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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 164787

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [X] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	M. J. Kupfer, LMHC, H5-49	[] Yes [X] No	8/25/97
	6. Project Title/No./Work Order No. Tank 241-SX-108	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-582, Rev. 0	10. Related ECN No(s). NA	11. Related PO No. NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

Add Appendix B, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-SX-108.

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14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[X]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

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-SX-108 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

15. Distribution (include name, MSIN, and no. of copies)

Central Files	A3-88	K. M. Hall	R2-12
DOE Reading Room	H2-53	K. M. Hodgson	R2-11
TCSRC	R1-10	J. G. Field	R2-12
File	H5-49		
W. W. Schulz	H5-49		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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DATE: AUG 28 1997
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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 164787

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
NA		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. M. J. Kupfer	M J Kupfer	8-27-97	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	8-27-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J. G. Field	B.C. Simpson for J.G. Field via Telecom	8-27-97	Other		
			DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

Tank Characterization Report for Single-Shell Tank 241-SX-108

W. W. Schulz (W^2S Corporation) and M. J. Kupfer
Lockheed Martin Hanford Corporation, Richland, WA 99352
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-SX-108 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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AUG 28 1997

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Release Approval Date

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-582	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-SX-108

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 07/11/96 on EDT 616016.	R. F. Eggers	J. G. Kristofzski
0A RS	Incorporate per ECN-164787.	M. J. Kupfer 8-27-97	K. M. Hodgson 8-27-97

APPENDIX B

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

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APPENDIX B

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

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-SX-108 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

The following sections establish a best-basis inventory estimate for chemical and radionuclide components in tank 241-SX-108. A complete list of data sources used in inventory evaluations is provided at the end of this section.

Tank 241-SX-108 is a known leaker. However, the quantity of material lost to the soil column is currently unknown. No attempt has been made in this assessment to correct for materials lost to the soil column.

B1.0 CHEMICAL INFORMATION SOURCES

This Tank Characterization Report (TCR) reports characterization results from the most recent sampling event for this tank. Two auger samples were obtained from only the top 48 cm (19 in.) of solid waste in the bottom of the tank. The total height of the solid waste in tank 241-SX-108 is estimated to be 93.7 cm (36.9 in.).

The auger samples cannot be considered completely representative of all the solid waste in tank 241-SX-108. Section 4.0 and Appendix A provide concentration data in units of μg/g for several analytes in the sampled waste. The density of the sampled solids was not determined. The concentration data have not been previously used to estimate a total tank inventory because only auger samples and not full core depth samples were taken.

Homogenized portions of both auger samples from tank 241-SX-108 were sent to the Pacific Northwest National Laboratory (PNNL) for solids water washing and sodium hydroxide leaching studies. As part of their experimental work the PNNL scientists also analyzed the tank 241-SX-108 samples for various radioactive and nonradioactive components. The PNNL chemists also did not measure the density of the solid waste and reported analyte concentrations either as μg/g or μCi/g.

The Hanford Defined Waste (HDW) model document (Agnew et al. 1997) provides tank content estimates, derived from the Los Alamos National Laboratory (LANL) model, in terms of component concentrations and inventories.

B2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Hanlon (1996) estimates that tank 241-SX-108 contains 329 kL (87 kgal) of sludge and the sludge includes 19 kL (5 kgal) of drainable interstitial liquid. According to the HDW model (Agnew et al. 1997), the solid waste in tank 241-SX-108 contains 28.0 wt% water; the HDW model also lists a value of 1.75 g/mL for the density of tank 241-SX-108 sludge. However, results reported in the Section 4.0 and Appendix A show that the waste in the auger samples was exceedingly dry, only 2.0 wt% water. This latter result surely casts doubt on the assumption of Hanlon that 19 kL (5 kgal) of drainable interstitial liquid are still present in tank 241-SX-108. The assumption in the HDW model that the waste sludge in this tank contains 28.0 wt% water also appears to be in serious error.

Listed in Table B2-1 are the mean analytical concentrations for several nonradioactive analytes as reported in Section 4.0 and Appendix A and by Lumetta et al. (1996). For many very minor components, the concentration data reported in Section 4.0 and Appendix A differ widely from those determined by the PNNL scientists. However, for some important and major analytes, (e.g., chromium, iron, manganese, etc.) the two sets of analytical concentrations are in reasonably good agreement. Also listed in Table B2-1 are the analyte concentrations values selected for further use in this report. For the most part these selected values are simply the average of the analyte concentrations reported in this TCR and by Lumetta et al. (1996). Where only one concentration for an analyte is reported (e.g., Cl) that value is the selected value. In three cases, Bi, Nd, and PO_4, a less-than concentration is the selected value.

Listed in Table B2-2 are analytical concentration data obtained by Lumetta et al. (1996) for various radioactive constituents of the tank 241-SX-108 sludge.

Table B2-3 lists the predictions of the HDW model (Rev. 4) (Agnew et al. 1997) for the inventories of various analytes in tank 241-SX-108 sludge waste. Also listed in Table B2-3 are calculated inventories of the same analytes based upon sampling data reported in Tables B2-1 and B2-2. The sample-based inventory estimates in Table B2-3 are calculated on the assumption that the bulk density of the sludge solids is 1.75 g/mL, the value reported by Agnew et al. (1997). For several analytes (e.g., Al, Ca, F, and U) there is good agreement between inventory estimates from both sampling data and HDW model (Rev. 4) predictions. Such agreement may be fortuitous, e.g., auger versus full depth core sampling, assumed versus measured density, etc.; conversely, the auger samples may indeed be representative of the bulk of the waste in tank 241-SX-108 and the density of this waste may be close to 1.75 g/mL.

