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Preliminary Tank Characterization Report for Single-Shell Tank 241-TX-103: Best-Basis Inventory

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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-103 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-103: BEST-BASIS INVENTORY

July 1997

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-TX-103: 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-103. 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.

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-103

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-103

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-103 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-103 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 recent (post 1989) core sample analyses are not available. The tank 241-TX-103 best-basis inventory, therefore, is based primarily on the HDW model predictions and composition data from other Hanford Site tanks containing similar waste types.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The tank 241-TX-103 chemical and radionuclide component inventories predicted by the HDW model (Agnew et al. 1997a) are provided in Tables D2-1 and D2-2. The chemical species are reported without charge designation per the best-basis inventory convention. The HDW model inventory is based on 594 kL (157 kgal) of salt cake produced by the 242-T Evaporator.

Table D2-1. Hanford Defined Waste Model Inventory Estimate for Nonradioactive Components in Tank 241-TX-103.

Analyte	HDW model[a] (kg)	Analyte	HDW model[a] (Ci)
Density (g/mL)	1.21	NO_2	19,600
Al	7,880	NO_3	75,000
Bi	135	OH	28,900
Ca	343	Pb	48.7
Cl	1,790	P as PO_4	3,740
TIC as CO_3	5,910	Si	438
Cr	1,210	S as SO_4	5,360
F	465	TOC	1,810
Fe	201	U_{TOTAL}	691
Hg	0.522	Zr	8.98
K	560	EDTA	527
La	2.81	NH_3	380
Mn	36.3	Volume (kL)	594
Na	66,700		
Ni	92.2		

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

Table D2-2. Hanford Defined Waste Inventory Estimate for Radioactive Components in Tank 241-TX-103 (Decayed to January 1, 1994).

Analyte	HDW model[a] (Ci)	Analyte	HDW model[a] (Ci)
^{3}H	41.9	^{226}Ra	2.90 E-05
^{14}C	6.12	^{227}Ac	1.88 E-04
^{59}Ni	0.455	^{228}Ra	0.0429
^{60}Co	6.8	^{229}Th	9.96 E-04
^{63}Ni	44.6	^{231}Pa	8.33 E-04
^{79}Se	0.623	^{232}Th	0.00265
^{90}Sr	20,800	^{232}U	0.216
^{90}Y	20,800	^{233}U	0.829
^{93m}Nb	2.22	^{234}U	0.25
^{93}Zr	3.06	^{235}U	0.0103
^{99}Tc	43.6	^{236}U	0.0066
^{106}Ru	0.00124	^{237}Np	0.156
^{113m}Cd	15.9	^{238}Pu	0.262
^{125}Sb	29.2	^{238}U	0.288
^{126}Sn	0.941	^{239}Pu	9.91
^{129}I	0.084	^{240}Pu	1.6
^{134}Cs	0.515	^{241}Am	11.6
^{137m}Ba	53,200	^{241}Pu	17.3
^{137}Cs	56,200	^{242}Cm	0.0281
^{151}Sm	2,190	^{242}Pu	9.48 E-05
^{152}Eu	0.722	^{243}Am	3.92 E-04
^{154}Eu	110	^{243}Cm	0.00261
^{155}Eu	42.9	^{244}Cm	0.0262

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

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 CONTRIBUTING WASTE TYPES

The HDW model (Agnew et al. 1997a), the Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) and the waste tank summary report (Hanlon 1997) are not consistent as to the waste types present in tank 241-TX-103 although they are consistent as to the total waste volume. Anderson (1990) provides a waste status summary consistent with the SORWT model.

The HDW model (Agnew et al. 1997a) predicts that the tank contains 11.4 kL (3 kgal) of salt cake waste generated from the 242-T Evaporator-crystallizer from 1951 until 1955 (T1SltCk), and 583 kL (154 kgal) of SMMT2 salt cake predicted from the Supernatant Mixing Model (SMM). The HDW model refers to 242-T Evaporator salt cakes formed during 1965 to 1976 as T2SltCk on a global basis, or SMMT2 when calculated for an individual tank by the SMM.

