.67E+01	4.67E+01
Tc-99	4.44E-04	2.08E-02			1.70E-02	2.61E-02	7.31E-09	7.31E-03	1.00E-06	1.00E-08	no	NA	**Tc-99**	2.08E-02	2.08E-02
Ru-106	5.00E-10	2.34E-08	yes		3.35E+03	1.49E-13	8.23E-15	8.23E-09							
Rh-106	5.00E-10	2.34E-08	yes		1.36E+07	3.68E-17	8.23E-15	8.23E-09							
Sb-125	2.85E-05	1.33E-03	yes		1.03E+03	2.76E-08	4.68E-10	4.68E-04							
Sn-126	4.38E-05	2.05E-03	yes		2.84E-02	1.54E-03	7.20E-10	7.20E-04							
I-129	2.02E-09	9.44E-08			1.77E-04	1.14E-05	3.32E-14	3.32E-08	1.00E-06	1.00E-08	no	NA	**I-129**	9.44E-08	9.44E-08
Cs-134	5.90E-07	2.75E-05	yes		1.29E+03	4.57E-10	9.70E-12	9.70E-06							
Cs-135	2.97E-07	1.39E-05	yes		1.15E-03	2.58E-04	4.89E-12	4.89E-06							
Cs-137	6.71E-02	3.13E+00	no		8.65E+01	7.75E-04	1.10E-06	1.10E+00	1.00E-05	1.00E-07		no	Cs-137	3.13E+00	3.13E+00
Ba-137m	6.34E-02	2.96E+00	no				1.04E-06	1.04E+00	1.00E-05	1.00E-07		no	Ba-137m	2.96E+00	2.96E+00
Ce-144	2.85E-11	1.33E-09	yes		3.19E+03	8.94E-15	4.69E-16	4.69E-10							
Pr-144	2.85E-11	1.33E-09	yes		7.56E+07	3.77E-19	4.69E-16	4.69E-10							
Pr-144m	2.85E-11	1.33E-09	yes				4.69E-16	4.69E-10							
Pm-147	5.42E-04	2.53E-02	yes		9.27E+02	5.85E-07	8.92E-09	8.92E-03							
Eu-154	3.37E-03	1.58E-01	yes(b)		2.64E+02	1.28E-05	5.55E-08	5.55E-02					Eu-154	1.58E-01	1.58E-01
U-233	3.39E-06	1.58E-04			9.64E-03	3.51E-04	5.57E-11	5.57E-05	1.00E-06	1.00E-08		no	U-233	1.58E-04	1.58E-04
U-234	4.74E-07	2.22E-05			6.22E-03	7.63E-05	7.80E-12	7.80E-06	1.00E-06	1.00E-08	no	NA	U-234	2.22E-05	2.22E-05
U-235	1.94E-08	9.04E-07			2.16E-06	8.95E-03	3.18E-13	3.18E-07					U-235	9.04E-07	9.05E-07
Np-237	2.87E-06	1.34E-04			7.05E-04	4.07E-03	4.72E-11	4.72E-05	1.00E-06	1.00E-08		no	Np-237	1.34E-04	1.34E-04
U-238	3.90E-07	1.82E-05			3.36E-07	1.16E+00	6.41E-12	6.41E-06	1.00E-06	1.00E-08	no	NA	**U-238**	1.82E-05	1.82E-05
Pu-238	2.36E-03	1.10E-01			1.71E+01	1.38E-04	3.89E-08	3.89E-02	1.00E-06	1.00E-08		no	Pu-238	1.10E-01	1.10E-01
Pu-239	2.21E-04	1.03E-02			6.20E-02	3.56E-03	3.63E-09	3.63E-03	1.00E-06	1.00E-08		no	Pu-239	1.03E-02	1.03E-02
Pu-240	2.21E-04	1.03E-02			2.27E-01	9.72E-04	3.63E-09	3.63E-03	1.00E-06	1.00E-08		no	Pu-240	1.03E-02	1.03E-02
Pu-241	1.45E-04	6.79E-03			1.03E+02	1.41E-06	2.39E-09	2.39E-03	1.00E-05	1.00E-07		no	Pu-241	6.79E-03	6.80E-03
Pu-242	2.13E-08	9.95E-07			3.93E-03	5.42E-06	3.51E-13	3.51E-07	1.00E-06	1.00E-08		yes			
Am-241	3.12E-03	1.46E-01			3.43E+00	9.09E-04	5.13E-08	5.13E-02	1.00E-05	1.00E-07		no	Am-241	1.46E-01	1.46E-01
Cm-244	2.52E-06	1.18E-04	yes		8.09E+01	3.12E-08	4.15E-11	4.15E-05	1.00E-06	1.00E-08		no			
Cm-245	2.65E-10	1.24E-08			1.72E-01	1.54E-09	4.36E-15	4.36E-09	1.00E-06	1.00E-08		yes			
Total	2.14E+00	1.00E+02				1.22E+00	3.52E-05	3.52E+01					Total	1.00E+02	1.00E+02

