0053593

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 649892

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	M. J. Kupfer, LMHC, H5-49, 376-6631	[] Yes [X] No	9/9/98
	6. Project Title/No./Work Order No. Tank 241-SX-104	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-643, 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

This ECN compiles all reconciliation changes made to the Best-Basis Inventory in FY 1998 and should replace Appendix D, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-SX-104, of the Tank Characterization Report. The reconciliation process involved correction of errata, reassessment of data outlyers, verification of uranium isotopic distribution and other alpha isotope distribution, and removal of "less than" values, etc. Changes were made to both text and tables. The inventory estimates of several waste components were revised.

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

Tank waste inventory estimates are being provided as standard source term for the various waste management activities. FY 1997 evaluation of available information for all 177 underground storage tanks was performed and published in TCRs, preliminary TCRs, or revisions to existing TCRs. In FY 1998, a reconciliation process is being performed to update the best-basis inventories. This process ensures that the latest inventory estimates are available as a consistent source-term to support the activities of TWRS disposal and other users.

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

Central Files	B1-07	K. M. Hodgson	R2-11
DIMC	R1-41 ~~H6-15~~	M. J. Kupfer	R3-75
DOE Reading Room	H2-53	M. D. LeClair (3)	R3-75
TCSRC	R1-10	J. H. Rasmussen	R2-12
K. M. Hall	R2-12		

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A-7900-013-2 (05/96) GEF095

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EDMC A-7900-013-1

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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	[]	Other	[X]
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	9-10-98	PE		
Cog. Mgr. K. M. Hodgson	K.M. Hodgson	9-21-98	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J. H. Rasmussen R2-12	J Rasmussen	9/17/98	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

A-7900-013-3 (05/96) GEF096

Preliminary Tank Characterization Report for Single-Shell Tank 241-SX-104: Best-Basis Inventory

D. W. Hendrickson
COGEMA Engineering Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 649892 UC: 721
Org Code: 7A110 Charge Code: N4G3A
B&R Code: EW3120074 Total Pages: 26

Key Words: TCR, best-basis inventory, standard inventory

Abstract: The best-basis inventory provides waste inventory estimates that serve as standard characterization source terms for the various waste management activities. To establish a best-basis inventory for single-shell tank 241-SX-104, an evaluation of available information was performed. This work follows the methodology established in *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0A (Kupfer et al. 1997).

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SEP 28 1998
DATE: PF
STA. 16
HANFORD RELEASE
ID: 4

9/28/98
Release Approval Date

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Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-643	Page 1

(2) Title
Preliminary Tank Characterization Report for Single-Shell Tank 241-SX-104: Best-Basis Inventory

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 08/28/97 on EDT 622680	M.J. Kupfer	K.M. Hodgson
RS 0A	Incorporate per ECN-649892	M.J. Kupfer	K.M. Hodgson
		M.J. Kupfer 9-10-98	K.M. Hodgson 9-28-98

A-7320-005 (08/91) WEF168

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-SX-104

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-SX-104

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-104 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

There is no previous Tank Characterization Report (TCR) for tank 241-SX-104. Available information for tank 241-SX-104 includes the following:

- Analytical data from other S and U Tank Farms with similar Supernatant Mixing Model S Plant (SMMS) salt cake waste and Reduction and Oxidation (REDOX [R]) sludge waste types.

- The Hanford Defined Waste (HDW) model document (Agnew et al. 1997) provides tank content estimates.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Hanford Defined Waste model inventories, generated by HDW model, are shown in Tables D2-1 and D2-2. No samples have been taken from tank 241-SX-104 that can be used to estimate tank inventories for comparison with the HDW model estimate. The tank volume used to generate the HDW inventory is 2,324 kL (614 kgal) waste which is partitioned into 640 kL (169 kgal) sludge, 1,684 kL (445 kgal) salt cake (Agnew et al. 1997), which differs from the 2,324 kL (614 kgal) waste which is partitions into 515 kL (136 kgal) sludge, 1,809 kL (478 kgal) salt cake reported by Hanlon (1996). The HDW model sludge density used is 1.74 g/mL and salt cake density used is 1.69 g/mL. (The chemical species are reported without charge designation per the best-basis inventory convention.)

Table D2-1. Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-SX-104.