The SORWT model (Hill et al. 1995) lists tributyl phosphate (TBP) waste (also called Uranium Recovery Process) and evaporator bottoms (EB) as the primary and secondary waste types, respectively, but credits the entire tank 241-TX-103 volume (594 kL [157 kgal]) to sludge with 56.8 kL (15 kgal) of interstitial liquid. Hanlon (1997) also indicates that the entire tank solids inventory is sludge with 56.8 kL (15 kgal) of interstitial liquor.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste Status and Transaction Record Summary (WSTRS) (Agnew et al. 1997b) shows that tank 241-TX-103 initially received 1,772 kL (467 kgal) of metal waste from tank 241-TX-102 in the third quarter of 1950. Tank 241-TX-103 is the third tank in the four tank cascade of 241-TX-101 through 241-TX-104. Additional metal waste cascades of 3,573 kL (943 kgal) were received from tank 241-TX-102 with 2,532 kL (668 kgal) cascaded to tank 241-TX-104 by the end of the first quarter of 1951. Metal waste recovery (sluicing) was conducted on the cascade in 1954, with a final heel cleanout of tank 241-TX-103 occurring in August 1954 (Rodenhizer 1987). Rodenhizer reports that tanks 241-TX-101 through 241-TX-103 received green (aged less than three years) bismuth phosphate waste from the fourth quarter of 1954 through the first quarter of 1955. Agnew et al. (1997b) agree with Rodenhizer, in that they recognize tank 241-TX-103 is the third tank in the cascade and identify Uranium Recovery (UR) Process supernatant liquid waste in the tank from the first quarter of 1954 through the second quarter of 1972. The WSTRS shows one transaction pair of equal volume during the end of 1955. This indicates that material was sent to the 242-T Evaporator and returned simultaneously which would explain why Agnew et al. (1997a) labeled the bottom 11.4 kL (3 kgal) as T1SltCk. As such, some T1 salt cake would be expected to precipitate during this time period as the result of water evaporation and further cooling of the salt solution.

The WSTRS (Agnew et al. 1997b) shows that tank 241-TX-103 began receiving evaporator bottoms, with recycle to tank 241-TX-118, between the third quarter of 1972 and the second quarter of 1975. These transfers were likely salt cake supernatants that were stored in tank 241-TX-103 to precipitate additional salt before recycle to the 242-T Evaporator. Anderson (1990) does indicate that tank 241-TX-103 was designated as an evaporator bottoms receiver during this time period and into the second quarter of 1976. T2 salt cake would be expected to precipitate during this time period as the result of water evaporation and further cooling of the salt solution.

Agnew et al. (1997b) indicates that salt well pumping of the tank 241-TX-103 interstitial liquid occurred from the second quarter of 1982 through the second quarter of 1983. Anderson (1990) does not report on events beyond 1980.

D3.3 DETERMINATION OF WASTE VOLUMES

The HDW model estimates the T1 salt cake volume based on a solids volume measurement made in the fourth quarter of 1965 (11.4 kL [3 kgal] of T1 salt cake). A solids level measurements made through the second quarter of 1972, (before the introduction of T2 salt solutions) indicated a solids volume of 11.4 kL (3 kgal), which is the volume used by the HDW model. A T1 salt cake volume of 11.4 kL (3 kgal) will be used for inventory calculations. The T1 salt cake supernatants and evaporator bottoms had been stored in tank 241-TX-103 for approximately 17 years, so the volume is reasonable.

The WSTRS (Agnew et al 1997b) shows that tank 241-TX-103 received and temporarily stored a total of 21,800 kL (5,760 kgal) of 242-T Evaporator salt solutions in 1972 to 1975. The formation of a quantity of salt cake in tank 241-TX-103 would be expected as the result of additional solution cooling. The HDW model volume of T2 salt cake (583 kL [154 kgal]) is calculated by subtracting the T1 salt cake volume from a August 14, 1980, solids volume measurement (Hanlon 1997). The resulting estimate of the T2 salt cake volume is 583 kL (154 kgal).

