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CHARACTERIZATION OF RADIONUCLIDES FOR 2H EVAPORATOR CLEANING TRANSFERS TO TANK 42(U)

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by
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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.

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 2H Evaporator cleaning transfers to Tank 42, based on process knowledge and available analytical data. The scaling factors developed for Tank 42 in this document supercede those presented in Reference 6, and any other previously developed radionuclide characterizations for Tank 42 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 for the 2H Evaporator cleaning transfers to Tank 42 in accordance with the methodology outlined in WAC 2.02, Rev. 5. A single, comprehensive characterization for supernate has been developed previously (Reference 7).

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 2H Evaporator cleaning transfers to Tank 42 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 2H Evaporator cleaning transfers to Tank 42 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, Transuranic 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 for Tank 42 (Reference 3) and analytical results for the 2H Evaporator. 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 3).

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 8). 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 35 radionuclides (Table 3.1) will be considered when developing the radionuclide distribution of waste packages contaminated with sludge from the 2H Evaporator cleaning transfers to Tank 42.

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			
Ni-59			X	
Co-60			X	
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 the 2H Evaporator have been developed based on sample analyses for preparation of the evaporator cleaning, while those for Tank 42 have been developed based on data in WCS (Attachment 1).

3.2 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).

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 35 radionuclides listed in Table 3.1, one is excluded because it is not expected to be present. This same radionuclide, tritium, is also present at below 1/100 of the MALLD. Seven non-PA radionuclides are excluded based on the third criteria (non-PA isotopes present at less than the MALLD). Of the 18 radionuclides included because they were expected to be present at more than 1% of total activity, 13 are determined to be present at less than 1% of the total activity. Three of these, however, Ce-144, Pr-144, and Eu-154 are retained in the distribution since they are near 1% of total activity. Calculations supporting this determination are summarized in Attachment 3; the results of the determination are summarized in Table 3.3.

Specific issues related to quantification of sludge-contaminated waste generated from the 2H Evaporator cleaning transfers to Tank 42 are contained in Section 5. Analysis of waste streams HTK-00002-2H42 is documented in Attachment 2. The presence of each PA radionuclide, expressed as a fraction of the mean scaling factor for 2H evaporator and Tank 42 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. For PA rads, C-14, Tc-99 and I-129 scaling factors were developed for only Tank 42 because these radionuclides were not present in the 2H Evaporator samples. For PA rads, U-234 and U-238, the scaling factors for Tank 42 differ by more than one order of magnitude from the mean scaling factor; however this is acceptable because use of the mean distribution is conservative.

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 the waste streams. The maximum variation from the proposed data set (the mean distribution) is 29.0%, 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 this waste stream, and the sludge fraction of sludge-contaminated waste from 2H Evaporator to Tank 42 in Table 3.2 may be consolidated. The arithmetic mean scaling factors will be used in the remainder of the development of the radionuclide distribution.

Table 3.2. Radionuclides Excluded from Consideration, Sludge Fraction

Radionuclide	Exclusion Criteria			
	Not Expected	PA Rads <.01 of MALLD	Non-PA <MALLD	Present at <1% (a)
H-3	X		X	
C-14		X		
Ni-59				X
Co-60				X
Se-79				X
Sr-90				
Y-90				
Tc-99				
Ru-106				X
Rh-106				X
Sb-125				
Sn-126				X
I-129				
Cs-134				X
Cs-135				X
Cs-137				
Ba-137m				
Ce-144				X(b)
Pr-144				X(b)
Pr-144m				X
Pm-147				X
Eu-154				X(b)
U-233			X	
U-234				
U-235			X	
Np-237			X	
U-238				
Pu-238				
Pu-239				
Pu-240				
Pu-241				
Pu-242			X	
Am-241			X	
Cm-244				X
Cm-245			X	

(a) For those radionuclides included only because were thought to have been present at >1% activity
(b) Retained in distribution because they are present at near 1% of total activity
Note: Bold = PA Rads

