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Preliminary Tank Characterization Report for Single-Shell Tank 241-TX-109: Best-Basis Inventory

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U.S. Department of Energy Contract DE-AC06-96RL13200

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Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-TX-109 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-109: BEST-BASIS INVENTORY

August 1997

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Richland, Washington

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-TX-109: 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-109. 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-109

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-TX-109

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-109 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-109 consist only of the inventory estimate generated by the Hanford Defined Waste (HDW) model (Agnew et al. 1996).

D2.0 COMPARISION OF COMPONENT INVENTORY VALUES

The tank 241-TX-109 chemical and radionuclide inventory predicted by the HDW model (Agnew et al. 1996) is provided in Table D2-1. The chemical species are reported without charge designation per the best-basis inventory convention.

Table D2-1. Hanford Defined Waste Model Prediction of Tank 241-TX-109 Inventory. (2 Sheets)

Analyte	HDW model[a] (kg)
Al	27,400
Bi	17,600
Ca	3,380
Cl	706
CO_3	5,060
Cr	310
F	4,990

Table D2-1. Hanford Defined Waste Model Prediction of Tank 241-TX-109 Inventory. (2 Sheets)

Analyte	HDW model[a] (kg)
Fe	19,400
Hg	22.7
K	169
La	0
Mn	0
Na	137,000
Ni	108
NO_2	14,600
NO_3	34,500
OH	72,700
Pb	0
PO_4	148,000
Si	2,270
SO_4	6,780
Sr	0
U	208
Zr	1,110
Radionuclide (Ci)	
^{137}Cs	32,100
^{90}Sr	27.6

HDW = Hanford Defined Waste

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

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 CONTRIBUTING WASTE TYPES

There is conflicting information concerning the types of wastes contained in tank 241-TX-109. The HDW model (Agnew et al. 1996) indicates that the tank inventory is entirely sludge, whereas the Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) and the waste tank summary report (Hanlon 1996) indicate that the tank inventory is salt cake.

The HDW model (Agnew et al. 1996) predicts that the tank contains entirely first decontamination cycle waste from the bismuth phosphate process (609 kL [161 kgal] of defined waste 1C1 sludge and 844 kL [223 kgal] of defined waste 1C2 sludge). Since these 1C wastes were generated prior to 1955, the coating wastes associated with the aluminum-clad reactor fuel being processed were combined with the 1C waste in the underground storage tank (Anderson 1990).

The SORWT model (Hill et al. 1995) lists EB (evaporator bottoms), 1C (first cycle $BiPO_4$ waste) and tri-butyl phosphate (TBP) (U Plant uranium recovery wastes) as the primary, secondary, and tertiary waste types respectively, and credits the entire tank 241-TX-109 volume (1,453 kL [384 kgal]) to salt cake with 38 kL (10 kgal) of interstitial liquid. Hanlon (1996) also indicates that the tank inventory is salt cake.

D3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste transaction records (Agnew et al. 1995) show that the cascade, consisting of tanks 241-TX-109 through 241-TX-112, received 1C wastes between the first quarter of 1949 and the fourth quarter of 1950, between the second quarter of 1952 and the first quarter of 1954, and in the third and fourth quarters of 1954. Waste transaction records indicate that a total of 19,455 kL (5,140 kgal) of combined 1C/CW waste was received into tank 241-TX-109 (Agnew et al. 1995). T plant fuel processing during these periods consisted of approximately 1,473 MTU. The estimated 1C/CW waste volume based on the $BiPO_4$ flowsheet (Schneider 1951) would be 21,726 kL (5,740 kgal), which is 12 percent higher than that indicated by the waste transaction records, but still in reasonably good agreement.