Analyte	HDW[a] inventory estimate (kg)	Analyte	HDW[a] inventory estimate (kg)
Al	182,000	NO_3	795,000
Bi	509	OH	579,000
Ca	6,730	oxalate	8.87
Cl	18,700	Pb	412
Cr	27,400	P as PO_4	16,500
F[b]	2,270	Si	5,320
Fe	22,600	S as SO_4	46,900
Hg	3.52	Sr	0
K	5,440	TIC as CO_3	57,400
La	10.7	TOC	24,500
Mn	414	U_{TOTAL}	5,550
Na	782,000	Zr	40.6
Ni	2,080	H_2O (Wt%)	28.1
NO_2	267,000	density (kg/L)	1.71

HDW = Hanford Defined Waste
[a] Agnew et al. (1997)
[b] Fluoride based on water soluble portion only.

Table D2-2. Predicted Inventory Estimates for Radioactive Components in Tank 241-SX-104.

Analyte	HDW[a] inventory estimate (Ci)	Analyte	HDW[a] inventory estimate (Ci)
^{90}Sr	655,000	^{239}Pu	296
^{137}Cs	630,000	^{240}Pu	45.6

HDW = Hanford Defined Waste
[a] Agnew et al. (1997) radionuclides decayed to January 1, 1994.

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 WASTE HISTORY TANK 241-SX-104

Tank 241-SX-104 was filled with waste from the REDOX facility from the first quarter of 1955 until the third quarter of 1971. Tank 241-SX-104 was a primary receiver of R1 waste directly from the REDOX Plant. Waste was cycled through the evaporator between 1971 and 1976. Some of the waste supernatants were evaporated in the tank to salt cake during a period that the waste in tank 241-SX-104 was self-boiling. Periodically waste was received and removed from the tank between 1976 and 1983. Receipt of the last transfer of waste was in 1980 from tank 241-S-103. The tank was removed from service and labeled inactive in 1980. The tank was partially isolated in June 1985. Between June 1988 and June 1989, 428.5 kL (113.2 kgal) of liquid were salt well jet pumped.

D3.2 CONTRIBUTING WASTE TYPES

The HDW model (Agnew et al. 1997) predicts that the tank contains a total of 2,324 kL (614 kgal) of waste which consists of 375 kL (99 kgal) first-cycle REDOX process high-level waste (R1), 265 kL (70 kgal) RSltCk, and 1,684 kL (445 kgal) of 242-S evaporator salt cake predicted from the supernatant mixing model (SMMS1).

The Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) lists R (high-level REDOX waste), and evaporator bottoms (EB) as the primary and secondary waste types respectively. EB waste is the SORWT definition for salt cake that is equivalent to the SMM waste type. SORWT also lists REDOX Ion Exchange (RIX) waste as a tertiary waste contributor.

Hanlon (1996) indicates 2,324 kL (614 kgal) of waste which consists of 515 kL (136 kgal) of sludge and 1,809 kL (478 kgal) of salt cake. No description of the source of the sludge and salt cake are given.

D3.3 INVENTORY EVALUATION

The following evaluation provides an engineering assessment of tank 241-SX-104 contents. For this evaluation, the following assumptions and observations are made:

- Tank volumes listed in Hanlon (1996) are used over Agnew et al. (1997). Both sources use the same total waste volumes but differ in the breakdown of sludge and salt cake volumes.

- Only the SMMS1, RSltCk, and R waste streams contributed to solids formation.

D3.4 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

Table D3-1 shows the engineering evaluation approaches used on tank 241-SX-104.

Table D3-1. Engineering Evaluation Approaches Used On Tank 241-SX-104.

Type of waste	How calculated	Check method
Supernate	Assumed no supernate	None, no supernate present.
Salt cake Volume = 1,809 kL (478 kgal) Density = 1.63 g/mL	Used sample-based concentrations from tanks with SMMS1 salt cake waste.	None, no sampling data available for this tank.
Sludge Volume = 515 kL (136 kgal) Density = 1.77 g/mL	Used the average analyte concentration from tank 241-S-102, 241-S-104, and 241-S-107. All have sample data and R1 waste. Only the segments that are believed to have R1 waste were used to calculate the concentration from each tank.	None, no sample-based information is available for this tank.

R = REDOX (reduction and oxidation) sludge waste
SMMS1 = Supernatant mixing model 242-S evaporator, 1973-1976.

