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Preliminary Tank Characterization Report for Single-Shell Tank 241-TY-101: 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-TY-101 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-TY-101: BEST-BASIS INVENTORY

July 1997

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-TY-101: 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-TY-101. 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 flow sheet 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-TY-101

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TY-101

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-TY-101 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

A single core sample was obtained from riser 3 of tank 241-TY-101 in 1985. This core consisted of three segments, only two of which contained representative samples of waste from the tank. Solids from two of these segments (segments 2 and 3) were combined to generate a composite sample for chemical and radionuclide analysis of the waste (Weiss and Mauss 1987). Metals and radionuclides were analytically measured after water digestion of the original sample, acid digestion of the water insoluble residue and strong acid (HNO_3-HF-HCl) digestion of the acid insoluble fraction in a teflon-lined Parr bomb. The Parr bomb procedure only dissolved 49 wt% of the acid insoluble residue, including the weight of the interstitial liquid remaining in the centrifuged solids. Metals were determined by inductively coupled plasma spectroscopy (ICP), while anions were measured by ion chromatography (IC).

The waste history of this tank is provided in other references (Anderson 1990). Tank 241-TY-101 was identified as a suspected leaker in 1974 and was removed from service the second quarter of 1975. Remaining supernatants were periodically removed from 1982 through 1993 via saltwell pumping to tanks 241-SY-102, 241-AY-101, 241-AW-102, and 241-AW-106. The 1985 core sample is considered to be generally representative of the sludge layers from which the 1985 composite core was taken (segments 2 and 3). Component inventories can be calculated by multiplying the concentration of an analyte by the volume and density of the sludge and liquid layers in the tank. The Hanford Defined Waste (HDW) model (Agnew et al. 1996) also provides an independent set of estimates for component inventories in this tank.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The 1985 core consists of two segments which were combined to make up a composite sample of the waste. Table D2-1 provides data on the segment recoveries from the core, together with the projected depth of the sludge layer based on the physical dimensions of the sampler. Each segment is 48.3 cm (19 in.) long, 2.54 cm (1 in.) in diameter, and has a maximum volume of 244.8 cm^3 (14.9 $in.^3$). Sample recoveries were identified as percent recovered based on the theoretical volume of the sampler. The average sludge depth was determined to be 97.5 cm (38.4 in.), including 30.48 cm (12 in.) of sludge not recovered in the first (top) segment. The sludge volume can be determined by taking the average sludge depth for riser 3 (97.5 cm [38.4 in.]) and multiplying this value by the volume factor for a 22.8 m (75 ft) diameter tank (4,110 L/cm). Tank 241-TY-101 thus contains 446.6 kL (118 kgal) of sludge, including 45.9 kL (12 kgal) due to the dish bottom configuration of the 22.86 m (75 ft) diameter tank. This inventory is consistent with the measured sludge level and tank farm surveillance estimate for this tank (446.6 kL (118 kgal) of sludge based on 130.5 cm [51.4 in.] sludge depth, including 30.48 cm (12 in.) of additional height for the Food Instrument Company (FIC) level gauge plummet (Hanlon 1996, Swaney 1993). The average density appears to be about 1.413 kg/L, although analytical measurements indicate the actual density is 1.64 kg/L (Weiss and Mauss 1987). The composite sample represents the lower 67 cm (26.4 in.) of the sludge layer or 61.7 percent of the total sludge volume in 241-TY-101.

Table D2-1. Core Segment Recoveries, Sample Segment Thickness and Estimated Sludge Levels in Tank 241-TY-101.[a]

Date	Riser/ core	Segment	Sample length (cm)	Sample recovery[b] (%)	Sample solids (g)	Estimated sludge depth[c] (cm) [in.]	Sample density[d] (g/ml)
1985	3/1	1	-	0	0	30.48 [12]	-
		2	34.9 cm	72	267.46	48.3 [19]	1.51
		3	14.6 cm	78	97.34	18.8 [7.4]	1.316
		Total	Total		364.80	97.6 [38.4]	Avg. 1.413

[a] Weiss and Mauss (1987)

[b] Based on volume of sample compared to theoretical volume of sampler.

