AUG 26 1997 22
Sta 37

ENGINEERING DATA TRANSMITTAL

1. EDT 622667

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) M. J. Kupfer, LMHC, H5-49	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: Tank 241-BY-109	6. Design Authority/ Design Agent/Cog. Engr.: M.J. Kupfer	7. Purchase Order No.: NA
8. Originator Remarks: For Approval/Release CW 8-26-97		9. Equip./Component No.: NA
		10. System/Bldg./Facility: NA
11. Receiver Remarks: 11A. Design Baseline Document? [] Yes [X] No		12. Major Assm. Dwg. No.: NA
		13. Permit/Permit Application No.: NA
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-SD-WM-ER-648	-	0	Preliminary Tank Characterization Report for Single-Shell Tank 241-BY-109: Best-Basis Inventory	NA	1,2		

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority				3		Central Files			A3-88
		Design Agent				3		DOE Reading Room			H2-53
1		Cog.Eng. M. J. Kupfer	M J Kupfer	8-25-97	H5-49	3		R. T. Winward			H5-49
1		Cog. Mgr. K. M. Hodgson	K M Hodgson	8-25-97	R2-11	3		TCSRC			R1-10
		QA				3		M. D. LeClair (4)			H0-50
		Safety				3		K. M. Hall			R2-12
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required)
M. J. Kupfer (signature) 8-25-97 Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	K.M. Hodgson (signature) 8-25-97 Design Authority/ Cognizant Manager / Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

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

R. T. Winward (Meier Associates) and M. J. Kupfer
Lockheed Martin Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 622667 UC: 712
Org Code: 74610 Charge Code: N4G3A
B&R Code: EW3120074 Total Pages: 27 cw 8-26-97

Key Words: TCR, best-basis inventory

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-BY-109 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

AUG 26 1997
DATE:
STA: 37
HANFORD RELEASE
ID: 22

Chris Willingham 8-26-97
Release Approval Date
Release Stamp

Approved for Public Release

HNF-SD-WM-ER-648
Revision 0

PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-BY-109: BEST-BASIS INVENTORY

August 1997

M. J. Kupfer
Lockheed Martin Hanford Corporation
Richland, Washington

R. T. Winward
Meier Associates
Richland, Washington

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

This page intentionally left blank.

PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-BY-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-BY-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 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.

REFERENCE

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W²S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

This page intentionally left blank.

APPENDIX D

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

This page intentionally left blank.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BY-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-BY-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 waste (chemical) information for tank 241-BY-109 included the following:

- Data from Weiss (1986), which was used for tributyl phosphate (TBP) waste information.

- The inventory estimate for this tank (Agnew et al. 1996) generated from the Hanford Defined Waste model (HDW), which is also referred to as the Los Alamos National Laboratory (LANL) model and the Historical Tank Content Estimate (HTCE). The HDW term will be used in this appendix.

- Tank Characterization Reports (TCRs) from other tanks in the BY Tank Farm with the same salt cake waste generated from in-tank solidification units 1 and 2 between 1965 and 1974 (BY SltCk) waste type.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The HDW model inventories, generated by HDW model, are shown in Tables D2-1 and D2-2. Table D2-1 lists nonradioactive components on a kilogram (kg) basis, and Table D2-2 lists the radioactive components on a curie basis. The tank volume used to generate the engineering assessment is a total waste volume of 1,601 kL (423 kgal) with a 314 kL (83 kgal) sludge layer, 1,287 kL (340 kgal) salt cake, and no supernatant (Hanlon 1996). The HDW inventories were calculated based on the same overall volume of 1,601 kL (423 kgal) with different sludge and salt cake volumes (136 kL [36 kgal] of sludge, and 1,465 kL [387 kgal] of salt cake). The mean solids density, including interstitial liquid, used to calculate the component inventories, is 1.71 g/mL (see Table D3-1), and the HDW model density for the total solid waste is estimated to be 1.63 g/mL. The chemical species, in this preliminary TCR, are reported without charge designation per the best-basis inventory convention.

Table D2-1. Hanford Defined Waste Model-Based Inventory Estimates for Nonradioactive Components in Tank 241-BY-109.