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Isotope	Mean Ci/Ci Sr-90	Mean Distribution	<1% of Dist?(a)	Not Expected	Specific Activity, Ci isotope per g isotope	g isotope per Ci Sr-90	Mean Ci isotope per g sludge	Mean uCi isotope per g sludge	MALLD, uCi/g	1/100 MALLD, uCi/g	PA Rads in sludge <1/100 MALLD?	Non-PA <MALLD?	RADs Remaining after Exclusion Criteria	Fractional Distribution (percent)	Re-normalized Distribution
H-3	0.00E+00	0.00E+00		x	9.22E+05	0.00E+00	0.00E+00	0.00E+00	1.00E-04	1.00E-06		yes			
C-14	1.57E-09	7.07E-08			4.46E+00	3.53E-10	1.62E-13	1.62E-07	1.00E-05	1.00E-07	no	NA	**C-14**	7.07E-08	7.07E-08
Se-79	1.29E-05	5.78E-04	yes		6.96E-02	1.85E-04	1.32E-09	1.32E-03							
Sr-90	1.00E+00	4.49E+01	no		1.39E+02	7.19E-03	1.03E-04	1.03E+02	1.00E-04	1.00E-06		no	Sr-90	4.49E+01	4.50E+01
Y-90	1.00E+00	4.49E+01	no		5.44E+05	1.84E-06	1.03E-04	1.03E+02	1.00E-04	1.00E-06		no	Y-90	4.49E+01	4.50E+01
Tc-99	2.18E-04	9.78E-03			1.70E-02	1.28E-02	2.24E-08	2.24E-02	1.00E-06	1.00E-08	no	NA	Tc-99	9.78E-03	9.79E-03
Ru-106	1.42E-04	6.38E-03	yes		3.35E+03	4.24E-08	1.46E-08	1.46E-02							
Rh-106	1.42E-04	6.38E-03	yes		1.36E+07	1.04E-11	1.46E-08	1.46E-02							
Sb-125	2.26E-03	1.02E-01	yes(b)		1.03E+03	2.19E-06	2.32E-07	2.32E-01					Sb-125	1.02E-01	1.02E-01
Sn-126	1.18E-05	5.29E-04	yes		2.84E-02	4.14E-04	1.21E-09	1.21E-03							
I-129	7.54E-10	3.39E-08			1.77E-04	4.26E-06	7.76E-14	7.76E-08	1.00E-06	1.00E-08	no	NA	**I-129**	3.39E-08	3.39E-08
Cs-134	3.95E-04	1.77E-02	yes		1.29E+03	3.06E-07	4.06E-08	4.06E-02							
Cs-135	1.45E-07	6.54E-06	yes		1.15E-03	1.26E-04	1.50E-11	1.50E-05							
Cs-137	5.39E-02	2.42E+00	no		8.65E+01	6.23E-04	5.55E-06	5.55E+00	1.00E-05	1.00E-07		no	Cs-137	2.42E+00	2.42E+00
Ba-137m	5.10E-02	2.29E+00	no				5.25E-06	5.25E+00	1.00E-05	1.00E-07		no	Ba-137m	2.29E+00	2.29E+00
Ce-144	3.49E-04	1.57E-02	yes		3.19E+03	1.09E-07	3.59E-08	3.59E-02							
Pr-144	3.49E-04	1.57E-02	yes		7.56E+07	4.62E-12	3.59E-08	3.59E-02							
Pr-144m	3.49E-04	1.57E-02	yes				3.59E-08	3.59E-02							
Pm-147	6.75E-02	3.03E+00	no		9.27E+02	7.28E-05	6.94E-06	6.94E+00					Pm-147	3.03E+00	3.03E+00
Eu-154	2.01E-02	9.04E-01	yes(b)		2.64E+02	7.62E-05	2.07E-06	2.07E+00					Eu-154	9.04E-01	9.04E-01
U-233	5.98E-06	2.69E-04			9.64E-03	6.21E-04	6.16E-10	6.16E-04	1.00E-06	1.00E-08		no	U-233	2.69E-04	2.69E-04
U-234	2.76E-06	1.24E-04			6.22E-03	4.45E-04	2.84E-10	2.84E-04	1.00E-06	1.00E-08	no	NA	U-234	1.24E-04	1.24E-04
U-235	4.00E-08	1.80E-06			2.16E-06	1.85E-02	4.11E-12	4.11E-06					U-235	1.80E-06	1.80E-06
Np-237	1.62E-06	7.28E-05			7.05E-04	2.30E-03	1.67E-10	1.67E-04	1.00E-06	1.00E-08		no	Np-237	7.28E-05	7.28E-05
U-238	4.97E-08	2.24E-06			3.36E-07	1.48E-01	5.12E-12	5.12E-06	1.00E-06	1.00E-08	no	NA	**U-238**	2.24E-06	2.24E-06
Pu-238	2.55E-02	1.15E+00			1.71E+01	1.49E-03	2.63E-06	2.63E+00	1.00E-06	1.00E-08		no	Pu-238	1.15E+00	1.15E+00
Pu-239	6.20E-05	2.79E-03			6.20E-02	1.00E-03	6.38E-09	6.38E-03	1.00E-06	1.00E-08		no	Pu-239	2.79E-03	2.79E-03
Pu-240	4.02E-05	1.81E-03			2.27E-01	1.77E-04	4.14E-09	4.14E-03	1.00E-06	1.00E-08		no	Pu-240	1.81E-03	1.81E-03
Pu-241	2.16E-03	9.72E-02			1.03E+02	2.10E-05	2.23E-07	2.23E-01	1.00E-05	1.00E-07		no	Pu-241	9.72E-02	9.73E-02
Pu-242	6.73E-08	3.02E-06			3.93E-03	1.71E-05	6.92E-12	6.92E-06	1.00E-06	1.00E-08		no	Pu-242	3.02E-06	3.03E-06
Am-241	8.46E-04	3.80E-02			3.43E+00	2.47E-04	8.71E-08	8.71E-02	1.00E-05	1.00E-07		no	Am-241	3.80E-02	3.81E-02
Cm-244	1.04E-05	4.69E-04	yes		8.09E+01	1.29E-07	1.07E-09	1.07E-03	1.00E-06	1.00E-08		no			
Cm-245	7.72E-10	3.47E-08			1.72E-01	4.49E-09	7.95E-14	7.95E-08	1.00E-06	1.00E-08		yes			
Total	2.23E+00	1.00E+02				1.94E-01	2.29E-04	2.29E+02					Total	9.99E+01	1.00E+02

