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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635520

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 []	T. A. Hu, Data Assessment and Interpretation, R2-12, 373-4098	[] Yes [X] No	08/05/97
	6. Project Title/No./Work Order No. Tank 241-AP-105	7. Bldg./Sys./Fac. No. 241-AP-105	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-360, Rev. 1	10. Related ECN No(s). ECN-635469	11. Related PO No. N/A

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)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

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

This ECN was generated to include additional explanatory text in the best-basis narrative, and to update the comprehensive radionuclide inventory estimates for the tank.

14a. Justification (mark one)

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

14b. Justification Details

Initial release of this document was deficient.

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

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A-7900-013-1

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1. ECN (use no. from pg. 1) ECN-635520

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
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. T.A. Hu	[signature]	5/22/97	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	9/20/97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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Tank Characterization Report for Double-Shell Tank 241-AP-105

T. A. Hu
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ECN-635520 UC: 2070
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Key Words: Waste Characterization, Double-Shell Tank, DST, Tank 241-AP-105, 241-AP-105, AP-105, AP Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-AP-105. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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(2) Title
Tank Characterization Report for Double-Shell Tank 241-AP-105

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr.	Date
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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-105

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AP-105

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 tank 241-AP-105 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

Data sources for the liquid layer in tank 241-AP-105 include the following:

- Data from the March 1993 and August/September 1996 sampling events as shown in Appendix B.
- The TCR for tank 241-AN-101, which provides data from the last sampling event for this tank before 3,660 kL (967 kgal) of DN were transferred to tank 241-AP-105 in August 1996.
- The inventory estimate (Agnew et al. 1997) generated from the HDW model.
- There are no sample analyses of the solids layer in tank 241-AP-105. A composition for the solids layer was estimated by the Environmental Simulation Program (ESP), a computer program produced by OLI Systems (OLI Systems Inc. 1996). ESP uses thermodynamic theory to predict phase equilibrium concentrations in aqueous systems. ESP predictions of binary phase systems have shown good agreement with laboratory results (Meng et al. 1994).

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The estimate made by the HDW model attempts to describe the contents of tank 241-AP-105 as of January 1, 1994. Transfers into and out of tank 241-AP-105 since January 1994 have invalidated the HDW model estimate. Therefore, no comparisons between the latest sample data and the HDW model are made in this evaluation.

D3.0 COMPONENT INVENTORY EVALUATION

D3.1 EVALUATION OF SOLIDS LAYER IN TANK 241-AP-105

In August 1995, material balance problems were detected during the transfer of double-shell slurry feed (DSSF) from tank 241-AP-105 to tank 241-AP-101. In September 1995, a video of the interior of tank 241-AP-105 indicated the presence of grayish-white, crystalline solids at a level of about 142 cm (56 in.) from the bottom of the tank (White 1996). This level measurement corresponds to a tank volume of 583 kL (154 kgal). Based on this information, the volume of the solids layer was set at 583 kL (154 kgal) (Hanlon 1997).

This solids volume conflicts with the March 1993 grab sampling event, where samples were obtained from depths as low as 43 cm (17 in.) from the bottom of the tank (see Appendix B). The samples taken from the lowest depths were characterized as liquid samples although solids were present in the lowest sample. The density of these samples was 1.38 g/mL.

A close inspection of the video indicates that exposed solids appear along the tank walls. These solids slope downward toward the center of the tank, and appear to form a bowl-like formation partially filled with liquid. Thus, the actual volume of solids would appear to be lower than 583 kL (154 kgal).

The rest of this section attempts to establish the best basis for the amount and composition of solids in the tank until more rigorous measurements and analyses are made. Section D3.1.1 summarizes the waste types that contributed to the formation of solids in tank 241-AP-105. Section D3.1.2 summarizes the ESP prediction for composition and volume of these solids at equilibrium.

D3.1.1 Contributing Waste Types

DSSF added to tank 241-AP-105 in 1989 from Evaporator Campaign 89-1 was the primary source of the solids in that tank. This campaign ran from September 27, 1988 to February 18,

1989 (Jonas 1989). At the beginning of January 1989, transfer lines were routed directly from the 242-A Evaporator to tank 241-AP-105. Tank 241-AP-105 received DSSF from the 242-A Evaporator through February 1989, reaching a peak volume of 1,800 kL (476 kgal) (see Figure D3-1).