Analyte[a]	HDW inventory estimate[b] (kg)	Analyte[a]	HDW inventory estimate[b] (kg)
Al	84,800	NO_3	583,000
Bi	275	OH	258,000
Ca	4,770	oxalate	0.356
Cl	6,600	Pb	1,720
Cr	3,870	P as PO_4	14,700
F	1,660	Si	3,230
Fe	2,220	S as SO_4	28,000
Hg	10.6	Sr	0.461
K	2,160	TIC as CO_3	59,500
La	0.657	TOC	10,700
Mn	262	U_{TOTAL}	73,500
Na	434,000	Zr	39.6
NH_4	256	H_2O (Wt%)	38.0
Ni	1,170	density (kg/L)	1.63
NO_2	117,000		

HDW = Hanford Defined Waste
NR = Not reported
[a] No Sample-based inventory
[b] Agnew et al. (1996).

Table D2-2. Hanford Defined Waste Model-Based Inventory Estimates for Radioactive Components in Tank 241-BY-109.

Analyte[a]	HDW inventory estimate[b] (Ci)	Analyte[a]	HDW inventory estimate[b] (Ci)
^{90}Sr	191,000	$^{239/240}$Pu	255
^{137}Cs	316,000		

NR = Not reported
HDW = Hanford Defined Waste
[a] No Sample-based Inventory
[b] Agnew et al. (1996), radionuclides decayed to January 1, 1994.

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would influence the HDW model component inventories, and to identify an engineering assessment-based inventory, which can then be compared to the HDW model inventory values.

Tank process history information from Anderson (1990) and Agnew et al. (1995) was used to develop the following information. Tank 241-BY-109 began operation on January 8, 1953, by receiving TBP supernatant wastes from tank 241-B-103. Some supernatant metal waste (MW) is shown in the tank in 1953 through 1955 although no source of the waste is listed. In 1955 the MW volume decreased and a notation of sluicing to be done was made. There is no record of sluicing, but no solids are listed in storage, until after TBP waste had again been sent to the tank in 1955 and 1956. TBP waste is listed through 1962 with 174 kL (46 kgal) in solids storage. In 1962, cladding waste (CW) from the C Tank Farm was sent to tank 241-BY-109. The tank received CW for the next few years with 329 kL (87 kgal) of total solids being recorded in 1969. From 1969 through 1977, evaporator bottoms (EB) waste was transferred into and out of the tank. The tank was deactivated on August 9, 1979, and a solids level adjustment was made. Partial salt well pumping occurred starting in 1982. Another solids level adjustment was made in 1984, and the tank was partially interim isolated in June 1985. The tank was jet pumped in 1991, and a solids level adjustment was made. The draw-down from pumping is noticeable in the solids and liquid observation well waste levels.

D3.1 EXPECTED TYPE OF WASTE BASED ON THIS ASSESSMENT

Agnew et al. (1996): MW, BY SltCk
Hill et al. (1995): TBP, EB-ITS, CW, MW

MW	=	Metal waste
CW	=	Cladding waste from the Plutonium Uranium Extraction Facility (PUREX)
BY SltCk	=	a mixture of supernatants from other waste types that have been blended to create a new waste type through concentration as a salt cake
TBP	=	Tributyl phosphate or Uranium Recovery Waste (UR)
EB-ITS	=	Evaporator Bottoms (EB)-In Tank Solidification (ITS) (Equivalent in this tank to BY SltCk)

Agnew et al. (1996) provides estimated volumes for these waste types as does Hanlon (1996), and these are addressed in Section D2.0. Agnew et al. projects a 136 kL (36 kgal) bottom layer of MW. Hill et al. (1995) also predicts a minor amount of MW but does not quantitate it. The Hanlon estimates includes a sludge layer of 341 kL (83 kgal). Neither Anderson (1990) nor Agnew et al. (1995) show MW in the solids of this tank in the 1950's. This tank farm was sluiced for MW in the mid 1950's, but no mention of this tank was made in Rodenhizer (1987). Rodenhizer shows the sluicing of MW from several BY Tank Farm tanks and from other tank farms. The MW was valuable and 136 kL (36 kgal) would not have been passed by. Grigsby et al. (1992) does not discuss this tank. Anderson shows 174 kL (46 kgal) of solids from TBP waste in 1961, then up to a total of 329 kL (87 kgal) of solids with the addition of cladding waste from PUREX (PUREX cladding waste [CWP]) by 1969. The other solids came from EB from that time forward. The engineering assessment used the Hanlon numbers because they appear more reasonable and assigned the TBP to 174 kL (46 kgal) and CWP to 140 kL (37 kgal). The other 1,287 kL (340 kgal) of waste was assigned to BY SltCk.

