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1		Cog.Eng. M. J. Kupfer [signature] 8-25-97 H5-49	3		R. E. Stout H5-49
1		Cog. Mgr. K. M. Hodgson [signature] 8-25-97 R2-11	3		TCSRC R1-10
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Preliminary Tank Characterization Report for Single-Shell Tank 241-S-106: Best-Basis Inventory

R. E. Stout (Meier Associates), 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

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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-S-106 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

Chris Willingham 8-26-97
Release Approval Date

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-S-106: BEST-BASIS INVENTORY

June 1997

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

R. E. Stout
R. T. Winward
Meier Associates
Kennewick, Washington

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

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-S-106: 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-S-106. No TCRs have been previously issued for this tank, and current core sample analyses are not available. The best-basis inventory, therefore, is based on an engineering assessment of waste type, process flowsheet data, early sample data, and/or other available information.

The *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes* (Kupfer et al. 1997) describes standard methodology used to derive the tank-by-tank best-basis inventories. This preliminary TCR will be updated using this same methodology when additional data on tank contents become available.

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), and 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.

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-S-106

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-S-106

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-S-106 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 this tank. Available waste (chemical) information for tank 241-S-106 includes the following:

- Analytical data from other S and U tanks with a similar salt cake waste type were used as a basis for predicting chemical inventories in tank 241-S-106.
- The Hanford Defined Waste (HDW) model document (Agnew et al. 1997) provides tank content estimates in terms of component concentrations and inventories.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

HDW model inventories are shown in Tables D2-1 and D2-2. Tank 241-S-106 has no analytical data available for comparison. The tank waste volume assumed by the HDW model is 1,798 kL (475 kgal). The HDW model estimated the waste density to be 1.66 g/ml. (The chemical species 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-S-106.

Analyte	HDW[a] inventory estimate (kg)	Analyte	HDW[a] inventory estimate (kg)
Al	131,000	NO_3	522,000
Bi	232	OH	452,000
Ca	2,620	oxalate	0.00638
Cl	15,400	Pb	3,200
Cr	18,200	PO_4	9,150
F	1,000	Si	3,470
Fe	1,990	SO_4	30,100
Hg	101	TIC as CO_3	30,400
K	4,220	TOC	9,570
La	0.00769	U_{TOTAL}	9,040
Mn	283	Zr	20.4
Na	612,000	H_2O (Wt%)	30.6
Ni	593	density (kg/L)	1.66
NO_2	231,000		

HDW = Hanford Defined Waste
[a]Agnew et al. (1997).

Table D2-2. Hanford Defined Waste-Model Based Inventory Estimates for Selected Radioactive Components in Tank 241-S-106.

Analyte	HDW[a] inventory estimate (Ci)	Analyte	HDW[a] inventory estimate (Ci)
^{14}C	58.4	^{155}Eu	306
^{90}Sr	190,000	^{237}Np	1.64
^{99}Tc	418	$^{239/240}Pu$	306.4
^{129}I	0.805	^{241}Pu	300
^{137}Cs	508,000	^{241}Am	98
^{154}Eu	978		

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

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 WASTE HISTORY

Tank 241-S-106 is the third tank of a three tank cascade including tanks 241-S-104 and 241-S-105. Waste was initially sent to the cascade in the first quarter of 1953 with reduction and oxidation (REDOX) high-level waste (R) and REDOX cladding waste (CWR). Tank 241-S-106 started receiving waste via the cascade in the second quarter of 1953 until the third quarter of 1953. The tank waste was classified as R waste in the Waste Status and Transaction Record Summary (WSTRS) (Agnew et al. 1995) at the end of 1953.

Agnew et al. (1995) only reports eight more transfers into tank 241-S-106 between the first quarter of 1954 and 1980. These transfers included waste from tanks 241-S-102, 241-S-103, and 241-S-107 along with two water additions.

Tank 241-S-106 is currently classified as sound and partially isolated and is not on any of the watch lists.