Waste Stream HTK-00002-30

Isotope	Mean Ci/Ci Sr-90	Mean Distribution	<1% of Dist?(a)	Not Expected	Specific Activity, Ci isotope per g isotope	g isotope per Ci Sr-90	Mean Ci isotope per g sludge	Mean uCi isotope per g sludge	MALLD, uCi/g	1/100 MALLD, uCi/g	PA Rads in sludge <1/100 MALLD?	Non-PA <MALLD?	RADs Remaining after Exclusion Criteria	Fractional Distribution (percent)	Re-normalized Distribution
H-3	0.00E+00	0.00E+00		x	9.22E+05	0.00E+00	0.00E+00	0.00E+00	1.00E-04	1.00E-06		yes			
C-14	2.35E-08	1.05E-06			4.46E+00	5.27E-09	4.39E-12	4.39E-06	1.00E-05	1.00E-07	no	NA	**C-14**	1.05E-06	1.05E-06
Se-79	1.42E-05	6.36E-04	yes		6.96E-02	2.04E-04	2.65E-09	2.65E-03							
Sr-90	1.00E+00	4.48E+01	no		1.39E+02	7.19E-03	1.87E-04	1.87E+02	1.00E-04	1.00E-06		no	Sr-90	4.48E+01	4.48E+01
Y-90	1.00E+00	4.48E+01	no		5.44E+05	1.84E-06	1.87E-04	1.87E+02	1.00E-04	1.00E-06		no	Y-90	4.48E+01	4.48E+01
Tc-99	2.41E-04	1.08E-02			1.70E-02	1.42E-02	4.50E-08	4.50E-02	1.00E-06	1.00E-08	no	NA	Tc-99	1.08E-02	1.08E-02
Ru-106	4.27E-05	1.91E-03	yes		3.35E+03	1.28E-08	7.99E-09	7.99E-03							
Rh-106	4.27E-05	1.91E-03	yes		1.36E+07	3.14E-12	7.99E-09	7.99E-03							
Sb-125	1.69E-03	7.58E-02	yes		1.03E+03	1.65E-06	3.17E-07	3.17E-01							
Sn-126	1.32E-05	5.93E-04	yes		2.84E-02	4.66E-04	2.47E-09	2.47E-03							
I-129	8.39E-10	3.75E-08			1.77E-04	4.74E-06	1.57E-13	1.57E-07	1.00E-06	1.00E-08	no	NA	**I-129**	3.75E-08	3.76E-08
Cs-134	2.69E-04	1.21E-02	yes		1.29E+03	2.09E-07	5.03E-08	5.03E-02							
Cs-135	1.61E-07	7.20E-06	yes		1.15E-03	1.40E-04	3.01E-11	3.01E-05							
Cs-137	5.45E-02	2.44E+00	no		8.65E+01	6.30E-04	1.02E-05	1.02E+01	1.00E-05	1.00E-07		no	Cs-137	2.44E+00	2.44E+00
Ba-137m	5.16E-02	2.31E+00	no				9.63E-06	9.63E+00	1.00E-05	1.00E-07		no	Ba-137m	2.31E+00	2.31E+00
Ce-144	5.76E-05	2.58E-03	yes		3.19E+03	1.80E-08	1.08E-08	1.08E-02							
Pr-144	5.76E-05	2.58E-03	yes		7.56E+07	7.62E-13	1.08E-08	1.08E-02							
Pr-144m	5.76E-05	2.58E-03	yes				1.08E-08	1.08E-02							
Pm-147	5.02E-02	2.25E+00	no		9.27E+02	5.41E-05	9.38E-06	9.38E+00					Pm-147	2.25E+00	2.25E+00
Eu-154	1.75E-02	7.83E-01	yes(b)		2.64E+02	6.62E-05	3.27E-06	3.27E+00					Eu-154	7.83E-01	7.83E-01
U-233	2.14E-06	9.57E-05			9.64E-03	2.22E-04	3.99E-10	3.99E-04	1.00E-06	1.00E-08		no	U-233	9.57E-05	9.58E-05
U-234	3.96E-07	1.77E-05			6.22E-03	6.37E-05	7.40E-11	7.40E-05	1.00E-06	1.00E-08	no	NA	**U-234**	1.77E-05	1.77E-05
U-235	6.91E-09	3.09E-07			2.16E-06	3.19E-03	1.29E-12	1.29E-06					U-235	3.09E-07	3.09E-07
Np-237	2.83E-07	1.27E-05			7.05E-04	4.02E-04	5.29E-11	5.29E-05	1.00E-06	1.00E-08		no	Np-237	1.27E-05	1.27E-05
U-238	2.35E-08	1.05E-06			3.36E-07	6.99E-02	4.39E-12	4.39E-06	1.00E-06	1.00E-08	no	NA	**U-238**	1.05E-06	1.05E-06
Pu-238	3.79E-02	1.70E+00			1.71E+01	2.22E-03	7.08E-06	7.08E+00	1.00E-06	1.00E-08		no	Pu-238	1.70E+00	1.70E+00
Pu-239	3.80E-04	1.70E-02			6.20E-02	6.13E-03	7.10E-08	7.10E-02	1.00E-06	1.00E-08		no	Pu-239	1.70E-02	1.70E-02
Pu-240	2.66E-04	1.19E-02			2.27E-01	1.17E-03	4.96E-08	4.96E-02	1.00E-06	1.00E-08		no	Pu-240	1.19E-02	1.19E-02
Pu-241	1.49E-02	6.65E-01			1.03E+02	1.44E-04	2.78E-06	2.78E+00	1.00E-05	1.00E-07		no	Pu-241	6.65E-01	6.66E-01
Pu-242	5.79E-07	2.59E-05			3.93E-03	1.47E-04	1.08E-10	1.08E-04	1.00E-06	1.00E-08		no	Pu-242	2.59E-05	2.59E-05
Am-241	1.79E-03	8.01E-02			3.43E+00	5.22E-04	3.35E-07	3.35E-01	1.00E-05	1.00E-07		no	Am-241	8.01E-02	8.02E-02
Cm-244	3.17E-03	1.42E-01	yes(b)		8.09E+01	3.92E-05	5.93E-07	5.93E-01	1.00E-06	1.00E-08		no	Cm-244	1.42E-01	1.42E-01
Cm-245	2.30E-07	1.03E-05			1.72E-01	1.34E-06	4.31E-11	4.31E-05	1.00E-06	1.00E-08		no	Cm-245	1.03E-05	1.03E-05
Total	2.23E+00	1.00E+02				1.07E-01	4.17E-04	4.17E+02					Total	9.99E+01	1.00E+02