[c] Estimated sludge depth based on observed sludge level and available ram travel for segment 1, physical dimensions of sampler (48.3 cm [19 in.]) for segment 2 and the ram travel before impacting the bottom of the tank for segment 3.

[d] Density of sample may be determined by dividing the weight of the sample/cm by the volume of the sampler (5.067 cm^3 of sample/cm).

Table D2-2 provides a summary of the composite sample analytical results and tank inventory estimates based on the estimated volume and density of the sludge (446,600 L and 1.64 kg/L, respectively). Analytical values in Table D2-2 are referenced from Weiss and Mauss (1987). The chemical species are reported without charge designation per the best-basis inventory convention.

Table D2-2. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-C-102.

Analyte	Core 1 Composite[a] (μg/g)	Tank Inventory[b] (Kg)
Al	29,032	21,264
Ba	1,927	1,411
Bi	27,225	19,940
Cd	10.6	7.8
Cl	757	554
Cr	8,404	6,155
F	3,370	2,468
Fe	40,153	29,409
Pb	224	164
Mn	558	409
Ni	5,092	3,730
PO_4	74,226	54,365
Si	38,679	28,329
Ag	3.8	2.8
Na	121,300	88,843
U	2,339	1,713
Zr	385	282
NO_3	145,000	106,200
SO_4	5,490	4,021
TOC	663	486
Density	1.64 kg/L	

[a] Based on analytical results from 1985 composite core (water + acid + Parr bomb) (Weiss and Mauss 1987).

[b] Tank inventory estimates based on core 1 composite analytical results, estimated sludge volume (446,600 L) and measured sludge density (1.64 kg/L).

Table D2-3 provides a summary of the composite sludge radionuclide concentrations and tank inventory estimates. The composite sludge values are derived from segments 2 and 3 of core 1. Radionuclide results are decayed to January 1, 1994.

Table D2-3. Analytical Results and Tank Inventory Estimates for Radioactive Components in Tank 241-TY-101 (Decayed to January 1, 1994).

Radionuclide	Core 1 composite[a] (μCi/g)	Tank Inventory[b] (Ci)
^{14}C	<4.35 E-05	<0.0319
^{60}Co	0.003	2.2
^{90}Sr	27.4	20,100
^{99}Tc	8.07 E-04	0.591
^{129}I	<4.7 E-05	<0.0344
^{137}Cs	0.231	171
$^{239/240}Pu$	0.192	140
^{241}Am	<0.0128	<9.37
Total Gamma[c]	0.284	210

[a] Based on analytical results from 1985 composite core (water + acid + Parr bomb), decayed to January 1, 1994 (Weiss and Mauss 1987)

[b] Tank inventory estimates based on core 1 composite analytical results, predicted sludge volume (446,600 L) and average sludge density (1.64 kg/L)

[c] Total gamma results were not decayed to 1994 due to uncertainty in the composition of gamma-emitting isotopes.

D2.1 COMPARE SAMPLE AND HANFORD DEFINED WASTE MODEL-BASED INVENTORIES

Sample-based estimates developed from analytical data and HDW model estimates from Los Alamos National Laboratory (LANL) (Agnew et al. 1996) are both potentially useful for estimating component inventories in the tank. The HDW model is mainly based on process production records and tank transaction records (Agnew et al. 1995) for each tank. Primary wastes are process wastes initially added to 241-TY-101, while secondary wastes were initially added to some other tank. A review of these records shows that tank 241-TY-101 received the following wastes:

- 3,399 kL (898 kgal) of 1C ($BiPO_4$) waste evaporator bottoms from 241-TX-116 and 241-TX-117, 3,224 kL (852 kgal) of which was sent to 241-TY-102 and the T-025 crib

- 6,476 kL (1,711 kgal) of primary ferrocyanide treated 1C (1CFeCN) waste
- 2,180 kL (576 kgal) of recycled supernatant and salt cake waste (T1SltCk) from the T evaporator in 1955
- 1,801 kL (476 kgal) of secondary uranium recovery (UR) supernatant waste from 241-TY-106
- 1,862 kL (492 kgal) of secondary REDOX (R2) waste from 241-SX-105 (45 percent) and secondary REDOX salt cake (RSltCk) waste from 241-SX-108 (55 percent).