3.3 Development of the Sludge Fraction Distribution

Thirty-five radionuclides were determined to be important to characterization of the sludge in 2H Evaporator and Tank 42. Nineteen of these have been excluded per discussion in Section 3.2 above, leaving 16 radionuclides to be quantified for waste stream HTK-00002-2H42. Mean scaling factors developed previously to determine compatability of waste in the tanks have been utilized to create an isotopic distribution for this waste stream. The radionuclides, their corresponding scaling factors (to Sr-90) and fractional activity in the waste stream are summarized in Table 3.3 below. Summaries of inclusion and exclusion criteria as well as supporting calculations for the development of the activity distribution are provided in Attachment 3.

Table 3.3. Radionuclide Scaling Factors and Distribution for 2H Evaporator to Tank 42

Radionuclide	Mean Scaling Factors (Ci/Ci Sr-90)	Mean Distribution, Normalized (%)
Sr-90	1.00E+00	3.32E+01
Y-90	1.00E+00	3.32E+01
Tc-99	3.06E-04	1.02E-02
Sb-125	6.69E-02	2.22E+02
I-129	1.07E-09	3.54E-08
Cs-137	1.78E-01	5.90E+00
Ba-137m	1.68E-01	5.58E+00
Ce-144	1.96E-02	6.51E-01
Pr-144	1.96E-02	6.51E-01
Eu-154	9.42E-03	3.13E-01
U-234	1.42E-02	4.72E-01
U-238	2.45E-03	8.14E-02
Pu-238	1.37E-01	4.56E+00
Pu-239	2.20E-03	7.31E-02
Pu-240	2.81E-03	9.34E-02
Pu-241	3.89E-01	1.29E+01
Total		1.00E+02

3.4 Other WAC Criteria

3.4.1 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 2H Evaporator to Tank 42 Sludge Waste Stream (Attachment 1) and its corresponding LAWV limits are summarized in Table 3.4. LAWV limits are expressed in Ci/ft^3 waste and Ci/90 ft^3 B-25 container.

Table 3.4. Comparison of Sludge-Contaminated Waste to LAWV Limits				
Radionuclide	**LAWV Limit (Ci/ft3)**	**LAWV Limit (Ci/B-25)**	**Sludge Slurry (Ci/gal)**	**Gal Sludge in B-25 to Reach LAWV Limit**
	A	B=A*90 ft3/B-25	C	D=C/B
C-14	2.50E-05	2.25E-03	1.90E-06	1.19E+03
Tc-99	4.90E-05	4.41E-03	7.46E-03	**5.91E-01**
I-129	5.60E-09	5.04E-07	2.59E-08	1.94E+01
U-234	1.10E-03	9.90E-02	4.55E-03	2.17E+01
U-238	1.20E-03	1.08E-01	7.87E-04	1.37E+02

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 the waste stream is Tc-99, which requires 0.59 gallons of sludge in a B-25 to meet the LAWV Limit. Sludge in 2H Evaporator and Tank 42 has an average activity of 26.6 Ci/gallon. Per Table 3.5 below, for waste stream HTK-00002-2H42, 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. 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 3.5. Comparison of Maximum Amount of Sludge Present to Meet LAWV Limits to TRU Criteria for Waste Stream HTK-00002-2H42				
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**
5.91E-01	2.66E+01	4.72E-02	7.43E-01	327

3.4.2 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
<u>+ activity concentration of isotope N/limit of isotope N</u>
≤ 1

Table 3.6 below calculates the maximum concentration of sludge slurry on sludge-contaminated waste in order for the sum-of-the-fractions criteria to be met.