D3.2 INVENTORY EVALUATION

The following evaluation provides an engineering assessment of tank 241-BY-109 contents. For this evaluation, the following assumptions and observations are made:

- Tank waste mass is calculated using the measured density of other similar tanks and the tank volume listed in Hanlon (1996).

- Only the BY SltCk waste stream and the TBP and CWP waste streams contributed to solids formation.

- Analyte concentrations from similar tanks with CWP and TBP wastes can be used to predict the inventories for these sludges. Analyte concentrations from similar tanks with BY SltCk can be used to predict the inventory for the salt cake.

- No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion purposes are factored into this evaluation.

D3.3 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

The general engineering approach is outlined in Table D3-1.

Table D3-1. Engineering Evaluation Approaches Used On Tank 241-BY-109.

Type of waste	How calculated	Check method
Supernatant	No supernatant predicted	NA
Salt cake Volume = 1,287 kL (340 kgal) Density = 1.71 g/mL	Used sample-based average concentrations for other BY Tank Farm tanks, multiplied by salt cake total mass in tank 241-BY-109. See Table D3-3. The density used was the average density of the tanks for which the concentrations were derived (1.71).	Since there are no sample-based data for this tank and no direct process flowsheet data, no check method was used for this tank.
Sludge TBP, CWP TBP Volume = 174 kL (46 kgal) CWP Volume = 140 kL (37 kgal) Density = not used in the calculations as the values are a direct ratio of kg/kgal from one tank to the other for TBP and total kgal/total kgal for CWP.	Used sample-based average concentrations for other tanks to predict the sludge in tank 241-BY-109. For the TBP sludge, data from Weiss (1986) for tanks 241-TY-105 and 241-TY-106 was used to calculate the average inventory for each analyte on a kg/kgal basis. The TBP portion of the sludge was determined by multiplying this information by 46 since it has 174 kL (46 kgal) of TBP in the tank. The CWP waste was calculated based on the total inventory of CWP in tank 241-C-105. The ratio of the 140 kL (37 kgal) of CWP in tank 241-BY-109 to the total kgal of sludge in 241-C-105 (511 kL [135 kgal]) (0.2741) was multiplied by the total inventory in tank 241-C-105 to determine the CWP inventory in tank 241-BY-109.	Since there are no sample-based data for this tank no check method was used for this tank. While there is process flow information on TBP and CWP, without direct sampling information for that portion of the tank, no meaningful comparison can be made.

CWP = Plutonium-uranium extraction (PUREX) cladding waste
TBP = Tributyl phosphate.

D3.3.1 Basis for Salt Cake Calculations Used in this Engineering Evaluation

For this evaluation, BY SltCk data from other BY Tank Farm tanks were used. Shown in Table D3-2 are the average concentrations for various analytes from seven BY Tank Farm tanks. Each of these tanks have been recently sampled. The "SC" column heading shows these data are for the average concentration of BY SltCk in the tank. The "Total" column heading means that both the sludge and salt cake were measured and the salt cake data could not be separated out because of mixed layers. The "SL" column heading stands for the ferrocyanide sludge produced by in-plant scavenging of waste from uranium recovery (PFeCN) average concentration for the tank. No PFeCN is predicted in this tank. Table D3-3 shows how the comparison values for tank 241-BY-109 salt cake were calculated.

Tank 241-BY-102 was not included in the average because it contained one of the ITS heaters and is not representative of tanks that received concentrated ITS wastes. Tanks 241-BY-104, 241-BY-107, and 241-BY-108 were not included because it was not possible to separate the salt cake concentrations from the total waste concentrations.

Table D3-2. BY Tank Farm Tank Average Analyte Concentrations. (3 Sheets)