D3.4.1 Basis for Salt Cake Calculations Used in This Engineering Evaluation

For this evaluation the methodology developed for SMMS1 salt cake was used. This is based on comparing concentrations from S and U Tank Farm sample data shown in Table D3-2. Tanks 241-S-101 (Kruger et al. 1996), 241-S-102 (Eggers et al. 1996), 241-U-106 (Brown et al. 1997), and 241-U-109 (Baldwin and Stephens 1996) were used to produce the average salt cake analyte concentrations for SMMS1 salt cake that were used in this comparison. It is assumed in this evaluation that the composition of the SMMS1 salt cake also represents the composition of the 265 kL (70 kgal) RSltCk expected to be in tank 241-SX-104. The RSltCk formed when the waste in tank 241-SX-104 was self boiling. To calculate the average SMMS1 concentration the waste volume and predicted location from Agnew et al. (1996) for SMMS1 layers in each tank was determined. The TCR sample data was reviewed and using the segments that were located within the predicted location from Agnew et al. (1996), an average concentration was calculated. The concentrations from each tank and the segments used in the calculation are shown in Table D3-2. For comparison the SMM salt cake composition predicted by the HDW model for tank 241-SX-104 is also shown.

Table D3-2. SMMS1 Salt Cake Concentrations for Tank 241-SX-104. (2 Sheets)

Analyte	241-S-101 segments 2L-4U[a] µg/g	241-S-102 segments 7L-10U[b] µg/g	241-U-106 segments 2U-4L[c] µg/g	241-U-109 segments 5U-8L[d] µg/g	Average concentration[e] µg/g	HDW model SMM concentration for tank 241-SX-104[f] µg/g
Al	18,000	15,085	13,620	13,625	15,100	30,600
Ag	12	17	16	NR	15	NR
B	110	75	80	NR	88	NR
Bi	71	76	<DL	<DL	73.5	178
Ca	273	237	336	<DL	282	917
Cl	4,500	4,099	2,926	NR	3,842	5,860
Cr	10,000	4,359	3,170	4,233	5,440	5,220
F	500	13,596	4,669	NR	6,255	796
Fe	508	1,298	3,096	<DL	1,630	418
K	1,109	898	1,309	NR	1,110	1,730
La	<DL	37	43	NR	40	3.75
Mn	266	597	1,189	<DL	684	145
Na	150,000	189,500	170,500	218,300	182,000	221,000
Ni	114	49	304	<DL	155	256
NO_2	91,000	40,100	56,000	42,900	57,500	76,800
NO_3	110,000	99,200	147,200	297,000	163,000	206,000
Pb	91	137	348	NR	192	141
PO_4	9,500	114,500	5,888	5,970	34,000	5,760
P	2,290	33,900	1,949	<DL	12,700	NR
S	5,940	2,683	3,878	NR	4,170	NR
Si	5,269	517	176	<DL	1,990	1,500
SO_4	20,700	12,500	10,774	11,100	13,800	16,000
Sr	7	<DL	<DL	NR	7	NR
TOC	1,900	5,340	24,626	3,920	8,950	8,590
U	560	1,403	781	<DL	914	1,590
Zn	30	32	54	<DL	39	NR
Zr	14	39	88	NR	47	14.2
Oxalate	15,400	15,700	9,880	NR	13,700	3.11
Density g/mL	1.58	1.69	1.57	1.67	1.63	1.69

Table D3-2. SMMS1 Salt Cake Concentrations for Tank 241-SX-104. (2 Sheets)

Analyte	241-S-101 segments 2L-4U[a] μg/g	241-S-102 segments 7L-10U[b] μg/g	241-U-106 segments 2U-4L[c] μg/g	241-U-109 segments 5U-8L[d] μg/g	Average concentration[e] μg/g	HDW model SMM concentration for tank 241-SX-104[f] μg/g
Radionuclides[g] (μCi/g)						
^{90}Sr	252	23	77	9	90	83.4
^{137}Cs	175	121	175	142	153	183

<DL = Less then the Detectable Limit.
HDW = Hanford Defined Waste
NR = Not reported
SMMS1 = Supernatant Mixing Model 242-S Evaporator salt cake generated from 1973 until 1976
[a] Kruger et al. (1996)
[b] Eggers et al. (1996)
[c] Brown et al. (1997)
[d] Baldwin and Stephens (1996)
[e] Average of tank 241-S-101, 241-S-102, 241-U-106, and 241-U-109 concentrations
[f] Agnew et al. (1997), Radionuclides decayed to January 1, 1994
[g] Radionuclides are reported as of the date of sample analysis.