Table 3.6. Sum-of-Fractions for Sludge Fraction of Sludge-Contaminated Waste						
Isotope	**Ci/gallon Sludge slurry**	**Ci/ft3 Sludge**	**ft3 Sludge/ ft3 Waste**	**Ci/ft3 Waste**	**LAWV Limit (Ci/ft3)**	**Fraction**
	A	B=A*7.48	C	D=B*C	E	=D/E
C-14	1.90E-06	1.42E-05	8.26E-04	1.17E-08	2.50E-05	4.69E-04
Tc-99	7.46E-03	5.58E-02	8.26E-04	4.61E-05	4.90E-05	9.40E-01
I-129	2.59E-08	1.94E-07	8.26E-04	1.60E-10	5.60E-09	2.86E-02
U-234	4.55E-03	3.41E-02	8.26E-04	2.81E-05	1.10E-03	2.56E-02
U-238	7.87E-04	5.89E-03	8.26E-04	4.86E-06	1.20E-03	4.05E-03
Sum of Fractions						**9.99E-01**

Tc-99 dominates the sum-of-the-fractions criteria for this waste stream. The criteria are met for a maximum of 0.56 gallons of sludge per B-25 for waste streams HTK-00002-2H42. Per Table 3.7 below, for waste stream HTK-00002-2H42, 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.

Table 3.7. Comparison of Maximum Amount of Sludge Present to Meet LAWV Sum-of Fraction Limits to TRU Criteria

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
0.56	26.6	4.72E-02	6.99E-01	308

3.4.3 Nuclear Criticality Safety Criteria

Sludge-contaminated LLW contains an insignificant quantity of fissionable material to impact nuclear criticality criteria. Table 3.8, below, shows the maximum quantity of sludge that could be placed in a B-25 prior to exceeding the 50-g Fissile Gram Equivalent (FGE) U-235 limit. This is equivalent to 6.83 gallons of sludge slurry, and 182 curies in a B-25, significantly greater than the TRU waste limit. Any such box will not be sent to the LAWV for disposal, therefore protecting this requirement.

Table 3.8. 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	Maximu m Curies Sludge in a B-25	Specific Activity (Ci/g)	Maximum Mass (grams) in a B-25	Equivalence Factor (from WSRC 1S Manual)	FGE U-235 (g)
	A	B	C=A*B	D	E=C/D	F	G=E*F
U-233	5.31E-05	6.83	3.62E-04	9.648E-03	3.76E-02	1.4	5.26E-02
U-235	1.55E-05	6.83	1.06E-04	2.16E-06	4.90E+01	1.0	4.90E+01
Pu-239	4.51E-03	6.83	3.08E-02	6.132E-02	5.02E-01	1.6	8.04E-01
Pu-241	1.53E-01	6.83	1.05E+00	1.034E+02	1.01E-02	3.5	3.54E-02
Am-242m	3.94E-05	6.83	2.69E-04	9.717E+00	2.77E-05	54.0	1.50E-03
Cm-243	0	6.83	0	5.253E+01	0	7.8	0
Cm-245	2.61E-08	6.83	1.78E-07	1.716E-01	1.04E-06	24.0	2.49E-05
Cm-247	0	6.83	0	9.396E-05	0	1.6	0
Cf-249	0	6.83	0	4.078E+00	0	70.0	0
Cf-251	0	6.83	0	1.582E+00	0	140.0	0

3.4.4 Class C Waste Determination

The sludge fraction of sludge-contaminated LLW disposed at the LAWV does not exceed Class C waste criteria. Table 3.9 includes the Class C radionuclide criteria (10 CFR 61.55, Table 1) along with the LAWV and ILV (Intermediate Level Vault) 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 3.9. Class C Waste Analysis for Sludge Fraction of Sludge-Contaminated Waste			
Radionuclide	**Class C (Ci/ft3)**	**WAC 3.17 for LAWV (Ci/ft3)**	**WAC 3.17 for ILV (Ci/ft3)**
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	1.32E+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, over 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, and would not be permitted in the LAWV.

