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Cognizant Manager
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☐ Disapproved w/comments

Preliminary Tank Characterization Report for Single-Shell Tank 241-TX-108: Best-Basis Inventory

J. Jo

Lockheed Martin Hanford Corporation, Richland, WA 99352
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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-108 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-108:
BEST-BASIS INVENTORY**

July 1997

J. Jo
Lockheed Martin Hanford Corporation
Richland, Washington

Prepared for
U.S. Department of Energy
Richland, Washington

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**PRELIMINARY TANK CHARACTERIZATION REPORT
FOR SINGLE-SHELL TANK 241-TX-108:
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-108. No TCR has 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, 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

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-108

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APPENDIX D**EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR
SINGLE-SHELL TANK 241-TX-108**

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 single-shell tank 241-TX-108 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-108 consist only of the inventory estimate generated by the Hanford Defined Waste (HDW) model (Agnew et al. 1997a). No Tank Characterization Report (TCR) has 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-108 and composition data from other Hanford tanks containing similar waste types.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The tank 241-TX-108 chemical and radionuclide inventory predicted by the HDW model (Agnew et al. 1997a) is provided in Table D2-1. The chemical species are reported without charge designation per the best-basis inventory convention. The HDW inventory estimates use a waste volume of 507 kL (134 kgal) (22.7 kL [6 kgal] sludge and 484 kL [128 kgal] salt cake), and a waste density of 1.36 g/mL as bases.

Table D2-1. Hanford Defined Waste Model Prediction of
Tank 241-TX-108 Inventory.

Analyte	HDW model ^a (kgs)
Al	11,300
Bi	141
Ca	660
Cl	2,470
CO ₃	8,940
Cr	1,710
F	630
Fe	1,540
Hg	0.77
K	721
La	4.62 E-05
Mn	46.4
Na	93,400
Ni	121
NO ₂	27,900
NO ₃	108,000
OH	43,300
Pb	74.1
PO ₄	3,800
Si	597
SO ₄	7,570
TOC	1,800
Zr	13.2
C ₆ H ₅ O ₇	1,040
Radionuclides ^b (Ci)	
¹³⁷ Cs	81,000
⁹⁰ Sr	27,100

HDW = Hanford Defined Waste

^aAgnew et al. (1997a)

^bThe Hanford Defined Waste (HDW) model (Agnew et al. 1997a) contains estimates for 46 radionuclides. Only the two most predominant are listed. Decay date for the HDW model is January 1, 1994.

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would have an effect upon the HDW model component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Information concerning the waste types contained in tank 241-TX-108 is not entirely consistent. The HDW model (Agnew et al. 1997a) predicts that the tank contains metal waste from the bismuth phosphate process (7.6 kL [2 kgal]) of metal waste [MW] sludge), uranium recovery (UR) waste (15 kL [4 kgal]), and 484 kL (128 kgal) Supernatant Mixing Model 242-T Evaporator salt cake generated from 1965 until 1976 (SMMT2).

The Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) lists evaporator bottoms (EB) and decontamination waste (wash solution from equipment decontamination efforts at the T plant) as the primary and secondary waste types, respectively, but credits the entire tank 241-TX-108 volume (507 kL [134 kgal]) to salt cake. Hanlon (1997) also indicates that the entire tank inventory is salt cake.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste transaction records (Agnew et al. 1997b) show that tank 241-TX-108 received MW between the first quarter of 1952 and the third quarter of 1956. By the first quarter of 1957, all the waste was sluiced from tank 241-TX-108. Beginning in the fourth quarter of 1960 and ending in the first quarter of 1965, tank 241-TX-108 received tri-butyl phosphate (TBP) supernatant from tank TY-105 (1,556 kL [411 kgal]) and decontamination waste (DW) from tank 241-TX-118 (541 kL [143 kgal]). Most of the supernatant, with the exception of 273 kL (72 kgal), was transferred to tank 241-TX-118 in first quarter of 1966. During the third and fourth quarters of 1966, the tank received evaporator bottom (EB) supernatant from tank 241-TX-117 (1,779 kL [470 kgal]) and Reduction and Oxidation (REDOX [R]) supernatant from tank 241-TX-101 (250 kL [66 kgal]).

Beginning in the fourth quarter of 1966 and continuing until the first quarter of 1976, tank 241-TX-108 received concentrated evaporator bottoms from the 242-T Evaporator and recycled supernatants to the evaporator via the evaporator feed tank (241-TX-118). Salt cake formed as the concentrated salt solutions cooled, which built up a large salt cake layer on top of previously existing sludge. The HDW model refers to 242-T Evaporator concentrates salt cakes from 1965 to 1976 as T2 SlcK.