D3.2 CONTRIBUTING WASTE TYPES

The HDW model (Agnew et al. 1997) predicts that the tank contains a total of 1,798 kL (475 kgal) of waste. This waste consists of 121 kL (32 kgal) of REDOX cladding waste (CWR) and 1,677 kL (443 kgal) of 242-S Evaporator salt cake generated from 1973 until 1976 (SMMS1) predicted from the Supernatant Mixing Model (SMM). Waste history records indicate the expected sludge in the bottom of the tank settled from waste that cascaded from tank 241-S-104 to 241-S-105 to 241-S-106. During the time the cascade was active, it was receiving both direct REDOX high-level waste (R) and CWR waste.

The Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995) lists R waste and Evaporator Bottoms (EB) as the primary and secondary waste types respectively. EB waste is the generic SORWT definition for salt cake that is roughly equivalent to the SMM waste types.

Hanlon (1997) reports 1,813 kL (479 kgal) of waste that consists of 106 kL (28 kgal) of sludge, 1,692 kL (447 kgal) of salt cake, and 15 kL (4 kgal) of supernatant. The source of the sludge and salt cake is not given.

D3.3 MAJOR ANALYTES OF CONTRIBUTING WASTE TYPES

The R layer should contain large quantities of aluminum, chromium, iron, sodium, and nitrite. This waste type should also contain appreciable quantities of ^{90}Sr, and ^{137}Cs. R waste entered the tank with CWR waste from the 241-S-104 cascade through 241-S-105 to

241-S-106 and is predicted to be a contributor to the waste by Hill et al. (1995) but not Agnew et al. (1997).

REDOX cladding waste from 1952 to 1960 (CWR1) has high concentrations of uranium, sodium, aluminum, silica, nitrate, nitrite, and hydroxide; moderate quantities of calcium, carbonate and iron; and low concentrations of strontium and cesium. Aluminum and uranium concentrations are predicted to be significantly higher than that found in R waste generated from 1952 to 1957 (R1 waste).

The SMMS1 waste composition should contain large quantities of sodium and nitrate, nitrite, sulfate, phosphate, carbonate, hydroxide and aluminum; and moderate quantities of calcium, iron, chromium, uranium, potassium, and total organic carbon (TOC). The plutonium concentration for the SMMS1 waste type should be much lower than CWR1 waste. The radioactivity for the evaporator concentrated waste types should be higher than for CWR1 waste but lower than for R1 waste.

D3.4 EVALUATION OF TANK WASTE VOLUME

The tank 241-S-106 surface level is monitored with a ENRAF (not an acronym, but the capitalized name of the manufacturer) gauge. As of March 23, 1997, surveillance data indicated a waste height of 458.9 cm (180.66 in), which corresponds to 1,803 kL (476 kgal) of total waste in the tank. This agrees with the 1,813 kL (479 kgal) reported by Hanlon (1997) and the 1,798 kL (475 kgal) predicted by Agnew et al. (1997).

D3.5 ASSUMPTIONS USED

For this evaluation, the following assumptions and observations are made:

- Tank volume listed in Agnew et al. (1997) 1,798 kL (475 kgal) is used. All three sources of volume estimates are within 1 percent of each other.
- Only the SMMS1, R, and CWR waste streams contributed to solids formation.
- All radionuclide data are corrected to January 1994.
- The small amount of supernatant will be disregarded in inventory calculations.
- The unknown sludge assigned as CWR in Agnew et al. (1997) will be treated as a combination R and CWR waste. Waste history records indicate the cascaded waste from tank 241-S-104 to 241-S-105 to 241-S-106 most likely contained both R and CWR wastes.

D3.6 BASIS FOR CALCULATIONS USED IN THIS ENGINEERING EVALUATION

Table D3-1 summarizes the engineering evaluation approaches used on 241-S-106.

Table D3-1. Engineering Evaluation Approaches Used On 241-S-106.