Element	BY-102[a] (SC) (μg/g)	BY-104[b] (Total) (μg/g)	BY-105[c] (SC) (μg/g)	BY-106[d] (SC) (μg/g)	BY-107[e] (Total) (μg/g)	BY-110[f] (SC) (μg/g)	BY-108[g] (Total) (μg/g)	BY-106 (SL)[h] (μg/g)	BY-110 (SL) (μg/g)
Al	14,600	30,100	18,400	20,400	38,000	14,100	39,800	30,800	28,300
As	<2,030	<62.4	NR	NR	<1,970	NR	<116	NR	NR
Sb	<1,220	<37.5	NR	NR	<1,180	NR	<186	NR	NR
Ba	<1,010	<69.1	NR	NR	<987	NR	124	NR	NR
Be	<101	<3.16	NR	NR	<98.7	NR	<6.73	NR	NR
Bi	<2,030	<285	55.6	NR	<1,970	NR	<495	NR	NR
B	<101	<45	NR	113	<987	92.3	250	NR	39.8
Br	<854	NR	NR	NR	NR	NR	NR	NR	NR
Cd	<101	16.1	6.54	8.25	<98.7	21.1	<16.3	NR	7.4
Ca	<2,110	1,240	216	308	<3,380	400	3,370	8,150	14,200
Ce	<2,030	<62.4	NR	NR	<1,970	NR	<123	NR	NR
Cl	1,220	2,320	897	2,060	2,420	2,250	1,540	NR	3,570
Cr	1,870	4,580	321	855	3,650	2,900	255	1,120	2,220
Co	<406	<15.2	8.75	NR	<395	NR	34.2	NR	NR
Cu	<210	<8.25	7.57	NR	<202	NR	<45.9	NR	NR
F	18,000	4,630	4,100	5,130	4,130	5,420	6,610	NR	4,220
Fe	1,860	4,090	476	215	5,300	924	7,190	33,000	20,000
La	<1,010	<36.8	NR	NR	<987	NR	<67.4	NR	NR
Pb	<2,030	190	50.3	64.5	<1,980	130	439	NR	1,880
Li	<203	NR	NR	NR	<197	NR	NR	NR	NR

Table D3-2. BY Tank Farm Tank Average Analyte Concentrations. (3 Sheets)

Element	BY-102[a] (SC) (µg/g)	BY-104[b] (Total) (µg/g)	BY-105[c] (SC) (µg/g)	BY-106[d] (SC) (µg/g)	BY-107[e] (Total) (µg/g)	BY-110[f] (SC) (µg/g)	BY-108[g] (Total) (µg/g)	BY-106 (SL)[h] (µg/g)	BY-110 (SL) (µg/g)
Mg	<2,030	<165	NR	NR	<1,970	NR	447	NR	NR
Mn	372	77.1	54.8	9.57	<259	52.8	209	NR	228
Mo	<1,010	36.5	NR	NR	<987	NR	<54.1	NR	NR
Nd	<2,030	<71.2	NR	NR	<1,970	NR	<119	NR	NR
Ni	4,820	1,160	75.9	47.9	4,230	193	2,510	6,960	6,670
NO_3	95,000	261,000	491,000	329,000	228,000	184,000	201,000	NR	111,000
NO_2	13,900	34,900	9,410	32,100	39,300	30,600	27,300	NR	43,200
Oxalate	19,300	13,100	11,300	8,990	13,600	13,600	7,500	NR	5,870
PO_4	27,000	11,200	4,890	5,270	13,100	14,200	26,000	NR	32,100
P	9,500	3,560	1,010	1,032	8,720	4,650	10,100	20,500	10,500
K	NR	3,390	712	2,470	3,770	1,930	2,650	NR	2,930
Sm	<2,030	<62.4	NR	NR	<1,970	NR	<131	NR	NR
Se	<2,030	<62.8	NR	NR	<1,970	NR	<135	NR	NR
Si	4,350	434	180	184	1,320	451	1,530	NR	1,190
Ag	<203	16.9	17.4	14.5	<197	17.5	<49.9	NR	10.2
Na	267,000	220,000	198,000	203,000	254,000	237,000	163,000	130,000	161,000
Sr	<203	2,330	88.3	44.4	1,520	58.1	3,190	NR	6,840
SO_4	57,700	17,300	10,600	11,300	17,600	18,400	22,900	NR	18,400
S	17,300	4,420	3,140	3,280	5,540	5,950	6,960	NR	5,360
Tl	<4060	<125	NR	NR	<3,950	NR	<479	NR	NR
Ti	<203	<12.1	NR	NR	<197	NR	74.9	NR	NR
TIC	27,800	14,800	NR	7,359	9,150	31,800	5,340	5,580	6,440
TOC	4,360	6,810	3,250	2,500	4,610	5,920	4,480	20,400	11,100
U	<10,100	3,270	261	164.2	4,820	697	9,470	NR	20,900
V	<1,010	<31.2	NR	NR	<987	NR	<47.3	NR	NR
Zn	396	41	36.8	18.4	<353	32.8	83.5	194	91.6
Zr	<203	13.2	5.23	6.28	<197	14.4	<34.7	589	19.7
Density (g/mL)	1.5	1.75	NR	1.71	1.76	NR	NR	NR	NR
wt% H_2O	NR	25.6	16.1	25.5	37.7	23.2	27.2	37.3	30.5
Radionuclides (µCi/g)[i]									
^{60}Co	NR	<0.0149	NR	NR	<0.0107	NR	<0.00911	NR	NR
^{90}Sr	NR	391	NR	<4.26	17.9	22.5	143	763	348
^{137}Cs	NR	97	NR	106	128	60	258	508	140