Supernatants remaining in tank 241-TX-108 were removed from the tank in 1976. During second and third quarter of 1976, supernatant was transferred to tank 241-U-102

(approximately 1,223 kL [323 kgal]) and tank 241-U-103 (approximately 852 kL [225 kgal]), respectively.

D3.3 DETERMINATION OF WASTE TYPES

Anderson (1990) indicates that the first solids volume measurement for tank 241-TX-108 in the fourth quarter of 1953 was 7.6 kL (2 kgal), which suggests that at least some sludge was initially placed in the tank. Subsequent solid volume measurement in the first quarter of 1956 (23 kL [6 kgal]) indicates TBP/uranium recovery (UR) waste was added to the solid layer.

Waste transaction records also show that tank 241-TX-108 received 21,574 kL (5,700 kgal) of evaporator bottom waste between 1966 and 1976. A T2 salt cake inventory would be expected to have been deposited on top of the sludge layer. This is confirmed by a 484 kL (128 kgal) increase in the solids volume between the first quarter of 1965 (Anderson 1990) and May 30, 1983 (Hanlon 1997).

D3.4 COMPOSITION OF TANK 241-TX-108 WASTE

The following are the calculational bases and example calculations for estimating component inventories in tank 241-TX-108.

D3.4.1 Composition of Tri-Butyl Phosphate Waste

Two tanks (241-TY-105 and 241-BX-109) provide the best examples of TBP/UR waste composition. The composition of these two tanks, based on the data package and the tank characterization reports (Weiss and Schull 1987, and Field et al. 1996), is provided in Table D3-1. The average of these two compositions will be used for estimating the sludge composition of tank 241-TX-108 with the exceptions of silicon. The HDW model composition for TBP/UR sludge (Agnew et al. 1997a) is included in Table D3-1 for comparison.

Table D3-1. Comparison of Tanks Containing Tri-Butyl Phosphate/Uranium Recovery Waste: Tanks 241-TY-105 and 241-BX-109. (3 Sheets)

Analyte	Tank 241-TY-105 sampling data ^a	Tank 241-BX-109 sampling data ^b	Predicted TBP/UR concentration $\mu\text{g/g}$	HDW TBP/UR $\mu\text{g/g}$
	1985 core sample $\mu\text{g/g}$	1996 core sample $\mu\text{g/g}$		
Ag	<1.59	NR	<1.59	NR
Al	1,910	1,910	1,910	0

Table D3-1. Comparison of Tanks Containing Tri-Butyl Phosphate/Uranium Recovery Waste: Tanks 241-TY-105 and 241-BX-109. (3 Sheets)

Analyte	Tank 241-TY-105 sampling data ^a	Tank 241-BX-109 sampling data ^b	Predicted TBP/UR concentration $\mu\text{g/g}$	HDW TBP/UR $\mu\text{g/g}$
	1985 core sample $\mu\text{g/g}$	1996 core sample $\mu\text{g/g}$		
Bi	383	<494 ^c	<438	0
Ca	NR	4,035	4,035	7,770
Cd	3.83	<49.4	<26.6	NR
Cl	NR	1,200	1,200	877
TIC as CO ₃	NR	NR	NR	14,500
Cr	133	137 ^c	135	43.1
F	NR	<458	<458	0
Fe	20,900	21,500	21,700	49,600
Hg	NR	NR	NR	0
K	NR	NR	NR	160
La	NR	<247 ^c	<247	0
Mn	150	149 ^c	150	0
Na	115,000	114,000	115,000	182,000
Ni	84.1	NR	84.1	24.4
NO ₃	178,000	213,000	196,000	468,000
NO ₂	NR	19,100	19,100	3,940
Pb	383	668 ^c	525	0
P as PO ₄	118,970	67,500	93,200	3,200
Si	368	1,720	1,040	0
S as SO ₄	NR	20,500	20,500	3,530
Sr	NR	590	590	0
TOC	805	410	608	1.13
Total U	5,400	18,000	11,700	94.1
Zr	<7.31	<49.8 ^c	<28.6	0
H ₂ O (wt%)	39.4	50.9	45.2	22.1
Density (kg/L)	1.53	1.48	1.50	1.77

