0049753

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 640367

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	[] Yes [X] No	August 26, 1997
	6. Project Title/No./Work Order No. Tank 241-T-106	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-ER-544, Rev. 0	10. Related ECN No(s). NA	11. Related PO No. NA

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

13a. Description of Change 13b. Design Baseline Document? [] Yes [X] No

Add Appendix B, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-T-106.

OCT 1998 RECEIVED EDMC

14a. Justification (mark one)

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

14b. Justification Details

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-T-106 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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

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

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1. ECN (use no. from pg. 1) 640367

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

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

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

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

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

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. M. J. Kupfer	M J Kupfer	8-27-97	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	8-27-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J. Jo	J Jo	8-27-97	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-T-106

M. J. Kupfer and R. T. Winward (Meier Associates)
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-T-106 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-544	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-T-106

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(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 B

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

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APPENDIX B

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-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-T-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.

B1.0 CHEMICAL INFORMATION SOURCES

Section 4.0 of this Tank Characterization Report (TCR) provides characterization results from the most recent sampling event for tank 241-T-106. In 1995 two auger samples were obtained from widely spaced risers. The analyses performed were limited to those required by the Safety Screening Data Quality Objective (DQO). Although a portion of the sample solids were dissolved by a fusion procedure, only total alpha activity analysis was performed (i.e., inductively coupled plasma spectroscopy [ICP] and ion chromatography [IC] methods were not used to determine concentrations of other analytes). However, in 1975 a limited number of analyses were performed on a sample of the sludge (Horton 1975). Although these historical results were not qualified according to recent Quality Assurance (QA) protocol, they serve to assist with verification of historical-based content estimates. According to the tank waste history listed earlier in this TCR, the tank contents have not changed (with the exception of drying and radioactive decay) since 1975. Component inventories can be calculated by multiplying the concentration of an analyte by the current tank volume and by the density of the waste. The Hanford Defined Waste (HDW) model document (Agnew et al. 1997a) provides tank content estimates, derived from the Los Alamos National Laboratory (LANL) model, in terms of component concentrations and inventories.

Tank 241-T-106 is a known leaker. However, the quantity of material lost to the soil column is currently unknown. No attempt has been made in this assessment to correct for materials lost to the soil column.

B2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Sample-based inventories derived from the 1975 analytical concentration data (Horton 1975), and HDW model inventories, generated by the HDW model (Agnew et al.

1997a), are compared in Tables B2-1 and B2-2. The tank volume used to generate these inventories is 21 kgal (79,500 kL) (Hanlon 1997). This volume is identical to that reported by Agnew et al. The density used to calculate the sample-based component inventories is 1.29 g/mL (Horton 1975) which is lower than the mean value of 1.49 g/mL reported in Agnew et al. A sample density was not measured from the 1995 sampling event. (The chemical species are reported without charge designation per the best-basis inventory convention.)

A list of references used in this evaluation is provided in Section B5.0.

Table B2-1. Sample-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-106.

Analyte	Sampling inventory estimate[a] (kg)	HDW model inventory estimate[b] (kg)	Analyte	Sampling inventory estimate[a] (kg)	HDW model inventory estimate[b] (kg)
Al	13,000	9,650	NO_2	220	1,770
Bi	NR	474	NO_3	119,000	3,560
Ca	460	337	P as PO_4	7,100	3,990
Cl	NR	52.7	Pb	NR	1,160
Cr	NR	13.5	Si	4,000	192
F	NR	102	S as SO_4	NR	222
Fe	2,500	1,150	Sr	NR	0
Hg	NR	39.1	TIC as CO_3	NR	505
K	NR	12.6	U_{TOTAL}	NR	3,710
Mn	110	0	Zr	NR	0.846
Na	11,000	9,390	H_2O (wt%)	15-17[c]	49.7
Ni	NR	4.83	density g/mL	1.29	1.49

HDW = Hanford Defined Waste
NR = Not reported
[a] Horton (1975)
[b] Agnew et al. (1997a).
[c] This Tank Characterization Report.

Table B2-2. Sample-Based and Hanford Defined Waste-Based Inventory Estimates for Radioactive Components in Tank 241-T-106, Decayed to January 1, 1994.