Equipment problems forced an early shutdown of the evaporator in February, 1989. As a consequence, 1,860 kL (492 kgal) of partially concentrated non-complexed waste (PCN) was transferred to tank 241-AP-106. During July of that same year 1,340 kL (355 kgal) of PCN was transferred to tank 241-AP-105 from tank 241-AP-106. This waste is not expected to contain a significant amount of solids.

During evaporator operations, slurry samples are frequently taken to assess process performance. These samples can be matched to the time periods in which tank 241-AP-105 received evaporator bottoms. Data from these samples can be input to the ESP model to obtain a prediction of the composition of the liquid and solid phases at equilibrium. Table D3-1 summarizes sampling activities during the slurry feed transfers.

Table D3-1. Slurry Samples Taken During Double-Shell Slurry Feed Transfers to Tank 241-AP-105.

Week of	Tank 241-AP-105 Volume kL (kgal)[1]	Slurry Sample Number[2]	Date Sample Taken[3]
1/9/89	69.7 (19.0)		
1/16/89	71.8 (19.0)	T-3635	1/16/89
1/23/89	198 (52.2)	T-3750	1/29/89
1/30/89	334 (88.3)	T-3789	1/31/89
2/6/89	913 (241)		
2/13/89	1,790 (472)	T-3954	2/13/89
2/20/89	1,800 (477)		

Notes:

[1]Volumes taken from SACS database
[2]Jonas (1989)
[3]Dates are in mm/dd/yy format

Between January 9 and January 30, 1989, tank 241-AP-105 received 264 kL (69.7 kgal) of DSSF that can be characterized as the average of slurry samples T-3635 and T-3750. After January 30, 1989, tank 241-AP-105 received another 1,470 kL (387 kgal) of DSSF, characterized by slurry sample T-3789. Sample T-3954 was discarded because the analyses included no ICP results; i.e., no metal cations were reported. Sample T-3954 had a density of

1.20 and 74.1 wt% water. Concentrations of the slurry samples used in ESP are shown in Table D3-2. (The chemical species are reported without charge designation per the best-basis inventory convention).

Table D3-2. Selected Slurry Sample Data for 242-A Evaporator Campaign 89-1.[1] (2 Sheets)

Analyte	T3635	T3750	Avg. T3635, T3750[2]	T3789	Avg. T3635, T3750, T3789[3]
Metals (M)					
Al	0.781	NR[4]	0.781	0.0675	0.543
B	0.00163	0.00153	0.00148	0.00251	0.00182
Ca	0.000524	0.000254	0.000391	0.00312	0.00130
Cr	0.00532	0.00520	0.00526	NR	0.00526
Fe	0.000410	0.000177	0.000410	NR	0.000293
Mg	0.000262	NR	0.000262	0.000382	0.000302
Np	6.14E-06	1.12E-05	3.07E-06	< 0.000153	5.30E-05
P	NR[3]	0.0148	0.0148	0.0129	0.0141
K	0.964	NR	0.964	NR	0.0962
Si	0.00835	0.00792	0.00813	0.00253	0.00627
Na	10.2	8.91	9.55	9.23	9.45
Zn	0.00835	0.000286	0.00133	0.00155	0.00141
Ions (M)					
NH_4	0.00681	< 0.00400	0.00540	0.0132	0.0476
CO_3	0.268	0.261	0.264	0.228	0.252
Cl	0.0766	0.120	0.0983	0.0781	0.0916
F	0.0102	0.0961	0.0531	0.102	0.0694
OH	5.59	6.45	6.02	5.12	5.72
NO_3	3.47	2.88	3.275	3.82	3.46
NO_2	0.504	1.89	1.20	1.24	1.21
PO_4	0.013	0.00926	0.0103	0.01202	0.0102
SO_4	< 0.00301	< 0.0290	0.0160	0.00699	< 0.013

Table D3-2. Selected Slurry Sample Data for 242-A Evaporator Campaign 89-1.[1] (2 Sheets)