Table D3-2. BY Tank Farm Tank Average Analyte Concentrations. (3 Sheets)

Element	BY-102[a] (SC) (μg/g)	BY-104[b] (Total) (μg/g)	BY-105[c] (SC) (μg/g)	BY-106[d] (SC) (μg/g)	BY-107[e] (Total) (μg/g)	BY-110[f] (SC) (μg/g)	BY-108[g] (Total) (μg/g)	BY-106 (SL)[h] (μg/g)	BY-110 (SL) (μg/g)
Radionuclides (μCi/g)[i]									
$^{239/240}Pu$	NR	NR	NR	NR	NR	0.0192	0.0459	0.0997	0.061

SC = Salt cake
SL = Sludge
Total = Total inventory of all solids (salt cake and sludge) and the interstitial liquids for the tank
[a] Sasaki et al. (1997)
[b] Benar et al. (1996)
[c] Simpson et al. (1996a)
[d] Bell et al. (1996)
[e] McCain et al. (1997)
[f] Simpson et al. (1996b)
[g] Baldwin et al. (1996)
[h] Tank 241-BY-106 sludge readings are suspect and should be used with caution (only one of three cores retrieved sludge)
[i] Radionuclides are reported as of the sample analysis date.

Calculations for Table D3-3 are: (average concentration of analyte in μg/g) x (waste in kgal) x 3,785 L/kgal x 1,000 mL/L x (density in g/mL) x kg/(1 E+09) μg = total kg for this waste type in the tank.

Table D3-3. Tank 241-BY-109 Salt Cake Calculations. (3 Sheets)

Element	241-BY-105[a] (SC) (μg/g)	241-BY-106[b] (SC) (μg/g)	241-BY-110[c] (SC) (μg/g)	Average conc. (μg/g)	HDW average conc. (μg/g)	SC volume of 1,287 kL (340 kgal) (kg)
Al	18,400	20,400	14,100	17,633	35,783	38,978
Bi	55.6	NR	NR	55.6	116.2	123
B	NR	113	92.3	103	NR	227
Cd	6.54	8.25	21.1	12	NR	26.4
Ca	216	308	400	308	1,817.9	681
Cl	897	2,060	2,250	1,736	2,784.3	3,837
Cr	321	855	2,900	1,359	1,628.7	3,003
Co	8.75	NR	NR	8.75	NR	19.3

Table D3-3. Tank 241-BY-109 Salt Cake Calculations. (3 Sheets)

Element	241-BY-105[a] (SC) (µg/g)	241-BY-106[b] (SC) (µg/g)	241-BY-110[c] (SC) (µg/g)	Average conc. (µg/g)	HDW average conc. (µg/g)	SC volume of 1,287 kL (340 kgal) (kg)
Cu	7.57	NR	NR	7.57	NR	16.7
F	4,100	5,130	5,420	4,883	699.5	10,794
Fe	476	215	924	538	554.4	1,190
Pb	50.3	64.5	130	82	726.1	180
Mn	54.8	9.57	52.8	39.1	110.4	86
Ni	75.9	47.9	193	106	489.7	233
NO_3	491,000	329,000	184,000	334,667	245,767	739,766
NO_2	9,410	32,100	30,600	24,037	49,532	53,132
Oxalate	11,300	8,990	13,600	11,297	0.15	24,971
PO_4	4,890	5,270	14,200	8,120	4,023.3	17,949
P	1,010	1,032	4,650	2,231	NR	4,931
K	712	2,470	1,930	1,704	910.8	3,767
Si	180	184	451	272	1,359.2	601
Ag	17.4	14.5	17.5	16.5	NR	36.4
Na	198,000	203,000	237,000	212,667	176,264	470,090
Sr	88.3	44.4	58.1	64	0.19	141
SO_4	10,600	11,300	18,400	13,433	11,357	29,694
S	3,140	3,280	5,950	4,123	NR	9,114
TIC	NR	7,359	31,800	19,580	3,720.6	43,280
TOC	3,250	2,500	5,920	3,890	NR	8,599
U	261	164.2	697	374	3,793	827
Zn	36.8	18.4	32.8	29.3	NR	65
Zr	5.23	6.28	14.4	8.64	16.7	19.1
Density (g/mL)	NR	1.71	NR	1.71	1.62	NR
wt% H_2O	16.1	25.5	23.2	21.6	37.4	NR
Radio-nuclides[d]	µCi/g	µCi/g	µCi/g	µCi/g	µCi/g	kCi
^{90}Sr	NR	<4.26	22.5	22.5	80.3	49.7
^{137}Cs	NR	106	60	83	133.2	184