It is significant that the calculated sampling tank inventories of sodium and nitrate are an order of magnitude or more higher than those predicted by the HDW model. The very high sodium and nitrate concentrations correlate very well with the low water content of the auger samples and indicate that all or almost all of the interstitial liquor and, possibly, residual supernatant left when the liquid portion of the contents of tank 241-SX-108 was pumped, crystallized on the top of the sludge.

(The chemical species are reported without charge designation per the best-basis inventory convention.)

Table B2-1. Tank 241-SX-108 Analytical Data from Auger Sample. (2 Sheets)

Samples--Nonradioactive Components			
	Concentration (μg/g)		Selected Value (μg/g)
Analyte	Analysis 1[a]	Analysis 2[b]	
Ag	7.52	188	97.8
Al	38,100	90,200	64,150
As	<28.0	350	350
B	30.3	292	161
Ba	139	140	140
Be	<2.80	NR	<2.80
Bi	66.4	<420	<420
Ca	1,750	8,720	5,240
Cd	17.3	42.0	29.7
Ce	198	2,940	1,570
Cl	2,160	NR	2,160
Co	18.7	NR	18.7
Cr	9,070	7,940	8,510
Cu	46.8	127	86.9
F	433	NR	433
Fe	17,900	16,400	17,200
K	632	8,330	Note[c]
La	121	196	159
Mg	269	504	387
Mn	5,990	5,250	5,620
Na	1.85 E+05	2.28 E+05	2.07 E+05
Nd	352	<590	<590

Table B2-1. Tank 241-SX-108 Analytical Data from Auger Sample. (2 Sheets)

Samples--Nonradioactive Components			
	Concentration (μg/g)		Selected Value (μg/g)
Analyte	Analysis 1[a]	Analysis 2[b]	
Ni	1,190	1,890	1,540
NO_2	15,700	NR	15,700
NO_3	3.72 E+05	NR	3.72 E+05
Oxalate	3,130	NR	3,130
Pb	234	616	425
PO_4	<1,440	3,520	<1,440
Se	<56.6	NR	<56.6
Si	1,090	426	758
Sm	102	NR	102
SO_4	6,890	NR	6,890
Sr	563	554	559
Ti	43.7	83.0	63.4
Tl	<112	NR	<112
U	7,540	15,100	11,300
V	34.0	60.0	47
Zn	75.2	121	98.1
Zr	433	79.0	256

NR = Not reported

[a] Data compiled in this Tank Characterization Report

[b] Data obtained by Lumetta et al. (1996)

[c] Because of wide variability, both analyses are considered in subsequent calculations in this section.

Table B2-2. Tank 241-SX-108 Analytical Data for Auger Samples-Radioactive Components.[a] (2 Sheets)

Radionuclides[c]	Concentration (μCi/g)	
Analyte	Analysis 1[a]	Analysis 2[b]
$^{144}Ce/Pr$	<18.6	NR
^{60}Co	<0.920	0.358
^{134}Cs	<1.15	NR
^{137}Cs	195	45.2

Table B2-2. Tank 241-SX-108 Analytical Data for Auger Samples-Radioactive Components.[a] (2 Sheets)

Radionuclides[c]	Concentration (μCi/g)	
Analyte	Analysis 1[a]	Analysis 2[b]
^{154}Eu	<43.6	4.94
^{155}Eu	<5.17	3.90
^{94}Nb	<0.915	NR
^{226}Ra	<30.6	NR
^{106}Ru/Rh	<24.1	NR
$^{89/90}$Sr	3,070	NR
Total Beta	6,930	NR
Total Alpha	3.29	8.89
$^{239/240}$Pu	NR	4.06
^{241}Am + ^{238}Pu	NR	4.83
^{241}Am	NR	5.70

NR = Not reported
[a] Appendix A
[b] Data obtained by Lumetta et al. (1996)
[c] Radionuclides reported as of the sample analysis date.

Table B2-3. Sampling and Historical Tank Content-Based Inventory Estimates for Selected Analytes in Tank 241-SX-108. (2 Sheets)

Nonradioactive		
	Sampling inventory	HDW model inventory[b]
Analyte	Estimate[a] (kg)	Estimate (kg)
Al	36,900	64,500
Bi	<241	0
Ca	3,020	3,690
Cl	1,240	609
Cr	4,900	1,080
F	249	0
Fe	9,900	25,000
K	364 to 4,800	146
La	91.5	0
Mn	3,240	0

Table B2-3. Sampling and Historical Tank Content-Based Inventory Estimates for Selected Analytes in Tank 241-SX-108. (2 Sheets)

Nonradioactive		
	Sampling inventory	HDW model inventory[b]
Analyte	Estimate[a] (kg)	Estimate (kg)
Na	119,000	55,300
Ni	887	1,250
NO_2	9,040	22,500
NO_3	214,000	85,600
Oxalate	1,800	0
Si	436	971
SO_4	3,970	377
U	6,510	115

HDW = Hanford Defined Waste

[a] Based on data in Tables B2-1 and B2-2 and on an assumed sludge density of 1.75 g/mL

[b] Agnew et al. (1997).

B3.0 COMPONENT INVENTORY EVALUATION

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

B3.1 CONTRIBUTING WASTE TYPES

Tank 241-SX-108 is the second tank in a cascade that includes tanks 241-SX-107 and 241-SX-109. Tank 241-SX-108 was designed to be a self-boiling tank with the condensate directed back to the tank. Tank 241-SX-108 was connected to an exhauster.

Tank 241-SX-108 first received Reduction and Oxidation (REDOX) process high-level waste (HLW) produced in November 1955. REDOX process HLW produced in from 1952 to 1957 is referred to as R1 waste (Agnew et al. 1997) while that produced from 1958 to 1966 is referred to as R2 waste. Both R1 and R2 waste types were transferred to tank 241-SX-108 from 1955 to 1964. Tank 241-SX-108 also received condensate from tank 241-SX-106 (1959 to 1963) and supernatant liquid from tanks 241-SX-105 (1962 to 1963)

and 241-SX-115 (1963). Tanks 241-SX-105 and 241-SX-115 received REDOX process R1 and R2-type wastes.