Analyte	T3635	T3750	Avg. T3635, T3750[2]	T3789	Avg. T3635, T3750, T3789[3]
Radionuclides (μCi/L)					
^{241}Am	< 3.57	1.65	< 2.61	1.21	< 2.14
^{14}C	5.95	0.312	3.13	4.20	349
^{134}Cs	600	648	624	570	606
^{137}Cs	301,000	370,000	335,500	308,300	326,400
$^{239/240}$Pu	0.0955	0.0605	0.0780	0.137	0.0977
$^{89/90}$Sr	206	86.1	146	148	147
^{99}Tc	124	NR[c]	124	32.5	93.5
Physical Properties					
Water (wt%)	50.9	53.7	52.3	51.8	52.1
SpG	1.44	1.42	1.43	1.43	1.43
TOC (g/L)	3.75	6.95	5.35	3.61	4.77

Notes:

[1]Jonas (1989)
[2]Inputs to ESP
[3]Assumed to be the same as the T3750 concentration
[4]Assumed to be the same as the T3635 concentration

D3.1.2 Environmental Simulation Program Results

An average of slurry samples T-3635 and T-3750 was used in ESP to represent the first period in which tank 241-AP-105 received DSSF; slurry sample T-3789 was used to represent the second period. A charge balance was imposed on the T-3645/T-3750 samples by adjusting the sodium concentration from 9.55*M* to 7.97*M*. The T-3789 composition was balanced by adjusting the hydroxide concentration from 5.12M to 3.83M. Densities, wt% water, and pH values calculated by ESP for the ionically balanced compositions are compared to the reported laboratory values in Table D3-3.

Table D3-3. Results of Environmental Simulation Program Reconciliation of Charge Imbalances for Evaporator Campaign 89-1 Slurry Samples.

	T-3635 / T-3750		T-3789	
	ESP	Laboratory	ESP	Laboratory
Density (g/mL)	1.48	1.43	1.43	1.43
Wt% water	45.6	52.3[1]	52.8	51.8
pH	16.1	13.2[2]	16.0	13.4[2]
Reconciling analyte	Na	n/a	OH	n/a

Notes:

[1]Using the reported laboratory concentrations, no reconciled compositions produced the reported density and weight percent water. The weight percent water value reported by the laboratory is assumed to be in error.

[2]Hydroxide concentrations are in excess of *5M*. It is impossible for solutions with these hydroxide concentrations to have such low pH values.

With the reconciled composition, ESP predicts that the solids with the greatest tendency to form at ambient temperatures and 1 atmosphere of pressure are KNO_3, KNO_2, $NaNO_3$, $NaNO_2$, with trace amounts of $Ca(OH)_2$, and $Mg(OH)_2$. Sample T-3635/T-3750 was predicted by ESP to contain 23.1 weight percent solids at equilibrium on a dry basis; sample T-3789 was predicted to contain 27.4 weight percent solids. The results are summarized in Table D3-4.

Table D3-4. Composition Predicted by Environmental Simulation Program for the Solids in Tank 241-AP-105 at Equilibrium.[1] (2 sheets)

Analyte	Solids from Slurry Sample T3635/T3750 (wt%)	Solids from Slurry Sample T3789 (wt%)	Solids from Slurry Sample T3635/T3750 (kg)	Solids from Slurry Sample T3789 (kg)	Total Mass of Solids (kg)
KNO_3	25.7	0	25,100	0	25,100
NaF	0.870	1.45	581	9,340	9,920
$NaNO_3$	73.1	97.5	71,500	628,000	699,000
$NaNO_2$	0.28	1.02	274	6,570	6,844
$Ca(OH)_2$	trace	trace	trace	trace	trace
$Mg(OH)_2$	trace	trace	trace	trace	trace

Table D3-4. Composition Predicted by Environmental Simulation Program for the Solids in Tank 241-AP-105 at Equilibrium.[1] (2 sheets)

Analyte	Solids from Slurry Sample T3635/T3750 (wt%)	Solids from Slurry Sample T3789 (wt%)	Solids from Slurry Sample T3635/T3750 (kg)	Solids from Slurry Sample T3789 (kg)	Total Mass of Solids (kg)
Wt% solids	23.1	27.6	N/A	N/A	N/A
Vol% solids	16.7	19.4	N/A	Total dry solids mass (kg)	741,000
Solids density, kg/L	2.22	2.26	N/A	Total dry solids volume	328 (86.6)
Slurry volume represented by sample, kL (kgal)	264 (69.7)	1,470 (388)	N/A	Total dry solids density (kg/L)	2.26

