EDMC # 47707

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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635537

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 []	Leela M. Sasaki, Data Assessment and Interpretation, R2-12, 373-1027	[] Yes [X] No	08/07/97
	6. Project Title/No./Work Order No. Tank 241-T-107	7. Bldg./Sys./Fac. No. 241-T-107	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-382, Rev. 1	10. Related ECN No(s). ECNs: 614165, 635447	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.

SEP 1997 RECEIVED EDMC

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)

See attached distribution.

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): ECN-635537

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.	L.M. Sasaki L M Sasaki	8/20/97	PE		
Cog. Mgr.	K.M. Hall Kathleen M. Hall	8/20/97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-T-107

Leela M. Sasaki
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ECN-635537 UC: 2070
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Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-T-107, 241-T-107, T-107, T 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-T-107. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

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(2) Title
Tank Characterization Report for Single-Shell Tank 241-T-107

CHANGE CONTROL RECORD

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3.0 BEST-BASIS INVENTORY ESTIMATE

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

Chemical inventory information generally is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The most recent model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1997). Not surprisingly, information derived from these two different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Hodgson and LeClair 1996). Appendix D contains the complete narrative regarding the derivation of the inventory estimates presented in Tables 3-1 and 3-2.

Table 3-1. Best Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-107. (2 sheets)

Analyte	Total Inventory (kg)	Best-Basis[1] (S, M, C or E)	Comment
Al	16,200	S	
Bi	11,100	S	
Ca	1,480	S	
Cl	541	S	
TIC as CO_3	4,180	S	
Cr	343	S	
F	11,400	S	Based on water soluble portion only.
Fe	27,000	S	
K	231	S	
Mn	201	S	
Na	1.217E+05	S	
Ni	289	S	

Table 3-1. Best Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-107. (2 sheets)

Analyte	Total Inventory (kg)	Best-Basis[1] (S, M, C or E)	Comment
NO_2	11,700	S	
NO_3	74,600	S	
OH	50,500	C[2]	charge balance calculation
Pb	636	S	
P as PO_4	1.128E+05	S	
Si	6,000	S	
S as SO_4	9,860	S	
Sr	852	S	
TOC	1,680	S	
U_{TOTAL}	22,400	S	
Zr	112	S	

Note:

[1]S = sampling, M = HDW model (Agnew et al. 1996a), and E = Engineering assessment.

[2]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 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-107 Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{3}H	0.219	M	
^{14}C	0.0561	M	
^{59}Ni	0.016	M	
^{60}Co	0.00782	M	
^{63}Ni	1.4	M	
^{79}Se	0.0118	M	
^{90}Sr	107000	S	
^{90}Y	107000	S	based on ^{90}Sr
^{93m}Nb	0.0485	M	
^{93}Zr	0.0562	M	
^{99}Tc	0.388	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-107 Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{106}Ru	1.84 E-10	M	
^{113m}Cd	0.114	M	
^{125}Sb	0.00422	M	
^{126}Sn	0.0175	M	
^{129}I	7.22 E-04	M	
^{134}Cs	6.69 E-05	M	
^{137m}Ba	11500	S	based on ^{137}Cs
^{137}Cs	12200	S	
^{151}Sm	44.6	M	
^{152}Eu	0.00547	M	
^{154}Eu	0.105	M	
^{155}Eu	0.828	M	
^{226}Ra	5.03 E-06	M	
^{227}Ac	2.54 E-05	M	
^{228}Ra	7.45 E-11	M	
^{229}Th	1.44 E-08	M	
^{231}Pa	5.28 E-05	M	
^{232}Th	1.74 E-11	M	
^{232}U	1.22 E-04	M	
^{233}U	7.33 E-06	M	
^{234}U	10.3	M	
^{235}U	0.464	M	
^{236}U	0.0659	M	
^{237}Np	0.00233	M	
^{238}Pu	0.0347	M	
^{238}U	10.5	M	
$^{239/240}Pu$	148	S	
^{241}Am	13.8	S	
^{241}Pu	0.41	M	
^{242}Cm	2.20 E-05	M	
^{242}Pu	1.25 E-06	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-107 Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{243}Am	5.45 E-08	M	
^{243}Cm	3.26 E-07	M	
^{244}Cm	8.34 E-07	M	

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

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-107

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-107

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available waste related information for tank 241-T-107 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

D1.0 IDENTIFY/COMPILE INVENTORY SOURCES

Appendix B provides the characterization results from the most recent sampling event. Section B3.4 provides mean concentrations calculated from the analytical results. Three push-mode core samples were obtained from three risers in November 1992 to March 1993. Samples from each core and core composites from two cores were analyzed.