Table D3-1. Comparison of Tanks Containing Tri-Butyl Phosphate/Uranium Recovery Waste: Tanks 241-TY-105 and 241-BX-109. (3 Sheets)

Analyte	Tank 241-TY-105 sampling data ^a	Tank 241-BX-109 sampling data ^b	Predicted TBP/UR concentration $\mu\text{g/g}$	HDW TBP/UR $\mu\text{g/g}$
	1985 core sample $\mu\text{g/g}$	1996 core sample $\mu\text{g/g}$		
Radionuclides ^d ($\mu\text{Ci/g}$)				
²⁴¹ Am	<0.0315	<0.284 ^c	<0.158	3.44 E-04
⁶⁰ Co	<0.0050	<0.0157 ^c	<0.0103	4.10 E-05
¹³⁷ Cs	7.86	14.3	11.1	5.84
¹⁵⁴ Eu	NR	<0.0548 ^c	<0.0548	7.38 E-04
¹⁵⁵ Eu	NR	<0.135 ^c	<0.135	0.0309

HDW = Hanford Defined Waste, Agnew et al. (1997a)

NR = Not reported

TBP/UR = Tri-butyl phosphate/uranium recovery

^aWeiss and Mauss (1987), composite analyses except as noted

^bField et al. (1996)

^cSegment analytical data

^dRadionuclides decayed to January 1, 1994.

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 contained in 26 underground storage tanks in the S, SX, U, T, TX, and TY Tank Farms (Agnew et al. 1997a). The HDW model refers to this salt cake as T2 SlitCk on a global basis or as SMMT2 when calculated by the Supernate Mixing Model (SMM) for an individual tank. The salt cake produced by the 242-T evaporator during 1965 to 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, 241-U-105, and 241-TX-116) have sufficiently comprehensive data regarding T2 salt cake to differentiate it from other waste types in the core sample data from these tanks.

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 locations is not possible because of 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 cannot be seen in the core sample data. The recent analytical data for tanks 241-U-102 and 241-U-105 should meet all Tri-Party Agreement requirements. Descriptions of the core sampling events and analytical data are available in the respective TCRs for tanks 241-U-102 and 241-U-105 (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 in 1976-1977 (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). Based on the HDW model, core segments 1 through 4 are expected to be representative of T2 salt cake, 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_2) 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 D3-1. The analytical results for tanks 241-U-102 and 241-U-105 were averaged for each tank based on the weight of each partial core segment analyzed (as opposed to simple arithmetic averaging of the analytical results) since the core segments were not of equal length nor the partial core segments of equal weight. Similarly, a weighted average was created for the combination of the two U Farm tanks. 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 Farm and 241-TX-116 concentrations. The data for tank 241-TX-116 were intentionally given more emphasis in the generalized T2 salt cake prediction (50 percent of the predicted concentration) 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 SlcK) 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 SlitCk ^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	1.0 E-04
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
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

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 SlitCk ^g (μg/g)
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, 1994ⁱ 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-108, 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 supernatants (i.e., salt solutions that had already cooled and would not form additional salt cake) rather than actual evaporator bottoms.

D3.5 PREDICTED INVENTORY FOR TANK 241-TX-108

The chemical and radionuclide inventory of tank 241-TX-108 can be estimated from the sludge and salt cake volumes (22.6 kL [6 kgal] and 485 kL [128 kgal], respectively), densities (1.5 and 1.7 g/mL, respectively) and the average of chemical/radionuclide concentrations calculated from TBP/UR 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. 1997a) are included in the table for comparison.

Table D3-3. Estimated Chemical and Radionuclide Inventory for
Tank 241-TX-108. (2 sheets)

Analyte	TBP/UR layer (kg)	T2 salt cake layer (kg)	TX-108 inventory (kg)	HDW model inventory (kg)
Ag	<0.054	10.8	10.9	NR
Al	65.3	22,700	22,800	11,300
Bi	<15.0	<54.6	<69.5	141
Ca	138	246	383	660
Cd	<0.91	<5.94	<6.85	NR
Cl	41.0	4,310	4,350	2,470
CO ₃	NR	44,700	44,600	8,940
Cr	4.6	1,080	1,090	1,710
F	<15.7	<1,580	<1,600	630
Fe	708	10,100	10,900	1,540
Hg	0	NR	0	0.772
K	NR	1,400	1,400	721
La	<8.44	<28.2	<36.6	4.62 E-05
Mn	5.11	195	201	46.4
Na	3,910	174,000	178,000	93,400
Ni	2.87	75.1	77.9	121
NO ₂	653	25,300	26,000	27,900
NO ₃	6,680	253,000	260,000	108,000
OH	NR	NA	NA	43,300
Pb	18.2	<112	<131	74.1
P as PO ₄	3,190	6,320	9,500	3,800