Cs-137 – In order to exceed the class C limit of 132 Ci/ft3 for Cs-137, over 750 [132 Ci/ft3* 90ft3/(0.59 Ci Cs-137/Ci sludge * 26.6 Ci sludge/gal] 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, 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 as high as 73% of total plutonium activity (see Table 3.10 below). Based on the Class C criteria, this would allow 4,780 nanocuries/gram of total plutonium before the criteria would be exceeded. Subtracting the Pu-241 activity results in 1,280 nanocuries/gram of alpha-emitting plutonium isotopes. This level of alpha-emitters exceeds the criteria for TRU waste and would not be allowed. Therefore, any waste box meeting the TRU limit will also satisfy the Class C Waste criteria for Pu-241 in the LAWV.

Table 3.10. Comparison of Maximum Amount of Sludge Present to Pu-241 Class C Waste Analysis		
% 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**
73.2	4780	1280

Cm-242 – Cm-242 is not expected in HLW sludge based on knowledge of the processes that have generated the waste and its 162.5-day half-life.

3.5 Documentation of the Sludge Fraction Distribution

Low level waste stream form HTK-00002-2H42, included as Attachment 4, documents the distribution from Tank 42 and 2H Evaporator. 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 7) 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 7). The following determinations were made for supernate waste:

- A B-25 container 90% full (81 ft3 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 FHW-00001, included in Attachment 5, 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 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 9 and 10).

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 11), 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.

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 12).

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

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8. Procedure 3.17, "Low Level Radioactive Waste Acceptance Criteria," WSRC 1S Savannah River Site Waste Acceptance Manual, Rev. 6, Interim, Savannah River Site, March 12, 2001.

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

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

Attachment 1

Development of Scaling Factors for Tank 42 and 2H Evaporator

Attachment 1, 2H Evaporator Cleaning Transfers to Tank 42H

Calculation of Scaling Factors from WCS Concentration Data and 2H Evaporator Sample 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	Pr-144m	Pm-147
Concentration Ci/gal																				
42	1.90E-06	4.44E-02	8.44E-04	4.40E-04	2.43E+01	2.43E+01	7.46E-03	1.47E-06	1.47E-06	2.79E-03	4.08E-04	2.59E-08	1.75E-04	4.99E-06	1.35E+00	1.27E+00	3.23E-07	3.23E-07	3.23E-07	7.18E-02
*2H Evap		5.38E-07			3.20E-01	3.20E-01				4.28E-02					9.59E-02	9.07E-02	1.25E-02	1.25E-02	1.79E-04	
Average	1.90E-06	2.22E-02	8.44E-04	4.40E-04	1.23E+01	1.23E+01	7.46E-03	1.47E-06	1.47E-06	2.28E-02	4.08E-04	2.59E-08	1.75E-04	4.99E-06	7.21E-01	6.82E-01	6.27E-03	6.27E-03	8.97E-05	7.18E-02

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	Pr-144m	Pm-147
Scaling Factors (Ci/Ci Sr-90)																				
42	7.79E-08	1.82E-03	3.47E-05	1.81E-05	1.00E+00	1.00E+00	3.06E-04	6.03E-08	6.03E-08	1.15E-04	1.68E-05	1.07E-09	7.19E-06	2.05E-07	5.53E-02	5.23E-02	1.33E-08	1.33E-08	1.33E-08	2.95E-03
2H Evap		1.68E-06			1.00E+00	1.00E+00				1.34E-01					3.00E-01	2.84E-01	3.92E-02	3.92E-02	5.60E-04	
Average	7.79E-08	9.13E-04	3.47E-05	1.81E-05	1.00E+00	1.00E+00	3.06E-04	6.03E-08	6.03E-08	6.69E-02	1.68E-05	1.07E-09	7.19E-06	2.05E-07	1.78E-01	1.68E-01	1.96E-02	1.96E-02	2.80E-04	2.95E-03