The HDW model predicts the following sludge types in 241-TY-101:

- 272.5 kL (72 kgal) of 1CFeCN sludge
- 174.1 kL (46 kgal) of T1SltCk.

The HDW model is based on an inventory of 446.6 kL (118 kgal) of salt cake and sludge, which agrees with the core sample-based estimate, tank level measurements, and the tank farm surveillance estimate developed for tank 241-TY-101 (Weiss and Mauss 1987, Swaney 1993, and Hanlon 1996). Secondary wastes such as secondary R2 and RSltCk can usually be ignored because 80 to 90 percent of the solids in these wastes usually precipitate in the first tank of the cascade. In-tank precipitation processes due to self-heating effects can usually be ignored. This seems to be a reasonable assumption for secondary R and RSltCk wastes such as those introduced to 241-TY-101.

Aluminum behaves somewhat differently from other components in the waste because aluminum tends to precipitate as the pH is reduced due to absorption of CO_2 from the atmosphere. Table D2-4 compares the sample-based and HDW model-based estimates for chemical components, while Table D2-5 provides a similar comparison for radioactive components in tank 241-TY-101.

Table D2-4. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-TY-101. (2 sheets)

Analyte	Sample-Based Sludge Concentration[a] (μg/g)	Sample-based inventory estimate[b] (Kg)	HDW model-based inventory estimate[c] (Kg)
Ag	3.8	2.8	NR
Al	29,032	21,264	3,980
Ba	1,927	1,411	NR
Bi	27,225	19,940	13,700
Cd	10.6	7.8	NR
Ca	NR	NR	3,390

Table D2-4. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-TY-101. (2 sheets)

Analyte	Sample-Based Sludge Concentration[a] (μg/g)	Sample-based inventory estimate[b] (Kg)	HDW model-based inventory estimate[c] (Kg)
Cl	757	554	676
Cr	8,404	6,155	73.9
F	3,370	2,468	1,580
Fe	40,153	29,409	3,780
Pb	224	164	0
Hg	NR	NR	1.36
Mn	558	409	0
Na	121,300	88,843	51,500
NH_4	NR	NR	148
Ni	5,092	3,730	3,180
NO_2	NR	NR	9,940
NO_3	145,000	106,200	34,300
OH	NR	NR	12,800
P as PO_4	74,226	54,365	39,300
K	NR	NR	139
Si	38,679	28,329	1,010
Sr	NR	NR	0
S as SO_4	5,490	4,021	2,800
TIC as CO_3	0	0	6,320
TOC	663	486	2,050
U_{TOTAL}	2,339	1,713	363
Zr	385	282	646
H_2O	43.5 (wt%)	319,000	500,000
density (Kg/L)	1.64	1.64	1.36

HDW = Hanford Defined Waste
NR = Not reported
[a] Analyte concentrations in sludge derived from 1985 core sample data in Table D2-2
[b] Sample inventory based on 446,600 L (118 kgal) of sludge, with a mean density of 1.64 kg/L
[d] Agnew et al. (1996).

Table D2-5. Comparison of Sample-based and HDW Model-Based Estimates for Radioactive Components in Tank 241-TY-101.[a]

Analyte	Sample-based inventory estimate[b] (Ci)	HDW model inventory estimate[c] (Ci)
^{14}C	<0.0319	NR
^{60}Co	2.2	NR
^{90}Sr	20,100	3,060
^{99}Tc	0.591	NR
^{125}Sb	NR	NR
^{129}I	<3.44 E-02	NR
^{137}Cs	1.71	202,000
^{239}Pu	1.40	9.82
^{241}Am	<9.37	NR

HDW = Hanford Defined Waste
NR = Not reported
[a] All radionuclides have been decayed to January 1, 1994.
[b] Sample based estimates derived from 1985 composite core sample data Table D2-3.
[c] Agnew et al. (1996)

D3.0 COMPONENT INVENTORY EVALUATION

Note that significant differences exist between the sample and HDW estimates for Al, Bi, Cr, F, Fe, Mn, Na, NO_3, PO_4, Si, SO_4, U, Zr, and TIC. In the following section, flowsheet, fuel production and tank transaction records (Agnew et al. 1995) will be used to independently evaluate the credibility of the sample and HDW estimates for this waste.