D3.4 COMPOSITION OF TANK 241-TX-103 WASTE

The tank 241-TX-103 waste composition can be estimated from the T1 and T2 salt cake compositions measured in other waste tanks. Estimation of the tank inventories based on the T1 and T2 salt cake layers allows a comparison with the inventories estimated by Agnew et al. (1997a).

D3.4.1 Composition of T1 Salt Cake

Operation of the 242-T Evaporator between 1951 and 1955 resulted in 2,903 kL (767 kgal) of salt cake, which is contained in 10 underground storage tanks in the T, TX, and TY Tank Farms (Agnew et al. 1997a). The evaporator feeds during this time period consisted largely of 1C and TBP waste supernatants. The HDW model refers to this salt cake as T1SltCk on a global basis. The HDW model uses this average T1SltCk composition to calculate the T1 salt cake inventories for individual tanks rather than the SMM because of the lack of detailed evaporator feed composition data. The salt cake produced by the 242-T Evaporator from 1951 through 1955 will be referred to as T1 salt cake, hereafter, in this report. Seventy-nine percent of the T1 salt cake is contained in the TX Tank Farm. With the exception of tank 241-T-109, all tanks containing T1 salt cake also contain other waste types. Five of the tanks containing T1 salt cake have been core or auger sampled (tanks 241-T-108, 241-T-109, 241-TX-116, 241-TY-101, and 241-TY-102).

The auger samples for tanks 241-T-108 and 241-T-109 are recent (1995) and the laboratory analyses of the samples should meet all Tri-Party Agreement requirements. Tank 241-T-108 is expected to contain 1C/CW sludge as well as T1 salt cake (Agnew et al. 1997a), however, the analytical results indicate that the tank 241-T-108 sample retrieved was primarily salt cake as evidenced by the high sodium concentration (223,000 μg/g) reported for the composite (Baldwin 1996). Tank 241-T-109 contains only T1 salt cake generated from the 242-T Evaporator concentration of TBP and 1C/CW supernatants. The composition of the tank 241-T-109 salt cake is not typical in that it is primarily sodium phosphate rather than sodium nitrate. The composition reported by the TCRs for tank 241-T-108 (Baldwin) and for tank 241-T-109 (Brown et al. 1996) are shown in Table D3-1.

T1 salt cake was deposited in tank 241-TX-116 between 1951 and 1955. The tank 241-TX-116 core sample was taken with the initial prototype of a rotary core sampler in 1976 to 1977 (Allen 1977). Sample recoveries were relatively poor and no material was recovered from several segments. Additionally, analytical methods and quality assurance requirements differed significantly from current practices. The analytical data are provided in a letter report (Horton 1977). Core segments 6, 7, 9, and 10 are expected to be T1 salt cake based on the HDW model layer volumes, and this is confirmed by differences in the core sample results as compared to segments 1 through 4 (T2 salt cake). No material was recovered in segments 5 and 8. The analytical results were corrected to a silicon-free basis since diatomaceous earth (92 percent SiO_2) was added to tank 241-TX-116 in November 1970, (Buckingham and Metz 1974). The analytical results are included in Table D3-1.

Table D3-1. Composition of T1 Salt Cakes (2 Sheets).