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
Concentration Ci/gal																				
42	2.29E-01	3.21E-06	1.76E-08	4.52E-05	1.66E-05	3.92E-07	2.22E-06	6.89E-06	1.37E-05	2.30E-01	7.71E-03	2.77E-03	5.83E-02	2.53E-06	8.74E-03	3.35E-02	3.94E-05	2.08E-04	2.61E-08	5.20E+01
*2H Evap		1.94E-09		6.09E-05	9.09E-03	3.06E-05	3.43E-04	1.57E-03	1.59E-04	8.48E-02	1.31E-03	1.76E-03	2.48E-01	7.13E-05						1.24E+00
Average	2.29E-01	1.61E-06	1.76E-08	5.31E-05	4.55E-03	1.55E-05	1.73E-04	7.87E-04	8.63E-05	1.57E-01	4.51E-03	2.26E-03	1.53E-01	3.69E-05	8.74E-03	3.35E-02	3.94E-05	2.08E-04	2.61E-08	2.66E+01

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
Scaling Factors (Ci/Ci Sr-90)																				
42	9.42E-03	1.32E-07	7.22E-10	1.86E-06	6.84E-07	1.61E-08	9.14E-08	2.83E-07	5.62E-07	9.44E-03	3.17E-04	1.14E-04	2.40E-03	1.04E-07	3.59E-04	1.37E-03	1.62E-06	8.53E-06	1.07E-09	2.14E+00
2H Evap		6.07E-09		1.90E-04	2.84E-02	9.57E-05	1.07E-03	4.90E-03	4.97E-04	2.65E-01	4.09E-03	5.51E-03	7.75E-01	2.23E-04						3.88E+00
Average	9.42E-03	6.90E-08	7.22E-10	9.62E-05	1.42E-02	4.79E-05	5.36E-04	2.45E-03	2.49E-04	1.37E-01	2.20E-03	2.81E-03	3.89E-01	1.12E-04	3.59E-04	1.37E-03	1.62E-06	8.53E-06	1.07E-09	3.01E+00

$Am\text{-}241_{tot}$ 1.73E-03

* 2H Evaporator data taken from Calculation of Radiation Inventory in the 242-16H Neutralization Tank, X-CLC-H-00150, Rev.1

Attachment 2

Comparison of Tank 42 and 2H Evaporator for Consolidation

Attachment 2. Comparison of Tank 42H and 2H Evaporator 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 42**	**2H Evap**	**Mean Ci/Ci Sr-90**	**Tank 42**	**2H Evap**
C-14	7.79E-08		7.79E-08		
Tc-99	3.06E-04		3.06E-04		
I-129	1.07E-09		1.07E-09		
U-234*	6.84E-07	2.84E-02	1.42E-02	0.00	2.00
U-238*	2.83E-07	4.90E-03	2.45E-03	0.00	2.00

*Note: The mean scaling factors will be utilized in the consolidated distribution, even though the scaling factor for Tank 42 differs by more than 1 order of magnitude. This is acceptable per WAC 2.02 if the mean distribution is conservative.

	Fractional Activity			Predominant Rads, Variation	
Isotope	**Tank 42**	**2H Evap**	**Mean**	**Tank 42**	**2H evap**
Sr-90	4.68E-01	2.58E-01	3.63E-01	29.0%	-29.0%
Y-90	4.68E-01	2.58E-01	3.63E-01	29.0%	-29.0%