Analyte	Sampling inventory estimate (Ci)[a]	HDW model inventory estimate[b] (Ci)
^{90}Sr	32,000	600
^{137}Cs	27,000	684
^{239}Pu	NR	84.2

HDW = Hanford Defined Waste
NR = Not reported
[a] Horton (1975)
[b] Appendix E of Agnew (1997a).

B3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed to identify potential errors and/or missing information and that would influence the sample-based and HDW model component inventories.

B3.1 CONTRIBUTING WASTE TYPES

The following abbreviations were used to designate waste types:

1C = First decontamination cycle $BiPO_4$ waste, operational 1944 to 1956
1C2 = First decontamination cycle $BiPO_4$ waste, operational 1952 to 1956
CWR = Reduction and Oxidation (REDOX) Process aluminum cladding waste
2C = Second decontamination cycle $BiPO_4$ waste, operational 1944 to 1951

Waste Transaction History

Tank 241-T-106 is the last tank in a cascade that includes tanks 241-T-104 and 241-T-105. Tank 241-T-106 initially received 2C waste via the cascade tie line from tank 241-T-105 in 1947 (Agnew et al. 1997b, Anderson 1990), but most of the 2C waste was pumped to a crib. From late 1948, 1C waste entered the tank via the cascade until 1954. Most of the supernatant was pumped to a crib and solids level measurements indicated only about 38 kL (10 kgal) of 1C solids. In 1956 tank 241-T-106 began receiving Reduction and Oxidation (REDOX) process cladding waste from tank 241-U-110, and again in 1965 to 1966 from tank 241-S-107. Solids level measurements indicate approximately 34 kL (9 kgal) of cladding waste.

Tank 241-T-106 was filled with supernatant from tank 241-T-105 beginning in 1973. The waste consisted primarily of T Plant decontamination waste and ion exchange waste. Shortly after the transfer, the surface level measurements indicated about 435 kL (115 kgal) waste leaked from the tank. The supernatant was pumped from the tank and the tank was removed from service.

Predicted Current Waste Types and Volumes

Anderson (1990): 1C and CW
Agnew et al. (1997a): 1C2, CWR1, CWR2

Predicted Current Inventory (Agnew et al. 1997a). Agnew also includes 8 kL (2 kgal) of supernatant in tank 241-T-106.

Waste Type	Waste volume kL (kgal)
1C2	38 (10)
CWR1	26 (7)
CWR2	8 (2)

B3.2 EVALUATION OF TECHNICAL FLOWSHEET INFORMATION

Waste compositions from flowsheets for 1C and REDOX process aluminum cladding waste (CWR) waste streams are provided in Table B3-1 (also see Appendixes C and D of Kupfer et al. 1997). The comparative HDW defined waste streams from Agnew et al. (1997a) are also provided in this table. The flowsheet information from Appendixes C and D of Kupfer et al. is based on actual processing history for 1C and Reduction and Oxidation process cladding waste (RCW) respectively.

B3.3 PREDICTED WASTE INVENTORIES

Reference engineering assessment inventories were estimated using an independent assessment that is based on a set of simplified assumptions. The predicted inventories were then compared with the sample-based inventories and the HDW model inventories. The assumptions and observations were based on best technical judgement pertaining to parameters that can significantly influence tank inventories. These parameters include: (a) correct prediction of contributing waste types, correct relative proportions of the waste types, (b) accurate predictions of model flowsheet conditions, fuel processed, and waste volumes, (c) accurate prediction of component solubilities, (d) accurate predictions of physical parameters such as density, percent solids, void fraction (porosity), etc. By using this evaluation the assumptions can be modified as necessary to provide a basis for identifying potential errors and/or missing information that could influence the sample- and model-based inventories. Following are the simplified assumptions and observations used for the evaluation.

1. The 1C and RCW waste streams contributed to solids formation. The relative proportions of 1C waste to RCW waste used for comparison, were, respectively 53:47 based on Agnew et al. (1997a).

   Note: RCW and CWR are both notations for REDOX process cladding wastes (Agnew et al. 1997a).

2. Components listed in the technical flowsheets summarized in Appendixes C and D of Kupfer et al. (1997) were used for the evaluation (refer to Table B3-1).