Analyte	Tank 241-T-108[a] (μg/g)	Tank 241-T-109[b] (μg/g)	Tank 241-TX-116 (μg/g)[c,d]	Relative std dev of mean (%)	Average - predicted T1 salt cake (μg/g)	HDW model T1 SltCk[e] (μg/g)
Ag	<7.96	18.6	NR	NA	<13.3	NR
Al	2,290	1,250	1,720	17.2%	1,750	140.1128
Bi	605	170	NR	56.1%	388	1,806.784
Ca	177	324	NR	29.3%	251	2,116.939
Cd	<7.96	<5	NR	NA	<5[f]	NR
Cl	<905	341	NR	NA	341[f]	1,376.542
CO_3	NR	10,400	32,800	67.2%	21,600	6,832.004
Cr	19.2	40	150	58.3%	69.9	128.6514
F	10,700	13,000	3,140	33.3%	8,950	948.0084
Fe	6,110	5,490	16,000	37.0%	9,200	4,040.613
Hg	NR	NR	NR	NA	NR	0.601441
K	<239	<500	NR	NA	<239[f]	270.302
La	<39.8	<50	NR	NA	<39.8[f]	0
Mn	182	1,030	NR	70.0%	606	0
Na	223,000	181,000	246,600	8.85%	216,900	185,809.8
Ni	<15.9	<20	NR	NA	<18	396.1703
NO_2	6,210	492	210	84.8%	2,300	5,525.867
NO_3	392,000	20,800	574,700	49.5%	329,200	333,726.3
OH	NR	NR	NR	NA	NR	8,933.119
Pb	533	303	NR	27.5%	418	0
P as PO_4	125,000	246,000	13,500	52.4%	128,200	70,614.37
Si	1,500	889	NA	25.6%	1,200	287.0366
S as SO_4	1,110	516	34,200	93.2%	11,900	5,974.895
Sr	21.6	<10	NR	NA	<15.8	0

Table D3-1. Composition of T1 Salt Cakes (2 Sheets).

Analyte	Tank 241-T-108[a] (μg/g)	Tank 241-T-109[b] (μg/g)	Tank 241-TX-116 (μg/g)[c,d]	Relative std dev of mean (%)	Average - predicted T1 salt cake (μg/g)	HDW model T1 SltCk[e] (μg/g)
TOC	NR	NR	NR	NA	NR	1.34 E-06 (wt%)
U	1,130	<500	0.0052	NA	<543	9,724.072
Zr	10.9	12.2	NR	5.63%	11.6	19.18255
Radio-nuclide	μCi/g	μCi/g	μCi/g	%	μCi/g	μCi/g
^{241}Am	<0.123	NR	NR	NA	<0.123[g]	4.67 E-04
^{60}Co	<0.0133	NR	NR	NA	<0.0162[g]	5.77 E-05
^{134}Cs	NR	NR	2.44	NA	0.0080[g]	2.43 E-06
^{137}Cs	2.00	NR	4.74	40.7%	2.63[g]	34.44064
^{154}Eu	<0.0455	NR	NR	NA	<0.0514[g]	0.001026
^{155}Eu	<0.0407	NR	NR	NA	<0.0503[g]	0.004959
Density (g/mL)	2.35	1.55[h]	NR	NA	1.95	1.742038
% H_2O	19.5%	47.70%	NR	NA	33.6%	37.7268%

HDW = Hanford Defined Waste
NA = Not applicable
NR = Not reported
[a] Baldwin (1996)
[b] Brown et al. (1996)
[c] Horton (1977)
[d] Silica-free basis due to the addition of diatomaceous earth to this tank
[e] Agnew et al. (1997a)
[f] Since these analytes were not expected in this waste, the lower value was used instead of an average
[g] Predicted T1 salt cake radionuclides are decayed to January 1, 1994. The radionuclides for tanks 241-T-108, 241-T-109, and 241-TX-116 are reported as of the date analyzed, therefore, the average predicted values may not match the reported values
[h] The density reported by the 241-T-109 TCR (Brown et al. 1996) was not actually measured, but based on a HDW model Rev. 3 estimate (Agnew et al. 1996).