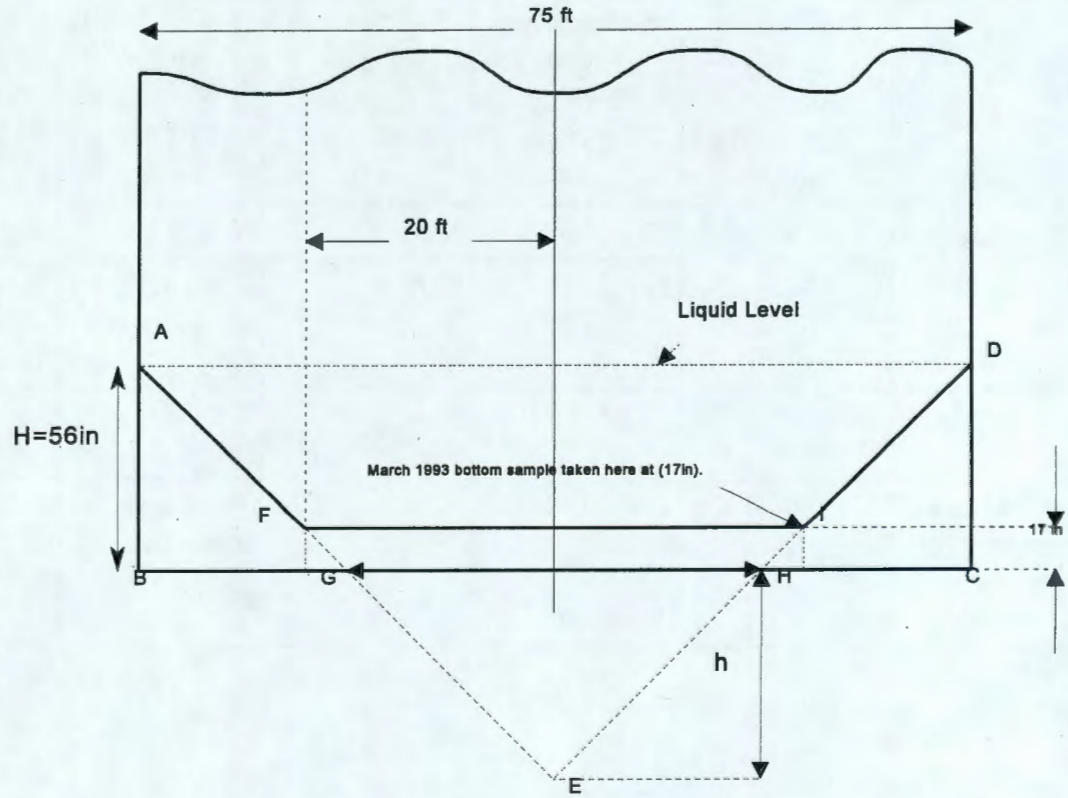
Note:

[1]On a dry weight basis

The dry solids volume predicted by ESP at equilibrium is 328 kL (86.7 kgal). The reported volume for the solids layer is 583 kL (154 kgal) (Hanlon 1997). As mentioned earlier, the March 1993 samples taken 6.1 m (20 ft) from the center of the tank at depths of 42 cm (17 in.) (sample G238) and 107 cm (42 in.) (sample G248) from the bottom of the tank were found to be mostly liquid with a density of 1.38 g/mL. From visual observations of the samples in the sample bottles, only sample G238 had a significant amount of solids (approximately 12 vol%).

Rather than extending across the tank at a uniform height, the exposed solids shown in the internal video of tank 241-AP-105 slope downward in a manner similar to Figure D3-1. The solids form a bowl-like shape. If the solids layer is assumed to resemble Figure D3-1, and sample G238 was taken at the point where the downgrade levels out, a solids volume can be approximated by subtracting the cone A-E-D in Figure D3-1 from cylinder A-B-C-D and then adding back the smaller cone G-E-H and smaller cylinder F-G-H-I. The resulting volume is 337 kL (89 kgal). This value compares reasonably well to the ESP equilibrium value of 328 kL (86.7 kgal), although the ESP value is on a dry basis.