3. Tank waste mass is calculated using the tank volume listed in Hanlon (1997). While this volume may or may not be correct, both the analytical-based and the model-based inventories are derived using volumes that are quite comparable (i.e., 79.5 kL [21 kgal] from both Hanlon [1997] and Agnew et al. [1997a]). As a result, inventory comparisons are made on the same volume basis.

4. Tanks 241-T-104 (DiCenso et al. 1994) and 241-T-107 (Valenzuela and Jensen 1994) 241-U-204 (Raphael and Tran 1995) and 241-B-108 (Schreiber et al. 1997), which contain only one waste type (1C and RCW, respectively) helped provide the analytical basis for inventories for the 1C and RCW waste types.

5. No radiolysis of NO_3 to NO_2 and no additions of NO_2 to the waste for corrosion purposes are factored into this independent assessment.

6. The 8 kL (2 kgal) supernatant layer in tank 241-T-106 was not included in the engineering assessment-based inventory for several reasons. Supernatant layers tend to be tank specific and can vary significantly from tank to tank with similar wastes, as they generally represent the more recent tank additions which could be from minor fractions of the solid waste or from special additions of liquids into a specific tank. There in no sample analysis for the supernatant in tank 241-T-106 nor is there any HDW model prediction for the supernatant in tank 241-T-106 or any of the other tanks used to produce the engineering assessment-based inventory. It is assumed that the exclusion of the analytical data for the supernatant layer posses no significant error in the predicted inventory for this tank, as the supernatant is usually quite dilute and generally represents less than 2 percent of the total inventory for any given analyte. Obviously the supernatant is usually made up of a higher percentage of water with the rest composed of soluble analytes.

Table B3-1. Technical Flowsheet and Los Alamos National Laboratory Defined Waste Streams.

Analyte	Flowsheet 1C[a] (M)	HDW model 1C2[b] (M)	Flowsheet RCW[c] (M)	HDW model RCW[b] (M)
NO_3	1.44	1.63	0.66	0.88
NO_2	0.058	0.044	1.2	1.36
SO_4	0.063	0.0696	0	0.013
Al	0.083	0.062	1.86	1.71
Bi	0.012	0.012	0	0
Fe	0.032	0.05	0	0.015
Si	0.031	0.053	0.052	0.023
U	0.00096	0.0007	0.0061	0.019
$Cr^{+3/+6}$	0.0033	0.0065	0	0.0030
PO_4	0.258	0.289	0	0
F	0.170	0.186	0	0
Na	2.17	2.94	4.4	3.46
K	0	0.00905	0	0.002
Ce	0.00019	NR	0	NR
Hg	0	2.19 E-05	0	0

[a] Appendix C of Kupfer et al. (1997) - 1C waste also contains cladding waste

[b] Appendix B of Agnew et al. (1997a). Reduction and Oxidation (REDOX) cladding waste composition is average of CWR1 and CWR2 (adjusted for waste volumes).

[c] Appendix D of Kupfer et al. (1997) Average concentrations for REDOX flowsheets 4 through 8.

Volume Ratio of Waste Types. The HDW model predicts 38 kL (10 kgal) 1C waste and 34 kL (9 kgal) RCW waste in tank 241-T-106. The relative contributions of the waste type often can be estimated using analytical data by determining the concentrations of chemical constituents in the tank that are found only in one of the contributing waste types. However, since only limited analytical information exists for tank 241-T-106, the waste transaction histories were examined and concur with the inventories listed in the Tank Layer Model (TLM) from Agnew et al. (1997a) as derived from the Waste Transaction and Status Summary (WSTRS) (Agnew et al. 1997b). The HDW model (Agnew et al. 1997a) predicts the following waste types in tank 241-T-106.

Based on the information just discussed, this evaluation assumes the volume for the waste types as follows:

Waste types	Waste volume kL (kgal)
REDOX Aluminum cladding waste	34 (9)
1C $BiPO_4$ solids	38 (10)
Supernatant	8 (2) [Supernatant not assessed]

