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1	1	Cog.Eng. M. J. Kupfer M J Kupfer 8-21-97	3		D. E. Place H5-27
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Preliminary Tank Characterization Report for Single-Shell Tank 241-TX-113: Best-Basis Inventory

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SGN Eurisys Services Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-TX-113 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-TX-113: BEST-BASIS INVENTORY

June 1997

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-TX-113: BEST-BASIS INVENTORY

This document is a preliminary Tank Characterization Report (TCR). It only contains the current best-basis inventory (Appendix D) for single-shell tank 241-TX-113. No TCRs have been previously issued for this tank, and current core sample analyses are not available. The best-basis inventory, therefore, is based on an engineering assessment of waste type, process flowsheet data, early sample data, and/or other available information.

The *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes* (Kupfer et al. 1997) describes standard methodology used to derive the tank-by-tank best-basis inventories. This preliminary TCR will be updated using this same methodology when additional data on tank contents become available.

REFERENCE

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^2S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-113

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-113

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for tank 241-TX-113 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

Available chemical and radiological inventory estimates for tank 241-TX-113 consist only of the inventory estimate generated by the Hanford Defined Waste (HDW) model (Agnew et al. 1996). No TCRs have been previously issued for this tank, and current core sample analyses are not available. The best-basis inventory, therefore, is based on the waste types contained in tank 241-TX-113 and composition data from other Hanford tanks containing similar waste types.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The tank 241-TX-113 chemical and radionuclide inventory predicted by the HDW model (Agnew et al. 1996) is provided in Table D2-1. The chemical species are reported without charge designation per the best-basis inventory convention.

Table D2-1. Hanford Defined Waste Model Prediction of Tank 241-TX-113 Inventory.

Analyte	Hanford Defined Waste model[a] (kg)
Al	66,500
Bi	7,070
Ca	3,260
Cl	8,930
CO_3	33,400
Cr	3,270
F	6,120
Fe	7,530
Hg	12.1
K	2,870
La	3.15 E-04
Mn	203
Na	378,000
Ni	615
NO_2	125,000
NO_3	425,000
OH	174,000
Pb	407
PO_4	74,100
Si	3,520
SO_4	35,200
Sr	6.63 E-05
TOC	5,816
U	3,990
Zr	667
Radionuclide (Ci)	
^{137}Cs	375,000
^{90}Sr	110,000

[a] Agnew et al (1996); radionuclides decayed to January 1, 1994.

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 CONTRIBUTING WASTE TYPES

Information concerning the waste types contained in tank 241-TX-113 is not entirely consistent. The HDW model (Agnew et al. 1996) indicates that the tank inventory includes both sludge and salt cake, whereas the Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) and the waste tank summary report (Hanlon 1996) indicate the tank contains only salt cake and the associated interstitial liquid.

The HDW model (Agnew et al. 1996) predicts that the tank contains 693 kL (183 kgal) first decontamination cycle waste from the bismuth phosphate process (1C) and 1,605 kL (424 kgal) Supernatant Mixing Model 242-T Evaporator salt cake generated from 1965 until 1976 (SMMT2). Since the 1C wastes sent to this cascade were generated before 1955, the coating wastes associated with the aluminum-clad reactor fuel being processed were combined with the 1C waste in the underground storage tank (Anderson 1990).

The SORWT model (Hill et al. 1995) lists evaporator bottoms (EB) and 1C as the primary and secondary waste types respectively, but credits the entire tank 241-TX-113 volume (2,297 kL [607 kgal]) to salt cake with 61 kL (16 kgal) of interstitial liquid. Hanlon (1996) also indicates that the entire tank inventory is salt cake.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste transaction records (Agnew et al. 1995) show that the cascade, consisting of tanks 241-TX-113 through 241-TX-115, received 1C wastes between the fourth quarter of 1950 and the fourth quarter of 1951. Waste transaction records indicate that a total of 8,418 kL (2,224 kgal) of combined 1C/Cladding Waste (1C/CW) was received into tank 241-TX-113. T Plant fuel processing during these periods consisted of approximately 466 MTU. The estimated 1C/CW waste volume based on the $BiPO_4$ flowsheet (Schneider 1951) would be 6,881 kL (1,818 kgal), which is 18 percent less than that indicated by the waste transaction records.

Beginning in the second quarter of 1952 and ending in the third quarter of 1953, tank 241-TX-113 was the active bottoms tank for the 242-T Evaporator. A total of 3,656 kL (966 kgal) of evaporator bottoms was received. A substantial salt cake layer would normally be expected. The HDW model refers to 241-T Evaporator salt cakes formed during the time period of 1951-1955 as T1 SltCk.