Attachment 4

Waste Characterization Forms for Sludge Fraction, HTK-00002-9, HTK-00002-43 and HTK-00002-30

EAV/CIF Low Level Waste Stream Characterization

1. Waste Stream ID	2. Generating Facility	3. Waste Organization	4. Building Name	5. Effective Date
HTK-00002-09	H Tank Farm	H-Area Tank Farm	241-H	9/1/2000

6. WITS Stream Description	7. Reason for Submittal	8. WCF No.	9. Rev
Sludge Cont'd Waste, H Tanks 9,10, 13 and 14	Re-characterize Stream		

10. Activity Generating Waste	11. Physical Form	12. TSD Facility/Location
Tank Farm Operations	Combustible	EAV-LAW Vault 1

13. Valid Calculation Method for Waste	14. STC Constant	15. STC Min Value	16. DTC Waste Form
☐ Char by Pack ☐ Dose-to-Curie ☐ Smear to Curie ☒ Curies or RAD Weight	N/A	N/A	N/A

17. Assigned Container Types	18. DTC Containers	19. Waste Description	Vol %
B-12 (14)	N/A	Contaminated Equipment	50
B-25 (Yellow)-Light (6)	N/A	Job Control Waste	50
55-gal Drum (A,7A) (15)	N/A		

20. WITS ID	21. Tech Baseline	22. Container Document No.	23. Deviation Document No.
HTK-00002-09	WSRC-TR-2000-00249, Rev.1	N/A	

24. GCO Name	25. GCO Address	26. GCO Phone	27. CERCLA	28. Waste < 2 nCi/g
R. J. Petras	707-H	208-1410	☐ Yes ☒ No	☐ Yes ☒ No

29. Source(s)	30. PCB Category
☐ Yes ☒ No	☐ PCB Bulk ☒ N/A ☐ PCB Article ☐ PCB Leachable ☐ PCB Remediation ☐ PCB Laboratory ☐ PCB Decontamination