Figure D3-1. Solids Level in Tank 241-AP-105.



A solids volume of 337 kL (89 kgal) is a better estimate for the saltcake in tank 241-AP-105 before the addition of DN waste from tank 241-AN-101 in August/September 1996. That volume was used to generate the best-basis solids inventory shown in Table D3-5. The solids volume reported in Hanlon (1997) cannot be correct because liquid samples were drawn at levels 99 cm (39 in.) below the solid level reported by Hanlon. ESP predicts the salts that have settled at the bottom of the tank and line its walls to consist of approximately 95 weight percent $NaNO_3$ with the rest being KNO_3, NaF, and $NaNO_2$. Weight percent values used to calculate the inventories in Table D3-5 were taken from Table D3-4. The DN waste from tank 241-AN-101 has probably dissolved a portion of this saltcake layer, but the extent to which this has happened is unknown.

Table D3-5. Best-Basis Inventory Estimates for Components in Tank 241-AP-105 Saltcake as of January 31, 1997.

Analyte	Composite Solids Concentration (μg/g)	Total Solids Inventory (kg)[1]
K	13,100	9,970
Na	268,000	203,000
F	6,060	4,610
NO_2	4,880	3,710
NO_3	709,000	538,000

Note:

[1]Based on a volume of 337 kL (89 kgal) and a density of 2.260 kg/L.

D3.2 EVALUATION OF LIQUID LAYER IN TANK 241-AP-105

Between August 27 and August 29, 1995, 2,500 kL (660 kgal) of DSSF were transferred from tank 241-AP-105, leaving 594 kL (157 kgal) of liquid and solid waste in the tank. On August 16, 1996, the tank received 3,660 kL (967 kgal) of DN waste from tank 241-AN-101. In February and March 1997, 3,622 kL (957 kgal) of DN waste was transferred out of the tank.

The only samples taken since the last transfer to tank 241-AP-105 were obtained August/September 1996. The lowest depth from which these samples were taken is 221 cm (87 in.). Appendix B of this report includes the results of the statistical analysis of these samples in addition to samples taken from depths of 107 cm (42 in.) and 43 cm (17 in.) from the bottom of the tank in March 1993 when it contained DSSF and PCN.

A comparison between mean concentrations from samples taken from the upper layer in tank 241-AP-105 and mean concentrations taken from tank 241-AN-101 in August/September 1995, approximately one year before waste was transferred from that tank to tank 241-AP-105, is shown in Table D3-6. Although saltwell liquid and water additions increased the volume in tank 241-AN-101 from 3,834 kL (1,013 kgal) to 4,103 kL (1,084 kgal) before the transfer to tank 241-AP-105, the compared values are reasonably close. The tank 241-AP-105 concentrations are generally lower than the tank 241-AN-101 concentrations but this is consistent with the lower weight percent water value and lower density in the 241-AP-105

samples. The higher nitrate concentration in tank 241-AP-105 could be caused by high nitrate concentrations in the saltwell liquid added to tank 241-AN-101 before the transfer, or re-dissolving of nitrate salts in tank 241-AP-105 after the transfer. The variations for F, PO_4, SO_4, ^{90}Sr, and TOC are the greatest; thus, they have a larger uncertainty. The lower F concentrations in the liquid phase are probably caused by precipitation of NaF (see Section D3.1.2).

Samples taken in March 1993 representing the bottom layer in tank 241-AP-105 are compared in Table D3-7 to the mean of the slurry samples from 242-A Evaporator Campaign 89-1. The compared values are reasonably close. The evaporator slurry sample concentrations all fall within the 95 percent confidence intervals for the March 1993 bottom layer samples (See Appendix B). The March 1993 concentrations are generally lower than the evaporator slurry samples; this is consistent with the higher percentage of water and lower density reported for the March 1993 samples.