B3.1.1 Expected Solids in Waste

Anderson (1990): R1, R2
Agnew et al. (1997), Brevick (1995): R1, R2

B3.1.2 Predicted Current Inventory

Agnew et al. (1997)

Waste Type	Waste volume 329 kL (87 kgal)
R1	261 kL (69 kgal)
R2	68 kL (18 kgal)

Hanlon (1996)
Waste Type Waste volume 329 kL (87 kgal)

B3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

In Table B3-1 are listed compositions for REDOX process HLW as stated in the HDW model, Rev. 4 (Agnew et al. 1997) for both R1 and R2 waste types and as determined from REDOX process flowsheets published in the period 1951 through 1960. The flowsheet data are reproduced from Table D1-3 in Kupfer et al. 1997.

Table B3-1. REDOX Process High-Level Waste Compositions. (2 Sheets)

Concentration (*M*)						
	REDOX Process Flowsheet[a]			Weighted	Predictions[b]	
Analyte	No. 4	No. 5	No. 6	Average[c]	R1	R2
Al	1.27	1.29	0.95	1.20	0.65	1.13
Bi	0	0	4.9 E-05	1.1 E-05	0	0
Cr	0.037	0.17	0.13	0.088	0.068	0.11
Fe	0.028	0.0074	0.0075	0.019	0.048	0.053
I	0	0	4.3 E-05	9.7 E-06	0	0
K	0.0034	0	0	0.0019	0.011	0.019
Mn	0.0034	0	0	0.0019	0	0
Na	6.9	7.1	7.3	7.0	2.9	5.3

Table B3-1. REDOX Process High-Level Waste Compositions. (2 Sheets)

Concentration (M)						
	REDOX Process Flowsheet[a]			Weighted	Predictions[b]	
Analyte	No. 4	No. 5	No. 6	Average[c]	R1	R2
NO_3	4.1	4.3	3.8	4.1	2.5	4.2
Oxalate	0	0.0077	0.0080	0.0035	NR	NR
Si	2.5 E-04	0	0	1.4 E-04	0.015	0.042
SO_4	0.056	0.023	0.022	0.041	0.019	0.030
U[d]	0.0019	0.0037	6.6 E-04	0.002	0.002	Unknown
Issue Date	7/51	8/55	10/60			

NR = Not reported.
[a] Adapted from Table D1-3 in Kupfer et al. (1997)
[b] HDW model, Rev. 4, Agnew et al. (1997)
[c] Weighted by volume of wastes produced using various REDOX process Flowsheets
[d] From Table D1-2 Kupfer et al. (1997).

As noted in Appendix C of Kupfer et al. (1997), the basis for the HDW R1 and R2 stream compositions is not clear. The HDW model R1 and R2 waste concentrations for sodium, aluminum, and nitrate show a strong increase between 1952 to 1958 (R1) and 1959 to 1966 (R2). Little, if any, change is expected between these two time periods in concentrations of sodium, aluminum, and nitrate.

Also listed in Table B3-1 is a calculated average composition of various analytes in the REDOX process HLW added to tank 241-SX-108. The average composition is calculated on the basis that 55 percent of the waste was generated in the period 1955 to 1959 under the conditions of REDOX process Flowsheet No. 4 and that 45 percent of the waste was generated in the period 1960 to 1964 under an average of the conditions (analyte compositions) stated in REDOX process Flowsheets No. 5 and No. 6. (Data presented in Roberts et al. [1992] substantiate that 55 percent of the waste added to tank 241-SX-108 was generated in the period 1955 through 1959.) REDOX Flowsheets No. 5 and No. 6 do not indicate the presence of either potassium or manganese in the HLW. Yet, analysis of auger samples taken from tank 241-SX-108 shows that significant amounts of both potassium and manganese are present in the solid waste in the tank. Also, as noted in Section 5.18.22 of Kupfer et al. (1997), the REDOX process consumed $KMnO_4$ from plant startup in 1952 until September 1959.

B3.3 PREDICTED WASTE INVENTORIES

This section presents results of an independent assessment of the inventories of various analytes in tank 241-SX-108 waste. A set of simplified assumptions forms the basis for the independent assessment. The assumptions and observations are based upon best technical judgement pertaining to parameters that can significantly influence tank inventories. These parameters include: (1) correct predictions of contributing waste types, (2) accurate predictions of model flowsheet conditions, fuel processed, and waste volumes, (3) accurate predictions of component solubilities, and (4) accurate predictions of physical parameters such as density, percent solids, void fraction (porosity), etc. As necessary, the assumptions used can be modified to provide a basis for identifying potential errors and/or missing information that could influence either or both sample- and model-based inventories. The simplified assumptions and observations used for predicting the inventory of several analytes in tank 241-SX-108 are as follows:

1. Only the neutralized REDOX process HLW slurry introduced into tank 241-SX-108 contributed to solids formation. Condensates and waste supernatant liquids from other SX Tank Farm tanks added to tank 241-SX-108 did not contribute to solids formation.

2. A weighted average of the analyte compositions specified in REDOX process Flowsheets Nos. 4, 5, and 6 (see Table B3-1) satisfactorily represents the composition of the REDOX process HLW added to tank 241-SX-108 from 1955 to 1964.

3. Tank waste mass is calculated using the waste volumes listed in Hanlon (1996).

4. Tank waste mass is calculated using the bulk density value of 1.75 g/mL cited by Agnew et al. (1997) for waste in the 241-SX-108 tank. This density value likely represents fairly well the density of the solid waste as it was originally deposited in tank 241-SX-108 but may be as much as a factor of two less than the density of the dried solids presently in tank 241-SX-108.