B3.4 BASIS FOR ASSESSING CLADDING WASTE INVENTORY IN TANK 241-T-106

Table B3-2 shows the analyte concentrations from the upper half of segment 1, cores 172 and 173 of tank 241-B-108 (Schreiber et al. 1997). The analytical data for tank 241-U-204 solids (Raphael and Tran 1995) are also shown for comparison in Table B3-2. Tank 241-U-204 solids consist entirely of aluminum cladding waste from the REDOX process. Also shown is the defined waste composition for CWR1 from the HDW model. The high aluminum and silicon concentrations in the samples of tanks 241-B-108 and 241-U-204 indicate that the sample data are consistent with the flowsheet basis for cladding waste. The presence of small amounts of uranium suggest that some fuel core material also is present. The high concentration of aluminum in the samples is comparable to that for the HDW model defined waste. The HDW model CWR1 defined waste indicates much less silicon, whereas significant concentrations of silicon were found in the samples. The presence of silicon in aluminum cladding waste is expected since the decladding process attacks the Al-Si alloy bonding. It is not clear why the HDW model indicates so little silicon for the defined waste.

The analytical data for tanks 241-B-108 and 241-U-204 were used as the basis for estimating the inventory of components for the cladding waste It is assumed that the cladding waste represents 34 kL (9 kgal) of waste estimated to be in the tank.

The inventory for the cladding waste was calculated as the product of the average of the component concentrations from Table B3-2, a waste volume of 34 kL (9 kgal), and the HDW estimated density of 1.49 g/mL for tank 241-T-106. The inventory in tank 241-T-106 attributed to CWR1 waste is calculated from data associated with Table B3-2 and is shown in Table B3-4 in column 2.

The following is an example calculation for the aluminum content in the cladding waste in tank 241-T-106:

(298,500 + 209,500)/2 μg/g x 1.0 E-06 g/μg x 1.49 kg/L(HDW density for tank 241-T-106) x 34 kL x 1,000 L/kL = 12,900 kg Al

Table B3-2. Chemical Compositions of Cladding Wastes.

Analyte	241-U-204[a] (μg/g)	241-B-108[b] (μg/g)	HDW model CWR1[c] (μg/g)
Al	298,500	209,500	170,733
Bi	1,630	3,593	0
Ca	1,700	<2,664	2,732
Cl	NR	1,533	141
CO_3	NR	NR	4,091
Cr	NR	525	59.8
F	NR	11,560	0
Fe	3,680	4,804	5,201
K	NR	NR	33.9
La	NR	<1,333	0
Mn	110	<267	0
Na	24,500	161,300	101,977
Ni	NR	NR	33.7
NO_3	NR	87,220	20,039
NO_2	NR	16,510	24,874
Pb	9,870	<2,664	13,762
PO_4	2,850	96,040	0
Si	3,220	2,245	319
SO_4	650	11,690	455
Sr	NR	<267	0
U	1,850	1,862	24,378
Zr	25	<267	0
Radionuclides (μCi/g)			
^{90}Sr	NR	NR	1.16
^{137}Cs	NR	32.3	1.33
$^{239/240}Pu$	NR	NR	1.04

HDW = Hanford Defined Waste
NR = Not reported
[b] Raphael and Tran (1995)
[b] Upper half of segment 1 from cores 172 and 173 (Schreiber et al. 1997)
[c] Agnew et al. (1997a).

B3.4 BASIS FOR ASSESSING 1C WASTE IN TANK 241-T-106

An estimate of the 1C1 sludge layer can be made by comparison to other tanks containing 1C sludge. In the bismuth phosphate process the 1C waste was combined with the CW stream before discharge from the plant.

Several tanks received 1C/CW waste directly from T Plant including tanks 241-T-104, 241-T-107, 241-TX-109, 241-TX-113, 241-U-110, 241-TY-101, and 241-TY-103. Sample data are not available for the solid layers of tanks 241-TX-109 or 241-TX-110. The 1C waste was mixed with substantial quantities of other wastes in tanks 241-TY-101, 241-TY-103, and 241-U-110, making it impossible to accurately determine the composition of the 1C/CW waste sludge. Two tanks (241-T-104 and 241-T-107) provide the best examples of T Plant 1C/CW sludge composition. The TCR for tank 241-BX-112 (Winkelman and Morris 1996) presents the sample-based composition for the 1C waste from B Plant which was compared with composition data from tanks 241-T-104 and 241-T-107. Calculations show that the composition for all three tanks are consistent with the flowsheet basis for the first cycle $BiPO_4$ process (Schneider 1951, Kupfer et al. 1997).