Because they are averages of samples taken from the evaporator before being sent to tank 241-AP-105, the slurry sample data have more uncertainty associated with them. However, the reasonable agreement between the slurry sample data and the March 1993 concentrations are a useful check on the analytical results of the latter. Cr, Fe P, F, PO_4, and TOC have the largest variation. Again, the lower F concentrations are likely caused by NaF precipitation. The fact that F, PO_4, and TOC concentrations from the tank 241-AP-105 samples are lower in both comparisons than the source term concentrations suggest that PO_4 and TOC have also precipitated to some extent. This may also account for the lower concentrations of SO_4 and ^{90}Sr in the August/September 1996 samples. In that case, ESP is not fully predicting the behavior of these species.

The August/September 1996 and March 1993 sample results provide the best basis for the liquid inventory in tank 241-AP-105. The August/September 1996 samples are assumed to represent 3,660 kL (967 kgal) of the waste volume in tank 241-AP-105. This is the amount of waste transferred from tank 241-AN-101 in August 1995. The March 1993, samples are assumed to represent 246 kL (65 kgal) of liquid. This is equal to the remaining 583 kL (154 kgal) minus the saltcake volume of 337 kL (89 kgal) calculated in Section D3.1. After February and March 1997 transfers, an estimated 291 kL (77 kgal) of supernatant remained in the tank. This volume is based on a total tank volume of 628 kL (Hanlon 1997), less a predicted solids inventory of 337 kL. For purposes of this report, it was assumed that the composition of the supernatant remained essentially the same as before the 1997 transfers. Results are shown in Tables D3-8 and D3-9.

Table D3-6. Comparison of Analytical Results for the Top Layer in Tank 241-AP-105 to Tank 241-AN-101 as of August, 1995.

Analyte	241-AP-105 Mean Concentrations[1]	241-AN-101 Mean Concentrations[2]	Ratios 241-AP-105/ 241-AN-101
Metals	μg/mL	μg/mL	
Al	17,400	20,900	0.832
Fe	NR	< 20.1	n/a
Na	113,000	128,000	0.883
Anions	μg/mL	μg/mL	
Cl	NR	3,300	n/a
CO_3 [3]	13,400	12,250	1.08
F	308	475	0.648
OH	33,500	31,400	1.07
NO_3	98,300	97,100	1.01
NO_2	46,700	48,200	0.969
PO_4	1,320	2,120	0.623
SO_4	2,180	3,040	0.717
Radionuclides[4]	μCi/L	μCi/L	
^{241}Am	NR	5.16E-05	n/a
^{134}Cs	NR	0.0161	n/a
^{137}Cs	116	128	0.906
^{60}Co	NR	< 0.00413	n/a
$^{239/240}Pu$	NR	5.60E-05	n/a
$^{89/90}Sr$	0.218	0.392	0.556
Physical properties			
Weight percent water	69.5	66.0	1.053
Specific gravity	1.23	1.24	0.992
Total organic carbon	1,490	2,630	0.556

Notes:

NR = not reported

[1]See Appendix B, Tables B3-5 and B3-6
[2]Benar and Amato (1996)
[3]Derived from TIC value
[4]Radionuclides decayed to January 1, 1994

Table D3-7. Comparison of the Analytical Results for the Bottom Layer in Tank 241-AP-105 to Slurry Samples Taken During 242-A Evaporator Campaign 89-1.

Analyte	241-AP-105 Mean Concentrations[1]	Slurry Sample Mean Concentrations[2]	Ratios 241-AP-105/ Slurry Sample
Metals	μg/mL	μg/mL	
Al	12,900	14,700	0.878
B	NR	19.7	n/a
Ca	NR	52.1	n/a
Cr	208	273	0.762
Fe	10.7	16.4	0.652
Mg	NR	16.6	n/a
Np	NR	0.0530	n/a
P	255	429	0.594
K	31,600	37,600	0.840
Si	NR	109	n/a
Na	184,000	217,000	0.848
Zn	NR	91.9	n/a
Anions	μg/mL	μg/mL	
Cl	2,650	3,250	0.815
CO_3	18,300	15,100	1.21
F	334	1,320	0.253
OH	NR	97,240	n/a
NO_3	191,000	214,000	0.892
NO_2	52,000	55,700	0.934
PO_4	513	974	0.527
SO_4	1,110	1,250	0.888
Physical properties			
Weight percent water	57.2	52.1	1.10
Specific gravity	1.37	1.43	0.958
NH_4	NR	809	n/a
Total organic carbon	3,020	4,770	0.633

Notes:

[1]See Appendix B, Table B3-8

[2]Based on the average of samples T-3635, T-3750, T-3789 (Jonas 1989)

Table D3-8. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-105 Supernatant as of May 31, 1997.[1]

Analyte	Supernatant Concentration (μg/mL)	Total Supernatant Inventory (kg)
Al	17,100	4,990
Bi	NR	NR
Ca	NR	NR
Cl	3,260	948
TIC as CO_3	13,700	3,990
Cr	213	62.0
F	310	90.3
Fe	<19.5	<0.903
Hg	NR	NR
K	1,990	580
La	NR	NR
Mn	NR	NR
Na	117,000	34,200
Ni	<4.69	1.37
NO_2	3,300	992
NO_3	104,000	30,400
OH	31,300	9,100
Pb	NR	NR
PO_4	1,270	370
Si	79.9	23.3
SO_4	2,130	621
Sr	NR	NR
TOC	1,590	463
U_{TOTAL}	15.0	34.2
Zr	NR	NR

Note:

[1]Inventories based on a volume of 291 kL (77 kgal).

Table D3-9. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-105 Supernatant as of May 31, 1997 (Decayed to January 1, 1994).[1] (2 Sheets)

Analyte	Supernatant Concentration (μCi/mL)	Total Supernatant Inventory (Ci)
^{3}H	0.00975	2.84
^{14}C	0.000324	0.0940
^{59}Ni	NR	NR
^{60}Co	<0.00731	<2.13
^{63}Ni	NR	NR
^{79}Se	<0.000199	<0.0579
^{90}Sr	0.207	60.2
^{90}Y	0.207	60.2
^{93}Zr	NR	NR
^{93m}Nb	NR	NR
^{99}Tc	0.0602	17.7
^{106}Ru	<0.838	<244
^{113m}Cd	NR	NR
^{125}Sb	<0.0355	<10.4
^{126}Sn	NR	NR
^{129}I	NR	NR
^{134}Cs	<0.0374	<10.9
^{137}Cs	119	34,700
^{137m}Ba	113	33,000
^{151}Sm	NR	NR
^{152}Eu	NR	NR
^{154}Eu	<0.0244	<7.10
^{155}Eu	<0.167	<48.6
^{226}Ra	<1.36	<396
^{227}Ac	NR	NR
^{228}Ra	NR	NR
^{229}Th	NR	NR
^{231}Pa	NR	NR

Table D3-9. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-105 Supernatant as of May 31, 1997 (Decayed to January 1, 1994).[1] (2 Sheets)

Analyte	Supernatant Concentration (μCi/mL)	Total Supernatant Inventory (Ci)
^{232}Th	NR	NR
^{232}U	NR	NR
^{233}U	NR	NR
^{234}U	NR	NR
^{235}U	NR	NR
^{236}U	NR	NR
^{237}Np	<0.00162	0.472
^{238}Pu	<0.000227	<0.0661
^{238}U	NR	NR
$^{239/240}$Pu	<0.000189	<0.0551
^{241}Am	<0.000364	<0.106
^{241}Pu	NR	NR
^{242}Cm	NR	NR
^{242}Pu	NR	NR
^{243}Am	NR	NR
$^{243/244}$Cm	<0.000370	<0.108
^{244}Cm	NR	NR

Note:

[1]Inventories based on a volume of 291 kL (77 kgal).

D4.0 DEFINE THE BEST BASIS AND ESTABLISH COMPONENT INVENTORIES

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with waste management activities, as well as regulatory issues. These activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage.

Chemical and radiological inventory information are generally derived using three approaches: 1) component inventories are estimated using the results of sample analyses; 2) component inventories are predicted using the HDW model based on process knowledge and historical information; or 3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage, and other operating data.

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, and evaluation of chemical information for tank AP-105 was performed. The engineering assessment done in this evaluation should serve as the basis for the best estimate inventory for tank 241-AP-105 for the following reasons:

1. The March 1993 and August/September 1996 samples are the only samples taken from tank 241-AP-105 that represent the current waste contents of the tank.

2. These samples agree reasonably well with samples taken before the waste was transferred to tank 241-AP-105.

3. The HDW model estimate is outdated because of the large number of waste transfers that have occurred subsequent to the date that the HDW model estimate is valid.