Table D3-3. Tank 241-BY-109 Salt Cake Calculations. (3 Sheets)

Element	241-BY-105[a] (SC) (μg/g)	241-BY-106[b] (SC) (μg/g)	241-BY-110[c] (SC) (μg/g)	Average conc. (μg/g)	HDW average conc. (μg/g)	SC volume of 1,287 kL (340 kgal) (kg)
Radio-nuclides[d]	μCi/g	μCi/g	μCi/g	μCi/g	μCi/g	kCi
$^{239/240}Pu$	NR	NR	0.0192	0.0192	0.107	0.0424
Total Alpha	0.0168	<0.00945	0.0434	0.0301	NR	0.067
Total Beta	NR	<80.2	NR	<80.2	NR	<176.5

HDW = Hanford Defined Waste (displayed for comparison only)
NR = Not reported
SC = Salt Cake
[a] Simpson et al. (1996a)
[b] Bell et al. (1996)
[c] Simpson et al. (1996b)
[d] Radionuclides are reported as of the sample analysis date.

D3.3.2 Basis for Sludge Calculations used In This Engineering Evaluation.

The engineering assessment used the sample-based average concentrations for other tanks, to predict the sludge total mass in tank 241-BY-109. For the TBP sludge, data from Weiss (1986) for tanks 241-TY-105 and 241-TY-106 was used to calculate the average inventory for each analyte on a kg/kgal basis. The TBP portion of the sludge was determined by multiplying this information by 46 since there was assumed to be 172 kL (46 kgal) of TBP in the tank. The CWP waste was calculated based on the total best-basis inventory of CWP in tank 241-C-105 (Lambert 1997). The ratio of the 140 kL (37 kgal) of CWP in tank 241-BY-109 to the total kgal of sludge in tank 241-C-105 (511 kL [135 kgal]) (0.2741) was multiplied by the total inventory in tank 241-C-105 to determine the CWP inventory in tank 241-BY-109. The results are shown in Table D3-4, which also shows the total sludge inventory and the tank 241-BY-109 total inventory (sludge and salt cake).

Table D3-4. Tank 241-BY-109 Sludge Calculations and Total Engineering Assessment Inventory.

Element	Average TBP[a] kg/kgal	241-BY-109 TBP x 46 kgal (kg)	CWP[b] kg/135 kgal	241-BY-109 CWP x 0.2741[c]	241-BY-109 total sludge (kg) TBP + CWP	241-BY-109 total salt cake and sludge inventory (kg) total tank
Al	13.2	607	31,500	8,630	9,240	48,220
Bi	2.8	129	340	93.2	222	345
Ca	NR	NR	3,970	1,090	1,090	1,770
Cl	7.53	346	287	79	425	4,262
Cr	0.90	41	680	186	227	3,230
F	<4.29	<197	<1.02	<0.3	<198	10,990
Fe	159.4	7,332	5,400	1,480	8,810	10,000
Pb	1.83	84	480	132	216	396
Mn	1.04	48	1,260	345	393	479
Ni	0.42	19	1,090	299	318	551
NO_3	1,039	47,794	11,300	3,100	50,890	790,660
NO_2	34.8	1,601	16,800	4,605	6,206	59,340
PO4	533.5	24,542	5,300	1,450	25,990	43,940
K	NR	NR	840	230	230	4,000
Si	2.13	98	20,300	5,560	5,660	6,260
Na	665.7	30,622	56,500	15,490	46,110	516,200
Sr	NR	NR	90	24.7	25	166
SO_4	73.5	3,381	1,230	337	3,718	33,410
TIC as CO_3	6.18	284	5,430	1,488	1,772	218,170
TOC	8.49	391	1,010	277	670	9,270
U	41.7	1,918	5,180	1,420	3,340	4,170
Zr	2.15	99	430	118	217	236
Radio-nuclides[d]	kCi/Kgal	kCi	kCi	kCi	kCi	kCi
^{90}Sr	2.05	94.3	365	100	194	244
^{137}Cs	0.0807	3.7	125	34.3	38	222
$^{239/240}Pu$	0.00019	0.0087	0.459	0.126	0.135	0.177