Waste transaction records also indicate that 2,684 kL (709 kgal) of TBP waste was received in the first quarter of 1955, most of which overflowed to the next tank in the cascade, tank 241-TX-110. The TBP waste was originally routed to tank 241-TY-103, which overflowed to tank 241-TY-104 and was eventually pumped to tank 241-TX-109. Since the TBP wastes were stored in two tanks before tank 241-TX-109, no significant solids would have been included in the transfer, and the TBP waste contribution to the final composition of tank 241-TX-109 is expected to be small. The supernate was eventually removed from tank 241-TX-109 before its use as the receiver tank for the 242-T Evaporator.

Beginning in the first quarter of 1974 and continuing until the first quarter of 1976, tank 241-TX-109 received solutions with high salt concentrations from tanks 241-T-111, 241-TX-118, and 241-TX-104 and sent the solutions to tank 241-TX-107 or more commonly the evaporator feed tank 241-TX-118. Additionally, waste concentrate from the 242-T Evaporator was being routed to tank 241-TX-109 and pumped to other tanks for cooling and salt precipitation during this time period. These transfers are not shown in the summary waste transfer records (Agnew et al. 1995). A final removal of supernate was transferred to tank 241-SY-102 in 1977. Salt well pumping of the interstitial liquid was accomplished in 1982 and 1983.

Additionally, there is some indication that 28,955 L (7,650 gal) of supernate from tank 216-Z-8 (used in Z Plant as solids settling tank for back flush of the Recuplex process feed filters) may have been transferred to tank 241-TX-109 via tank truck in 1974 (Raab 1974). This supernate transfer would not be expected to significantly affect the composition of tank 241-TX-109.

3.3 DETERMINATION OF WASTE TYPE

The 1C/CW volumes routed to tank 241-TX-109 would result in approximately 1,930 kL (510 kgal) of sludge (concentration factor of 10 based on tank 241-T-104 that also contains only 1C/CW sludge). Some volume loss might be accounted for by entrained solids in the overflow to tank 241-TX-110, sludge compaction and leaching of soluble components into the various tank supernates. However, the material remaining in tank 241-TX-109 is still expected to be primarily 1C/CW sludge.

Tank 241-TX-109 was designated as the waste concentrate distributor tank for the 242-T Evaporator in 1972 (Fraser and Borsheim 1972). Waste concentrate from the evaporator was routed to tank 241-TX-109 and pumped to other tanks. However, there is no indication that salt cake was intentionally allowed to accumulate in tank 241-TX-109.

More dilute salt solutions were periodically routed through the tank. Cooling curves run on tank 241-TX-109 supernate between August 27, 1975, and April 5, 1976, (25 separate analyses) indicate no significant solids precipitation down to 5 °C. In contrast, the lowest temperature for tank 241-TX-109 reported between January 1976 and October 1977 was 35 °C (Brevick et al. 1995). A viscosity measurement of interstitial liquid after final removal of supernate from tank 241-TX-109 (Jansky 1981) also did not show precipitation until the temperature reached 25 °C. Any salt cake formed during transfer of evaporator waste concentrate through tank 241-TX-109 would have been dissolved by later addition of unsaturated solutions.

Further evidence that sludge, rather than salt cake is present is provided by the low porosity of the waste. Only 274 kL (72.3 kgal) of interstitial liquid were removed (Hanlon 1996) from the 1,703 kL (450 kgal) of sludge during salt well pumping. Low pumpout rates during salt well pumping (Kurath 1983) are also indicative of a sludge waste.

A bookkeeping error or an erroneous sludge level measurement for the third quarter of 1969 may have been the initial cause for the confusion regarding the waste type stored in tank 241-TX-109. The sludge inventory was reduced from the previous 2,233 kL (590 kgal) to 466 kL (123 kgal) with no credible explanation for this large decrease. The sludge level was not revised again until the third quarter of 1977 (Anderson 1990) when supernate was pumped from the tank. The sludge volume at that time was 1,703 kL (450 kgal), possibly creating the impression that the "increase" was due to salt cake.