D3.4.2 *Basis for Sludge Calculations Used in This Engineering Evaluation*

Data from tanks 241-S-102 (Eggers, et al., 1996), 241-S-104 (DiCenso et al. 1994), and 241-S-107 (Simpson, et al., 1996) were used to produce average analyte concentrations for R1 sludge waste. To calculate the average concentration, the volumes and predicted location of the sludge were taken from Agnew et al. (1997) for the R1 waste. The TCR sample data were then reviewed, and only the segments that were located within the predicted sludge location from Agnew et al. (1997) were used in deriving an average concentration. The average concentration from each tank and the segments used in the calculation is shown below in Table D3-3. For comparison the average sludge layer composition predicted by the HDW model for tank 241-SX-104 is also shown.

Table D3-3. R1 Sludge Concentration (Average from Tanks with Tank Characterization Reports) for Tank 241-SX-104. (2 Sheets)

Analyte	241-S-101 segments 7U-8L[a] (μg/g)	241-S-104 (total sludge concentration)[b] (μg/g)	241-S-107 segments[c] (μg/g)	Average concentration[d] (μg/g)	HDW model sludge values for 241-SX-104[e] (μg/g)
Al	127,000	117,000	56,400	100,000	85,300
Bi	<38.8	<45.7	NR	<42.2	0.342
Ca	322	247	234	268	3,700
Cl	2,050	3,200	1,860	2,370	1,740
Cr	2,230	2,350	1,180	1,920	11,300
F	<65.7	145	150	<120	1.60
Fe	1,960	1,720	1,160	1,613	19,300
Hg	NR	<0.126	NR	<0.126	0.0516
K	539	300	457	432	446
La	<19.5	<2.07	NR	<10.8	5.60E-07
Mn	2,750	1,150	83	1,330	0.655
Na	112,000	121,000	60,400	97,800	137,000
Ni	90.7	56	206	118	1,210
NO_2	31,100	25,900	34,300	30,433	43,100
NO_3	119,000	191,000	57,600	122,500	188,000
Pb	37	29.6	33	33.2	8.45
PO_4	1,360	<2,190	1,630	<1,730	10.1
Si	1,360	1,330	1,060	1,250	947
SO_4	897	2,270	1,300	1,489	1,260
Sr	456	424	378	420	0
TIC as CO_3	NR	4,140	NR	4,140	5,620
TOC	NR	1,730	NR	1,730	21.4
U	7,684	6,690	8,685	7,690	904
Zr	36	33.6	131	66.9	0.0149

Table D3-3. R1 Sludge Concentration (Average from Tanks with Tank Characterization Reports) for Tank 241-SX-104. (2 Sheets)

Analyte	241-S-101 segments 7U-8L[a] (μg/g)	241-S-104 (total sludge concentration)[b] (μg/g)	241-S-107 segments[c] (μg/g)	Average concentration[d] (μg/g)	HDW model sludge values for 241-SX-104[e] (μg/g)
Radionuclides (μCi/g)[f]					
^{90}Sr	NR	301	276	288	376
^{137}Cs	98	60.5	74	77.6	96.1
density (g/mL)	1.77	1.64	1.90	1.77	1.74

NR = Not reported.
HDW = Hanford Defined Waste.
[a] Kruger et al. (1996)
[b] DiCenso et al. (1994)
[c] Statistically determined median R1 sludge concentrations for tank 241-S-107 contained in the attachment to Simpson et al. (1996)
[d] Average of analyte concentrations for tankS 241-S-101, 241-S-104, and 241-S-107
[e] Agnew et al. (1997)
[f] Radionuclides decayed to January 1, 1994.

D3.5 ESTIMATED COMPONENT INVENTORIES

The chemical inventory of tanks 241-SX-104 is estimated from the assumed salt cake and sludge volumes (Table D3-1). The resulting inventories are provided in Table D3-4. The inventories estimated by the HDW model are included for comparison.

Since no post-1989 analytical data were available from this tank, the reliability of these estimates (in either this engineering assessment or the HDW model inventory estimates) are suspect. Although these uncertainties cannot be resolved at this point, some trends can be discussed.

Table D3-4. Comparison of Selected Component Inventory Estimates for Tank 241-SX-104.