5. Radiolysis of NO_3 to NO_2 and additions of NO_2 to the wastes in tank 241-SX-108 for corrosion control purposes are not accounted for in this independent assessment.

6. All Bi, Fe, Mn, Si, and U in the REDOX high-level process waste added to tank 241-SX-108 precipitated as water-insoluble compounds. The HDW model predicts varying water solubilities for these analytes.

7. The precipitated solids concentrated by a factor of 38.4 in REDOX process HLW.

8. All Na, NO_3, and oxalate remained dissolved in interstitial liquid associated with the initially precipitated solids.

9. Al, SO_4, and Cr partitioned between the liquid and solid phases.

B3.4 PREDICTED SOLIDS CONCENTRATION FACTORS FOR REDUCTION OXIDATION PROCESS HIGH-LEVEL WASTE

The concentration factor (CF) for any analyte is defined as the ratio of the concentration of a component in solids fully precipitated from solution to the concentration of that component in the neutralized waste stream.

B3.4.1 Iron

Concentration of iron in neutralized waste = 0.014*M*

Moles of iron in current solid waste in tank 241-SX-108:

9.90 MT (Table B3-1) x 1.0 E+06 g/MT x mole/55.85 g = 1.77 E+05 moles

Volume waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of iron in solid waste:

1.77 E+05 moles/3.3 E+05 L = 0.54*M*

CF(Fe) = 0.54/0.014 = 38.4

B3.4.2 Bismuth

Concentration of bismuth in neutralized waste steam = 1.6 E-05*M*

Moles of bismuth in current solid waste in tank:

<0.24 MT (Table B3-1) x 1.0 E+06 g/MT x mole/210 g = <1,143 moles

Volume waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of bismuth in solid waste:

$<1{,}143/3.3\ E+05 = <0.0035M$

$CF(Bi) = <0.0023/1.6\ E-05 = <216$

B3.4.3 Manganese

Concentration of manganese in neutralized waste stream = 0.0017*M*

Moles of manganese in current solid waste in tank:

3.2 MT (Table B2-3) x 1.0 E+06 g/MT x mole/54.94 g = 5.82 E+04 moles

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of manganese in solid waste:

5.82 E+04/3.3 E+05 = 0.18*M*

CF(Mn) = 0.18/0.0017 = 104

B3.4.4 Silicon

Concentration of silicon in neutralized waste stream = 0.00013*M*

Moles of silicon in current solid waste:

0.44 MT (Table B2-3) x 1.0 E+06 g/MT x mole/28.086 = 1.57 E+04 moles

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of silicon in solid waste:

1.57 E+04/3.3 E+05 = 0.047*M*

CF(Si) = 0.044/0.00013 = 365

B3.4.5 Uranium

Concentration of uranium in neutralized waste stream = 0.002*M*

Moles of uranium in current solid waste in tank 241-SX-108:

6.51 MT (Table B2-3) x 1.0 E+06 g/MT x mole/238 g = 2.73 E+04 moles

Volume of waste now in tank 242-SX-108 = 3.3 E+05 L

Concentration of uranium in solid waste:

2.73 E+04/3.3 E+05 = 0.0829

CF(U) = 0.0829/0.002 = 41.4

The CF for iron is calculated to be 35.7. This value is in excellent agreement with the ratio: volume added to tank/volume waste now in tank = 1.037 E+07L/3.3 E+05 L = 31.5. Such agreement indicates that a CF of 38.4 is reasonably correct.

Calculated CFs for other metals that are assumed to completely precipitate, e.g., bismuth, manganese, silicon and uranium, vary from 16 to 339. This wide variation is thought to be due to inaccurate analytical data for these components that were present only in small concentrations in neutralized REDOX process HLW.

The CF for iron of 38.4 is used in subsequent inventory calculations.

B3.5 ESTIMATE OF PARTITIONING FACTORS FOR COMPONENTS ASSUMED TO PARTITION BETWEEN AQUEOUS AND SOLID PHASES

Because of their chemistry some analytes; e.g., chromium, aluminum, and sulfate, in neutralized REDOX process HLW reported to both the liquid and solid phases. The relative concentrations of these components in both the solid and liquid phases is termed the Partition Factor (PF). Partition factors are approximated by comparing the CF for a component in a waste type (e.g., REDOX process HLW) with the CF for a constituent known to completely precipitate (e.g., iron with CF = 38.4). Accordingly:

PF for Cr

CF for Cr

Concentration of chromium in neutralized waste stream = 0.11*M*

Moles of chromium in solid waste in tank 241-SX-108:

4.9 MT x 1.0 E+06 g/MT x mole/52 g = 9.42 E+04 moles

Volume of solid waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of chromium in solid waste:

9.42 E+04/3.3 E+05 = 0.29*M*

CF (Cr) = 0.29/0.11 = 2.6

PF (Cr) = 2.6/38.4 = 0.07

PF for Al

CF for Al

Concentration of aluminum in neutralized waste stream = 1.17*M*

Moles of aluminum in solid waste in tank 241-SX-108:

36.9 MT x 1.0 E+06 g/MT x mole/27 g = 1.37 E+06 moles

Volume of solid waste in tank 241-SX-108 = 3.3 E+05 L

Concentration of aluminum in solid waste:

1.37 E+06/3.3 E+05 = 4.14

CF(Al) = 4.14/1.17 = 3.54

PF(Al) = 3.54/38.4 = 0.09

PF for Sulfate

CF for SO_4

Concentration of sulfate in neutralized waste stream = 0.034*M*

Moles of sulfate in solid waste in tank 241-SX-108:

3.97 MT x 1.0 E+06 g/MT x mole/96 g = 4.14 E+04 moles

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of sulfate in solid waste:

4.14 E+04/3.3 E+05 = 0.13

CF(SO_4) = 0.13/0.034 = 3.69

$PF(SO_4) = 3.69/38.4 = 0.10$

PF For Nitrate

CF for NO_3

Concentration of nitrate in neutralized waste stream = 4.1M

Moles of nitrate in solid waste in tank 241-SX-108:

214 MT x 1.0 E+06 g/MT x mole/62 g = 3.45 E+06

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of nitrate in solid waste:

3.45 E+06/3.3 E+05 = 10.5*M*

$CF\ (NO_3) = 10.5/4.1 = 2.55$

$PF\ (NO_3) = 2.55/38.4 = 0.066$

PF for Oxalate

Concentration of oxalate in neutralized waste steam = 0.0052*M*

Moles of oxalate in solid waste in tank 241-SX-108 =

1.8 MT x 1.0 E+06 g/MT x mole/88 g = 2.05 E+04 moles

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of oxalate in solid waste:

2.05 E+04/3.30 E+05 = 0.062*M*

CF (Oxalate) = 0.062/0.0052 = 11.92
PF (Oxalate) = 11.92/38.4 = 0.31

PF for Potassium

Concentration of potassium in neutralized waste = 0.0017*M*

Moles of potassium in solid waste in tank 241-SX-108:

0.36 MT x 1.0 E+06 g/MT x mole/39 g = 9.23 E+03 moles

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of potassium in solid waste:

9.23 E+03/3.3 E+05 = 0.028*M*

CF(K) = 0.028/0.0017 = 16.47

PF (K) = 16.47/38.4 = 0.43

PF for Na

Concentration of sodium in neutralized waste stream = 7.1*M*

Moles of sodium in solid waste in tank 241-SX-108:

119 MT x 1.0 E+06 g/MT x mole/23 g = 5.17 E+06 moles

Volume of waste now in tank 241-SX-108 = 3.3 E+05 L

Concentration of sodium in salt waste:

5.17 E+06/3.3 E+05 = 15.68*M*

CF(Na) = 15.68/7.1 = 2.21

PF (Na) = 2.21/38.4 = 0.058

From known chemistry, assuming most of the chromium in REDOX process HLW remained as soluble Cr(VI) when the waste was made alkaline, one would not expect large quantities of aluminum, chromium, nitrate, sodium, or sulfate to be associated with REDOX process sludge. The calculated PF values for these analytes are in agreement with this latter expectation. The PF for oxalate indicates that about 30 percent of the oxalate added to tank 241-SX-108 reported to the solid phase; there is no chemical basis to either refute or accept this result. The only PF which is questionable is that for potassium (PF = 0.54); from analogy with sodium, a much lower PF would be expected. But, as noted earlier, analytical data for potassium in the solids in tank 241-SX-108 are quite uncertain.

B3.6 PREDICTED INVENTORY OF ANALYTES IN TANK 241-SX-108

Components Assumed to Completely Precipitate

A CF of 38.4 is used to calculate the inventories of bismuth, iron, manganese, silicon, and uranium in tank 241-SX-108.

Bi: 1.6 E-05 mole/L x 38.4(CF) x 3.3 E+05 L x MT/1.0 E+06 g x 209 g/mole = 0.04 MT = 43 kg

Fe: 0.014 mole/L x 38.4(CF) x 3.3 E+05 L x MT/1.0 E+06 g x 55.85 g/mole = 9.2 MT = 9,900 kg

Similarly:

Mn: 1.18 MT = 1,180 kg

Si: 0.043 MT = 43 kg

U: 14.5 MT = 14,500 kg

Components Assumed to Partition Between Aqueous and Solids Phases (Al, Cr, SO_4).

Aluminum

Al(solids) = 1.17 mole/L 3.3x E+05 L x 27 g/mole x 38.4 (CF) x 0.09 (PF) x MT/1.0 E+06g = 36.0 MT = 36,000 kg

Chromium

Cr(solids) = 0.11 mole/L x 3.3 E+05 L x 52 g/mole x 38.4 (CF) x 0.07 (PF) x MT/1.0 E+06 g = 5.1 MT = 5,100 kg

Sulfate

SO_4(solids) = 0.034 mole/L x 3.3 E+05 L x 96 g/mole x 38.4 (CF) x 0.10 (PF) x MT/1.0 E+06 g = 4.14 MT = 4,140 kg

Sodium

Na(solids) = 7.1 mole/L x 3.3 E+05 L x 23 g/mole x 38.4 (CF) x 0.058 (PF) x MT/1.0 E+06 g = 120 MT = 120,000 kg

Nitrate

NO_3 (solids) = 4.1 mole/L x 3.3 E+05 L x 62 g/mole x 38.4 (CF) x 0.058 (PF) x MT/1.0 E+06 g = 213 MT = 213,000 kg

Oxalate

Oxalate (solids) = 0.0052 mole/L x 3.3 E+05 L x 88 g/mole x 38.4 (CF) x 0.31 (PF) x MT/1.0 E+06 g = 1.80 MT = 1,800 kg

Potassium

K (solids) = 0.0017 mole/L x 3.3 E+05 L x 39 g/mole x 38.4 (CF) x 0.43 (PF) x MT/1.0 E+06 g = 0.36 MT = 360 kg

Estimated component inventories from the evaluation discussed in this section are compared in Table B3-2 with sample- and HDW model-based inventories. Observations regarding these inventories are noted for each component in the following text.

Table B3-2. Comparison of Selected Component Estimates for Tank 241-SX-108 Waste.

Component	kg		
	Engineering evaluation	Sample based	HDW model[a]
Al	36,000	36,900	64,500
Bi	43	<241	0
Ca	NR	3,020	3,690
Cl	NR	1,243	609
Cr	5,100	4,900	1,080
F	NR	249	0
Fe	9,900	9,900	25,000
K	360	364 to 4,800	146
La	NR	91.5	0
Mn	1,180	3,240	0
Na	120,000	119,000	55,300
Ni	NR	887	1,250
NO_2	NR	9,040	22,500
NO_3	213,000	214,000	85,600
Oxalate	1,800	1,800	0
Si	43	436	971
SO_4	4,140	3,970	377
U	14,500	6,510	115

NR = Not Reported
[a] Agnew et al. (1997).