D3.4 COMPOSITION OF 1C SLUDGES

Several tanks received 1C/CW waste directly from T Plant including tanks 241-T-104, 241-T-107, 241-TX-109, 241-TX-113, 241-U-110, 241-TY-101, and 241-TY-103. Sample data are not available for solid layers in tanks 241-TX-109 or 241-TX-110. The 1C waste was mixed with substantial quantities of other wastes in tanks 241-TY-101, 241-TY-103, and 241-U-110, making it impossible to accurately determine the composition of the 1C/CW waste sludge from these data. Two tanks (241-T-104 and 241-T-107) provide the best examples of T Plant 1C/CW sludge composition. The composition of these two tanks, based on the corresponding tank characterization reports (DiCenso et al. 1994 and Valenzuela and Jensen 1994), is provided in Table D3-1. The average of these two compositions will be used for estimating the composition of tank 241-TX-109.

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

Analyte	Tank 241-T-104[a] (μg/g)	Tank 241-T-107[b] (μg/g)	Average concentration (μg/g)
Ag	6.4	7.37	6.9
Al	16,200	16,300	16,200
Bi	18,900	12,000	15,400
Ca	1,450	760	1,100
Cd	5.44	6.94	6.19
Cl	670	540	605
CO_3	<500	14,800	7,680
Cr	901	360	631
F	8,570	11,400	9,980
Fe	9,020	29,200	19,100
Hg	0.127	0.14	0.13
K	89.0	234	162
La	<10.4	<2	<10
Mn	61.8	213	137
Na	64,500	130,200	97,400
Ni	11.3	267	139
NO_2	4,080	11,700	7,890
NO_3	58,000	74,500	66,200
Pb	NR	649	649
P as PO_4	75,700	98,400	87,100
Si	6,520	6,050	6,280
S as SO_4	3,830	9,810	6,820
Sr	99.1	878	489
TOC	706	963	835
U	897	26,400	13,600
Zr	67.5	93	80

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

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

NR = Not reported

[a] DiCenso et al. (1994)

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

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

D3.5 ESTIMATED INVENTORY FOR TANK 241-TX-109

The chemical and radionuclide inventory of tank 241-TX-109 can be estimated from the sludge volume (1,450 kL), the density (1.4 kg/L), and the average of chemical/radionuclide concentrations from tanks 241-T-104 and 241-T-107. The resulting inventories are provided in Table D3-2. The inventories estimated by the HDW model (Agnew et al. 1996) and the maximum quantity predicted from the $BiPO_4$ flowsheet (see Kupfer et al. 1997, Appendix C) are included in the table for comparison. The flowsheet inventory was calculated using the same volume and density used for the estimated 241-TX-109 inventory.

Table D3-2. Estimated Chemical and Radionuclide Inventory for Tank 241-TX-109. (2 Sheets)

Analyte	Estimated 241-TX-109 inventory (kg)	HDW model (kg)	Maximum predicted $BiPO_4$ flowsheet[a] (kg)
Ag	14	NR	NR
Al	33,100	27,400	48,500
Bi	31,400	17,600	52,300
Ca	2,250	3,380	NR
Cd	13	NR	NR
Cl	1,230	706	NR
CO_3	15,600	5,060	NR
Cr	1,280	310	3,460
F	20,300	4,990	70,300
Fe	38,900	19,400	38,300
Hg	0.27	22.7	NR
K	329	169	NR
La	NR	0	NR
Mn	280	0	NR
Na	198,000	137,000	1.09 E+06
Ni	283	108	NR
NO_2	16,100	14,600	57,700
NO_3	135,000	34,500	1.94 E+06
OH	NR	72,700	NR
Pb	1,320	0	NR
P as PO_4	177,000	148,000	533,000

Table D3-2. Estimated Chemical and Radionuclide Inventory for Tank 241-TX-109. (2 Sheets)