According to tank transaction records (Agnew et al. 1995), 6,476 (1,711 kgal) of ferrocyanide treated 1C waste were transferred to 241-TY-101 from the fourth quarter of 1954 to first quarter of 1956. Based on the fuel records from B Plant, this volume is equivalent to 675.8 MTU of 1C waste. Table D3-1 provides the expected composition profile of 1C waste, in kg/MTU, based on the $BiPO_4$ flowsheet (GE 1944), together with the estimated inventory of these components in 241-TY-101. ($BiPO_4$ flowsheet values are also referenced in Appendix C of Kupfer et al. 1997.) Three scavenging campaigns were conducted to treat different types of waste (U Plant, T Plant, and In-Farm wastes). Approximately 0.005 g moles/L of $K_4Fe(CN)_6$ and $NiSO_4$ were added to T Plant 1C waste to coprecipitate the radiocesium in this waste (Grigsby et al. 1992). As a result of this operation, about 7.49 kg/MTU of K, 2.68 kg/MTU of Fe, 1.73 kg/MTU of CN, 2.81 kg/MTU of Ni and 4.6 kg/MTU of SO_4 were also added to the ferrocyanide treated 1C waste (based on 6,476 L and 675.8 MTU of equivalent 1CFeCN waste added to 241-TY-101).

The composition of 1CFeCN waste in 241-TY-101 can also be estimated from the known composition of 1C waste in tank 241-T-104, which received 13,096 kL (3,460 kgal) of this waste. This estimate can be generated by multiplying the ratio of 1C waste added to 241-TY-101 and 241-T-104 by the composition of 1C waste in 241-T-104, with the necessary correction for chemicals added during the ferrocyanide scavenging campaign. The results are summarized in Table D3-1.. Finally, the sample-based inventory estimates (from Table D2-4) are also provided for comparison in Table D3-1.

Table D3-1. Comparison of Flowsheet, Common Sludge Layer and Sample Derived Inventories for Tank 241-TY-101. (2 Sheets)

Analyte	1C Waste (based on $BiPO_4$ flowsheet) (kg/MTU)	$BiPO_4$ flowsheet derived inventory[a] (kg)	Common sludge layer derived inventory[b] (kg)	Sample-derived inventory[c] (kg)
Al	NR	NR	17,504	21,264
Bi	36	24,328	20,122	19,940
Ce	0.4	270	NR	NR
Cr	2.4	1,622	989	6,155
F	48	32,438	9,492	2,468
Fe	28.7[d]	19,395	11,543[d]	29,409
Pb	NR	NR	131	164
Mn	NR	NR	129	409
Ni	2.81[d]	1,899	1,926[d]	3,730
NO_3	1,268	856,915	61,925	106,200
PO_4	361	243,964	83,530	54,365
K	7.5[d]	5,068	101[d]	NR
Si	12	8,110	6,982	28,329
Na	1,268	856,914	73,929	88,843
SO_4	93.6[d]	63,255	4,547[d]	4,021
U	NR	NR	2,166	1,713

Table D3-1. Comparison of Flowsheet, Common Sludge Layer and Sample Derived Inventories for Tank 241-TY-101. (2 Sheets)

Analyte	1C Waste (based on $BiPO_4$ flowsheet) (kg/MTU)	$BiPO_4$ flowsheet derived inventory[a] (kg)	Common sludge layer derived inventory[b] (kg)	Sample-derived inventory[c] (kg)
Zr	0.4	270	72	282

NR = Not reported

[a] Estimated inventory of 1C waste based on 675.8 MTU of fuel, corrected for chemicals added during the 1C scavenging campaign; projected inventory includes all of soluble and semi-soluble F, Na, NO_3, PO_4, and SO_4 added to the tank

[b] Estimated inventory of 1C waste based the relative volumes of such waste added to tanks 241-TY-101 (6,476 kL) and 241-T-104 (13,096 kL) and the measured sludge composition in tank 241-T-104 (DiCenso et al. 1994); includes all of the Na, NO_3, and PO_4 that precipitated in the tank but not the fraction that remained in the supernatant

[c] Tank inventory based on 446.6 kL (118 kgal) of sludge with an average density of 1.64 g/ml

[d] Added inventory of scavenging chemicals, including 2.7 kg/MTU of Fe, 2.81 kg/MTU of Ni, 7.5 kg/MTU of K and 4.6 kg/MTU of SO_4, based on 675.8 MTU of such waste.