Caveat

Since the "independent" engineering analysis for tank 241-SX-108 for the analytes Al, Cr, K, NO_3, Na, oxalate, and sulfate were calculated using PFs based on sample-based inventory data, the inventories for these analytes are not independent of sample data. For Al, Cr, K, NO_3, Na, oxalate, and sulfate, therefore, "independent" engineering assessment inventory data cannot be correctly compared to sample-based inventories. This caveat should be remembered when inspecting and examining the data in Table B3-2.

Aluminum. The aluminum inventory in tank 241-SX-108 predicted by analysis of the auger samples is 36,900 kg. But, the HDW model (Rev. 4) predicts tank 241-SX-108 to contain about twice as much aluminum as does the sample-based inventory. It is interesting to note that Rev. 3 of the HDW model predicted 38,000 kg of aluminum in tank 241-SX-108 compared to the 64,500 kg predicted by Rev 4. Apparently, Agnew et al. (1997) over corrected aluminum inventories for at least some of the SX Tank Farm tanks. The sample-based value of 36,900 kg, is chosen as the best-basis aluminum inventory for tank 241-SX-108.

Bismuth. The HDW model predicts that wastes in tank 241-SX-108 contain no bismuth. This prediction cannot be correct since at least some of the REDOX process HLW added to tank 241-SX-108 contained bismuth as sodium bismuthate. The independent engineering assessment leads to a predicted inventory of 43 kg bismuth, a reasonable value. Analysis of the auger samples taken from tank 241-SX-108 indicate the tank contains less than 230 kg of bismuth. For best-basis inventory purposes, the value of 43 kg bismuth is chosen.

Calcium. Calcium entered tank 241-SX-108 as an impurity in the commercial-grade NaOH used to neutralize the acidic REDOX process HLW. The HDW model predicts tank 241-SX-108 to contain 3,690 kg of calcium. The sample-based inventory of calcium is 3,020 kg. The limited independent engineering assessment performed did not estimate the inventory of calcium in tank 241-SX-108. For best-basis inventory estimation purposes, the average, 3,690 kg, of the HDW model and sample-based values is selected.

Chlorine. Presumably, chlorine entered tank 241-SX-108 as an impurity in the commercial-grade NaOH used to neutralize the acidic REDOX process HLW. The inventory of chloride ion in tank 241-SX-108 was not estimated in the limited engineering assessment. The HDW model predicts this tank to contain 609 kg of chloride, while the current sample-based inventory is 1,243 kg. Again, in view of the assumptions upon which the sample-based inventory rests, 609 and 1,243 kg, are not in serious disagreement. The sample-based value (1,243) is chosen as the best-basis inventory estimate.

Chromium. Throughout its operation the REDOX plant used sodium dichromate to oxidize plutonium to the extractable +6 state. When the REDOX process HLW was made alkaline for interim storage most of the chromium remained as soluble Cr(VI) but some was reduced to Cr(III) which precipitated as a hydrate oxide.

Data listed in Table B3-2 show that the sample-based inventory of chromium in tank 241-SX-108 is 4,560 kg. The HDW model predicts tank 241-SX-108 to contain 10,800 kg of chromium. The chemical basis for the HDW model prediction of the chromium inventory is not at all clear; apparently, the HDW model assumes considerable reduction of Cr(VI) to Cr(III) in the REDOX process HLW as the result of radiolytic effects and/or reaction of Cr(VI) with nitrite ion. The sample-based inventory value indicates such extensive reduction did not occur. For best-basis inventory purposes, the sample-based value of 4,900 kg of chromium is selected.

Fluoride. Analysis of auger samples taken from tank 241-SX-108 indicates the waste in this tank contains 249 kg of fluoride. The sample-based value of 249 kg of fluoride is selected as the best-basis inventory estimate since the HDW model predicts the tank to contain no fluoride.

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. No adjustments were required for this tank. This charge balance approach is consistent with that used by Agnew et al. (1997).

Iron. The sample-based inventory of iron in tank 241-SX-108 is 9,900 kg. However, the HDW model (Rev. 4) predicts tank 241-SX-108 to contain a factor of about three more iron, 25,000 kg. In applying the HDW model to tank 241-SX-108 Agnew et al. (1997) assumed (Table B3-1) that the concentration of iron in REDOX process HLW, both R1 and R2 types, was a factor of about three higher than the weighted average concentration of 0.014*M* derived from published flowsheets. However, since the sample-based inventory value of 9,900 kg of iron includes both process and corrosion-generated iron, it appears that Agnew et al. seriously overestimated the amount of corrosion-generated iron in REDOX process HLW. Thus, the best-basis inventory estimate of the iron in tank 241-SX-108 is 9,900 kg.

Manganese. The HDW model predicts that the waste in tank 241-SX-108 does not contain any manganese. This prediction is clearly in error since it is known that $KMnO_4$ was used in REDOX process operation up to and including part of calendar year 1959. And, it is also known that substantial volumes of REDOX process HLW produced from 1955 to 1959 were added to tank 241-SX-108.

According to the sample-based inventory estimate tank 241-SX-108 contains 3,240 kg of manganese. The independent engineering assessment leads to an inventory of 1,180 kg of manganese. The latter value derives from the choice of 0.0017*M* manganese as the average concentration in REDOX process HLW routed to tank 241-SX-108. It is possible, although considered highly unlikely, that all the HLW added to tank 241-SX-108 contained as much as 0.0034*M* manganese, the concentration specified in REDOX process Flowsheet No. 4. In the latter case, as much as 2,000 kg of manganese could be present in the waste solids

currently in tank 241-SX-108. For best-basis inventory purposes, the sample-based manganese inventory of 3,240 kg is chosen.