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 HDW model document (Agnew et al. 1996a) provides tank content estimates, derived from the Los Alamos National Laboratory model, in terms of component concentrations and inventories. Appendix D lists the data sources used in this evaluation.

D2.0 COMPARE COMPONENT INVENTORY VALUES

The sample-based inventory, derived from analytical mean concentration data for the most recent sampling event (see Appendix B), and model-based inventory, generated by the HDW model (Agnew et al. 1996a), are compared in Tables D2-1 and D2-2. (The chemical species are reported without charge designation per the best-basis inventory convention). Table D2-1 compares nonradioactive components on a kilogram basis, and Table D2-2 compares the radioactive components on a curie basis.

The sample-based inventory listed in Tables D2-1 and D2-2 was calculated by multiplying each mean composite fusion analyte concentration value by the current tank volume, 655 kL (173 kgal) (Hanlon 1996), and by the mean density of the waste, 1.51 g/mL (see Appendix B). At the time the tank was sampled, the waste volume was reported as 681 kL (180 kgal) with

647 kL (171 kgal) of sludge and 34 kL (9 kgal) of supernatant. The HDW model-based inventory was derived using this volume and 1.28 g/mL as the mean density.

Table D2-1. Sampling-Based and Hanford Defined Waste-Based Inventory Estimates for Nonradioactive Components in Tank 241-T-107.

Analyte	Sampling[1] Inventory Estimate (kg)	HDW[2] Inventory Estimate (kg)	Analyte	Sampling[1] Inventory Estimate (kg)	HDW[2] Inventory Estimate (kg)
Al	16,200	8,300	Ni	289	44.1
Bi	11,100	10,400	NO_2	11,700	5,330
Ca	1,480	1,960	NO_3	74,600	15,000
Cd	6.8	nr	OH	nr	28,800
Cl	541	340	P as PO_4	1.128E+05	81,900
Cr	343	127	Si as SiO_3	6,000	1,150
F[3]	11,400	2,030	S as SO_4	9,860	2,780
Fe	27,000	11,700	Sr	852	0
FeCN/CN	68.8	nr	TIC	4,180	2,930
Hg	nr	13.7	TOC	1,680	0
K	231	81.7	U_{TOTAL}	22,400	88
Mg	229	nr	Zr	112	608
Mn	199	nr	H_2O (wt%)	4.55E+05 (46)	6.26E+05 (72)
Na	1.217E+05	72,600	Density (g/mL)	1.51	1.28
NH_3	nr	1.97			

Notes:

nr = not reported

[1]Appendix B
[2]Agnew et al. (1996a), solids only
[3]Fluoride based on water soluble portion only.

Table D2-2. Sampling and Hanford Defined Waste Predicted Inventory Estimates for Radioactive Components in Tank 241-T-107.

Analyte	Sampling[1] Inventory Estimate (Ci)	HDW[2] Inventory Estimate (Ci)	Analyte	Sampling[1] Inventory Estimate (Ci)	HDW[2] Inventory Estimate (Ci)
^{90}Sr	1.068E+05	69.8	^{241}Am	13.8	nr
^{99}Tc	50	nr	Total α	429	nr
^{137}Cs	12,200	7,890	Total β	3.264E+05	nr

Notes:

nr = not reported

[1]Appendix B
[2]Agnew et al. (1996a)

D3.0 REVIEW AND EVALUATION OF COMPONENT INVENTORIES

The following evaluation of tank contents is performed to identify potential errors and/or missing information that would influence the sampling-based and HDW model component inventories. Computations for the HDW model are based on the assumption that most solid waste in tank 241-T-107 is a single waste type, 1C waste; the remaining unknown waste has also been designated as 1C. The implication is that all tank waste is a single type. Both the waste transfer history and the sampling results indicate that other waste types have contributed to the solids in tank 241-T-107. Appendix A includes a complete summary of the waste transfer history of tank 241-T-107. An abbreviated summary follows and highlights the waste types added to the tank that may have an effect on the solid waste inventory.

Tank 241-T-107 is the first tank in a cascade that includes tanks 241-T-108 and 241-T-109. The tank was filled in 1945 and 1946 with 1C waste and was undisturbed until 1951 when over half the supernatant was removed. The tank then received TBP waste, also known as uranium recovery (UR) waste, until mid-1953. The supernatant was removed again and replaced with unconcentrated, ferrocyanide-scavenged TBP waste. Between 1954 and late 1966, no waste transfers into or out of tank 241-T-107 were recorded, and the waste volume remained constant.