Type of waste	How calculated	Check method
Supernate	Disregard small quantity of free supernatant.	None.
Salt Cake Volume = 1,677 kL (443 kgal)	Used sample-based concentrations from tanks with SMMS1 salt cake waste. An average density of 1.63 g/ml is used for SMMS1 waste.	None; no sample-based information is available for this tank.
Sludge Volume = 121 kL (32 kgal)	Used the average analyte concentration from tank 241-S-102, 241-S-104, and 241-S-107. All have sample data and R1 and/or CWR1 waste. Only the segments that are believed to have R1 and/or CWR1 waste were used to calculate the concentration from each tank. Used an average sample-based density of 1.77 g/ml.	None; no sample-based information is available for this tank.

SMMS1 = Supernatant Mixing Model salt cake
R1 = REDOX waste generated between 1952 and 1957
CWR1 = REDOX cladding waste from 1952 to 1960.

D3.6.1 Basis for Salt Cake Calculations Used in this Engineering Evaluation

Sample-based characterization data for four tanks (241-S-101, 241-S-102, 241-U-106, and 241-U-109 [Kruger et al. 1996, Eggers et al. 1996, Brown et al. 1997, and Baldwin and Stephens 1996]) known to contain the same SMMS1 salt cake waste type as tank 241-S-106 are summarized in Tables D3-2 and D3-3. The analytical results for these tanks were evaluated at the core segment level and the SMMS1 salt cake was identified. The SMMS1 component concentrations for these tanks were averaged to provide a generalized composition for SMMS1 salt cake. The average concentrations were used as the basis for estimating the inventory for the SMMS1 components in tank 241-S-106. For comparison the SMMS1 salt cake composition predicted by Agnew et al. (1997) for tank 241-S-106 is also shown in Tables D3-2 and D3-3.

As indicated in Table D3-2, the concentrations of major waste components (e.g., Na, Al, NO_3, NO_2, and SO_4) for the four tanks containing SMMS1 salt cake vary between tanks by no more than an approximate factor of three. A major exception is phosphate that exhibits exceptionally high concentrations for tank 241-S-102 waste and, thus, skews the average concentration high for phosphate for the SMMS1 tanks used in this assessment. The variation between several minor components for the four tanks is quite high.

The analyte concentrations for the four SMMS1 salt cake tanks compare within approximately a factor of two for most major components with the predicted SMMS1 composition from the HDW model. However, significant difference occur for several components including F, Fe, PO_4, Mn, Si, and oxalate. The concentrations of these components for the four salt cake tanks are consistently higher than the HDW model estimates. It is, thus, concluded that the concentrations of these components best represent the SMMS1 salt cake basis for tank 241-S-106.

Table D3-2. SMMS1 Salt Cake Concentrations. (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-S-106[f] μg/g
Al	18,000	15,085	13,620	13,625	15,100	33,800
Ag	12	17	16	NR	15	NR
B	110	75	80	NR	88	NR
Bi	71	76	<DL	<DL	73.5	82.7
Ca	273	237	336	<DL	282	727
Cl	4,500	4,099	2,926	NR	3,842	5,490
Cr	10,000	4,359	3,170	4,233	5,440	6,500
F	500	13,596	4,669	NR	6,255	359
Fe	508	1,298	3,096	<DL	1,630	311
K	1,109	898	1,309	NR	1,110	1,500
La	<DL	37	43	NR	40	0.00275
Mn	266	597	1,189	<DL	684	101
Na	150,000	189,500	170,500	218,300	182,000	211,000
Ni	114	49	304	<DL	155	209
NO_2	91,000	40,100	56,000	42,900	57,500	80,600
NO_3	110,000	99,200	147,200	297,000	163,000	185,000
Pb	91	137	348	NR	192	88.3
PO_4	9,500	114,500	5,888	5,970	34,000	3,270
P	2,290	33,900	1,949	<DL	12,700	NR
S	5,940	2,683	3,878	NR	4,170	NR