Nickel. The inventory of nickel in the solid waste in tank 241-SX-108 according to analyses of auger samples from the tank is 887 kg. The HDW model predicts tank 241-SX-108 to contain 1,250 kg of nickel. These two inventory values appear to be in reasonable agreement.

There were two sources for nickel in REDOX process HLW: corrosion of stainless steel equipment and as a minor component in aluminum-clad uranium fuel. Stainless steel 304L contains 10 wt% nickel. If all the nickel in tank 241-SX-108 solids represented a corrosion source term, then 7,800 kg of iron should also be present in the sludge. However, it is already known that iron introduced during REDOX processing operations accounts for all the 9,900 kg of iron found by analysis of auger samples. Thus, it is not physically possible that corrosion of stainless steel could have introduced 9,900 kg of iron into tank 241-SX-108. The sample-based nickel value of 887 kg is selected as the best-basis inventory value.

Nitrate. The HDW model predicts tank 241-SX-108 to contain 85,600 kg of nitrate. On the other hand, analyses of auger samples from the tank lead to an estimated 214,000 kg as the nitrate inventory. It is thought that the sample-based inventory estimate is in error because it was calculated on the basis that the entire volume of waste (330 kL [87 kgal]) in tank 241-SX-108 contains 372,000 μg nitrate/g sludge. In fact, it appears that only the very topmost material in tank 241-SX-108 is enriched in sodium nitrate. Most of the solids in tank 241-SX-108 likely contain only moderate amounts of nitrate. For these latter reasons, the HDW model prediction of 85,600 kg nitrate is selected as the best-basis inventory estimate.

Nitrite. The nitrite content of the solids in tank 241-SX-108, based upon one analysis, of auger waste samples from the tank is 9,040 kg. The HDW model predicts that the solids in tank 241-SX-108 contain 22,500 kg of nitrite. The HDW model estimate for nitrite likely overestimates the amount of the original inventory of nitrate that was radiolytically converted to nitrite. The sample-based value of 9,040 kg is selected as the best-basis inventory of nitrite in tank 241-SX-108.

Oxalate. REDOX process flowsheets indicate small concentrations of oxalic acid were routinely added in reprocessing of spent fuel. Most of the added oxalate was expected to report to the REDOX process HLW. Analyses of auger samples from tank 241-SX-108 does indeed show that the waste in this tank contains oxalate; the assumptions used in calculating sample-based inventories lead to a value of 1,800 kg oxalate. This latter value is thought to be the most appropriate best-basis inventory estimate. The HDW model does not predict the oxalate content of the waste in tank 241-SX-108.

Potassium. The HDW model predicts that waste currently in tank 241-SX-108 contains 120 kg of potassium. Depending upon which result is chosen, analyses of actual waste in tank 241-SX-108 provide both a high, 4,800 kg, and a low, 364 kg, estimate of the potassium inventory in tank 241-SX-108. The lower estimate of 364 kg is clearly in better agreement with the value 120 kg obtained using the HDW model. For best-basis inventory purposes, the sample-based value of 364 kg potassium is chosen.

Silicon. The sample-based inventory of silicon in tank 241-SX-108 is 436 kg, whereas, the HDW model silicon inventory for this tank is 971 kg. Silicon in REDOX process HLW originated most likely as the result of partial dissolution of the Al-Si bond layer in aluminum-clad fuel. Chemical removal of the aluminum cladding exposed the Al-Si bond material for subsequent attack by nitric acid. Only small amounts of silicon were introduced into the REDOX process feed from partial dissolution of the Al-Si bond material. For example, the start-up REDOX process flowsheet (Flowsheet No. 4) specified that the HLW would contain only 0.00025*M* silicon; subsequently issued flowsheets did not include silicon as a component of REDOX process HLW. In the independent engineering assessment the REDOX process waste introduced into tank 241-SX-108 was assumed to contain only 0.0001*M* silicon. For unknown reasons, the HDW model assumed that R1 and R2 type wastes contained much higher, 0.015 to 0.042*M*, concentrations of silicon. The sample-based silicon inventory, 436 kg, is selected as the best-basis silicon inventory estimate in tank 241-SX-108.

Sodium. The HDW model predicts that there are 55,300 kg of sodium in the solid waste in tank 241-SX-108. The sample-based inventory is 119,000 kg of sodium. The sample-based sodium inventory was calculated on the basis that the entire volume (329 kL [87 kgal]) of waste in tank 241-SX-108 contained 2.07 E+05 μg Na/g sludge and on the basis of an assumed sludge density of 1.75 g/mL. This latter approach may greatly overestimate the amount of sodium in the waste solids currently in tank 241-SX-108. The auger samples from tank 241-SX-108 contained two types of solids; typical SST sludge and a layer of finely-divided ("flighty") material. This latter material, which appears to be highly enriched in sodium and nitrate, is thought to represent salts which deposited as the wet sludge containing interstitial liquor converted to a very dry solid. Possibly, any residual supernatant liquid left when the tank was pumped in 1964 also evaporated over time and its salt content also deposited on top of the sludge solids.

From information currently available, it appears that tank 241-SX-108 contains a large volume, perhaps as much as 329 kL (87 kgal), of sludge whose sodium content is of the order of 53,000 kg. Also present in tank 241-SX-108, on top of the sludge layer, is a small but unknown, volume of material containing mainly sodium nitrate. For best-basis inventory purposes, the HDW model estimate of 55,300 kg sodium is selected.