The composition of waste in tanks 241-T-104 and 241-T-107, based on the corresponding TCR (DiCenso et al. 1994 and Valenzuela and Jensen 1994), is provided in Table B3-3. The average of these two compositions are used for estimating the composition of the 1C layer in tank 241-T-106. Also shown for comparison is the 1C1 defined waste from Agnew et al. (1997a).

The inventory for the 1C waste components for tank 241-T-106 was calculated as the product of the average component concentrations in Table B3-3, a waste volume of 38 kL (10 kgal), and a density of 1.49 g/mL and is shown in column 3 in Table B3-4.

Table B3-3. Component Concentrations for Tanks 241-T-104 and 241-T-107. (2 Sheets)

Analyte	Tank 241-T-104[a] (μg/g)	Tank 241-T-107[b] (μg/g)	Average concentration (μg/g)	HDW model[c] (μg/g)
Ag	6.4	7.37	6.9	NR
Al	16,200	16,300	16,200	8,633
Bi	18,900	12,000	15,400	9,245
Ca	1,450	760	1,100	2,172
Cl	670	540	605	833
CO_3	<500	2,970	1,480	3,252
Cr	901	360	631	191
F	8,570	11,400	9,980	1,997
Fe	9,020	29,200	19,100	13,917
Hg	0.127	0.14	0.13	13.8
K	89.0	234	162	200
La	<10.4	<2	<10	0
Mn	61.8	213	137	0
Na	64,500	130,200	97,400	85,045
Ni	11.3	267	139	53.1
NO_2	4,080	11,700	7,890	10,148
NO_3	58,000	74,500	66,200	45,103
Pb	NR	649	649	0
PO_4	17,800	113,500	65,600	77,726
Si	6,520	6,050	6,280	3,455
SO_4	3,900	9,980	6,940	3,779
Sr	99.1	878	489	0
TOC	706	963	835	0
U	897	26,400	13,600	32,786
Zr	67.5	93	80	16.5
Radionuclide[d] (μCi/g)				
^{90}Sr	2.63	108	54.0	10.0
^{99}Tc	5.79 E-04	NR	5.79 E-04	7.1 E-04
^{137}Cs	0.199	12.0	5.96	11.4
^{154}Eu	0.0041	<0.00463	0.0038	5.3 E-04
^{155}Eu	0.00342	<0.0149	0.0030	0.0027

Table B3-3. Component Concentrations for Tanks 241-T-104 and 241-T-107. (2 Sheets)

Analyte	Tank 241-T-104[a] (μg/g)	Tank 241-T-107[b] (μg/g)	Average concentration (μg/g)	HDW model[c] (μg/g)
Radionuclide[d] (μCi/g)				
^{238}U	2.98 E-06	NR	4.5 E-05[e]	0.0109
$^{239/240}Pu$	0.14	0.131	0.136	0.045
^{241}Am	0.0173	0.0141	0.157	2.7 E-04
Density (g/mL)	1.29	1.51	1.40	1.36
Wt% H_2O	70.5%	56.0%	63.2%	65.6

HDW = Hanford Defined Waste
[a] DiCenso et al. (1994)
[b] Valenzuela and Jensen (1994)
[c] Agnew et al. (1997a), Appendix B, 1C2 waste
[d] Decayed to January 1, 1994 to match HDW model
[e] Curie value escalated to match the average chemical uranium concentration for the two tanks.

B3.5 ESTIMATED INVENTORY FOR TANK 241-T-106

The chemical inventory and radionuclide inventory for selected analytes for the cladding waste, and 1C sludge components in tank 241-T-106 are provided in Table B3-4. The inventories estimated by the HDW model (Agnew et al. 1997a) are included for comparison. Comments and observations regarding these inventories are provided by component in the text following Table B3-4.