Table D3-2. SMMS1 Salt Cake Concentrations. (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-S-106[f] µg/g
Si	5,269	517	176	<DL	1,990	1,210
SO_4	20,700	12,500	10,774	11,100	13,800	10,700
Sr	7	<DL	<DL	NR	7	0
TOC	1,900	5,340	24,626	3,920	8,950	9,570
U	560	1,403	781	<DL	914	1,360
Zn	30	32	54	<DL	39	NR
Zr	14	39	88	NR	47	7.3
Oxalate	15,400	15,700	9,880	NR	13,700	0.00228
Density g/mL	1.58	1.69	1.57	1.67	1.63	1.66
Radionuclides[g] (µCi/g)						
^{90}Sr	252	23	77	9	90	67.6
^{137}Cs	175	121	175	142	153	181

<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. (1996)
[g] Radionuclides are reported as of the date of sample analysis.

D3.6.2 Basis for Sludge Calculations used In This Engineering Evaluation

Sample-based sludge values, R1 and/or CWR1 sludge concentrations from other tanks in the S Tank Farm, are used to calculate the sludge concentration for tank 241-S-106. Sample data from tanks 241-S-102, 241-S-104, and 241-S-107 (Kruger et al. 1996, DiCenso et al. 1996, and Simpson et al. 1996) were used to produce average analyte concentrations for R1/CWR1 sludge waste. To calculate the average concentration, the volumes and predicted location of the sludge were taken from Agnew et al. for the tanks R1/CWR1 waste.

All the tanks except 241-S-104, which is a total core composite, have mixed R1 and CWR1 waste layers reported by Agnew et al. (1997). 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 and density from each tank and the segments used in the calculation is shown below in Table D3-3. All data for the radioactive components were recorded as less than the detectable limit for all the tanks sample data. For comparison the composition of the CWR sludge predicted by the HDW model for tank 241-S-106 is also shown.

Table D3-3. R1 Sludge Concentration Estimate. (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 CWR sludge concentration for tank 241-S-106[e]
Al	127,000	117,000	56,400	100,000	171,000
Bi	<38.8	<45.7	NR	<42.2	0
Ca	322	247	234	268	2,730
Cl	2,050	3,200	1,860	2,370	141
Cr	2,230	2,350	1,180	1,920	59.8
F	<65.7	145	150	<120	0
Fe	1,960	1,720	1,160	1,613	5,200
Hg	NR	<0.126	NR	<0.126	
K	539	300	457	432	33.9
La	<19.5	<2.07	NR	<10.8	
Mn	2,750	1,150	83	1,330	0
Na	112,000	121,000	60,400	97,800	102,000
Ni	90.7	56	206	118	33.7
NO_2	31,100	25,900	34,300	30,433	24,900
NO_3	119,000	191,000	57,600	122,500	20,000
Pb	37	29.6	33	33.2	13,800
PO_4	1,360	<2,190	1,630	<1,730	0
Si	1,360	1,330	1,060	1,250	319

Table D3-3. R1 Sludge Concentration Estimate. (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 CWR sludge concentration for tank 241-S-106[e]
SO_4	897	2,270	1,300	1,489	455
Sr	456	424	378	420	0
TIC as CO_3	NR	4,140	NR	4,140	
TOC	NR	1,730	NR	1,730	0
U	7,684	6,690	8,685	7,690	24,400
Zr	36	33.6	131	66.9	0
Radionuclides (μCi/g)					
^{90}Sr	NR	301[f]	276[f]	288[f]	
^{137}Cs	98[f]	60.5[f]	74[f]	77.6[f]	
density (g/ml)	1.77	1.64	1.90	1.77	1.77

HDW = Hanford Defined Waste
NR = Not reported
REDOX = Reduction oxidation process
R1 = REDOX waste generated between 1952 and 1957
[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 tank 241-S-101, 241-S-104, and 241-S-107
[e] Agnew et al. 1996
[f] Radionulcides decayed to January 1, 1994.

D3.7 ESTIMATED COMPONENT INVENTORIES

The Chemical inventory of tank 241-S-106 is estimated from the assumed salt cake and sludge volumes and density (Table D3-1) and the average SMMS1 and R/CWR concentrations from tables D3-2 and D3-3. The resulting inventories are provided in Table D3-4. The inventory estimated by the HDW model is included for comparison.