The common sludge layer derived estimates (in Table D3-1) are consistent with, and in most cases in excellent agreement with, the sample-based estimates for Al, Bi, Pb, Na, SO_4 and U. While the common layer projected estimates for F and PO_4 are high and Mn and NO_3 low, based on the waste in 241-T-104, these estimates are also generally consistent with sample-derived estimates for tank 241-TY-101. Flowsheet estimates for Bi and Zr also agree with sample-based estimates for these components, while the flowsheet estimates for Fe, Cr, Ni, and Si appear to be well below the measured values in 241-TY-101 waste. If the excess Fe is assumed to have come from corrosion sources, approximately 10,014 kg of such Fe may be in the 241-TY-101 waste. According to the $BiPO_4$ Technical Manual (GE 1944), the $BiPO_4$ plant metallurgy consisted of 25-12 stainless steel (25 percent Cr, 12 percent Ni, and 63 percent Fe). Based on these values, approximately 3,974 kg of Cr and 1,907 kg of Ni may have been introduced as well, by corrosion processes, to the 241-TY-101 waste. Thus, the total amount of Cr and Ni from flowsheet and corrosion sources could be as high as 5,596 kg and 3,806 kg, respectively. These values are in good agreement with the sample-based estimates for Cr and Ni (6,155 kg and 3,730 kg, respectively). The sample-based estimates are obviously more reasonable than the HDW model estimates for Al, Bi, Cr, Fe, Pb, Mn, Na, Ni, NO_3, Si, SO_4, U, and Zr.

It appears that flowsheet estimates for Si (8,100 kg) are not consistent with the sample-based estimate (28,329 kg). This discrepancy, however, may be due to the amount of Si added with the 1C waste evaporator bottoms from tanks 241-TX-116 and 241-TX-117.

Based on the relative concentrations of sodium in the 1C evaporator bottoms (300.5 g/L) and unconcentrated 1C waste routed to cribs (59.6 g/L), it seems that the 1C evaporator bottoms were concentrated by a factor of 5.04 (Waite 1991). If the volume of evaporator bottoms sent to 241-TY-101 (889 kgal) is multiplied by this concentration factor, and divided by the volume of 1C waste produced per MTU (3,628 gal/MTU), it appears that 1,247.5 MTU of equivalent 1C waste were added to 241-TY-101 (in the form of 1C evaporator bottoms). Based on the accepted flowsheet values for 1C waste, approximately 14,970 kg of Si might have added to tank 241-TY-101 with the 1C evaporator bottoms, thus increasing the total amount of Si to 23,070 kg compared to the sample-based value of 28,329 kg. While this may help to explain the amount of Si in this waste, it seems clear from the sample-based inventories that the 1C evaporator bottoms did not carry over significant amounts of Bi, Fe and Zr to 241-TY-101 (perhaps because of prior settling in one of the primary receiver tanks such as 241-TX-116 or 241-TX-117).

If the sample-based estimates for Na and NO_3 are compared to the common sludge layer estimates (Table D3-1), it appears that 14,914 kg of additional Na and 44,275 kg of added NO_3 are in the 241-TY-101 waste (648.4 kg-moles of Na and 714.1 kg-moles of NO_3). Most salt cakes contain about 85 wt% $NaNO_3$ and have an average density of about 1.63 (average density of four S farm salt cakes). Based on these values, approximately 59,189 kg of $NaNO_3$ and 69,634 kg of salt cake may be in the 241-TY-101 waste. This inventory is equivalent to 42.7 kL (11.3 kgal) of salt cake, compared to Agnew's (Agnew et al. 1996) estimate of 174.1 kL (46 kgal) of salt cake (T1SltCk). Therefore, tank 241-TY-101 contains approximately 403.8 kL (106.7 kgal) of ferrocyanide treated 1C (1CFeCN) waste. We also know that tank 241-TY-101 received 6,476 kL of ferrocyanide treated 1C waste and that the sludge in this tank contains 43.5 wt% water and has an average density of 1.64 kg/L. For tank 241-T-104, the comparable figures are 13,096 kL of 1C waste, 1,672.9 kL of 1C sludge, with 70.65 wt% water and a density of 1.29 kg/L. If the ratio of 1C waste added to these tanks (6,476/13,096) is multiplied by the volume of 1C waste in 241-T-104 (1,672.9 kL), and by the density ratio of these sludges (1.29/1.64), and moisture ratio in these sludges (43.5 percent/70.65 percent), approximately 400.6 kL (105.8 kgal) of 1C sludge should have been added to 241-TY-101 based on this comparison. This prediction (400.6 kL) almost exactly matches the aforementioned prediction (403.8 kL) for 1C waste based on the amount of salt cake in this tank. Therefore, it appears that Agnew's predictions should be amended to reflect a volume of 400.6 kL of 1CFeCN sludge and 42.7 kL of T evaporator salt cake (T1SltCk) in 241-TY-101.