Table B3-4. Estimated Chemical Inventory for Tank 241-T-106 (kg). (2 Sheets)

Analyte	Cladding waste[a]	1C waste	Engineering total tank	Sampling[a] total tank	HDW model[b]
Al	12,900	914	13,800	13,000	9,650
Bi	133	869	1,000	NR	474
Ca	111	62	173	460	337
Cl	77.8	34.1	112	NR	52.7
CO_3	NR	83.5	83.5	NR	505
Cr	26.6	35.6	62.2	NR	13.5
F	587	563	1,150	NR	102
Fe	215	1,080	1,300	2,500	1,150

Table B3-4. Estimated Chemical Inventory for Tank 241-T-106 (kg). (2 Sheets)

Analyte	Cladding waste[a]	1C waste	Engineering total tank	Sampling[a] total tank	HDW model[b]
Hg	NR	0.007	0.007	NR	39.1
K	NR	9.1	9.1	NR	12.6
La	<68	<0.56	<68	NR	0
Mn	<9.57	7.73	<17.3	110	0
Na	4,710	5,490	10,200	11,000	9,390
Ni	NR	7.8	7.8	NR	4.83
NO_2	838	445	1,280	220	1,770
NO_3	4,420	3,730	8,150	119,000	3,560
OH	NR	NR	NR	NR	24,000
Pb	318	36.6	355	NR	1,160
PO_4	2,510	3,700	6,210	7,100	3,990
Si	139	354	493	4,000	192
SO_4	313	391	704	NR	222
Sr	<13.6	27.6	<41.2	NR	0
TOC	NR	47.1	47.1	NR	0
U	94.2	767	861	NR	3,710
Zr	<7.4	4.5	<11.9	NR	0.846
Radionuclides (Ci)[c]					
^{90}Sr	NR	3,050	3,050	32,000	600
^{137}Cs	1,640	336	1,980	27,000	684
$^{239/240}Pu$	NR	7.67	7.67	NR	96.9
^{241}Am	NR	8.85	8.85	NR	0.0305

HDW = Hanford Defined Waste
[a] Based on Horton (1975)
[b] Agnew et al. (1997a)
[c] Radionuclides decayed to January 1, 1994.

Aluminum. The engineering assessment-based, and sampling-based inventories are very close for aluminum. The HDW model-based inventory value is about 70 percent that of the engineering assessment. The aluminum concentrations in both the 1C and CWR comparison samples are higher than those for the HDW model 1C and CWR waste types.

This implies that the model 1C and CWR1 concentrations are lower than the actual values found in tanks containing these wastes. The HDW model assumes 90 percent aluminum partitions to the solids in 1C2 waste, and that only 20 percent aluminum partitions to RCW. Since partitioning of aluminum is important for defining glass compositions and glass volumes for low-level waste (LLW) and high-level waste (HLW), the basis for aluminum partitioning factors should be examined closer, based on tank samples and process development testing.

Bismuth. The engineering assessment-based inventory is over twice that of the HDW model-based inventory. The 1C defined waste from the HDW model is about 60 percent of the 1C predicted by the engineering analysis. The HDW model predicts that only 68 percent of the bismuth precipitates with the solids whereas sample analyses indicate bismuth precipitates essentially 100 percent. Additionally, the HDW model predicts no bismuth from the CWR waste stream which also accounts for the major difference in predicted values.

Fluoride. The engineering assessment-based inventory is about eleven times higher than that predicted by the HDW model-based inventory. The fluoride concentrations in the 1C comparison tanks are 4 to 6 times higher than those in the predicted HDW 1C2 stream. The water insoluble solids may contain fluoride, but it is not possible to determine how much until an analytical method that measures total fluoride is utilized. The fluoride concentration predicted for the CWR1 waste is fairly high and the HDW model predicts no fluoride in CWR1 waste. It is likely that the fluoride content in the CWR comparison samples (specifically tank 241-B-108) may be biased by the presence of 1C salt cake. For this assessment only the contribution from the 1C waste is included in the best-basis estimate.

Iron. The engineering assessment-based Fe inventory is comparable to that predicted for the HDW model inventory. The HDW 1C iron concentration is about 25 percent lower that of the engineering assessment-based concentrations. However, the engineering-based concentration may be biased slightly high because of the high iron concentration in tank 241-T-107. Analytical error and/or much higher corrosion than expected could be possible.

Manganese. This assessment and the HDW model both predict little to no manganese in tank 241-T-106. Records do not indicate additions of manganese as part of the flowsheet. However, some manganese was detected in the sample. The source may be waste from decontamination of equipment at T Plant using $KMnO_4$. Agnew et al. (1997a) shows that decontamination waste (DW) was added to tank 241-T-106 in 1973 (see Section B3.1).