Beginning in the third quarter of 1970 and continuing until the second quarter of 1976, tank 241-TX-113 received concentrated evaporator bottoms again from the 242-T Evaporator and recycled supernates to the evaporator via the evaporator feed tank (241-TX-118). Salt cake formed as the concentrated salt solutions cooled and built up a large salt cake layer on top of previously existing sludge. Three airlift circulators were installed in the tank to facilitate evaporative cooling and prevent the formation of a crust that would have impeded evaporative heat removal. The HDW model refers to 242-T Evaporator salt cakes from 1965 to 1976 as T2 SltCk.

A small quantity (53 kL [14 kgal]) of evaporator feed was transferred to tank 241-TX-113 from tank 241-S-102 in 1976 and early 1977. Supernate remaining in tank 241-TX-113 was removed from the tank in 1977. Salt well pumping of the interstitial liquid was accomplished in 1982 and 1983.

D3.3 DETERMINATION OF WASTE TYPES

The 1C/CW volumes routed to the tank 241-TX-113 through 241-TX-115 cascade would result in 840 kL (222 kgal) of sludge (concentration factor of 10 based on tank 241-T-104). Most of this sludge volume would have been retained in the first tank of the cascade, but minor concentrations of entrained solids would still be expected in the overflow to tank 241-TX-114.

The HDW model predicts 693 kL (183 kgal) of 1C/CW sludge in tank 241-TX-113, based primarily on a sludge reading during the first quarter of 1965 before the tank had been placed in evaporator bottoms service for the second time. As noted by Anderson (1990), there was a significant degree of uncertainty in these sludge level measurements. The HDW model also predicts only 15 kL (4 kgal) of 1C sludge in tank 241-TX-114, and none in tank 241-TX-115. Assuming that 222 kgal of sludge resulted from the 1C/CW waste routed to this three tank cascade, the 241-TX-113 1C sludge inventory could be as high as 825 kL (218 kgal) rather than the reported 693 kL (183 kgal). Available information does not allow refinement of the sludge volume. The 1C sludge inventory for tank 241-TX-113 will be assumed to be 693 kL (183 kgal) to be consistent with the HDW model.

The HDW model discounts any inventory of T1 salt cake in tank 241-TX-113, although the tank did receive evaporator bottoms from 1952 to 1953. Based on the evaporator bottoms transferred to tank 241-TX-113, a substantial T1 salt cake layer would normally be expected if: (1) the evaporator bottoms were sufficiently concentrated to reach saturation upon cooling, (2) the evaporator bottoms were not immediately transferred to other tanks or (3) the salt cake was not dissolved by subsequent transfers of unsaturated solutions through the tank. Anderson (1990) indicates that the initial solids volume measurement for tank 241-TX-113 in the third quarter of 1953 was 954 kL (252 kgal), which tends to indicate that at least some salt cake was formed in the tank. Subsequent solids volume measurements in the second quarter of 1957 and the first quarter of 1965 (537 kL [142 kgal] and 693 kL [183 kgal] respectively) indicate that layer had been removed. Unrecorded solution transfers or inadvertent liquid intrusion may have resulted in the dissolution of the salt cake. The solids volume measurement in the first quarter of 1965 indicates that no significant T1 salt cake layer remained (after consideration of the 1C/CW sludge volume).

Waste transaction records also show that tank 241-TX-113 received 8,259 kL (2,182 kgal) of concentrated evaporator waste between 1966 and 1976. A substantial T2 salt cake inventory would be expected to have been deposited on top of the sludge layer. This is confirmed by a 1,605 kL (424 kgal) increase in the solids volume between the first quarter of 1965 (Anderson 1990) and May 30, 1983 (Hanlon 1996).

D3.4 COMPOSITION OF TANK 241-TX-113 WASTE

3.4.1 Composition of 1C Sludges

Several tanks received 1C/CW waste directly from T Plant including tanks 241-T-104, 241-T-107, 241-TX-109, 241-TX-113, 241-U-110, 241-TY-101, and 241-TY-103. Sample data are not available for solid layers in tanks 241-TX-109 or 241-TX-113. The 1C waste was mixed with substantial quantities of other wastes in tanks 241-TY-101, 241-TY-103, and 241-U-110, making it impossible to accurately determine the composition of the 1C/CW waste sludge. Two tanks (241-T-104 and 241-T-107) provide the best examples of T Plant 1C/CW sludge composition. The composition of these two tanks, based on the corresponding tank characterization reports (DiCenso et al. 1994 and Valenzuela and Jensen 1994), is provided in Table D3-1. The average of these two compositions will be used for estimating the sludge composition of tank 241-TX-113 with the exceptions of iron and uranium. Higher uranium and iron concentrations have been noted in several tanks (including tank 241-T-107) that stored Uranium Recovery (UR) wastes on top of 1C sludges. Since tank 241-TX-113 did not receive UR waste, only the iron and uranium data for tank 241-T-104 were used. The HDW model composition for 1C2 sludge (Agnew et al. 1996) is included in Table D3-1 for comparison.