31. Comments

32. Meas Tech	33. Waste Incidental to Reprocessing (WIR) — Evaluation Document No.
☐ Sample and Analysis ☒ Process Knowledge	N/A

34. Currently Assigned Isotopes

Isotope	Ci %	Basis for Exclusion (PA isotopes only)	Isotope	Ci %	Basis for Exclusion*
C-14	1.33E-06		**H-3**	0	not present per process knwldg
Sr-90	4.67E+01				
Y-90	4.67E+01				
Tc-99	2.08E-02				
I-129	9.44E-08				
Cs-137	3.13E+00				
Ba-137m	2.96E+00				
Eu-154	1.58E-01				
U-233	1.58E-04				
U-234	2.22E-05				
U-235	9.05E-07				
Np-237	1.34E-04				
U-238	1.82E-05				
Pu-238	1.10E-01				
Pu-239	1.03E-02				
Pu-240	1.03E-02				
Pu-241	6.80E-03				
Am-241	1.46E-01				

Total 100.00 %

35. GCO Signature**	Date	Environmental Compliance Authority Signature	Date
[signature]	12/14/00	Stuart Stinson	12/14/00
Solid Waste Approval	Date	WITS Data Input Signature	Date

**Generator Certification Statement: "I certify that to the best of my knowledge, the data submitted provides a true and accurate description of the waste."

EAV/CIF Low Level Waste Stream Characterization

Waste Stream ID	WCF No.	Rev	WITS ID
HTK-00002-09			HTK-00002-09

CIF Section

36. Major Waste Components

Description	Concentration Wt%	Description	Concentration Wt%

37. Chemicals/Organics/Metals

37. Chemicals/Organics/Metals	Concentration, PPM	Chemicals/Organics/Metals	Concentration, PPM

38. Properties

Heat Value (BTU/lb)	Ash Content (Weight %)	Total Halogens (Weight %)

No. of Liquid Layers in Waste	Water (Weight%)

Liquid Layer Description	Vol % Liquid Layer	pH	Spec Gravity	Est Viscosity(CP)	Total Susp Solids (Wt%)	Total Diss Solids (Wt%)

EAV/CIF Low Level Waste Stream Characterization

1. Waste Stream ID	2. Generating Facility	3. Waste Organization	4. Building Name	5. Effective Date
HTK-00002-43	H Tank Farm	H-Area Tank Farm	241-H	9/1/2000

6. WITS Stream Description	7. Reason for Submittal	8. WCF No.	9. Rev
Sludge Cont'd Waste, H Tanks 21-24, 38, 41 and 43	Re-characterize Stream		

10. Activity Generating Waste	11. Physical Form	12. TSD Facility/Location
Tank Farm Operations	Combustible	EAV-LAW Vault 1

13. Valid Calculation Method for Waste	14. STC Constant	15. STC Min Value	16. DTC Waste Form
☐ Char by Pack ☐ Dose-to-Curie ☐ Smear to Curie ☒ Curies or RAD Weight	N/A	N/A	N/A

17. Assigned Container Types	18. DTC Containers	19. Waste Description	Vol %
B-12 (14)	N/A	Contaminated Equipment	50
B-25 (Yellow)-Light (6)	N/A	Job Control Waste	50
55-gal Drum (A,7A) (15)	N/A		

20. WITS ID	21. Tech Baseline	22. Container Document No.	23. Deviation Document No.
HTK-00002-43	WSRC-TR-2000-00249, Rev.1	N/A	SWMD-RFD-2000-0096

24. GCO Name	25. GCO Address	26. GCO Phone	27. CERCLA	28. Waste < 2 nCi/g
R. J. Petras	707-H	208-1410	☐ Yes ☒ No	☐ Yes ☒ No

29. Source(s)	30. PCB Category
☐ Yes ☒ No	☐ PCB Bulk ☒ N/A ☐ PCB Article ☐ PCB Leachable ☐ PCB Remediation ☐ PCB Laboratory ☐ PCB Decontamination

31. Comments

32. Meas Tech	33. Waste Incidental to Reprocessing (WIR) — Evaluation Document No.
☐ Sample and Analysis ☒ Process Knowledge	N/A

34. Currently Assigned Isotopes

Isotope	Ci %	Basis for Exclusion (PA isotopes only)	Isotope	Ci %	Basis for Exclusion*
H-3	0	not present per process knwldg			
C-14	7.07E-08				
Sr-90	4.50E+01				
Y-90	4.50E+01				
Tc-99	9.79E-03				
Sb-125	1.02E-01				
I-129	3.39E-08				
Cs-137	2.42E+00				
Ba-137m	2.29E+00				
Pm-147	3.03E+00				
Eu-154	9.04E-01				
U-233	2.69E-04				
U-234	1.24E-04				
U-235	1.80E-06				
Np-237	7.28E-05				
U-238	2.24E-06				
Pu-238	1.15E+00				
Pu-239	2.79E-03				
Pu-240	1.81E-03				
Pu-241	9.73E-02				
Pu-242	3.03E-06				
Am-241	3.81E-02				

Total 100.00 %

35. GCO Signature**	Date	Environmental Compliance Authority Signature	Date
Robert Petras	12/14/00	Stuart Stinson	12/14/00
Solid Waste Approval	Date	WITS Data Input Signature	Date

**Generator Certification Statement: "I certify that to the best of my knowledge, the data submitted provides a true and accurate description of the waste."