Attachment 3

Sludge Waste Stream 2H42, Exclusion Criteria

Attachment 3. Tank 42 and 2H Evaporator Sludge Waste Stream Exclusion Criteria

Isotope	Mean Ci/Ci Sr-90	Mean Distribution	<1% of Dist?(a)	Not Expected	Comparison to MALLD: 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?	Distribution: RADs Remaining after Exclusion Criteria	Fractional Distribution (percent)	Re-normalized Distribution
					Waste Stream HTK-00002-2H42								Waste Stream		
H-3	0.00E+00	0.00E+00		x	9.65E+03	0.00E+00	0.00E+00	0.00E+00	1.00E-04	1.00E-06		yes			
C-14	7.79E-08	2.58E-06			4.46E+00	1.75E-08	2.13E-16	2.13E-10	1.00E-05	1.00E-07	yes				
Ni-59	3.47E-05	1.15E-03	yes												
Co-60	9.13E-04	3.03E-02	yes												
Se-79	1.81E-05	5.99E-04	yes		6.96E-02	2.60E-04	4.94E-14	4.94E-08							
Sr-90	1.00E+00	3.32E+01			1.39E+02	7.19E-03	2.73E-09	2.73E-03	1.00E-04	1.00E-06		no	Sr-90	3.32E+01	3.32E+01
Y-90	1.00E+00	3.32E+01			5.44E+05	1.84E-06	2.73E-09	2.73E-03	1.00E-04	1.00E-06		no	Y-90	3.32E+01	3.32E+01
Tc-99	3.06E-04	1.02E-02			1.70E-02	1.80E-02	8.37E-13	8.37E-07	1.00E-06	1.00E-08	no		Tc-99	1.02E-02	1.02E-02
Ru-106	6.03E-08	2.00E-06	yes		3.35E+03	1.80E-11	1.65E-16	1.65E-10							
Rh-106	6.03E-08	2.00E-06	yes		1.36E+07	4.44E-15	1.65E-16	1.65E-10							
Sb-125	6.69E-02	2.22E+00	no		1.03E+03	6.50E-05	1.83E-10	1.83E-04					Sb-125	2.22E+00	2.22E+00
Sn-126	1.68E-05	5.56E-04	yes		2.84E-02	5.91E-04	4.58E-14	4.58E-08							
I-129	1.07E-09	3.53E-08			1.77E-04	6.02E-06	2.91E-18	2.91E-12	1.00E-06	1.00E-08	yes		**I-129**	3.53E-08	3.54E-08
Cs-134	7.19E-06	2.38E-04	yes		1.29E+03	5.57E-09	1.96E-14	1.96E-08							
Cs-135	2.05E-07	6.79E-06	yes		1.15E-03	1.78E-04	5.60E-16	5.60E-10							
Cs-137	1.78E-01	5.89E+00	no		8.65E+01	2.05E-03	4.85E-10	4.85E-04	1.00E-05	1.00E-07		no	Cs-137	5.89E+00	5.90E+00
Ba-137m	1.68E-01	5.57E+00	no				4.59E-10	4.59E-04	1.00E-05	1.00E-07		no	Ba-137m	5.57E+00	5.58E+00
Ce-144	1.96E-02	6.50E-01	yes(b)		3.19E+03	6.14E-06	5.36E-11	5.36E-05					Ce-144	6.50E-01	6.51E-01
Pr-144	1.96E-02	6.50E-01	yes(b)		7.56E+07	2.59E-10	5.36E-11	5.36E-05					Pr-144	6.50E-01	6.51E-01
Pr-144m	2.80E-04	9.28E-03	yes		1.81E+08	1.55E-12	7.65E-13	7.65E-07							
Pm-147	2.95E-03	9.78E-02	yes		9.27E+02	3.18E-06	8.06E-12	8.06E-06							
Eu-154	9.42E-03	3.12E-01	yes(b)		2.64E+02	3.57E-05	2.57E-11	2.57E-05					Eu-154	3.12E-01	3.13E-01
U-233	9.62E-05	3.19E-03			9.64E-03	9.97E-03	2.63E-13	2.63E-07	1.00E-06	1.00E-08		yes			
U-234	1.42E-02	4.71E-01			6.22E-03	2.29E+00	3.88E-11	3.88E-05	1.00E-06	1.00E-08	no		**U-234**	4.71E-01	4.72E-01
U-235	4.79E-05	1.59E-03			2.16E-06	2.21E+01	1.31E-13	1.31E-07	1.00E-06	1.00E-08		yes			
Np-237	2.49E-04	8.25E-03			7.05E-04	3.53E-01	6.80E-13	6.80E-07	1.00E-06	1.00E-08		yes			
U-238	2.45E-03	8.13E-02			3.36E-07	7.29E+03	6.70E-12	6.70E-06	1.00E-06	1.00E-08	no		**U-238**	8.13E-02	8.14E-02
Pu-238	1.37E-01	4.55E+00			1.71E+01	8.03E-03	3.75E-10	3.75E-04	1.00E-06	1.00E-08		no	Pu-238	4.55E+00	4.56E+00
Pu-239	2.20E-03	7.30E-02			6.20E-02	3.55E-02	6.01E-12	6.01E-06	1.00E-06	1.00E-08		no	Pu-239	7.30E-02	7.31E-02
Pu-240	2.81E-03	9.32E-02			2.27E-01	1.24E-02	7.68E-12	7.68E-06	1.00E-06	1.00E-08		no	Pu-240	9.32E-02	9.34E-02
Pu-241	3.89E-01	1.29E+01			1.03E+02	3.77E-03	1.06E-09	1.06E-03	1.00E-05	1.00E-07		no	Pu-241	1.29E+01	1.29E+01
Pu-242	1.12E-04	3.70E-03			3.93E-03	2.84E-02	3.05E-13	3.05E-07	1.00E-06	1.00E-08		yes			
Am-241	1.73E-03	5.75E-02			3.43E+00	5.05E-04	4.74E-12	4.74E-06	1.00E-05	1.00E-07		yes			
Cm-244	8.53E-06	2.83E-04	yes		8.09E+01	1.05E-07	2.33E-14	2.33E-08							
Cm-245	1.07E-09	3.55E-08			1.72E-01	6.23E-09	2.93E-18	2.93E-12	1.00E-06	1.00E-08		yes			
Total	3.02E+00	1.00E+02				7.32E+03	8.24E-09	8.24E-03					Total	9.98E+01	1.00E+02