Table D3-3. Estimated Chemical and Radionuclide Inventory for
Tank 241-TX-108. (2 sheets)

Analyte	TBP/UR layer (kg)	T2 salt cake layer (kg)	TX-108 inventory (kg)	HDW model inventory (kg)
Si	35.7	138	173	597
S as SO ₄	701	13,400	14,100	7,570
Sr	20.2	<5.45	<25.6	0
TOC	20.8	7,590	7,610	1,800
U	400	<320	<720	3,890
Zr	<1.0	14.2	<15.1	13.2
Radionuclide* (Ci)				
²⁴¹ Am	<5.39	<25,000	<25,000	15.1
⁶⁰ Co	<0.353	<117	<117	8.96
¹³⁴ Cs	NR	0.795	0.795	0.647
¹³⁷ Cs	379	91,600	92,000	8.10E+04
¹⁵⁴ Eu	<1.87	<411	<413	144
¹⁵⁵ Eu	<4.61	<861	<866	54.7

HDW = Hanford Defined Waste, Agnew et al. (1997a)

NA = Not applicable

NR = Not reported

TBP/UR = Tri-butyl phosphate/uranium recovery

*Radionuclides decayed to January 1, 1994.

D3.6 COMPARISON OF TANK 241-TX-108 INVENTORY ESTIMATES

The lack of sample-based inventory data adds considerable uncertainty to estimation of chemical and radionuclide inventories for tank 241-TX-108. The use of waste composition data from tanks 241-BX-109, 241-TY-105, 241-U-102, 241-U-105, and 241-TX-116 to represent the wastes in tank 241-TX-108 is a reasonable approach in the absence of analytical data. However, it should be noted that the operating history of tank 241-TX-108 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-108 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 estimates are generally somewhat lower. Part of the explanation for this difference may be that the HDW model calculated density for the 241-TX-108 salt cake is 1.34 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 two times the HDW model inventory. Part of this difference is due to the low salt cake density calculated by the HDW model (1.34 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 Al coating wastes from 1967 to 1968. Some R supernate was also transferred into 241-TX-108.

Carbonate and Hydroxide. The estimated tank 241-TX-108 carbonate inventory is 5 times the HDW model inventory. 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. Conversion of 20,300 kg of hydroxide to carbonate would account for the differences. The HDW model does not adequately account for the absorption of carbon dioxide from the atmosphere.

Fluoride. The estimated fluoride inventory is 2.5 times that predicted by the HDW model. This is possibly 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 2.4 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 supernate 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 D3-1) are very reasonable, indicating that either the problem lies within the SMM model or some feed inputs have been missed.

Sodium. The predicted HDW sodium inventory is about 52 percent that estimated from tanks 241-BX-109, 241-By-105, 241-U-102, 241-U-105, and 241-TX-116 data. The HDW model density calculated by the HDW model is 1.34 g/cc, which is about 20 percent below that normally expected for a salt cake. The global HDW model T2 salt cake sodium concentration is very reasonable (see Table D3-1). 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. (1997a). The revised total hydroxide inventory based on sample analyses is 55,000 kg, which is a factor of 1.3 more than the HDW model estimate.

Cesium-137 and Strontium-90. The heat load for tank 241-TX-108 has been estimated at 408 watts (1,392 BTU/h [Kummerer 1995]). This corresponds to a maximum of 60,900 Ci ^{90}Sr (0.0228 BTU/Ci ^{90}Sr) or a maximum of 86,500 Ci ^{137}Cs (0.0161 BTU/Ci ^{137}Cs). About 1.06 times the heat load appears to be the result of ^{137}Cs based on the estimated ^{137}Cs inventory. This result is very close to the heat load estimation and ^{90}Sr was not available for the estimates.