Tank 241-T-107 received cladding waste in 1967. Both aluminum and Zircaloy CW are expected in the tank. In 1969, approximately half the waste content, mostly liquids with a small amount of solids, was removed from tank 241-T-107. In 1973, the tank received ion

exchange (IX) waste, which was immediately distributed to other tanks. In 1976, tank 241-T-107 was removed from service and designated inactive.

D3.1 CONTRIBUTING WASTE TYPES

The waste types expected to have accumulated in tank 241-T-107, as reported by various sources, are listed in Table D3-1. The waste transfer history (see Appendix A) reveals that several waste types were added to tank 241-T-107. The HDW model (Agnew et al. 1996a) assumes these other waste types do not contribute to the tank inventory significantly at this time. Agnew et al. (1996a) predicts the presence of 496 kL (131 kgal) of 1C1 waste, and an additional 151 kL (40 kgal) of unknown waste assigned as 1C1. The calculations that follow indicate constituents of other waste types are present.

Table D3-1. Expected Solids for Tank 241-T-107.

Reference	Waste Type
HDW Model (Agnew et al. 1996a)	1C1
SORWT (Hill et al. 1995)	1C, CW, UR
WSTRS (Agnew et al. 1996b) (see Appendix A)	1C1, CW, UR, IX

Notes:

1C = First cycle decontamination $BiPO_4$ waste
1C1 = First cycle decontamination $BiPO_4$ waste, specifically before 1950
CW = Cladding waste produced at PUREX from dissolution of aluminum and/or Zircaloy fuel cladding
IX = Ion exchange waste from the cesium recovery process at B Plant
SORWT = Sort of Radioactive Waste Types (model)
UR = Uranium recovery waste from uranium recovery operations; also called TBP waste

D3.2 EVALUATION OF TECHNICAL INFORMATION

Table D3-2 compares technical flowsheet information for the 1C (Kupfer 1996) and TBP (Hill et al. 1995) waste streams and the corresponding HDW model waste streams (Agnew et al. 1996a). According to the HDW model, cladding wastes were sent to the same tanks as first decontamination cycle waste until 1954. The model assumes a mixture of the two waste types, with cladding waste making up approximately 24 percent of the waste stream. The HDW also divides the pre-1950 1C waste from the waste transferred to the tanks after 1950, designating them as 1C1 and 1C2, respectively. The tank was filled in 1946 and was undisturbed until 1951; therefore, only the 1C1 waste type is predicted to be in the tank. According to the transfer history, the tank did not receive additional 1C waste after 1951.

Table D3-2. Technical Flowsheet and Hanford Defined Waste Streams.

Analyte	Flowsheet[1] 1C/CW (*M*)	Flowsheet[2] TBP (*M*)	HDW[3] 1C/CW (*M*)	HDW[3] TBP (*M*)
Al	0.0826	nr	0.233	nr
Bi	0.0115	nr	0.014	nr
Cr	0.00306	nr	0.0052	0.0032
F	0.17	nr	0.228	nr
Fe	0.0315	0.03	0.046	0.046
Na	2.17	8.87	2.24	4.50678
Si	0.0312	nr	0.038	0.1416
U	0.000963	0.0061	0.000767	0.0078
Zr	0.000296	nr	0.004	nr
NO_2	0.0577	nr	0.174	nr
NO_3	1.44	7.35	0.588	3.40208
PO_4	0.258	0.3	0.326	0.13
SO_4	0.0631	0.31	0.0616	0.1416

Notes:

nr = not reported

[1]Appendix C of Kupfer (1996)
[2]Hill et al. (1995)
[3]Appendix B of Agnew et al. (1996)

The waste transfer history indicates that several types of waste were added to tank 241-T-107 over time. Analytical results support this history. The analytical core segment results reveal the tank is horizontally homogeneous and vertically heterogeneous (Jensen et al. 1994).

The history indicates that in addition to the 1C/CW waste noted by Agnew et al. (1996a), tank 241-T-107 received TBP and aluminum and/or Zircaloy CW. The history also indicates IX waste was added to the tank. This waste was mostly liquid and probably mixed with the existing supernatant; it does not appear to have had an effect on the solids. Much of the supernatant was transferred from the tank shortly after the IX waste was added.