Table D3-1. Tank Characterization Report Concentrations for Tanks 241-T-104 and 241-T-107. (2 Sheets)

Analyte	Tank 241-T-104 concentration[a] (μg/g)	Tank 241-T-107 concentration[b] (μg/g)	Predicted 1C sludge concentration (μg/g)	HDW model 1C2 sludge concentration (μg/g)
Ag	6.4	7.37	6.9	NR
Al	16,200	16,300	16,200	19,018.6
Bi	18,900	12,000	15,400	7,550.36
Ca	1,450	760	1,100	1,490.94
Cd	5.44	6.94	6.19	NR
Cl	670	540	605	373.259
CO_3	<500	14,850	7,680	2,232.32
Cr	901	360	631	184.53
F	8,570	11,400	9,980	2,981.5
Fe	9,020	29,200	9,020 [d]	8,165.25
Hg	0.127	0.14	0.13	9.51201
K	89.0	234	162	89.5485
La	<10.4	<2	<10	0
Mn	61.8	213	137	0
Na	64,500	130,200	97,400	66,898.2
Ni	11.3	267	139	64.105
NO_2	4,080	11,700	7,890	9,282.12
NO_3	58,000	74,500	66,200	19,711.6
OH	NR	NR	NR	44,187.1
Pb	NR	649	649	0
P as PO_4	75,700	98,400	87,100	68,393.2
Si	6,520	6,050	6,280	1,150.54
S as SO_4	3,830	9,810	6,820	4,038.15
Sr	99.1	878	489	0
TOC	706	963	835	0
U	897	26,400	897 [d]	121.576
Zr	67.5	93	80	523.61

Table D3-1. Tank Characterization Report Concentrations for Tanks 241-T-104 and 241-T-107. (2 Sheets)

Radionuclides	Tank 241-T-104 concentration (μCi/g)	Tank 241-T-107 concentration (μCi/g)	Predicted 1C sludge concentration[c] (μCi/g)	HDW model 1C2 sludge concentration (μCi/g)
^{241}Am	0.0173	0.0141	0.0157	NR
^{14}C	<4.5 E-05	1.81 E-04	1.1 E-04	NR
^{60}Co	<3.0 E-04	<0.00199	<9.85 E-04	NR
^{134}Cs	NR	<0.00164	<0.0012	NR
^{137}Cs	0.199	12.0	5.96	23.9325
^{154}Eu	0.0041	<0.00463	0.0038	NR
^{155}Eu	0.00342	<0.0149	0.0030	NR
^{3}H	<3.38 E-04	0.00124	5.9 E-04	NR
^{129}I	<0.0464	NR	<0.0464	NR
^{237}Np	0.137	NR	0.137	NR
^{238}Pu	<0.018	0.144	0.072	NR
$^{239/240}$Pu	0.14	0.131	0.136	NR
^{106}Ru	NR	<0.0757	<0.038	NR
^{79}Se	<1.75 E-04	NR	<1.75 E-04	NR
^{90}Sr	2.63	108	54.0	0.21406
^{99}Tc	5.79 E-04	NR	5.79 E-04	NR
Density (g/mL)	1.29	1.51	1.40	1.22228
Wt% H_2O	70.5%	56.0%	63.2%	74.2694

HDW = Hanford Defined Waste, Agnew et al. (1996)
NR = Not reported

[a] DiCenso et al. (1994)

[b] Valenzuela and Jensen (1994), Table 5-23

[c] Decayed to January 1, 1994, to match Hanford Defined Waste model

[d] Since tank 241-TX-113 did not receive UR wastes, the higher uranium and iron concentrations for tank 241-T-107 were ignored. Higher uranium and iron concentrations have been noted in several tanks (including tanks 241-T-107, 241-BX-107, and 241-B-106) that stored UR wastes on top of 1C sludges.