EAV/CIF Low Level Waste Stream Characterization

Waste Stream ID	WCF No.	Rev	WITS ID
HTK-00002-43			HTK-00002-43

CIF Section

36. Major Waste Components

Description	Concentration Wt%	Description	Concentration Wt%

37. Chemicals/Organics/Metals

37. Chemicals/Organics/Metals	Concentration, PPM	Chemicals/Organics/Metals	Concentration, PPM

38. Properties

Heat Value (BTU/lb)	Ash Content (Weight %)	Total Halogens (Weight %)

No. of Liquid Layers in Waste	Water (Weight%)

Liquid Layer Description	Vol % Liquid Layer	pH	Spec Gravity	Est Viscosity(CP)	Total Susp Solids (Wt%)	Total Diss Solids (Wt%)

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Ref. 1S Manual, Appendix A-17 Instructions

EAV/CIF Low Level Waste Stream Characterization

1. Waste Stream ID	2. Generating Facility	3. Waste Organization	4. Building Name	5. Effective Date
HTK-00002-30	H Tank Farm	H-Area Tank Farm	241-H	9/1/2000

6. WITS Stream Description	7. Reason for Submittal	8. WCF No.	9. Rev
Sludge Cont'd Waste, H Tanks 11, 12, 15, 16, 29-32, 35-37	Re-characterize Stream		

10. Activity Generating Waste	11. Physical Form	12. TSD Facility/Location
Tank Farm Operations	Combustible	EAV-LAW Vault 1

13. Valid Calculation Method for Waste	14. STC Constant	15. STC Min Value	16. DTC Waste Form
☐ Char by Pack ☐ Dose-to-Curie ☐ Smear to Curie ☒ Curies or RAD Weight	N/A	N/A	N/A

17. Assigned Container Types	18. DTC Containers	19. Waste Description	Vol %
B-12 (14)	N/A	Contaminated Equipment	50
B-25 (Yellow)-Light (6)	N/A	Job Control Waste	50
55-gal Drum (A,7A) (15)	N/A		

20. WITS ID	21. Tech Baseline	22. Container Document No.	23. Deviation Document No.
HTK-00002-30	WSRC-TR-2000-00249	N/A	SWMD-RFD-2000-0096

24. GCO Name	25. GCO Address	26. GCO Phone	27. CERCLA	28. Waste < 2 nCi/g
R. J. Petras	707-H	208-1410	☐ Yes ☒ No	☐ Yes ☒ No

29. Source(s)	30. PCB Category
☐ Yes ☒ No	☐ PCB Bulk ☒ N/A ☐ PCB Article ☐ PCB Leachable ☐ PCB Remediation ☐ PCB Laboratory ☐ PCB Decontamination

31. Comments

32. Meas Tech	33. Waste Incidental to Reprocessing (WIR) — Evaluation Document No.
☐ Sample and Analysis ☒ Process Knowledge	N/A

34. Currently Assigned Isotopes

Isotope	Ci %	Basis for Exclusion (PA isotopes only)	Isotope	Ci %	Basis for Exclusion*
C-14	1.05E-06		**H-3**	0	not present per process knwldg
Sr-90	4.48E+01				
Y-90	4.48E+01				
Tc-99	1.08E-02				
I-129	3.76E-08				
Cs-137	2.44E+00				
Ba-137m	2.31E+00				
Pm-147	2.25E+00				
Eu-154	7.83E-01				
U-233	9.58E-05				
U-234	1.77E-05				
U-235	3.09E-07				
Np-237	1.27E-05				
U-238	1.05E-06				
Pu-238	1.70E+00				
Pu-239	1.70E-02				
Pu-240	1.19E-02				
Pu-241	6.66E-01				
Pu-242	2.59E-05				
Am-241	8.02E-02				
Cm-244	1.42E-01				
Cm-245	1.03E-05				

Total 100.00 %

35. GCO Signature**	Date	Environmental Compliance Authority Signature	Date
Robert Petras	12/14/00	Stuart Stinson	12/14/00
Solid Waste Approval	**Date**	**WITS Data Input Signature**	**Date**

**Generator Certification Statement: "I certify that to the best of my knowledge, the data submitted provides a true and accurate description of the waste."