Analyte	Estimated 241-TX-109 inventory (kg)	HDW model (kg)	Maximum predicted $BiPO_4$ flowsheet[a] (kg)
Si	12,800	2,270	19,100
S as SO_4	13,900	6,780	132,000
Sr	990	0	NR
TOC	1,700	NR	NR
U	27,800	208	NR
Zr	163	1,110	588
Radionuclide[b]	241-TX-109 inventory (Ci)	HDW model (Ci)	Max per $BiPO_4$ flowsheet[a] (Ci)
^{241}Am	31.9	NR	NR
^{14}C	0.230	NR	NR
^{60}Co	<2.0	NR	NR
^{134}Cs	<2.4	NR	NR
^{137}Cs	12,100	32,100	NR
^{154}Eu	7.70	NR	NR
^{155}Eu	6.05	NR	NR
^{3}H	1.19	NR	NR
^{129}I	<94	NR	NR
^{237}Np	279	NR	NR
^{238}Pu	145	NR	NR
$^{239/240}Pu$	276	NR	NR
^{106}Ru	<77.5	NR	NR
^{79}Se	<0.36	NR	NR
^{90}Sr	110,000	27.6	NR
^{99}Tc	1.18	NR	NR

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

[a] An upper bound assuming that all chemicals from the T Plant processing of 1,473 MTU precipitated and that none overflows to the next tank in the cascade

[b] Radionuclides decayed to January 1, 1994.

D3.6 COMPARISON OF TANK 241-TX-109 INVENTORY ESTIMATES

The lack of sample-based inventory data adds considerable uncertainty to estimation of chemical and radionuclide inventories for tank 241-TX-109. The use of tanks 241-T-104 and 241-T-107 composition data to represent the 1C/CW waste in tank 241-TX-109 is a reasonable approach. However, it should be noted that the operating history of tank 241-TX-109 is different than the other two tanks. In particular, concentrated salt wastes from the 242-T Evaporator were routed through tank 241-TX-109 from 1974 to 1976.

Aluminum. The HDW model estimate and the inventory estimated from the compositions of tanks 241-T-104 and 241-T-107 are in reasonable agreement. However, the Al concentration used by the HDW model is approximately a factor of three higher than that predicted from the $BiPO_4$ flowsheet (see Kupfer et al. 1997, Appendix C, Table C-5). The higher Al concentration used by the HDW model is partially offset by a higher average Al solubility (80 percent for 1C1 and 10 percent for 1C2) and a slightly lower waste volume. The HDW model may have a mathematical flaw in the aluminum inventory calculation. The agreement between the two inventory estimates is just coincidental.

Bismuth. The HDW model seems to underestimate the Bi inventory for 1C/CW waste tanks. Part of this discrepancy results from the HDW model assumption that 27 percent of the Bi is soluble, Agnew et al. (1996). Another factor is that the total of the waste volume transactions for 1C/CW wastes received in tank 241-TX-109 is about 12 percent lower than that predicted from the $BiPO_4$ flowsheet (Section D3.2).

Chromium, Iron, and Nickel. The higher inventories of corrosion products predicted from 1C/CW wastes in tanks 241-T-104 and 241-T-107 indicates that HDW model is underestimating corrosion contribution for this waste type. The HDW model currently distributes a global estimate of corrosion products to various tanks based on fixed concentrations.

Fluorides. The HDW model inventory estimate for fluorides is only 25 percent of that predicted from tank 241-T-104/107 data. The HDW model assumes that no or little sodium fluoride precipitates. Another compound (such as a sodium fluorophosphate) may be forming, causing fluoride to precipitate and remain in the tank.

Silica. The HDW predicted silica inventory is only 18 percent of that predicted from the tanks 241-T-104 and 241-T-107 data. This may have resulted from either assuming too high a silica solubility (85 to 86 percent) or from the introduction of silica from essential material impurities or windblown sand.