Tanks 241-TY-101 and 241-TY-102 were core sampled in 1985. As with the tank 241-TX-116 core sample, the analytical methods and quality assurance differed from current practices. Tank 241-TY-101 contains ferrocyanide scavenging wastes as well as salt cake. The relatively low sodium concentration reported for the composite (121,000 μg/g, Weiss and Mauss 1987b) indicates that the sample was primarily sludge and that the data are not appropriate examples of T1 salt cake. The sodium concentrations in salt cakes are typically near 200,000 μg/g (see Table D3-1). Tank 241-TY-102 contains both T1 and T2 salt cakes (about 45 percent T1 salt cake). Since only composite analyses were performed, the results cannot be used as an example of T1 salt cake.

The phosphate concentration for tank 241-TY-102 is relatively low (29,000 μg/g, Weiss and Mauss 1987a), indicating that the phosphate concentration of the T1 salt cake added to tank 241-TY-102 could not have been comparable to concentrations measured for tanks 241-T-108 and 241-T-109 (125,000 and 246,000 μg/g respectively, Table D3-1). Phosphate concentrations exceeding 100,000 μg/g are not necessarily typical of T1 salt cakes based on the analytical results for tanks 241-TY-102 and 241-TX-116. The reason for this wide variation in phosphate concentration is not known, but supernatants recycled from salt receiving tanks to the 242-T Evaporator might have been depleted in phosphate, and consequently the salt cakes formed from recycled supernatants would have a lower phosphate concentration.

The mean analytical data for tanks 241-T-108, 241-T-109, and 241-TX-116 are tabulated in Table D3-1. The relative standard deviation of the mean for all components except sodium and zirconium are extremely high, indicating that the composition of the waste type is extremely variable. The reason for the salt cake composition variability is not known, but the variations may be caused by differences in the fraction of 1C and TBP waste supernatants included in the evaporator feed and the recycle of salt cake supernatants. Any model which assumes that T1 salt cake has a relatively consistent composition, including the prediction in Table D3-1 or the HDW model (Agnew et al. 1997a), will have very limited usefulness in predicting the inventory of a tank containing T1 salt cake. The composition predicted by the HDW model for the global composition of T1 salt cake is included in Table D3-1 for comparison. With the exception of sodium and nitrate, the predicted T1 salt cake composition differs significantly from the HDW model T1 SltCk concentrations for most chemical analytes. The predicted T1 salt cake concentrations used to estimate the tank 241-TX-103 inventory for this evaluation will be based on the average of the concentrations in tanks 241-T-108, 241-T-109, and 241-TX-116.

The density reported for tank 241-T-108 is relatively high and reflects a particle density measurement, rather than a bulk density. The density of the predicted T1 salt cake was arbitrarily set to 1.7 g/mL to avoid over-reporting of the waste components. T1 salt cake constitutes roughly 2 vol% of the tank inventory, so the impact of the tank 241-T-108 high waste density could otherwise have been neglected. The selected value is in good agreement with the HDW model prediction for T1 salt cake.

D3.4.2 Composition of T2 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. 1997a). The HDW model refers to this salt cake as T2SltCk on a global basis or as SMMT2 when calculated by the SMM for an individual tank. The salt cake produced by the 242-T Evaporator from 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.

Eight tanks containing T2 salt cake have been core sampled (tanks 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 analytical data available at the core segment level and T2 salt cake layers large enough to differentiate it from other waste layers in the core sample data.

T2 salt cake was formed in tanks 241-U-102 and 241-U-105 from 1975 through 1976 (Agnew et al. 1997b). 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 because of a lack of solids volume measurements in this time period. Furthermore, a significant composition change between the expected S2 salt cake and T2 salt cake layers cannot be seen in the core sample data. Descriptions of the core sampling events and analytical data for tanks 241-U-102 and 241-U-105 are available in the respective TCRs (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 for tank 241-TX-116 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 silicon-free basis because diatomaceous earth (92 percent SiO_2) was added to tank 241-TX-116 in November of 1970 (Buckingham and Metz 1974). The diatomaceous earth had migrated into the top four core segments (approximately 203 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 percent tank 241-U-102 and 18.5 percent 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 (T2SltCk) is included in the Table D3-2 for comparison.