Component	This evaluation (kg) Sludge	This evaluation (kg) Salt cake	This evaluation (kg)	HDW estimated (kg)
Bi	<38.4	217	<255	509
K	394	3,270	3,660	5,440
La	NR	118	118	10.7
NO_3	112,000	481,000	593,000	795,000
Mn	1,210	2,020	3,230	414
SO_4	1,360	40,700	42,100	46,900
Ni	108	457	565	2,080
Ca	244	832	1,080	6,730
Cr	1,750	16,000	17,800	27,400
PO_4	<1,580	100,000	<102,000	16,500
F	<109	18,400	<18,600	2,270
Al	91,100	44,500	136,000	182,000
Fe	1,470	4,810	6,280	22,600
TOC	1,580	26,400	28,000	24,500
Na	89,100	537,000	626,000	782,000
H_2O (percent)	NR	30.6	30.6	28.1

HDW = Hanford Defined Waste, Agnew et al. (1997)
NR = Not Reported.

Manganese. Potassium permanganate was used in the REDOX process until 1959, thus manganese is expected to be found in tanks containing waste from that process. It is most likely present as highly insoluble manganese dioxide in the alkaline waste materials and would be expected to be in the sludge. The R1 Sludge composition estimate developed in this engineering assessment for Mn was 1,330 μg/g. Interestingly, the SMMS1 salt cake composition estimate for Mn was 684 μg/g--much higher than would be expected based on solubility considerations. It should be noted that there are large ranges in both the SMMS1 and R1 data sets for Mn.

The HDW model predicts essentially no Mn in the Sludge (0.7 kg) in tank 241-SX-104 and 145 μg/g in the salt cake layer. The HDW model inventory estimate for Mn is 414 kg. Based on the discussion above, the 3,230 kg inventory estimate developed in this engineering assessment is likely to be closer to the true value.

Phosphate. There is a large difference between the engineering assessment tank inventory estimate (102,000 kg) and the HDW model estimate (16,500 kg). The engineering assessment value is biased high because of one extremely high phosphate value in data set used to develop the SMMS1 salt cake composition estimate (see Table D3-2). If the phosphate data from tank 241-S-102 are eliminated from the SMMS1 composition estimate, then the engineering assessment and the HDW estimate would be in reasonable agreement. However, since the HDW model failed to predict the high phosphate value for 241-S-102, it should not be taken as a reliable indicator for phosphate in tank 241-SX-104.

Calcium. The calcium found in tanks containing REDOX waste is believed to have been an impurity in the commercial grade sodium hydroxide used in the neutralization of high-level waste in the process. The calcium value developed in this engineering assessment (1,080 kg) is about one sixth of the HDW model value (6,730 kg). Since many calcium salts of anions such as carbonate, oxalate and phosphate are insoluble and the concentrations of these anions are essentially unknown, it is not surprising that Ca values differ between this engineering assessment and the HDW model.

Fluoride. The fluoride ion inventory estimate is about a order of magnitude higher in the engineering assessment (18,600 kg) than in the HDW model (2,270 kg). However, as shown by the data in Table D3-2, the fluoride values in one of the four tanks agree reasonably with the HDW model value. The other three tanks are different than the HDW model. The SMMS analytical data ranges from 500 μg/g to 13,600 μg/g. Without analytical data from tank 241-SX-104, it is difficult to defend the choice of one value over the other.

Iron. The Fe inventory estimate is about 3.5 times lower in the engineering assessment than in the HDW model. The Fe value determined in the engineering assessment for the salt cake is approximately 6 times the HDW model value. As shown in Table D3-2, the data set used to estimate Fe in the SMMS1 salt cake varies from 3,096 μg/g to less than the detection limit. Without analytical data from tank 241-SX-104 it is difficult to defend the choice of one value over the other.

Nickel. The nickel inventory from the engineering assessment is approximately one-fourth the value of the HDW model inventory. The HDW model predicts the majority of the Ni to be in the sludge, this is where the major differences in the two evaluations is seen. The salt cake engineering assessment value and the SMM modeling from the HDW salt cake estimate agree very well with each other. The HDW model predicts a sludge concentration of 1,210 $\mu g/g$ which is more than an order of magnitude greater than the 118 $\mu g/g$ predicted in the engineering assessment.

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

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. 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.