D3.4.2 Composition of 242-T Salt Cake

Post-1965 operation of the 242-T Evaporator resulted in 22,672 kL (5,990 kgal) of salt cake that is contained in 26 underground storage tanks in the S, SX, U, T, TX, and TY Tank Farms (Agnew et al. 1996). The HDW model refers to this salt cake as T2 SltCk on a global basis or as SMMT2 when calculated by the Supernatant Mixing Model (SMM) for an individual tank. The salt cake produced by the 242-T evaporator during the time period of 1965-1976 will be referred to as T2 salt cake hereafter in this report. Ninety-one percent of the T2 salt cake is contained in the TX tank farm. All tanks containing T2 salt cake also contain other waste types.

Only 8 tanks containing T2 salt cake have been core sampled, 241-S-107, 241-U-102, 241-U-105, 241-U-107, 241-TX-107, 241-TX-116, 241-TY-102, and 241-TY-103. Only three of these tanks (241-U-102 [Hu et al. 1997], 241-U-105 [Brown and Franklin 1996], and 241-TX-116 [Horton 1977]) have T2 salt cake layers large enough to differentiate it from other waste types in core sample data.

T2 salt cake was formed in tanks 241-U-102 and 241-U-105 in 1975 through 1976. Core sampling of tanks 241-U-102 and 241-U-105 was performed in early 1996. Based on the HDW model, segments 4, 5 and 6 for the two cores from tank 241-U-102 and segment 8 of two cores from tank 241-U-105 are expected to be representative of the T2 salt cake waste type. An independent determination of these levels is not possible due to a lack of solids volume measurements in this time period and the fact a significant composition change between the S2 salt cake and T2 salt cake layers can not be seen in the core sample data. The recent analytical data should meet all *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994) requirements. Descriptions of the core sampling events and analytical data are available in the respective Tank Characterization Reports (Hu et al. 1997 and Brown and Franklin 1996).

T2 salt cake was deposited in tank 241-TX-116 between 1966 and 1971. The tank 241-TX-116 core sample was taken with the initial prototype of a rotary core sampler from 1976 to 1977 (Allen 1977). Sample recoveries were relatively poor. Additionally, analytical methods and quality assurance differed significantly from current practices. However, this sample event provides the only composition data for early production of the T2 salt cake waste type. Inclusion of an early T2 salt cake type is important since 242-T Evaporator feeds and operating practices changed over time. The analytical data are provided in a letter report (Horton 1977). Core segments 1 through 4 are expected to be representative T2 salt cake from the HDW model, and this is confirmed by vertical differences in the core sample results. It was necessary to correct the analytical results to a silica-free basis since diatomaceous earth (92 percent SiO_3) had been added to tank 241-TX-116. The silica from the diatomaceous earth had migrated into the top four core segments (approximately 203.2 cm [80 in.]) of the salt cake.

The composition data for tanks 241-U-102, 241-U-105, and 241-TX-116 are summarized in Table D3-2. The analytical results for tanks 241-U-102 and 241-U-105 are mass-weighted averages based on the mass of the partial core segment corresponding to each analytical result. Mass-weighted averages, rather than simple arithmetic averages, were calculated because the core segments were not of equal length and the mass of the partial core segments analyzed varied from approximately 30 g to 250 g. Similarly, a mass-weighted average was created for the combination of the T2 salt cake in the two U Farm tanks (81.5% tank 241-U-102 and 18.5 % tank 241-U-105). The analytical results for tank 241-TX-116 core segments were simply averaged since the core segments were of equal length. The T2 salt cake prediction is the arithmetic average of the U Tank Farm and tank 241-TX-116 concentrations. The data for tank 241-TX-116 were intentionally given more emphasis (50 percent of the predicted concentration) in the generalized T2 salt cake prediction as it represents an operating period that is more applicable to the TX Tank Farm. The global HDW model composition for T2 salt cake (T2 SltCk) is included in the Table D3-2 for comparison.

Table D3-2. Composition of T2 Salt Cakes (2 Sheets).