The use of the composition data from tanks 241-U-102, 241-U-105, and 241-TX-116 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-103, these data are being applied to a salt cake which has been salt well pumped 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 Tank Farm supernatants (i.e., saturated salt solutions that had already cooled and would not form significantly more salt cake) rather than evaporator bottoms.

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
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 SltCk[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, 1994
[i] A simple average is used for the density.

D3.4.3 Tank 241-TX-103 Inventory Based on T1 and T2 Salt Cake Compositions

The chemical and radionuclide inventory of tank 241-TX-103 can be estimated from the T1 salt cake, and T2 salt cake volumes (11.4 kL [3 kgal], and 583 kL [154 kgal] respectively), density (1.7 g/mL) and the average of chemical/radionuclide concentrations calculated for the 242-T Evaporator salt cake wastes that have been analyzed. The resulting chemical and radionuclide inventories are provided in Table D3-3.

Table D3-3. Predicted Tank 241-TX-103 Inventory Based on Salt Cake Layers. (2 Sheets)

Analyte	T1 salt cake layer[a] (kg)	T2 salt cake layer[b] (kg)	Predicted 241-TX-103 inventory (kg)
Ag	<0.256	13.0	<13.3
Al	33.9	27,295	27,329
Bi	7.5	<66	<73
Ca	4.84	295	300
Cd	<0.097	7.1	<7.2
Cl	6.6	5,184	5,190
CO_3	416	53,676	54,092
Cr	1.35	1,301	1,302
F	173	1,905	2,078
Fe	178	12,211	12,388
K	<4.61	1,683	<1,688
La	<0.77	<33.9	<34.7
Mn	11.7	235	247
Na	4,187	208,851	213,037
Ni	<0.347	90	<90.66
NO_2	44.5	30,463	30,508
NO_3	6,354	304,156	310,511
OH	124	32,585	32,709
Pb	8.1	<135	<143.3
P as PO_4	2,474	7,599	10,073
Si	23.1	166	189
S as SO_4	231	16,150	16,381
Sr	<0.305	<6.6	<6.9
TOC	NR	9,126	9,126
U	<10.5	<385	<395
Zr	0.223	17.0	17.3

Table D3-3. Predicted Tank 241-TX-103 Inventory Based on Salt Cake Layers. (2 Sheets)

Radio-nuclides[c]	T1 salt cake layer[a] (Ci)	T2 salt cake layer[b] (Ci)	Predicted 241-TX-103 inventory (Ci)
^{241}Am	<2.37	<30,051	<30,053
^{60}Co	<0.313	<141	<141
^{134}Cs	0.155	0.96	1.11
^{137}Cs	51	110,212	110,263
^{154}Eu	<0.99	<495	<496
^{155}Eu	<0.97	<1,036	<1,037
Volume (kgal)	3,000	154,000	157,000
Density (g/mL)	1.7	1.7	1.7

[a] Based on the T1 salt cake prediction in Table D3-1
[b] Based on the T2 salt cake prediction in Table D3-2
[c] Radionuclides decayed to January 1, 1994.

D3.5 TANK 241-TX-103 CHEMICAL AND RADIONUCLIDE INVENTORIES

The tank 241-TX-103 chemical and radionuclide inventories estimated from the 242-T Evaporator salt cake layers are tabulated in Table D3-4. The inventories estimated by the HDW model (Agnew et al. 1997a) are included in the table for comparison. All inventory estimates are based on a total waste volume of 594.3 kL (157 kgal).