CWP = Plutonium-uranium extraction cladding waste
NR = Not reported
TBP = Tributyl phosphate
[a] Average kg/kgal TBP from tanks 241-TY-105 and 241-TY-106 (Si from tank 241-TY-105 only) (Weiss 1986)
[b] CWP inventory from tank 241-C-105 (Lambert 1997)
[c] CWP Inventory in tank 241-BY-109 (37 kgal/135 kgal = 0.2741)
[d] Radionuclides reported as of the sample analysis date.

D3.3.3 Inventory Comparisons

The engineering assessment-based inventory values and the HDW model values are compared in Table D3-5. No values are shown for sample-based values as none were determined for this tank. Selected comparisons follow:

Table D3-5. Comparison of Selected Component Inventory Estimates for Tank 241-BY-109 Waste. (2 Sheets)

Component	Engineering assessment-based estimate (kg)	HDW model-based estimate (kg)
Al	48,200	84,800
Bi	345	275
Cl	4,260	6,600
Cr	3,230	3,870
F	11,000	1,660
Fe	10,000	2,220
K	4,000	2,160
La	NR	0.657
Mn	479	262
Na	516,200	434,000
Ni	551	1,170
NO_3	790,660	583,000
NO_2	54,730	117,000
Pb	396	1,720
PO_4	43,940	14,700
Si	6,260	3,230
SO_4	36,000	28,000
Sr	166	0.461
TIC as CO_3	216,680	59,500
TOC	9,270	10,700
U	4,170	73,500

Table D3-5. Comparison of Selected Component Inventory Estimates for Tank 241-BY-109 Waste. (2 Sheets)

Component	Engineering assessment-based estimate (kg)	HDW model-based estimate (kg)
Zr	236	39.6

HDW = Hanford Defined Waste
NR = Not reported.

Several problems exist in trying to compare individual analyte inventories between the engineering assessment and the HDW model. At this time, there is no way to accurately predict the salt cake analytical values through an engineering assessment, other than by using analytical data from other tanks containing BY SltCk. The majority of this tank's inventory is from BY SltCk salt cake with contributions from TBP sludge and CWP sludge. Best-basis evaluations dealing with different sludge waste types have shown that the solubilities of some analytes determined from flowsheet and sample data do not agree with the HDW model treatment of solubilities. The best-basis inventory analyses of tanks with 1C and 2C waste types discuss these disagreements in detail. Solubility assumptions affect salt cake predictions because flowsheet analytes not found in the sludge are placed by the HDW model in the salt cakes and vise versa.

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

Key waste management 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/disposal. Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with these activities.

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, 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 evaluation of available chemical information for tank 241-BY-109 was performed, including the following:

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

- Comparison of BY SltCk by evaluation of similar BY tanks.

Based on this evaluation, a best-basis inventory was developed for tank 241-BY-109 (for which sampling information was not available). The engineering assessment-based inventory was chosen as the best-basis for those analytes reported in sample analyses from similar tanks, for the following reasons:

- The salt cake analytical concentrations from tanks that have been sampled compared well

- No methodology is available to fully predict BY SltCk from process flowsheet or historical records

- Waste transfer records are not complete and not always accurate

- The best-basis assessments performed for tanks 241-TY-105 (Weiss 1986), 241-TY-106 (Weiss 1986), and 241-C-105 (Lambert 1997) suggest that the sample-based data used to calculate TBP and CWP are reasonable.

- For those few analytes where no values could be calculated, the HDW model values were used with notation that they were of lower reliability.

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 retained. No such adjustments were necessary in this tank. 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 Hanford Defined Waste 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.

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-BY-109 (Effective January 31, 1997).