Table D3-4. Comparison of Selected Component Inventory Estimates for Tank 241-S-106.

Component	Inventory Estimates for R1 sludge layer (kg)	Inventory Estimates for SMMS1 salt cake layer (kg)	Engineering Assessment-based Tank Inventory Estimates (kg)	HDW model tank inventory estimates[a] (kg)
Bi	<9.08	201	<210	232
K	93	3,030	3,130	4,220
NO_3	26,400	446,000	472,000	522,000
NO_2	6,550	157,000	164,000	231,000
Mn	286	1,870	2,160	283
SO_4	321	37,700	38,000	30,100
Cr	413	14,870	15,300	18,200
PO_4	<373	92,900	93,300	9,150
F	<25.8	17,100	17,100	1,000
Al	21,600	41,300	62,900	131,000
Fe	347	4,460	4,800	1,990
TOC	372	24,500	24,900	9,570
Na	21,000	497,000	518,000	612,000
^{90}Sr[b] (Ci)	61,985	260,120	322,000	190,000
^{137}Cs (Ci)	16,702	441,157	458,00	508,000

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

Since analytical data were not available from this tank, the reliability of these estimates (in either this engineering assessment or the HDW model inventory estimates) is unknown. Although these uncertainties cannot be resolved at this point, some observations are discussed in the following text.

Chromium. The chromium content of the solids in tank 241-S-106 as determined by the independent engineering assessment is 15,300 kg. This value is in fair agreement with the value of 18,200 kg of chromium as predicted by the HDW Model. The value of 15,300 kg of Cr is chosen as the best-basis estimate.

Sodium. The sodium content of the solids in tank 241-S-106 as determined by the independent engineering assessment (518,000 kg) is in reasonable agreement with the value of predicted by the HDW Model (612,000 kg). The value of 518,000 kg of sodium is chosen as the best-basis estimate.

Nitrite, Nitrate, and Sulfate. The nitrite, nitrate, and sulfate content of the solids in tank 241-S-106 as determined by the independent engineering assessment is in reasonable agreement with the value predicted by the HDW Model. The value of the engineering assessment for all three compounds was chosen as the best-basis estimate.

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 zero Mn in the Sludge in tank 241-S-106 (Table D3-3) and 101 μg/g in the salt cake layer (Table D3-2). The HDW model inventory estimate for Mn is 283 kg. Based on the discussion above, the 2,160 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 inventory estimate (93,300 kg) and the HDW model estimate (9,150 kg). The engineering assessment value maybe biased high because of one extremely high phosphate value in the data set used to develop the SMMS1 salt cake composition estimate (see Table D3-2). However, if the phosphate data from tank 241-S-102 are eliminated from the SMMS1 composition estimate, then the engineering assessment would still be significantly higher than the HDW estimate. The HDW model predicts phosphate concentrations in SMMS salt cake and in REDOX process wastes to be lower thank found in actual waste samples.

Fluoride. The fluoride ion inventory estimate is more than an order of magnitude higher in the engineering assessment (17,100) than in the HDW model (1,000). However, as shown by the data in Table D3-2, the fluoride values in two of the four tanks agree reasonable with the HDW model value and the other two tanks are much larger than the HDW model prediction. Without analytical data from tank 241-S-106, it is difficult to defend the choice of one value over the other.

Iron. The Fe inventory estimate is about six times higher in the engineering assessment than in the HDW model. Although the 121 kL of sludge only represents approximately 7 percent of the waste volume in this tank, it contributes approximately 56 percent of the total Fe in the HDW model. However, in the engineering assessment only approximately 7 percent of the Fe comes from the sludge. 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 detection limit. Without analytical data from tank 241-S-106, it is difficult to defend the choice of one value over the other.

Aluminum. The aluminum value determined in this engineering assessment is approximately 48 percent of the value predicted by the HDW model. The largest contribution of the Al is from the salt cake. As shown in Table D3-2, the aluminum concentrations for the four salt cake tanks are consistently about half that predicted by the HDW model.