Tank 241-TY-101 has an estimated heat load of 3,140 BTU/h or 918 watts (Kummerer 1995). This heat load corresponds to 194,500 Ci of ^{137}Cs or 136,900 Ci of ^{90}Sr, values that are considerably higher than the sample-based estimates for this tank (171 Ci of ^{137}Cs and 20,100 Ci of ^{90}Sr). Sample-based estimates are equivalent to a heat load of 135.5 watts, only 14.7 percent of the estimated heat load based a vapor space temperature of 64.7 °F and waste temperature of 17.6 °C (63.8 °F). Since the reliability of the tank thermal model has not been independently verified for this tank, it will be assumed for purposes of the standard inventory estimate that the sample-based values for ^{90}Sr and ^{137}Cs are correct.

Sample-based estimates for Al, Bi, Pb, Na, SO_4, and U are in excellent agreement with common sludge layer derived estimates for 1C waste (based on tank 241-T-104). Also sample estimates for Bi and Zr are completely consistent with flowsheet estimates for these components, and if corrosion processes are taken into account, sample estimates for Fe, Ni, and Cr are in good agreement with the expected values based on flowsheet and corrosion processes that may have occurred in the $BiPO_4$ process. Sample estimates for Si are similarly consistent with flowsheet estimates for concentrated evaporator bottoms and unconcentrated 1C waste from the $BiPO_4$ process. Finally, excellent volumetric matches have been obtained by estimating the volume of salt cake in this waste, based on excessive amounts of Na and NO_3 in the tank samples, and volumetric comparisons with tank 241-T-104 waste.

Based on these comparisons, the 1985 core sample appears to offer the most reasonable and consistent set of estimates currently available for this tank. The sample-based estimates will be used accordingly to develop the best-basis inventory for tank 241-TY-101.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Chemical and radionuclide inventory estimates are generally derived from one of three sources of information: (1) sample analysis and sample-derived inventory estimates, (2) component inventories predicted by the HDW model based on process knowledge and historical tank transfer information, or (3) a tank-specific process estimate based on process flowsheets, reactor fuel data, essential materials records or comparable sludge layers and sample information from other tanks. Such data are often inconsistent.

An effort is currently underway to provide waste inventory estimates that will serve as the standard characterization data for various waste management activities. As part of this effort, a survey and analysis of various sources of information relating to the chemical and radionuclide component inventories in 241-TY-101 was performed, including the following:

1. Data from the 1985 composite core sample (Weiss and Mauss 1987)

2. Component inventory estimates provided by the HDW model (Agnew et al. 1996)

3. Evaluation of 1C waste based on the $BiPO_4$ flowsheet, fuel records for T Plant *ferrocyanide chemical additions and waste transaction records for 241-TY-101*

4. Analysis of Al, Bi,Pb, Na, SO_4, U, F, PO_4, Mn, and NO_3 based on common sludge layers and waste transaction records for 241-T-104

5. Evaluation of corrosion estimates based on the amount of excess Fe in 241-TY-101 waste and $BiPO_4$ plant metallurgy (relative to Fe, Cr, and Ni)

6. Analysis of cribbing records and 1C waste evaporator bottoms to rationalize the amount Si in the 241-TY-101 waste

7. Evaluation of salt cake and sludge inventories in 241-TY-101 based on excessive amounts of Na and NO_3 in the waste, comparable salt cake values from other tanks and common sludge layer estimates derived from 241-T-104 (based on the volume of sludge in 241-T-104 and differences in the amount of 1C waste added to 241-TY-101 and 241-T-104 and related differences in sludge density and moisture content).