Analyte	241-U-102 T2 salt cake wt. avg.[a,b] (μg/g)	241-U-105 T2 salt cake wt. avg.[a,c] (μg/g)	U Tank Farm T2 salt cake wt. avg.[a] (μg/g)	241-TX-116 T2 salt cake mean[d,e] (μg/g)	T2 salt cake prediction[f] (μg/g)	HDW T2 SltCk[g] (μg/g)
Ag	11.6	19.7	13.1	NR	13.1	NR
Al	18,000	12,900	17,100	38,000	27,500	17,912
Bi	<70.5	<47.2	<66.2	NR	<66.2	220.81
Ca	308	253	298	NR	298	1,462
Cd	<5.94	12.8	<7.21	NR	<7.21	NR
Cl	5,100	5,790	5,230	NR	5,230	3,327.8
CO_3	53,500	36,500	50,300	58,000	54,200	17,093
Cr	2,310	2,100	2,270	353	1,310	4259.6
F	<125	1,110	<307	3,540	<1,920	930.79
Fe	391	2,270	737	23,900	12,300	620.58
Hg	NR	NR	NA	NR	NA	1.1338
K	1750	1,470	1,700	NR	1,700	1060.7
La	<35.2	29.7	<34.2	NR	<34.2	0.0001
Mn	123	743	237	NR	237	160.31
Na	262,600	220,500	254,800	166,700	210,800	192,764
Ni	91.5	89.5	91.1	NR	91.1	405.82
NO_2	56,700	40,100	53,600	7,840	30,700	46,096
NO_3	284,700	395,700	305,200	308,700	306,946	268,197

Table D3-2. Composition of T2 Salt Cakes (2 Sheets).

Analyte	241-U-102 T2 salt cake wt. avg.[a,b] (μg/g)	241-U-105 T2 salt cake wt. avg.[a,c] (μg/g)	U Tank Farm T2 salt cake wt. avg.[a] (μg/g)	241-TX-116 T2 salt cake mean[d,e] (μg/g)	T2 salt cake prediction[f] (μg/g)	HDW T2 SltCk[g] (μg/g)
OH	NR	NR	NA	NA	NA	68,079
Pb	<119	214	<136	NR	<136	109.91
P as PO_4	5,050	14,100	6,720	8,620	7,670	7,707.9
Si	152	232	167	NR	167	1,817.7
S as SO_4	17,900	8,350	16,200	16,400	16,300	13,823
Sr	<7.04	<4.72	<6.61	NR	<6.61	0
TOC	8,810	11,000	9,210	NR	9,210	5,191
U	<353	545	<388	NR	<388	2,174.3
Zr	10.8	45.4	17.2	NR	17.2	14.707
Radionuclide[h] (μCi/g)						
^{241}Am	<37.0	<0.95	<30.3	NR	<30.3	0.0285
^{60}Co	<0.155	0.086	<0.142	NR	<0.142	0.027
^{134}Cs	NR	NR	NA	9.64 E-04	9.64 E-04	0.0016
^{137}Cs	197	145	188	34.8	111	163.24
^{154}Eu	<0.475	0.61	<0.499	NR	<0.499	0.431
^{155}Eu	<1.10	0.82	<1.05	NR	<1.05	0.1849
Density (g/mL)	1.66	1.73	1.70[i]	NR	1.70	1.634

HDW = Hanford Defined Waste
NA = Not applicable
NR = Not reported

[a] Weighted average based on the weight of each partial core segment analyzed
[b] Hu et al. (1997)
[c] Brown and Franklin (1996)
[d] Silica-free basis due to the addition of diatomaceous earth to this tank
[e] Horton (1977)
[f] Average of U Tank Farm and tank 241-TX-116 data
[g] Agnew et al. (1997)
[h] Decayed to January 1, 1994
[i] A simple average is used for the density.

The use of the 241-U-102, 241-U-105, and 241-TX-116 composition data to represent the composition of other T2 salt cakes should be viewed only as an approximation. None of these three tanks had undergone salt well pumping at the time of the respective core samples. In the case of tank 241-TX-113, these data are being applied to a salt cake that has been salt well pumped and has collapsed to a reduced volume as the result of the removal of interstitial liquid. Additionally, the T2 salt cake projected by the HDW model in tanks 241-U-102 and 241-U-105 could be erroneous if the transfers were TX Farm supernates (i.e. saturated salt solutions that had already cooled and would not form additional salt cake) and formed rather than actual evaporator bottoms.

D3.5 PREDICTED INVENTORY FOR TANK 241-TX-113

The chemical and radionuclide inventory of tank 241-TX-113 can be estimated from the sludge and salt cake volumes (693 kL [183 kgal] and 1,605 kL [424 kgal], respectively), densities (1.4 and 1.7 g/mL, respectively) and the average of chemical/radionuclide concentrations calculated for 1C/CW sludges and T2 salt cake wastes that have been analyzed. The resulting inventories are provided in Table D3-3. The inventories estimated by the HDW model (Agnew et al. 1996) are included in the table for comparison.