Back of
OSR 29-82# (Rev 7-26-2000)

EAV/CIF Low Level Waste Stream Characterization

Waste Stream ID	WCF No.	Rev	WITS ID
HTK-00002-30			HTK-00002-30

CIF Section

36. Major Waste Components

Description	**Concentration Wt%**	**Description**	**Concentration Wt%**

37. Chemicals/Organics/Metals	Concentration, PPM	Chemicals/Organics/Metals	Concentration, PPM

38. Properties

Heat Value (BTU/lb)	Ash Content (Weight %)	Total Halogens (Weight %)

No. of Liquid Layers in Waste	Water (Weight%)

Liquid Layer Description	Vol % Liquid Layer	pH	Spec Gravity	Est Viscosity(CP)	Total Susp Solids (Wt%)	Total Diss Solids (Wt%)

Attachment 5

Waste Characterization Form for Supernate Fraction, HTK-00001

SR 29-82# (Rev 07-15-99) — Ref. 1S Manual, Appendix A-17 Instructions

EAV/CIF Lo[redacted]am Characterization

1. Waste Stream ID	2. Generating Facility	3. Waste Organization	4. Building Name	5. Effective Date
HTK-00001	H Tank Farm	H-Area Tank Farm	241-H	12/1/99

6. WITS Stream Description	7. Reason for Submittal	8. WCF No.	9. Rev
Supernate Portion, Sludge Waste, H Tank Farm	~~Correct~~ Char Stream	SWE-WSCF-1999-0010	1

10. Activity Generating Waste	11. Physical Form	12. TSD Facility/Location
Tank Farm Operations	Combustible	EAV-LAW Vault 1

13. Valid Calculation Method for Waste	14. STC Constant	15. STC Min Value	16. DTC Waste Form
☐ Dose-to-Curie ☐ Smear to Curie ☐ Char by Pack ☒ Curies or RAD Weight	N/A	N/A	N/A

17. Assigned Container Types	18. DTC Containers	19. Waste Description	Vol %
B-12	N/A	Contaminated Equipment	50
B-25	N/A	Job Control Waste	50
Recycled 55 gallon drum	N/A		

20. WITS ID	21. Tech Baseline	22. Container Document No.	23. Deviation Document No.
HTK-00001-LLW	WSRC-TR-94-00290, Rev. 3	N/A	N/A

24. GCO Name	25. GCO Address	26. GCO Phone	27. CERCLA	28. Waste < 2 nCi/g
R. J. Petras	707-H	208-1410	☐ Yes ☒ No	☐ Yes ☒ No

29. Source(s)	30. PCB Category
☐ Yes ☒ No	☐ PCB Bulk ☐ PCB Remediation ☒ N/A ☐ PCB Laboratory ☐ PCB Article ☐ PCB Decontamination

31. Comments

32. Meas Tech ☒ Sample and Analysis ☒ Process Knowledge

33. Currently Assigned Isotopes

Isotope	Ci %	Basis for Exclusion*	Isotope	Ci %	Basis for Exclusion*
H-3	2.0E-01	X			
Co-60	1.7E+00	X			
Sr-90	4.7E-02	X			
Tc-99	9.1E-03	X			
I-129	1.1E-05	X			
Cs-137	5.0E+01	X			
Ba-137m	4.7E+01	X			
U-233	2.6E-04	X			
U-234	7.1E-05	X			
Pu-238	2.5E-01	X			
Pu-239	2.9E-03	X			
Pu-240	1.3E-03	X			
Pu-241	1.9E-01	X			
Am-241	1.8E-02	X			

*PA Isotopes Only — Total 1.00E+02 %

34. GCO Signature**	Date	Environmental Compliance Authority Signature	Date
[signature]	12/8/99	[signature]	12/8/99
Solid Waste Approval	Date	WITS Data Input Signature	Date
[signature]	12/28/99	[signature]	1/18/00

**Generator Certification Statement: "I certify that to the best of my knowledge, the data submitted provides a true and accurate description of the waste."

EAV/CIF Low Level Wast[redacted]zation *Page 2* [redacted]

Waste Stream ID	WCF No.	Rev	WITS ID
HTK-00001	4WE-WSCP-1999-0010	1	HTK-00001

CIF Section

35. Major Waste Components

Description	Concentration Wt%	Description	Concentration Wt%
NA	NA		

36. Chemicals/Organics/Metals	Concentration, PPM	Chemicals/Organics/Metals	Concentration, PPM
NA	NA		

37. Properties

Heat Value (BTU/lb)	Ash Content (Weight %)	Total Halogens (Weight %)

No. of Liquid Layers in Waste	Water (Weight%)

Liquid Layer Description	Vol % Liquid Layer	pH	Spec Gravity	Est Viscosity(CP)	Total Susp Solids (Wt%)	Total Diss Solids (Wt%)

Attachment 6

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

Attachment 6. H-Area tank Farm Sludge Waste Streams
Sludge and Supernate Fractions Activity Distributions