As part of this effort, an evaluation of available chemical information for tank 241-SX-104 was performed, including the following:

- The inventory estimate generated by the HDW model (Agnew et al. 1997)
- An engineering evaluation which produced a predicted SMMS1 salt cake inventory and R sludge inventory based on methodology developed by evaluation of similar S and U Tank Farm tanks.

Based on this evaluation, a best-basis inventory was developed for tank 241-SX-104 since sampling information is not available. The engineering evaluation inventory was chosen as the best basis for those analytes for which sample-based analytical values were available, from similar S and U Tank Farm tanks, and tank 241-S-104, for the following reasons:

- The sample-based inventory analytical concentrations of the other S and U tanks containing SMMS1 and R waste compared favorably with each other for SMMS1 salt cake and R sludge.
- No methodology is available to fully predict SMMS1 salt cake from process flowsheet or historical records.
- No methodology is available to fully predict R1 waste from process flowsheet or historical records for this tank. REDOX first cycle R1 waste changed composition during the process and accurate records of these changes are not available at this time. Also R1 waste was cascaded and transferred into and out of many S, SX, and U tanks between 1972 and 1978 which makes it hard to predict precipitation.
- For those few analytes where no values were available from the sample-based inventory of similar tanks, the HDW model values were used.

The best-basis inventory for tank 241-SX-104 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) (LMHC 1998) 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. For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. (1997) Section 6.1.10.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-SX-104 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	136,000	E	
Bi	236	E	Assumed bismuth inventory of sludge at ½ of upper bound.
Ca	1,080	E	
Cl	13,500	E	
TIC as CO_3	57,400	M	
Cr	17,800	E	
F	18,600	E	Assumed fluoride inventory of sludge at upper bound.
Fe	6,280	E	
Hg	0	E	Simpson 1998
K	3,660	E	
La	118	E	
Mn	3,230	E	
Na	626,000	E	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-SX-104 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Ni	565	E	
NO_2	197,000	E	
NO_3	593,000	E	
OH_{TOTAL}	373,000	C	
Pb	596	E	
PO_4	102,000	E	Assumed phosphate inventory of sludge at upper bound.
Si	7,000	E	
SO_4	42,100	E	
Sr	403	E	
TOC	28,000	E	
U_{TOTAL}	9,700	E	
Zr	200	E	

[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 D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-SX-104, decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	568	M	
^{14}C	76.7	M	
^{59}Ni	12	M	
^{60}Co	84	M	
^{63}Ni	1,150	M	
^{79}Se	9.14	M	
^{90}Sr	528,000	E	
^{90}Y	528,000	E	Based on ^{90}Sr
^{93}Zr	44.5	M	
^{93m}Nb	33.1	M	
^{99}Tc	548	M	
^{106}Ru	0.015	M	
^{113m}Cd	199	M	
^{125}Sb	359	M	
^{126}Sn	13.9	M	
^{129}I	1.06	M	
^{134}Cs	5.84	M	
^{137}Cs	522,000	E	
^{137m}Ba	494,000	E	Based on ^{137}Cs
^{151}Sm	32,300	M	
^{152}Eu	13.2	M	
^{154}Eu	1,380	M	
^{155}Eu	732	M	
^{226}Ra	8.29 E-04	M	
^{227}Ac	0.00441	M	
^{228}Ra	0.289	M	
^{229}Th	0.00679	M	
^{231}Pa	0.0118	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-SX-104, decayed to January 1, 1994 (Effective January 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}Th	0.0193	M	
^{232}U	2.60	E/M	Based on total uranium and HDW model isotopic distribution.
^{233}U	9.95	E/M	Based on total uranium and HDW model isotopic distribution.
^{234}U	3.58	E/M	Based on total uranium and HDW model isotopic distribution.
^{235}U	0.145	E/M	Based on total uranium and HDW model isotopic distribution.
^{236}U	0.117	E/M	Based on total uranium and HDW model isotopic distribution.
^{237}Np	2.03	M	
^{238}Pu	6.03	M	
^{238}U	3.24	E/M	Based on total uranium and HDW model isotopic distribution.
^{239}Pu	296	M	
^{240}Pu	45.6	M	
^{241}Am	154	M	
^{241}Pu	380	M	
^{242}Cm	0.376	M	
^{242}Pu	0.00195	M	
^{243}Am	0.00527	M	
^{243}Cm	0.0307	M	
^{244}Cm	0.291	M	

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

D5.0 APPENDIX D REFERENCES

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