4. Because of the lack of sample data for the solids in tank 241-AP-105, ESP calculations provide the best available estimate of the solids composition.

5. The reported solids volume (Hanlon 1997) conflicts with recent sampling events. This evaluation demonstrates that the reported solids volume overstates the amount of solids in the tank.

Best-basis inventory estimates for tank 241-AP-105 are presented in Tables D4-1 and D4-2. Where sample data were not available, solids best basis estimates are based on HDW model estimates for tank AP-105 ratioed to a solids volume of 337 kl (89 kgal) and supernatant

inventories are based on HDW model predictions for tank 241-AN-101 ratioed to a volume of 291 kL (77 kgal). The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

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

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-105 as of May 31, 1997.

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	4,990	S/E	
Bi	73.0	M/E	
Ca	894	M/E	
Cl	948	S/E	241-AN-101 concentration used for top layer (3,300 μg/mL)
TIC as CO_3	3,990	S/E	
Cr	620	S/E	
F	4,700	S/E	4,610 kg estimated for saltcake
Fe	<0.903	S/E	
Hg	1.14	M/E	
K	17,700	S/E	9,970 kg estimated for saltcake
La	0.797	M/E	
Mn	261	M/E	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AP-105 as of May 31, 1997.

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Na	237,000	S/E	203,000 kg estimated for saltcake
Ni	<1.37	S/E	
NO_2	4,700	S/E	3,710 kg estimated for saltcake
NO_3	568,000	S/E	538,000 kg estimated for saltcake
OH	9,100	S/E	
Pb	64.0	M/E	
PO_4	370	S/E	
Si	23.3	S/E	
SO_4	621	S/E	
Sr	0	M/E	
TOC	463	S/E	
U_{TOTAL}	34.2	S/E	
Zr	95.9	M/E	

Note:
[1]S = Sample-based, M = HDW model-based, E = Engineering assessment-based

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-105 as of May 31, 1997 (Decayed to January 1, 1994). (3 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	2.84	S/E	
^{14}C	0.0940	S/E	
^{59}Ni	0.563	M/E	
^{60}Co	<2.13	S/E	
^{63}Ni	55.2	M/E	
^{79}Se	< 0.0579	S/E	
^{90}Sr	60.2	S/E	
^{90}Y	60.2	S/E	
^{93}Zr	5.52	M/E	
^{93m}Nb	4.11	M/E	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-105 as of May 31, 1997 (Decayed to January 1, 1994). (3 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{99}Tc	17.7	S/E	
^{106}Ru	<244	M/E	
^{113m}Cd	26.6	M/E	
^{125}Sb	<10.4	S/E	
^{126}Sn	64.2	M/E	
^{129}I	0.125	M/E	
^{134}Cs	10.9	S/E	
^{137}Cs	34,700	S/E	
^{137m}Ba	33,000	S/E	
^{151}Sm	4,080	M/E	
^{152}Eu	1.26	M/E	
^{154}Eu	7.10	S/E	
^{155}Eu	<48.6	S/E	
^{226}Ra	<396	S/E	
^{227}Ac	3.22E-04	M/E	
^{228}Ra	0.0640	M/E	
^{229}Th	0.00149	M/E	
^{231}Pa	0.00130	M/E	
^{232}Th	0.0106	M/E	
^{232}U	0.225	M/E	
^{233}U	0.863	M/E	
^{234}U	0.646	M/E	
^{235}U	0.0251	M/E	
^{236}U	0.0759	M/E	
^{237}Np	<0.472	S/E	
^{238}Pu	<0.0661	S/E	
^{238}U	0.551	M/E	
$^{239/240}Pu$	<0.0551	S/E	
^{241}Am	<0.106	S/E	
^{241}Pu	135	M/E	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AP-105 as of May 31, 1997 (Decayed to January 1, 1994). (3 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{242}Cm	0.0514	M/E	
^{242}Pu	0.00567	M/E	
^{243}Am	0.00228	M/E	
$^{243/244}Cm$	<0.108	S/E	
^{244}Cm	0.0811	M/E	

Note:

[1]S = Sample-based, M = HDW model-based, E = Engineering assessment-based

D5.0 APPENDIX D REFERENCES

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