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	48,200	E	
Bi	345	E	
Ca	1,770	E	
Cl	4,260	E	
TIC as CO_3	218,000	E	
Cr	3,230	E	
F	11,000	E	
Fe	10,000	E	
Hg	10.6	M	
K	4,000	E	
La	0.657	M	
Mn	479	E	
Na	516,000	E	
Ni	551	E	
NO_2	59,300	E	
NO_3	790,000	E	
OH_{TOTAL}	70,100	C	
Pb	396	E	
P as PO_4	43,900	E	
Si	6,260	E	
S as SO_4	33,400	E	
Sr	166	E	
TOC	9,270	E	
U_{TOTAL}	4,170	E	
Zr	236	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_3, NO_2, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-BY-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	191	M	
^{14}C	50.1	M	
^{59}Ni	5.32	M	
^{60}Co	46.6	M	
^{63}Ni	528	M	
^{79}Se	4.19	M	
^{90}Sr	245,000	E	
^{90}Y	245,000	E	Calculated from Sr
^{93}Zr	20.2	M	
^{93}Nb	14.6	M	
^{99}Tc	278	M	
^{106}Ru	0.00930	M	
^{113}Cd	107	M	
^{125}Sb	209	M	
^{126}Sn	6.26	M	
^{129}I	0.537	M	
^{134}Cs	2.27	M	
^{137}Cs	223,000	E	
^{137m}Ba	211,000	E	Calculated from Cs
^{151}Sm	14,500	M	
^{152}Eu	6.56	M	
^{154}Eu	787	M	
^{155}Eu	398	M	
^{226}Ra	2.19 E-04	M	
^{227}Ac	0.00289	M	
^{228}Ra	2.49	M	
^{229}Th	0.0575	M	
^{231}Pa	0.0147	M	
^{232}Th	0.0920	M	
^{232}U	13.9	M	
^{233}U	53.2	M	

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

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{234}U	22.5	M	
^{235}U	0.982	M	
^{236}U	0.245	M	
^{237}Np	0.932	M	
^{238}Pu	3.71	M	
^{238}U	26.8	M	
^{239}Pu	177	E	
^{240}Pu	22.8	M	
^{241}Am	65.2	M	
^{241}Pu	267	M	
^{242}Cm	8.73 E-04	M	
^{242}Pu	0.00129	M	
^{243}Am	0.00226	M	
^{243}Cm	1.77 E-05	M	
^{244}Cm	2.99 E-04	M	

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

D5.0 APPENDIX D REFERENCES

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1995, *Waste Status, and Transaction Record Summary (WSTRS Rev. 2)*, WHC-SD-WM-TI-615, -614, -669, -689, Rev. 2, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical, and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical, and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Rev. 4, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Baldwin, J. H., R. J. Cash, W. I. Winters, L. C. Amato, and T. Tran, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-108*, WHC-SD-WM-ER-533, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

Bell, K. E., J. Franklin, J. Stroup, and J. L. Huckaby, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-106*, WHC-SD-WM-ER-616, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Benar, C. J., J. G. Field, and L. C. Amato, 1996, *Tank Characterization Report for Single-Shell Tank 241-BY-104*, WHC-SD-WM-ER-608, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Grigsby, J. M., D. B. Bechtold, G. L. Borsheim, M. D. Crippen, D. R. Dickinson, G. L. Fox, D. W. Jeppson, M. Kummerer, J. M. McLaren, J. D. McCormack, A. Padilla, B. C. Simpson, and D. D. Stepnewski, 1992, *Ferrocyanide Waste Tank Hazard Assessment--Interim Report,* WHC-SD-WM-RPT-032, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending June 30, 1996*, WHC-EP-0182-99, Westinghouse Hanford Company, Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

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

Lambert, S. L., 1997, *Tank Characterization Report for Tank 241-C-105*, WHC-SD-WM-ER-489, Rev. 0C, SGN Eurisys Services Corporation, Richland, Washington.

McCain, D. J., M. J. Kupfer, R. D. Cromar, J. L. Stroup, and L. Fergestrom, 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-107*, HNF-SD-WM-ER-637, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History,* WHC-SD-WM-TI-302, Westinghouse Hanford Company, Richland, Washington.

Sasaki, L. M., M. J. Kupfer, L. C. Amato, B. J. Morris, J. L. Stroup, R. D. Cromar, and R. T. Winward, 1997, *Tank Characterization Report for Single-Shell Tank 241-BY-102*, HNF-SD-WM-ER-630, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Simpson, B. C., J. G. Field, and L. M. Sasaki, 1996a, *Tank Characterization Report for Single-Shell Tank 241-BY-105*, WHC-SD-WM-ER-598, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Simpson, B. C., R. D. Cromar, and R. D. Schreiber, 1996b, *Tank 241-BY-110 Characterization Report*, WHC-SD-WM-ER-591, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Weiss, R. L., 1986, *TY Tank Farm Waste Characterization Data,* RHO-WM-TI-1P, Rockwell Hanford Operations, Richland, Washington.