	SLUDGE FRACTION		
	activity fraction (%)	normalized distribution	scaling factors Ci/Ci Sr-90
Radionuclide	Waste Stream HTK-00002-9		
H-3			
C-14	1.33E-06	1.33E-06	2.84E-08
Co-60			
Sr-90	4.67E+01	4.67E+01	1.00E+00
Y-90	4.67E+01	4.67E+01	1.00E+00
Tc-99	2.08E-02	2.08E-02	4.44E-04
I-129	9.44E-08	9.44E-08	2.02E-09
Cs-137	3.13E+00	3.13E+00	6.71E-02
Ba-137m	2.96E+00	2.96E+00	6.34E-02
Eu-154	1.58E-01	1.58E-01	3.37E-03
U-233	1.58E-04	1.58E-04	3.39E-06
U-234	2.22E-05	2.22E-05	4.74E-07
U-235	9.04E-07	9.05E-07	1.94E-08
Np-237	1.34E-04	1.34E-04	2.87E-06
U-238	1.82E-05	1.82E-05	3.90E-07
Pu-238	1.10E-01	1.10E-01	2.36E-03
Pu-239	1.03E-02	1.03E-02	2.21E-04
Pu-240	1.03E-02	1.03E-02	2.21E-04
Pu-241	6.79E-03	6.80E-03	1.45E-04
Pu-242			
Am-241	1.46E-01	1.46E-01	3.12E-03
Total	1.00E+02	1.00E+02	
Radionuclide	Waste Stream HTK-00002-43		
C-14	7.07E-08	7.07E-08	1.57E-09
Co-60			
Sr-90	4.49E+01	4.50E+01	1.00E+00
Y-90	4.49E+01	4.50E+01	1.00E+00
Tc-99	9.78E-03	9.79E-03	2.18E-04
Sb-125	1.02E-01	1.02E-01	2.26E-03
I-129	3.39E-08	3.39E-08	7.54E-10
Cs-137	2.42E+00	2.42E+00	5.39E-02
Ba-137m	2.29E+00	2.29E+00	5.10E-02
Pm-147	3.03E+00	3.03E+00	6.75E-02
Eu-154	9.04E-01	9.04E-01	2.01E-02
U-233	2.69E-04	2.69E-04	5.98E-06
U-234	1.24E-04	1.24E-04	2.76E-06
U-235	1.80E-06	1.80E-06	4.00E-08
Np-237	7.28E-05	7.28E-05	1.62E-06
U-238	2.24E-06	2.24E-06	4.97E-08
Pu-238	1.15E+00	1.15E+00	2.55E-02
Pu-239	2.79E-03	2.79E-03	6.20E-05
Pu-240	1.81E-03	1.81E-03	4.02E-05
Pu-241	9.72E-02	9.73E-02	2.16E-03
Pu-242	3.02E-06	3.03E-06	6.73E-08
Am-241	3.80E-02	3.81E-02	8.46E-04
Total	9.99E+01	1.00E+02	
Radionuclide	Waste Stream HTK-00002-30		
C-14	1.05E-06	1.05E-06	2.35E-08
Co-60			
Sr-90	4.48E+01	4.48E+01	1.00E+00
Y-90	4.48E+01	4.48E+01	1.00E+00
Tc-99	1.08E-02	1.08E-02	2.41E-04
I-129	3.75E-08	3.76E-08	8.39E-10
Cs-137	2.44E+00	2.44E+00	5.45E-02
Ba-137m	2.31E+00	2.31E+00	5.16E-02
Pm-147	2.25E+00	2.25E+00	5.02E-02
Eu-154	7.83E-01	7.83E-01	1.75E-02
U-233	9.57E-05	9.58E-05	2.14E-06
U-234	1.77E-05	1.77E-05	3.96E-07
U-235	3.09E-07	3.09E-07	6.91E-09
Np-237	1.27E-05	1.27E-05	2.83E-07
U-238	1.05E-06	1.05E-06	2.35E-08
Pu-238	1.70E+00	1.70E+00	3.79E-02
Pu-239	1.70E-02	1.70E-02	3.80E-04
Pu-240	1.19E-02	1.19E-02	2.66E-04
Pu-241	6.65E-01	6.66E-01	1.49E-02
Pu-242	2.59E-05	2.59E-05	5.79E-07
Am-241	8.01E-02	8.02E-02	1.79E-03
Cm-244	1.42E-01	1.42E-01	3.17E-03
Cm-245	1.03E-05	1.03E-05	2.30E-07
Total	9.99E+01	1.00E+02	

	SUPERNATE FRACTION		
Radionuclide	activity fraction (%)	normalized distribution	scaling factors Ci/Ci Cs-137
H-3	2.00E-01	2.01E-01	4.00E-03
C-14			
Co-60	1.70E+00	1.71E+00	3.40E-02
Sr-90	4.70E-02	4.73E-02	9.30E-04
Y-90			
Tc-99	9.10E-03	9.15E-03	1.80E-04
I-129	1.10E-05	1.11E-05	2.10E-07
Cs-137	5.00E+01	5.03E+01	1.00E+00
Ba-137m	4.70E+01	4.73E+01	9.40E-01
Eu-154			
U-233	2.60E-04	2.62E-04	5.20E-06
U-234	7.10E-05	7.14E-05	1.40E-06
U-235			
Np-237			
U-238			
Pu-238	2.50E-01	2.51E-01	5.00E-03
Pu-239	2.90E-03	2.92E-03	5.90E-05
Pu-240	1.30E-03	1.31E-03	2.60E-05
Pu-241	1.90E-01	1.91E-01	3.80E-03
Pu-242			
Am-241	1.80E-02	1.81E-02	3.50E-04
Total	9.94E+01	1.00E+02	