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%

Attachment 4

Waste Characterization Form for Sludge Fraction, HTK-00002-2H42

EAV/CIF Low Level Waste Stream Characterization

1. Waste Stream ID	2. Generating Facility	3. Waste Organization	4. Building Name	5. Effective Date
HTK000022H42	H Tank Farm East	H-Area Tank Farm	241-197H	4/1/2001

6. WITS Stream Description	7. Reason for Submittal	8. WCF No.	9. Rev
Sludge Cont'd Waste, 2H Evaporator to H Tank 42	New Waste 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
☐ 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 (14)	All B-12s	Contaminated Equipment	50
B-25 (Yellow)-Light (6)	All B-25s	Job Control Waste	50
55-gal Drum (A,7A) (15)	All 55-gal Drums		
Skid Pan (183)	Skid Pan		
Recondition 55 Gal Drum (43)			

20. WITS ID	21. Tech Baseline	22. Container Document No.	23. Deviation Document No.
HTK-00002-2H42	WSRC-TR-2001-00132, Rev.0	N/A	N/A

24. GCO Name	25. GCO Address	26. GCO Phone	27. CERCLA	28. Waste < 2 nCi/g
D. E. Lott	241-197H	208-0644	☐ Yes ☒ No	☐ Yes ☒ No

29. Source(s)	30. PCB Category			
☐ Yes ☒ No	☐ PCB Leachable	☐ PCB Bulk ☐ PCB Remediation	☒ N/A ☐ PCB Laboratory	☐ PCB Article ☐ 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			
Sr-90	3.32E+01				
Y-90	3.32E+01				
Tc-99	1.02E-02				
Sb-125	2.22E+00				
I-129	3.54E-08				
Cs-137	5.90E+00				
Ba-137m	5.58E+00				
Ce-144	6.51E-01				
Pr-144	6.51E-01				
Eu-154	3.13E-01				
U-234	4.72E-01				
U-238	8.14E-02				
Pu-238	4.56E+00				
Pu-239	7.31E-02				
Pu-240	9.34E-02				
Pu-241	1.29E+00				

Total ______________ %

35. GCO Signature**	Date	Environmental Compliance Authority Signature	Date
Dana E. Lott	4/9/01	[signature]	4/10/01
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
HTK000022H42			HTK-00002-2H42