Sodium. The engineering assessment-based inventory is slightly higher than that predicted by the HDW model. The engineering assessment-based inventory may be biased slightly high due to the high sodium content for the CWR comparison samples (i.e., tank 241-B-108). It is thought that this sample may contain some salt cake.

Nitrate. The NO_3 inventory predicted by this engineering assessment is about twice that of the HDW model. Both the HDW model and this engineering assessment assume all NO_3 to remain in the aqueous portion, and the concentrations of nitrate in 1C waste is

reasonably close with the HDW model being about 25 percent lower. The major difference in concentration between the engineering assessment and the HDW model concentrations is in the CWR1 waste. The engineering assessment concentration is over four times higher than that estimated in the HDW model. The CWR sample tank 241-B-108 may contain salt cake, thus biasing the nitrate concentration high. The sample-based inventory is extremely high. Based on anion/cation balance, the analytical value is considered a flyer. Because of the apparent anomalies in the tank samples, the HDW estimate for nitrate is used as the best basis.

Phosphate. The PO_4 inventory predicted by the engineering assessment is about 56 percent higher than that predicted by the HDW model. The concentration of phosphate in 1C waste is only about 21 percent lower for the engineering analysis than that in the HDW flowsheet. However a high concentration of phosphate is shown for the CWR1 waste in the engineering assessment, whereas the HDW flowsheet for CWR1 waste predicts no phosphate. The phosphate concentration in the CWR waste sample (tank 241-B-108) may be biased high due to the apparent presence of salt supernatants from the $BiPO_4$ process. For this reason the HDW model value for phosphate is chosen as the best basis.

Potassium. The flowsheets for 1C in Appendix C and for RCW in Appendix D do not indicate additions of potassium as part of the flowsheets. the HDW model shows potassium in the 1C defined waste. It is likely present as a contaminant from sodium hydroxide which was used to neutralize the acidic wastes. There is also evidence that potassium entered the tank as $KMnO_4$ from decontamination activities at T Plant. The engineering assessment-based inventory matches the HDW model-based inventory fairly well (within about 25 percent) and both predict very low amounts of potassium in this tank.

Silicon. The engineering assessment silicon inventory predicted is approximately two and one half times that predicted by the HDW model. The apparent explanation is that this assessment assumes that all silicon precipitates while the HDW model assumes a significant portion of the silicon is in the aqueous stream that is sent to cribs. The older (1975) sample data is judged not to be representative of the current tank contents. Both the 1C and CWR1 concentration predictions of the HDW model are considerably lower than that for the engineering assessment. The major difference resides in the CWR1 waste where the HDW model greatly underestimates the concentration of silicon. It is suggested that the HDW model needs to adjust the silicon estimate in both of these waste types.

Sulfate. The HDW inventory is over three times lower than the engineering assessment inventory estimated by this evaluation. The 1C concentration for sulfate for the HDW model is about one half that found in the engineering assessment. The CWR1 concentration again is much different as the engineering assessment is almost 26 times that of the HDW model. The HDW model assumes sulfate is totally soluble. The sample data suggest that significant amounts of sulfate precipitate with the solids.

Total Hydroxide. Once the best-basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes.

In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. No such adjustments were needed in this tank. This charge balance approach is consistent with that used by Agnew et al. (1997a).

B4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

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

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

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort an evaluation of chemical information for tank 241-T-106 was performed, including the following:

- Data from a sludge sample (Horton 1975).
- Analytical data from two waste tanks (241-T-104 and 241-T-107) which contain $BiPO_4$ process 1C solids.
- Analytical data from two waste tanks (241-U-204 and 241-B-108) which contain CWR1 process solids.
- An inventory estimate generated by the HDW model (Agnew et al. 1997a).

Based on this evaluation a best-basis inventory was developed for tank 241-T-106. The estimated inventory was based on the composition data for tanks 241-T-104 and 241-T-107 which contain 1C waste solids and the composition data for tanks 241-U-204 and 241-B-108 which contain CWR1 waste for the following reasons:

- Since the waste solids in tank 241-T-106 were not completely sampled and the sample was taken in 1975 it is unlikely that the sample-based inventory is representative of the current entire tank.
- Waste transactions based on Anderson (1990) for tank 241-T-106 show significant quantities of aluminum cladding waste as well as 1C waste solids entering the tank. The HDW model also predicts 1C waste and CWR waste in the tank. The

HDW model consistently shows different concentrations of several analytes than does the analytical data for the same waste types found in other tanks.