^{90}Strontium and ^{137}Cesium. The strontium and cesium inventories from the engineering assessment are in reasonable agreement with their respective HDW model inventories. The engineering assessment is used as the best-basis inventory for tank 241-S-106.

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. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997).

Note: The HDW model inventory is used when no data for the engineering evaluation are available for a given component.

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

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 chemical information for tank 241-S-106 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.

As part of this effort, an evaluation of available chemical information for tank 241-S-106 was performed, including the following:

- The inventory estimate generated by the HDW model (Agnew et al. 1997)
- An engineering evaluation that estimated a SMMS inventory and a predicted R/CWR inventory based on evaluation of similar waste types in other S and U tank waste.

Based on this evaluation, a best-basis inventory was developed for tank 241-S-106 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 Farm tanks for the following reasons:

- The sample-based inventory analytical concentrations of the other S and U tanks containing SMMS1 waste compared favorably with each other for SMMS1 salt cake.
- The sample-based inventory analytical concentrations of the other S tanks containing R/CWR waste compared favorably with each other for R/CWR sludge.
- No methodology is available to fully predict R1 or CWR1 sludge waste or SMM salt cake from process flowsheet or historical records for this tank.

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

The best-basis inventory estimate for tank 241-S-106 is presented in Tables D4-1 and D4-2. Since there was no analysis for TIC and mercury, for the salt cake and sludge comparison tanks, the HDW model value was used.

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-S-106 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[a]	Comment
Al	62,900	E	
Bi	232	M	
Ca	829	E	
Cl	11,000	E	
TIC as CO_3	30,400	M	
Cr	15,300	E	
F	17,100	E	
Fe	4,800	E	
Hg	101	M	
K	3,130	E	
La	0.00769	M	
Mn	2,160	E	
Na	518,000	E	
Ni	450	E	
NO_2	164,000	E	
NO_3	472,000	E	
OH_{TOTAL}	222,000	C	
Pb	532	E	
PO_4	93,300	E	
Si	5,710	E	
SO_4	38,000	E	
Sr	110	E	
TOC	24,900	E	
U_{TOTAL}	4,160	E	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-S-106 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[a]	Comment
Zr	142	E	

[a]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-S-106 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[a]	Comment
^{3}H	478	M	
^{14}C	58.4	M	
^{59}Ni	3.82	M	
^{60}Co	59.9	M	
^{63}Ni	372	M	
^{79}Se	6.05	M	
^{90}Sr	322,000	E	
^{90}Y	322,000	E	Based on ^{90}Sr activity
^{93}Zr	29.6	M	
^{93m}Nb	21.8	M	
^{99}Tc	418	M	
^{106}Ru	0.00981	M	
^{113}Cd	149	M	
^{125}Sb	246	M	
^{126}Sn	9.15	M	
^{129}I	0.805	M	
^{134}Cs	2.92	M	
^{137}Cs	458,000	E	
^{137}Ba	433,000	E	Based on 0.946 of ^{137}Cs activity
^{151}Sm	21,300	M	
^{152}Eu	5.34	M	
^{154}Eu	978	M	
^{155}Eu	306	M	
^{226}Ra	2.67 E-04	M	
^{227}Ac	0.00161	M	
^{228}Ra	0.0874	M	
^{229}Th	0.00209	M	
^{231}Pa	0.00724	M	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-S-106 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[a]	Comment
^{232}Th	0.00603	M	
^{232}U	0.547	M	
^{233}U	2.10	M	
^{234}U	3.16	M	
^{235}U	0.132	M	
^{236}U	0.0799	M	
^{237}Np	1.64	M	
^{238}Pu	5.04	M	
^{238}U	3.15	M	
^{239}Pu	267	M	
^{240}Pu	39.4	M	
^{241}Am	980	M	
^{241}Pu	300	M	
^{242}Cm	0.185	M	
^{242}Pu	0.00143	M	
^{243}Am	0.00296	M	
^{243}Cm	0.0166	M	
^{244}Cm	0.186	M	

[a]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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