D4.0 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-108 was performed including the following:

- Waste transactions and operating data to confirm that salt cake was retained in tank 241-TX-108.
- Composition data from two waste tanks (241-BX-109 and 241-TY-105 [Weiss and Mauss 1987, Field et al. 1996]) that are expected to have similar TBP/UR compositions.
- Composition data from three waste tanks (241-U-102, 241-U-105 and 241-TX-116 [Baldwin 1996, Brown et al. 1996, and Horton 1977]) that are expected to have similar salt cake compositions.
- An inventory estimate generated by the HDW model (Agnew et al. 1997a)

Based on this evaluation, a best-basis inventory was developed. No analytical data are available for the salt cake remaining in tank 241-TX-108 as no samples have been taken. The estimated inventory was therefore based on the composition the TBP/UR wastes in tanks 241-BX-109 and 241-TY-105 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-108 consists of small amounts of sludge (MW and TBP/UR waste) and salt cake produced by the 241-T Evaporator (485 kL [128 kgal]). The sludge

layer has been contacted with large volumes of supernatants, 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 TBP/UR wastes. The best-basis inventory for tank 241-TX-108 is presented in Tables D4-1 and D4-2.

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 , $^{239/240}\text{Pu}$, 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. 1997a). 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.

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.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-108 (Effective May 31, 1997). (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C) ¹	Comment
Al	22,800	E	
Bi	< 69.5	E	
Ca	383	E	
Cl	4,350	E	
TIC as CO ₃	44,600	E	Includes only T2 salt cake layer.
Cr	1,090	E	
F	1,600	E	
Fe	1,540	M	
Hg	0.772	M	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-108 (Effective May 31, 1997). (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, E or C) ¹	Comment
K	1,400	E	Includes only T2 salt cake layer.
La	< 36.6	E	
Mn	201	E	
Na	178,000	E	
Ni	77.9	E	
NO ₂	26,000	E	
NO ₃	260,000	E	
OH _{TOTAL}	55,300	C	from charge balance
Pb	< 131	E	
P as PO ₄	9,500	E	
Si	173	E	
S as SO ₄	14,100	E	
Sr	< 25.6	E	
TOC	7,610	E	
U _{TOTAL}	< 720	E	
Zr	< 15.1	E	

¹S = Sample-based

M = Hanford Defined Waste model-based, Agnew et al. (1997a)

E = Engineering assessment-based

C = Calculated by charge balance; includes oxides as hydroxides, not including CO₃, NO₃, NO₂, PO₄, SO₄ and SiO₃.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-108 Decayed to January 1, 1994 (Effective May 31, 1997). (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E) ¹	Comment
³ H	57.4	M	
¹⁴ C	8.21	M	
⁵⁹ Ni	0.628	M	
⁶⁰ Co	8.96	M	
⁶³ Ni	61.5	M	
⁷⁹ Se	0.84	M	
⁹⁰ Sr	27,100	M	
⁹⁰ Y	27,100	M	
^{93m} Nb	2.99	M	
⁹³ Zr	4.12	M	
⁹⁹ Tc	58.5	M	
¹⁰⁶ Ru	0.00159	M	
^{113m} Cd	21.3	M	
¹²⁵ Sb	38	M	
¹²⁶ Sn	1.27	M	
¹²⁹ I	0.113	M	
¹³⁴ Cs	0.647	M	
¹³⁷ Cs	92,000	E	
^{137m} Ba	87,000	E	Based on ¹³⁷ Cs
¹⁵¹ Sm	2,960	M	
¹⁵² Eu	0.92	M	
¹⁵⁴ Eu	144	M	
¹⁵⁵ Eu	54.7	M	
²²⁶ Ra	4.12 E-05	M	
²²⁷ Ac	2.66 E-04	M	
²²⁸ Ra	0.0677	M	
²²⁹ Th	0.00157	M	
²³¹ Pa	0.00117	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-108 Decayed to January 1, 1994 (Effective May 31, 1997). (2 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E) ¹	Comment
²³² Th	0.00415	M	
²³² U	0.338	M	
²³³ U	1.3	M	
²³⁴ U	1.31	M	
²³⁵ U	0.0578	M	
²³⁶ U	0.0155	M	
²³⁷ Np	0.211	M	
²³⁸ Pu	0.336	M	
²³⁸ U	1.39	M	
²³⁹ Pu	12.2	M	
²⁴⁰ Pu	2.01	M	
²⁴¹ Am	15.1	M	
²⁴¹ Pu	22.1	M	
²⁴² Cm	0.0352	M	
²⁴² Pu	1.20 E-04	M	
²⁴³ Am	5.09 E-04	M	
²⁴³ Cm	0.00326	M	
²⁴⁴ Cm	0.0338	M	

¹S = Sample-based

M = Hanford Defined Waste model-based, Agnew et al. (1997a)

E = Engineering assessment-based.

D5.0 APPENDIX D REFERENCES

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