Sodium. The predicted HDW inventory is about 69 percent that predicted from tanks 241-T-104 and 241-T-107 data. This difference might be explained by the fact that wastes with high sodium concentrations were subsequently stored on top of the 1C/CW sludges (for example, evaporator bottoms or TBP wastes).

Sulfate. The HDW predicted sulfate inventory is only about half of that predicted from the tank 241-T-104 and 241-T-107 data. This difference is probably attributable to TBP waste added to tank 241-T-107. TBP waste was also stored in tank 241-TX-109, so the higher sulphate inventory is a more reasonable estimate.

Nitrate. There is a substantial difference between the nitrate inventory predicted by the HDW model and that predicted from tanks 241-T-104 and 241-T-107 (see Table D3-1). This discrepancy is probably caused by the supernates stored on top of the 1C/CW sludges, which had high sodium nitrate concentrations. Another contributor to this difference is that the HDW model nitrate concentration for 1C/CW waste is only 41 percent of that predicted from the $BiPO_4$ flowsheet (see Kupfer et al. 1997, Appendix C, Table C-5).

Phosphate. The HDW model inventory for phosphate and the estimate based on tanks 241-T-104 and 241-T-107 are in fair agreement (within 20 percent). However, it should be noted that there is a larger difference between the 241-T-104 and 241-T-107 phosphate concentrations (241-T-107 is a factor 1.3 higher).

Uranium. The HDW model predicts less than 1 percent of the inventory predicted from tanks 241-T-104 and 241-T-107 data. The $BiPO_4$ flowsheet also would predict low U inventories in 1C/CW sludges (see Kupfer et al. 1997, Appendix C). There also is a substantial difference between the U concentration in tanks 241-T-104 and 241-T-107 (see Table D3-2), although even the lower 241-T-104 concentration results in a U inventory which is nine times the HDW model estimate. The source of this U is unknown, but the average of tanks 241-T-104 and 241-T-107 is the best estimate currently available.

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

Cesium-137 and Strontium-90. Significant inventories or ^{137}Cs are not expected in tank 241-TX-109 despite the HDW model estimate of 32,100 Ci ^{137}Cs. Cesium is more soluble than sodium, hence most Cs originally present in the 1C/CW waste would have been diluted by the relatively large volumes of supernates routed through the tank or removed with the final transfers of supernate and interstitial liquid.

The heat load for tank 241-TX-109 has been estimated at 2,240 BTU/h (Kummerer 1995). This corresponds to a maximum of 98,200 Ci ^{90}Sr (0.0228 BTU/h/Ci ^{90}Sr) or a maximum of 139,100 Ci ^{137}Cs (0.0161 BTU/h/Ci ^{137}Cs). Assuming that the 12,100 Ci ^{137}Cs (estimated from tanks 241-T-104 and 241-T-107 sample data) is correct, the ^{90}Sr concentration can be estimated to be 89,700 Ci. This is 18 percent less than the 110,000 Ci ^{90}Sr estimated from the data for tanks 241-T-104 and 241-T-107, but tends to confirm that significant ^{90}Sr is present in tank 241-TX-109.

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. Not surprisingly, the information derived from these different approaches is often inconsistent.

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-109 was performed including the following:

- T Plant $BiPO_4$ reactor fuel processing to confirm 1C/CW waste volumes transferred into the tank and to predict the quantity of resulting sludge.
- Waste transactions and operating data to confirm that salt cake was not retained in this tank during its service as the waste concentrate receiver/distributor for the 242-T Evaporator.
- Composition data from two waste tanks (241-T-104 [DiCenso et al 1994] and 241-T-107 [Valenzula and Jensen 1994]) which are expected to have a similar composition.
- An inventory estimate generated by the HDW model (Agnew et al. 1996)

Based on this evaluation, a best-basis inventory was developed. No applicable analytical data are available for tank 241-TX-109 because no samples of the sludge remaining in tank 241-TX-109 have been taken. The estimated inventory was, therefore, based on the composition of the 1C/CW wastes in tanks 241-T-104 and 241-T-107 since the sludges in these tanks have actually been analyzed. The HDW model inventories were used when no other data were available.