The best-basis inventory estimates for tank 241-T-106 are shown in Tables B4-1 and B4-2. In most cases an engineering assessment basis was used for analytes. In many cases the older analytical data for tank 241-T-106 showed reasonable agreement with the engineering assessment-based inventories. The 7.6 kL (2 kgal) supernatant was not included as part of the best-basis because there is no sample analysis for the supernatant in tank 241-T-106 nor is there any HDW model prediction for the supernatant in tank 241-T-106, nor for any of the other tanks used to produce the engineering assessment-based inventory.

It is assumed that the exclusion of the analytical data for the supernatant layer posses no significant error in the predicted best-basis inventory for this tank, as the supernatant is usually quite dilute and generally represents less than 2 percent of the total inventory for any given analyte. Obviously the supernatant is usually made up of a higher percentage of water with the rest composed of soluble analytes.

The HDW model inventory values for phosphate and nitrate were chosen as the best-basis since there was an apparent bias to these data for the REDOX cladding waste tank 241-B-108.

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. 1997a). 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 inventory values reported in Tables B4-1 and B4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Table B4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-T-106 (Effective May 31, 1997).

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	13,800	E	
Bi	1,000	E	
Ca	173	E	
Cl	112	E	
TIC as CO_3	83.5	E	Poor sample basis
Cr	62.2	E	
F	563	E	Based on 1C comparison sample only
Fe	1,300	E	
Hg	39.1	M	No sample basis
K	9.1	E	Poor sample basis
La	<68	M	Poor sample basis
Mn	<17.3	E	
Na	10,200	E	
Ni	7.8	E	Poor sample basis
NO_2	1,280	E	
NO_3	3,560	M	
OH_{TOTAL}	30,700	C	
Pb	355	E	
PO_4	3,990	M	
Si	493	E	
SO_4	704	E	
Sr	<41.2	E	Poor sample basis
TOC	47.1	E	Poor sample basis
U_{TOTAL}	861	E	
Zr	<11.9	E	Poor sample basis

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3

Table B4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-106, decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.0635	M	
^{14}C	0.00925	M	
^{59}Ni	0.00263	M	
^{60}Co	0.00394	M	
^{63}Ni	0.244	M	
^{79}Se	0.00203	M	
^{90}Sr	3,050	E	Poor sample basis
^{90}Y	3,050	E	Based on ^{90}Sr
^{93}Zr	0.00964	M	
^{93m}Nb	0.00787	M	
^{99}Tc	0.0670	M	
^{106}Ru	3.66 E-07	M	
^{113m}Cd	0.0286	M	
^{125}Sb	0.00897	M	
^{126}Sn	0.00305	M	
^{129}I	1.27 E-04	M	
^{134}Cs	3.85 E-04	M	
^{137}Cs	1,980	E	Poor sample basis
^{137m}Ba	1,870	E	Based on ^{137}Cs
^{151}Sm	7.39	M	
^{152}Eu	0.0166	M	
^{154}Eu	0.0866	M	
^{155}Eu	0.948	M	
^{226}Ra	3.22 E-07	M	
^{227}Ac	1.66 E-06	M	
^{228}Ra	3.26 E-11	M	
^{229}Th	3.32 E-09	M	
^{231}Pa	3.83 E-06	M	
^{232}Th	3.70 E-12	M	
^{232}U	5.86 E-05	M	

Table B4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-106, decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{233}U	2.07 E-06	M	
^{234}U	1.37	M	
^{235}U	0.0571	M	
^{236}U	0.0421	M	
^{237}Np	4.75 E-04	M	
^{238}Pu	2.10	M	
^{238}U	1.24	M	
$^{239/240}Pu$	7.67	E	Poor sample basis
^{241}Am	8.85	E	
^{241}Pu	95.5	M	
^{242}Cm	2.37 E-04	M	
^{242}Pu	3.12 E-04	M	
^{243}Am	2.46 E-07	M	
^{243}Cm	5.34 E-06	M	
^{244}Cm	7.30 E-06	M	

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

B5.0 APPENDIX B REFERENCES

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