Table D3-3. Estimated Chemical and Radionuclide Inventory for Tank 241-TX-113. (3 Sheets)

Analyte	1C/CW sludge layer[a] (kg)	T2 salt cake layer[b] (kg)	TX-113 inventory (kg)	HDW model inventory (kg)
Ag	6.68	35.8	42.8	NR
Al	15,800	75,200	90,900	66,500
Bi	15,000	<181	15,200	7,070
Ca	1,070	812	1,880	3,260
Cd	6.00	<19.7	<25.7	NR
Cl	587	14,300	14,900	8,930
CO_3	7,440	147,800	155,200	33,400
Cr	611	3,580	4,190	3,270
F	9,680	<5,240	<14,900	6,120
Fe	8,750	33,600	42,400	7,530
Hg	0.129	NR	NA	12.1
K	157	4,630	4,790	2,870
La	<9.7	<93.3	<103	3.15 E-04

Table D3-3. Estimated Chemical and Radionuclide Inventory for Tank 241-TX-113. (3 Sheets)

Analyte	1C/CW sludge layer[a] (kg)	T2 salt cake layer[b] (kg)	TX-113 inventory (kg)	HDW model inventory (kg)
Mn	133	647	781	203
Na	94,400	575,000	669,400	378,000
Ni	135	249	384	615
NO_2	7,650	83,900	91,500	125,000
NO_3	64,200	837,400	901,700	425,000
OH	NR	NR	NR	174,000
Pb	629	<372	<1,000	407
P as PO_4	84,400	20,900	105,400	74,100
Si	6,100	456	6,550	3,520
S as SO_4	6,620	44,500	51,100	35,200
Sr	474	<18.0	<492	6.63 E-05
TOC	809	25,100	25,900	5,816
U	870	<1,060	<1,930	3,990
Zr	77.9	46.9	125	667
Radionuclide[c] (Ci)				
^{241}Am	15.2	<82,700	NA	NR
^{14}C	0.110	NR	NA	NR
^{60}Co	<0.96	<387	NA	NR
^{134}Cs	<1.14	2.63	<3.77	NR
^{137}Cs	5,780	303,400	309,200	375,000
^{154}Eu	3.67	<1,360	NA	NR
^{155}Eu	2.88	<2,850	NA	NR
^{3}H	0.568	NR	NA	NR
^{129}I	<45.0	NR	NA	NR
^{237}Np	133	NR	NA	NR
^{238}Pu	69.3	NR	NA	NR
$^{239/240}$Pu	131	NR	NA	NR

Table D3-3. Estimated Chemical and Radionuclide Inventory for Tank 241-TX-113. (3 Sheets)

Analyte	1C/CW sludge layer[a] (kg)	T2 salt cake layer[b] (kg)	TX-113 inventory (kg)	HDW model inventory (kg)
Radionuclide[c] (Ci)				
^{106}Ru	<36.9	NR	NA	NR
^{79}Se	<0.170	NR	NA	NR
^{90}Sr	52,400	NR	NA	110,000
^{99}Tc	0.561	NR	NA	NR

HDW = Hanford Defined Waste, Agnew et al. (1996)
NR = Not reported
[a] Based on the predicted 1C waste concentrations in Table D3-1
[b] Based on the T2 salt cake prediction in Table D3-2
[c] Radionuclides decayed to January 1, 1994.

D3.6 COMPARISON OF TANK 241-TX-113 INVENTORY ESTIMATES

The lack of sample-based inventory data adds considerable uncertainty to estimation of chemical and radionuclide inventories for tank 241-TX-113. The use of waste composition data from tanks 241-T-104, 241-T-107, 241-U-102, 241-U-105, and 241-TX-116 to represent the wastes in tank 241-TX-113 is a reasonable approach in the absence of analytical data. However, it should be noted that the operating history of tank 241-TX-113 is different from any other Hanford tank containing similar waste types. Estimation based on compositions measured in other tanks should be regarded as only an approximation.

The tank 241-TX-113 inventories predicted by the HDW model and the estimate based on waste analyses in other tanks are generally of the same order of magnitude, although the HDW generally somewhat lower. Part of the explanation for this difference may be that the HDW model calculated density for the 241-TX-113 salt cake is 1.41 g/cc based on the sodium, aluminum and hydroxide concentrations. This HDW calculated density is much lower than is generally found when salt cakes are analyzed. The calculated density is used in determining the HDW model inventory for all analytes.