Table D3-4. Tank 241-TX-103 Inventory Estimates. (2 Sheets)

Analyte	HDW model[a] (kg)	Inventory based on T1[b] and T2[c] salt cake layers (kg)
Density	1.21	1.7
Heat load (kW)	0.40	0.19
Heat load calculated (kW)	0.41	0.52
Ag	NR	<13.3
Al	7,880	27,300
Bi	135	<73.0
Ca	343	300
Cd	NR	<7.24
Cl	1,790	5,190
TIC as CO_3	5,910	54,100
Cr	1,210	1,300
F	465	2,080
Fe	201	12,400
K	560	<1,690
La	2.81	<34.7
Mn	36.3	247
Na	66,700	213,000
Ni	92.2	<90.7
NO_2	19,600	30,500
NO_3	75,000	311,000
OH	28,900	32,700
Pb	48.7	<143
P as PO_4	3,740	10,100
Si	438	189
S as SO_4	5,360	16,400
Sr	NR	<6.86
TOC	1,810	9,130
U_{TOTAL}	691	395
Zr	8.98	17.3
Analyte	HDW model (kg)	Inventory Based on T1 and T2 Salt Cake Layers (kg)
Volume (kL)	594	594.3

Table D3-4. Tank 241-TX-103 Inventory Estimates. (2 Sheets)

Radionuclides[d]	HDW model (Ci)	Inventory Based on T1 and T2 Salt Cake Layers (Ci)
^{60}Co	6.8	< 141
^{134}Cs	0.515	1.11
^{137}Cs	56,200	110,300
^{137m}Ba	53,200	104,000
^{154}Eu	110	< 496
^{155}Eu	42.9	< 1,037
^{241}Am	11.6	< 30,000

[a] Agnew et al. (1997a)
[b] Based on the T1 salt cake prediction in Table D3-1
[c] Based on the T2 salt cake prediction in Table D3-2
[d] Radionuclides decayed to January 1, 1994.

D3.6 COMPARISON OF TANK 241-TX-103 INVENTORY ESTIMATES

The lack of recent core samples adds considerable uncertainty to estimation of chemical and radionuclide inventories for tank 241-TX-103. The use of waste composition data from tanks 241-T-108, 241-T-109, 241-TX-116, 241-U-102, and 241-U-105 to represent the wastes in tank 241-TX-103 is a reasonable approach in the absence of a more recent core sample. The estimates which are based on compositions measured in other tanks should be regarded only as approximations.

Carbonate and Hydroxide. The tank 241-TX-103 carbonate inventory estimated from the salt cake layers in other tanks was 9.1 times the HDW model inventory. The hydroxide ion in Hanford Site waste tanks is converted to carbonate by the absorption of carbon dioxide from the ambient air. 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, and is accelerated by use of airlift circulators installed in many Hanford Site underground storage tanks. Conversion of 27,300 kgs of hydroxide to carbonate would account for the difference. The HDW model does not account for the absorption of carbon dioxide from the atmosphere.

Fluoride . The fluoride inventory estimated from salt cake layers in other tanks is 4.5 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 iron inventory estimated from the salt cake layers in other tanks is skewed by the high iron concentration (2.4 wt% on silicon-free basis) reported for the tank 241-TX-116 T2 salt cake. A high iron concentration is not likely for a salt cake since iron is insoluble in alkaline solutions and significant iron concentrations would not be expected in the evaporator feed solutions. The inventory calculated from the HDW model will be used for the best-basis inventory.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of the 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. The charge balance approach is consistent with that used by Agnew et al. (1997a).

Cesium-137 and Strontium-90. The heat load for tank 241-TX-103 has been estimated at 0.188 kW (Kummerer 1995). This corresponds to a maximum of 28,100 Ci ^{90}Sr (6.69E-03 W/Ci ^{90}Sr) or a maximum of 39,800 Ci ^{137}Cs (4.72E-03 W/Ci ^{137}Cs). The HDW model radionuclide inventories represent 215 percent of the heat load. T1 and T2 Salt cake tank layer estimates (for strontium) and ^{137}Cs estimated by HDW represent 350 percent of the heat load described by Kummerer. Since tank 241-TX-103 waste volume is relatively small and consists only of salt cake, the heat load estimate appears to be in error. The ^{90}Sr and ^{137}Cs inventories estimated from the HDW model will be used for the best-basis estimate.