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, FHW-00001

OSR 29-82# (Rev 7-26-2000) Ref. 1S Manual, Appendix A-17 Instructions

EAV/CIF Low Level Waste Stream Characterization

1. Waste Stream ID FHW-00001	2. Generating Facility FTF, HTF, WPT	3. Waste Organization F, H Tank Farm, WPT	4. Building Name 241-F, 241-H, 241-197H	5. Effective Date 4/1/2001
6. WITS Stream Description Supernate-Ct'd Waste from HTF, FTF and WPT		7. Reason for Submittal Correct Stream	8. WCF No.	9. Rev
10. Activity Generating Waste F, H-TF operations, ITP/ESP Operations		11. Physical Form Combustible	12. TSD Facility/Location EAV-LAW Vault 1	
13. Valid Calculation Method for Waste ☐ Dose-to-Curie ☐ Smear to Curie ☐ Char by Pack ☒ Curies or RAD Weight		14. STC Constant N/A	15. STC Min Value N/A	16. DTC Waste Form N/A

17. Assigned Container Types	18. DTC Containers	19. Waste Description	Vol %
B-12 (14)	All B-12s	Job Control Waste	50
B-25 (Yellow)-Light (6)	All B-25s	Contaminated Equipment	50
55-gal Drum (A,7A) (15)	All 55-gal Drums		
Skid Pan (183)	Skid Pan		
ITP Slurry Pump Box - 15K			
ITP Slurry Pump Box - 30K			

20. WITS ID FHW-00001-LLW	21. Tech Baseline WSRC-TR-94-0290, Rev. 3, 4/99	22. Container Document No. N/A	23. Deviation Document No. N/A

24. GCO Name R. J. Petras	25. GCO Address 703-H	26. GCO Phone 208-1410	27. CERCLA ☐ Yes ☒ No	28. Waste < 2 nCi/g ☐ Yes ☒ No
29. Source(s) ☐ Yes ☒ No	30. PCB Category ☐ PCB Leachable	☐ PCB Bulk ☐ PCB Remediation	☒ N/A ☐ PCB Laboratory	☐ PCB Article ☐ PCB Decontamination

31. Comments

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

34. Currently Assigned Isotopes

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

Total __________ %

35. GCO Signature**	Date	Environmental Compliance Authority Signature	Date
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
FHW-00001			FHW-00001-LLW

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 6

Sludge Waste Stream 2H42, Sludge and Supernate Fractions Activity Distributions

Attachment 6. Tank 42 and 2H Evaporator Sludge Waste Stream
Sludge and Supernate Fractions Activity Distributions

	SLUDGE FRACTION		
	activity fraction (%)	normalized distribution	scaling factors Ci/Ci Sr-90
Radionuclide	Waste Stream HTK-00002-2H42		
H-3			
Co-60			
Sr-90	3.32E+01	3.32E+01	1.00E+00
Y-90	3.32E+01	3.32E+01	1.00E+00
Tc-99	1.02E-02	1.02E-02	3.06E-04
Sb-125	2.22E+00	2.22E+00	6.69E-02
I-129	3.53E-08	3.54E-08	1.07E-09
Cs-137	5.89E+00	5.90E+00	1.78E-01
Ba-137m	5.57E+00	5.58E+00	1.68E-01
Ce-144	6.50E-01	6.51E-01	1.96E-02
Pr-144	6.50E-01	6.51E-01	1.96E-02
Eu-154	3.12E-01	3.13E-01	9.42E-03
U-233			
U-234	4.71E-01	4.72E-01	1.42E-02
U-238	8.13E-02	8.14E-02	2.45E-03
Pu-238	4.55E+00	4.56E+00	1.37E-01
Pu-239	7.30E-02	7.31E-02	2.20E-03
Pu-240	9.32E-02	9.34E-02	2.81E-03
Pu-241	1.29E+01	1.29E+01	3.89E-01
Am-241			
Total	9.98E+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
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
Sb-125			
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
Ce-144			
Pr-144			
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-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
Am-241	1.80E-02	1.81E-02	3.50E-04
Total	9.94E+01	1.00E+02	