Based on this analysis, a best-basis inventory was developed. The 1985 core sample results were used to generate estimates for the chemical and radionuclide components in this waste. The waste in 241-TY-101 primarily consists of ferrocyanide treated 1C waste (1CFeCN) and T evaporator salt cake (T1SltCk). The best-basis inventory for tank 241-TY-101 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.

The quality of these estimates is generally considered to be high for Al, Bi, Cr, Fe, Pb, Ni, NO_3, Si, Na, SO_4, U, and Zr, where common sludge layer, flowsheet and corrosion derived estimates are consistent with sample-based estimates for this waste. For other components, a medium or low level of confidence is assumed because of inherent inconsistencies in the flowsheet or common sludge layer derived estimates and incomplete recoveries from the 1985 core sample.

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).

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. When values for all 46 radionuclides became available in Rev 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-TY-101 (Effective January 31, 1997).

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	21,260	S	Weiss 1987
Bi	19,940	S	Weiss 1987
Ca	3,390	M	Agnew et al. 1996
Cl	550	S	Weiss 1987
CO_3	6,320	M	Agnew et al. 1996
Cr	6,160	S	Weiss 1987
F	2,470	S	Weiss 1987
Fe	29,410	S	Weiss 1987
Hg	1.4	M	Agnew et al. 1996
K	139	M	Agnew et al. 1996
La	0	M	Agnew et al. 1996
Mn	410	S	Weiss 1987
Na	88,840	S	Weiss 1987
Ni	3,730	S	Weiss 1987
NO_2	9,940	M	Agnew et al. 1996
NO_3	106,200	S	Weiss 1987
OH	46,300	C	
Pb	160	S	Weiss 1987
PO_4	54,360	S	Weiss 1987
Si	28,330	S	Weiss 1987
SO_4	4,020	S	Weiss 1987
Sr	0	M	Agnew et al. 1996
TOC	490	S	Weiss 1987
U	1,710	S	Weiss 1987
Zr	280	S	Weiss 1987

[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 Estimate for Radioactive Components in Tank 241-TY-101, Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.667	M	
^{14}C	<0.0319	S	Weiss 1987
^{59}Ni	0.4	M	
^{60}Co	2.2	S	Weiss 1987
^{63}Ni	36.3	M	
^{79}Se	0.0264	M	
^{90}Sr	20,100	S	Weiss 1987
^{90}Y	20,100	S	Referenced to ^{90}Sr
^{93m}Nb	0.106	M	
^{93}Zr	0.126	M	
^{99}Tc	0.591	S	Weiss 1987
^{106}Ru	1.33 E-08	M	
^{113m}Cd	0.313	M	
^{125}Sb	0	S	Weiss 1987
^{126}Sn	0.0398	M	
^{129}I	<0.0344	S	Weiss 1987
^{134}Cs	0.00792	M	
^{137m}Ba	162	S	Referenced to ^{137}Cs
^{137}Cs	171	S	Weiss 1987
^{151}Sm	98.2	M	
^{152}Eu	0.0606	M	
^{154}Eu	0.549	M	
^{155}Eu	4.26	M	
^{226}Ra	6.67 E-06	M	
^{227}Ac	3.44 E-05	M	
^{228}Ra	1.91 E-10	M	
^{229}Th	3.72 E-08	M	
^{231}Pa	7.56 E-05	M	
^{232}Th	3.54 E-11	M	
^{232}U	3.02 E-04	M	
^{233}U	1.38 E-05	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-TY-101, Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{234}U	12.6	M	
^{235}U	0.559	M	
^{236}U	0.129	M	
^{237}Np	0.00539	M	
^{238}Pu	0.389	M	
^{238}U	12.9	M	
^{239}Pu	140	S	Weiss 1987
^{240}Pu	4.81	M	
^{241}Am	<9.37	S	Weiss 1987
^{241}Pu	16.6	M	
^{242}Cm	0.00114	M	
^{242}Pu	7.57 E-05	M	
^{243}Am	1.86 E-06	M	
^{243}Cm	2.34 E-05	M	
^{244}Cm	4.27 E-05	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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