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-103 was performed including the following:

- Waste transactions and operating data to confirm that only 242-T Evaporator salt cakes were expected in this tank

- Composition data from three waste tanks (241-T-108, 241-T-109, and 241-TX-116) which are expected to have a similar T1 salt cake compositions, and three waste tanks (241-U-102, 241-U-105, and 241-TX-116) that are expected to have similar T2 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 recent analytical data are available for the salt cake remaining in tank 241-TX-103 because no core samples have been taken. The estimated inventory was, therefore, based on the composition of T1 salt cakes in tanks 241-T-108, 241-T-109, and 241-TX-116, and the composition of T2 salt cakes in tanks 241-U-102, 241-U-105, and 241-TX-116. The HDW model inventories (Agnew et al. 1997a) were used when no other data were available or when analytical data were suspect.

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., 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., Section 6.1.10.

The waste in tank 241-TX-103 consists of 594.3 kL (157 kgal) of T1 and T2 salt cake produced by the 242-T Evaporator. The best-basis inventory for tank 241-TX-103 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.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TX-103 (Effective May 31, 1997).

Analyte	Total inventory (kg)	Basis (S, M, E or C)[1]	Comment
Al	27,300	E	
Bi	<73	E	
Ca	300	E	
Cl	5,190	E	
TIC as CO_3	54,100	E	
Cr	1,300	E	
F	2,080	E	
Fe	201	M	
Hg	0.52	M	
K	<1,690	E	
La	2.81	M	
Mn	247	E	
Na	213,000	E	
Ni	91	E	
NO_2	30,500	E	
NO_3	311,000	E	
OH	64,900	C	Full balance basis
Pb	48.70	M	
P as PO_4	10,100	E	
Si	189	E	
S as SO_4	16,400	E	
Sr	<6.86	E	
TOC	9,130	E	
U_{TOTAL}	395	E	
Zr	17.3	E	

[1]S = Sample-based
M = Hanford Defined Waste model-based
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-103 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	41.9	M	
^{14}C	6.12	M	
^{59}Ni	0.455	M	
^{60}Co	6.8	M	
^{63}Ni	44.6	M	
^{79}Se	0.623	M	
^{90}Sr	20,800	M	
^{90}Y	20,800	M	Referenced to ^{90}Sr.
^{93m}Nb	2.22	M	
^{93}Zr	3.06	M	
^{99}Tc	43.6	M	
^{106}Ru	0.00124	M	
^{113m}Cd	15.9	M	
^{125}Sb	29.2	M	
^{126}Sn	0.941	M	
^{129}I	0.084	M	
^{134}Cs	0.515	M	
^{137}Cs	56,200	M	
^{137m}Ba	53,200	M	Referenced to ^{137}Cs.
^{151}Sm	2,190	M	
^{152}Eu	0.722	M	
^{154}Eu	110	M	
^{155}Eu	42.9	M	
^{226}Ra	2.90 E-05	M	
^{227}Ac	1.88 E-04	M	
^{228}Ra	0.0429	M	
^{229}Th	9.96 E-04	M	
^{231}Pa	8.33 E-04	M	
^{232}Th	0.00265	M	
^{232}U	0.216	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-TX-103 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{233}U	0.829	M	
^{234}U	0.250	M	
^{235}U	0.0103	M	
^{236}U	0.00660	M	
^{237}Np	0.156	M	
^{238}Pu	0.262	M	
^{238}U	0.288	M	
^{239}Pu	9.91	M	
^{240}Pu	1.60	M	
^{241}Am	11.6	M	
^{241}Pu	17.3	M	
^{242}Cm	0.0281	M	
^{242}Pu	9.48 E-05	M	
^{243}Am	3.92 E-04	M	
^{243}Cm	0.00261	M	
^{244}Cm	0.0262	M	

[1]S = Sample-based
M = Hanford Defined Waste model-based
E = Engineering assessment-based.

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D5.0 APPENDIX D REFERENCES

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