Aluminum. The estimated aluminum inventory is 37 percent higher than that predicted by the HDW model. Part of this difference is due to the low salt cake density calculated by the HDW model (1.41 g/cc), as compared to the 1.7 g/ml estimated based on the analytical results from tanks 241-U-102 and 241-U-105. Additionally, the tank 241-TX-116 analytical results show a much higher aluminum concentration and Anderson (1990) indicates processing of a substantial volume of aluminum coating wastes in the 1967-1968 time period. The estimated aluminum inventory will be used for the best-basis inventory.

Bismuth. The HDW model seems to underestimate the Bi inventory for 1C/CW waste tanks. Part of this discrepancy results from the HDW model assumption that 27 percent of the Bi is soluble.

Carbonate and Hydroxide. The estimated tank 241-TX-113 carbonate inventory is 4.6 times the HDW model inventory, whereas the estimated hydroxide inventory is only 52 percent of the predicted by the HDW model. The hydroxide ion in Hanford waste tanks is converted to carbonate by the absorption of carbon dioxide from the ambient air. The one mole of absorbed carbon dioxide will react with two moles of hydroxide ion to form one mole of carbonate ion. The rate is difficult to model at best, and is accelerated by use of airlift circulators such as those installed in tank 241-TX-113. Conversion of the excess hydroxide predicted by the HDW model to carbonate improves the agreement. The estimated carbonate inventory would then be 85 percent the modified HDW model carbonate inventory. The HDW model does not be adequately account for the absorption of carbon dioxide from the atmosphere.

Fluorides. The estimated fluoride inventory is 2.4 times that predicted by the HDW model. This is likely the result of the HDW model assumptions that sodium fluoride is the only chemical compound containing fluoride and that it does not precipitate. The formation of insoluble fluoride compounds (such as sodium fluorophosphate) may be causing some fluoride to precipitate and remain in the tank.

Iron. The estimated iron inventory is skewed by the high iron concentration (2.4 wt%) reported for 241-TX-116. A later analysis of the tank 241-TX-116 salt cake (Schulz 1980) indicated very little insoluble material. The high iron concentration is not likely for a salt cake since iron is insoluble in alkaline solutions and significant iron concentration would not be expected in the evaporator feed solutions. Therefore, the HDW model iron inventory will be used for the best-basis.

Nitrate. The estimated nitrate inventory is 2.1 times that predicted by the HDW model. Nearly all of the nitrate is associated with the salt cake. The HDW model salt cake inventory is predicted by the Supernatant Mixing Model (SMM), and it is therefore difficult to determine the cause of this discrepancy. The global HDW model T2 salt cake concentrations (see Table D3-2) are very reasonable, indicating that either the problem lies within the SMM model or that some feed inputs have been missed.

Sodium. The predicted HDW sodium inventory is about 56 percent that predicted from tanks 241-T-104 and 241-T-107 data. The HDW model density calculated by the HDW model is 1.41 g/cc, which is about 17 percent below that normally expected for a salt cake. The global HDW model T2 salt cake sodium concentration is very reasonable (see Table D3-2). Either there is an internal problem in the SMM model calculations or some feed inputs have been missed.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997).

Cesium-137 and Strontium-90. The heat load for tank 241-TX-113 has been estimated at 5,588 BTU/hr (Kummerer 1995). This corresponds to a maximum of 245,000 Ci ^{90}Sr (0.0228 BTU/h/Ci ^{90}Sr) or a maximum of 347,000 Ci ^{137}Cs (0.0161 BTU/h/Ci ^{137}Cs). About 89 percent of the heat load appears to be the result of ^{137}Cs based on the estimated ^{137}Cs inventory. The higher ^{90}Sr inventory estimated by the HDW model is not in agreement with the estimated tank heat load. However, the tank was used to store complexed wastes that were relatively high in strontium, so the HDW model estimate for ^{90}Sr will be used as the best-basis. The combined best-basis ^{90}Sr and ^{137}Cs inventories would produce 34 percent more heat than estimated by Kummerer (1995).

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4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage.

Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the HDW Model based on process knowledge and historical information, or (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for tank 241-TX-113 was performed including the following:

- T Plant $BiPO_4$ reactor fuel processing to confirm 1C/CW waste volumes transferred into the tanks 241-TX-113 through 241-TX-115 cascade and to predict the quantity of resulting sludge.

- Waste transactions and operating data to confirm that salt cake was retained in tank 241-TX-113.

- Composition data from two waste tanks (241-T-104 [DiCenso et al. 1994] and 241-T-107 [Valenzuela and Jensen 1994]) that are expected to have a similar sludge compositions and three waste tanks (241-U-102 [Hu et al. 1997], 241-U-105 [Brown and Franklin 1996], and 241-TX-116 [Horton 1977]) that are expected to have similar salt cake compositions.