The waste in tank 241-TX-109 consists primarily of combined $BiPO_4$ first decontamination cycle and coating wastes generated by T Plant during processing of irradiated, Al-clad reactor fuel. The sludge has been contacted with large volumes of supernates, including salt solutions with sodium hydroxide concentrations of up to 3 molar. Leaching of some sludge components may have occurred and remaining sludge may differ from that predicted from other tanks containing 1C/CW wastes. The best-basis inventory for tank 241-TX-109 is presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

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

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

Table D4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-TX-109 (Effective January 31, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	33,100	E	
Bi	31,400	E	Concentration varies between 1C wastes.
Ca	2,250	E	
Cl	1,230	E	
TIC as CO_3	15,600	E	
Cr	1,280	E	
F	20,300	E	
Fe	38,900	E	Concentration varies between 1C waste tanks.
Hg	0.27	E	
K	329	E	
La	0	M	
Mn	280	E	
Na	198,000	E	Concentration varies significantly between 1C waste tanks.
Ni	283	E	Concentration varies significantly between 1C waste tanks.
NO_2	16,100	E	
NO_3	135,000	E	
OH_{TOTAL}	81,800	C	
P as PO_4	177,000	E	Concentration varies between 1C waste tanks.
Pb	1,320	E	
S as SO_4	13,900	E	
Si	12,800	E	
Sr	990	E	
TOC	1,700	E	

Table D4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-TX-109 (Effective January 31, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
U_{TOTAL}	27,800	E	Concentration varies significantly between 1C waste tanks.
Zr	163	E	

[1] S = Sample-based

M = Hanford Defined Waste model-based, Agnew et al. (1996)

E = Engineering assessment-based

C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-TX-109 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	1.2	E	
^{14}C	0.230	E	
^{59}Ni	0.0483	M	
^{60}Co	<2.0	E	
^{63}Ni	4.36	M	
^{79}Se	<0.36	E	
^{90}Sr	110,000	E	
^{90}Y	110,000	E	Referenced to ^{90}Sr
^{93m}Nb	0.144	M	
^{93}Zr	0.17	M	
^{99}Tc	1.18	E	
^{106}Ru	<77.5	E	
^{113m}Cd	0.416	M	
^{125}Sb	0.0361	M	
^{126}Sn	0.0539	M	
^{129}I	<94	E	
^{134}Cs	<2.4	E	
^{137m}Ba	11,400	E	Referenced to ^{137}Cs
^{137}Cs	12,100	E	
^{151}Sm	133	M	
^{152}Eu	0.0504	M	
^{154}Eu	7.7	E	
^{155}Eu	6.05	E	
^{226}Ra	9.76 E-06	M	
^{227}Ac	4.98 E-05	M	
^{228}Ra	1.95 E-10	M	
^{229}Th	3.79 E-08	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-TX-109 Decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{231}Pa	1.08 E-04	M	
^{232}Th	4.84 E-11	M	
^{232}U	4.12 E-04	M	
^{233}U	2.05 E-05	M	
^{234}U	22	M	
^{235}U	0.981	M	
^{236}U	0.188	M	
^{237}Np	279	E	
^{238}Pu	145	E	
^{238}U	22.4	M	
$^{239/240}$Pu	276	E	$^{239/240}$Pu based on tanks 241-T-104/241-T-107
^{241}Am	31.9	E	
^{241}Pu	17	M	
^{242}Cm	9.20 E-04	M	
^{242}Pu	7.70 E-05	M	
^{243}Am	2.29 E-06	M	
^{243}Cm	1.88 E-05	M	
^{244}Cm	5.41 E-05	M	

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

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D5.0 APPENDIX D REFERENCES

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