Sulfate. The HDW model assumes that sulfate ion, derived from sulfamate used in REDOX process operations, is largely soluble in alkaline REDOX process HLW. On this very reasonable basis, the HDW model predicts the solid waste in tank 241-SX-108 to contain only 377 kg of sulfate. Conversely, analyses of auger samples from tank 241-SX-108 show that the existing waste contains a very large amount, 3,970 kg, of sulfate. For best-basis inventory purposes, the sample-based value of 3,970 kg of sulfate appears most correct.

Uranium. The HDW model predicts that the waste in tank 241-SX-108 contains only 115 kg of uranium. This estimate is extremely low compared to the value of 6,510 kg determined by analysis of auger samples to be in tank 241-SX-108. Note also that the independent engineering assessment indicates that the waste in this tank could contain as much as 13,500 kg of uranium. This latter value appears unreasonably large and reflects, most likely, a poor choice (too high) for the estimated concentration of uranium in the REDOX process HLW added to tank 241-SX-108. For best-basis inventory purposes, the sample-based value of 6,510 kg of uranium is chosen.

B4.0 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 assessments 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/disposal.

Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using results of sample analyses, (2) component inventories are estimated 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 was made of available chemical information for tank 241-SX-108 including the following:

- Inventory estimates generated by HDW Model (Agnew et al. 1997)
- Analyte inventory estimates as determined from analyses of auger samples taken from the tank in 1995.
- Inventory estimates for bismuth, iron, manganese, and uranium generated by a tank-specific assessment process using chemical process flowsheets and a detailed historical tank waste transaction data base.

The results from this evaluation support using a predicted inventory based primarily on results from analysis of auger samples from the tank supplemented, in some cases, by results from the independent engineering assessment and the HDW model for the following reasons:

1. The waste in tank 241-SX-108 has not been core sampled; it is not possible to use a predicted inventory based solely on analytical results from auger samples taken only from the top half of the solids in the tank.
2. The HDW model appears to have used incorrect compositions for the REDOX process HLW added to tank 241-SX-108.

3. The tank-specific assessment based upon the volume and composition of the REDOX process HLW added to the tank provides good estimates of the content of insoluble components such as bismuth, iron, manganese, and uranium.

Best-basis tank inventory values were 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 were only reported for total beta, total alpha, ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., were 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 nuclides 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.

Table B4-1 lists the best-basis inventory of nonradioactive and radioactive components in tank 241-SX-108 as determined from consideration of both HDW model, sample analytical data, and engineering assessment values. The inventory values reported in Tables B4-1 and B4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values

Table B4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-SX-108 (Effective June 30, 1997).

Analyte	Tank inventory, kg	Basis (S, M, C, or E)[1]	Comment
Al	36,900	S	
Bi	43	E	
Ca	3,690	M	
Cl	1240	S	
TIC as CO_3	5,520	M	Not determined in S
Cr	4,900	S	
F	249	S	
Fe	9,900	S	
Hg	0	M	Not determined in S
K	364	S	
La	91.5	S	
Mn	3,240	S	
Na	55,300	M	
Ni	887	S	
NO_2	9,040	S	
NO_3	85,600	M	
OH_{TOTAL}	102,000	C	
Pb	245	S	
PO_4	<829	S	
Si	436	S	
SO_4	3,970	S	
Sr	321	S	
TOC	0	M	
U_{TOTAL}	6,510	S	
Zr	147	S	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997)
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 B4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-SX-108 Decayed to January 1, 1994 (Effective June 30, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	17.7	M	
^{14}C	1.02	M	
^{59}Ni	9.4	M	
^{60}Co	0.715	M	
^{63}Ni	908	M	
^{79}Se	2.5	M	
^{90}Sr	1.09 E+06	M	
^{90}Y	1.09 E+06	M	
^{93m}Nb	9.9	M	
^{93}Zr	10.5	M	
^{99}Tc	7.65	M	
^{106}Ru	1.32 E-04	M	
^{113m}Cd	3.8	M	
^{125}Sb	2.21	M	
^{126}Sn	3.19	M	
^{129}I	0.0146	M	
^{134}Cs	0.173	M	
^{137m}Ba	30,700	M	
^{137}Cs	32,500	M	
^{151}Sm	8,960	M	
^{152}Eu	9.46	M	
^{154}Eu	17.4	M	
^{155}Eu	476	M	
^{226}Ra	7.87 E-04	M	
^{227}Ac	0.0035	M	
^{228}Ra	1.58 E-08	M	
^{229}Th	1.29 E-06	M	
^{231}Pa	0.00267	M	
^{232}Th	5.77 E-10	M	
^{232}U	2.32 E-06	M	

Table B4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-SX-108 Decayed to January 1, 1994 (Effective June 30, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{233}U	7.42 E-08	M	
^{234}U	0.0408	M	
^{235}U	0.0017	M	
^{236}U	0.00114	M	
^{237}Np	0.0394	M	
^{238}Pu	6.85	M	
^{238}U	0.0385	M	
^{239}Pu	222	M	
^{240}Pu	36.8	M	
^{241}Am	152	M	
^{241}Pu	350	M	
^{242}Cm	0.403	M	
^{242}Pu	0.00189	M	
^{243}Am	0.00678	M	
^{243}Cm	0.0376	M	
^{244}Cm	1.11	M	

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

B5.0 APPENDIX B REFERENCES

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, 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.

Brevick, C. H., 1995, *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area*, WHC-SD-WM-ER-352, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending May 31, 1996*, WHC-EP-182-99, Westinghouse Hanford Company, 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.

Lumetta, G. J., B. M. Rapko, M. J. Wagner, J. Liu, and Y. L. Chen, 1996, *Washing and Caustic Leaching of Hanford Tank Sludges: Results of FY 1996 Studies*, PNNL-11278, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

Roberts, R. R., D. B. Uebelacha, and J. D. Anderson, 1992, *CPD Waste Storage Experience*, HWN-1991-DEL, 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.