- An inventory estimate generated by the HDW model (Agnew et al. 1996)

Based on this evaluation, a best-basis inventory was developed. No analytical data are available for the sludge or salt cake remaining in tank 241-TX-113 as no samples have been taken. The estimated inventory was therefore based on the composition of the 1C/CW wastes in tanks 241-T-104 and 241-T-107 and the T2 salt cakes in tanks 241-U-102, 241-U-105, and 241-TX-116 since the wastes in these tanks have actually been analyzed. The HDW model inventories were used when no other data were available or when analytical data were suspect.

The waste in tank 241-TX-113 consists of combined $BiPO_4$ first decontamination cycle and coating wastes generated by T Plant during processing of irradiated, Al-clad reactor fuel (693 kL [183 kgal]) and salt cake produced by the 241-T Evaporator (1,605 kL [424 kgal]). The sludge layer has been contacted with large volumes of supernates, including salt solutions with sodium hydroxide concentrations of up to 3 molar. Leaching of some sludge components may have occurred and remaining sludge may differ from that predicted from other tanks containing 1C/CW wastes. The best-basis inventory for tank 241-TX-113 is presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis tables for chemicals and only four radionuclides (^{90}Sr, ^{137}Cs, Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the HDW model (Agnew et al. 1996). When values for all 46 radionuclides became available in Rev. 4 of the HDW model (Agnew et al. 1997), they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit HDW Rev. 3 chemical values to be updated to HDW Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-113 (Effective May 31, 1997). (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
Al	90,900	E	
Bi	15,200	E	Concentration varies between 1C wastes.
Ca	1,880	E	
Cl	14,900	E	
TIC as CO_3	155,000	E	
Cr	4,190	E	
F	<14,900	E	
Fe	7,530	M	
Hg	12.1	M	
K	4,790	E	
La	<103	E	
Mn	780	E	
Na	669,000	E	
Ni	380	E	Concentration varies significantly between 1C waste tanks.
NO_2	91,500	E	
NO_3	902,000	E	
OH_{TOTAL}	204,000	C	
Pb	<1,000	E	
P as PO_4	105,000	E	Concentration varies between 1C waste tanks.
Si	6,550	E	
S as SO_4	51,100	E	
Sr	<490	E	Inventory is likely to be <2.6 kg based on ^{90}Sr inventory.
TOC	25,900	E	
U_{TOTAL}	<1,930	E	Concentration varies significantly between 1C waste tanks.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-113 (Effective May 31, 1997). (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
Zr	125	E	

[1] S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1996)
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-113 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	242	M	
^{14}C	34.2	M	
^{59}Ni	2.60	M	
^{60}Co	38.0	M	
^{63}Ni	254	M	
^{79}Se	3.68	M	
^{90}Sr	133,000	M	
^{90}Y	133,000	E/M	
^{93}Zr	18.0	M	
^{93m}Nb	13.1	M	
^{99}Tc	243	M	
^{106}Ru	0.00717	M	
^{113m}Cd	93.2	M	
^{125}Sb	164	M	
^{126}Sn	5.55	M	
^{129}I	0.469	M	
^{134}Cs	<3.8	E	
^{137}Cs	309,000	E	
^{137m}Ba	292,000	E	Based on ^{137}Cs.
^{151}Sm	12,900	M	
^{152}Eu	4.50	M	
^{154}Eu	635	M	
^{155}Eu	269	M	
^{226}Ra	1.75 E-04	M	
^{227}Ac	0.00114	M	
^{228}Ra	0.268	M	
^{229}Th	0.00621	M	
^{231}Pa	0.00499	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-113 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}Th	0.0165	M	
^{232}U	1.34	M	
^{233}U	5.14	M	
^{234}U	11.2	M	
^{235}U	0.491	M	
^{236}U	0.139	M	
^{237}Np	0.878	M	
^{238}Pu	1.83	M	
^{238}U	11.6	M	
^{239}Pu	92.5	M	
^{240}Pu	12.8	M	
^{241}Am	67.7	M	
^{241}Pu	114	M	
^{242}Cm	0.173	M	
^{242}Pu	6.16 E-04	M	
^{243}Am	0.00233	M	
^{243}Cm	0.0160	M	
^{244}Cm	0.152	M	

[1] S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997)
E = Engineering assessment-based.

D5.0 APPENDIX D REFERENCES

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