D3.3 ASSUMPTIONS FOR RECONCILING WASTE INVENTORIES

Inventories of certain components in tank 241-T-107 were estimated using an engineering assessment that is based on a set of simplified assumptions. The inventories were compared with tank 241-T-107 sample-based inventories and HDW model inventories.

The assumptions and observations for the engineering assessment were based on best technical judgment pertaining to parameters that can significantly influence tank inventories. These parameters include the following:

1. contributing waste types and correct relative proportions of the waste types

2. model flowsheet conditions, fuel processed, and waste volumes

3. partitioning of components

4. physical parameters such as density, percent solids, and void fraction.

The assumptions can be modified to provide a basis for identifying potential errors that could influence the sampling-based and model-based inventories. The following simplified assumptions and observations were used for the assessment.

1. Analytical data from tanks 241-T-104 and 241-BX-112, which contain only 1C waste, and tank 241-TY-105, which contains only TBP waste, helped provide the analytical basis for estimating the inventory in tank 241-T-107.

2. The waste in tank 241-T-107 consists of 1C waste from the $BiPO_4$ process and the associated CW waste, uranium recovery waste from the TBP process, and aluminum and/or Zircaloy cladding waste. Ion exchange waste made no significant contributions to the solids in the tank.

3. Components listed in the technical flowsheets (see Table D3-1) were used for the evaluation. Cerium is not expected in significant amounts and was not reported in the sampling data. This evaluation makes no estimate about the effect of the cladding waste which was added late in the tank transfer history.

4. Tank inventory comparisons are made on nearly the same volume basis, using the tank volume listed in Hanlon (1996). The engineering evaluation and the sampling-based inventories use equivalent volumes of 655 kL (173 kgal) solids, and the HDW model-based inventories are based on 647 kL (171 kgal) solids.

5. The waste in the tank is treated as two distinct layers. The bottom layer is composed of 496 kL (131 kgal) of 1C waste; the upper layer is assumed to be 159 kL (42 kgal) of TBP waste (this is slightly larger than the Agnew et al.

1996a assignment of unknown solids. This assumption was made to conform to current surveillance information regarding the solids volume). The constituents of these wastes are assumed to be evenly distributed throughout their respective layers.

6. All Bi, Si, and Zr are assumed to precipitate as water insoluble components in the 1C waste. The Fe and U are assumed to precipitate in 1C and TBP wastes. Bi, Si, and Zr are not expected in TBP waste.

7. The Al, Cr, Na, F, NO_2, and PO_4 are assumed to partition between the liquid and solid phases. Al, Cr, F, and NO_2 are not assigned to TBP waste.

8. The NO_3 and SO_4 are assumed to remain dissolved in the interstitial liquid in 1C and TBP waste.

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

D3.4 CONCENTRATION FACTOR AND PARTITIONING FACTORS FOR TANK 241-T-107

One method for estimating a component inventory for a particular waste type in a tank is to derive a concentration factor (CF) for that component. This approach was used to estimate inventories in tank 241-T-107. Concentration factors are a method of reconciling process-based information and sample-based information for particular waste types. The CF is derived by dividing the concentration of a component found in the tank samples by the concentration of that component in the neutralized process waste stream (that is, the flowsheet concentrations in Table D3-2). The CF values for components of a defined waste are determined best when the tank contains only one waste type and when abundant representative analytical data are available. Multiple waste types are assumed for this tank.

The relative concentrations of components expected to precipitate essentially 100 percent to the waste solids should be approximately proportional to the respective flowsheet concentrations for those components, that is, these components should exhibit nearly the same CF values.

It was noted in the assumptions that this evaluation assumes Bi precipitated nearly 100 percent from the neutralized 1C waste, and no Bi is expected in the TBP waste. The following procedure is used to calculate the CF for Bi in tank 241-T-107. From Table D2-1, the analytical-based inventory for Bi is 11,100 kg. The solids waste volume in the tank is treated as 496 kL of 1C waste. This is a Bi concentration in the solids of 0.107*M*. The flowsheet concentration for Bi is 0.0115 *M* (Table D3-2).

The $CF_{Bi(1C)}$ is:

$$CF_{Bi(1C)} = \frac{0.107 \text{ mole Bi/L}}{0.0115 \text{ mole Bi/L}} = 9.30$$

Tank 241-T-104 has a CF_{Bi} of 10, and tank 241-BX-112 has a CF_{Bi} of 9.5. The $CF_{Bi(1C)}$ value for tank 241-T-107 appears to be reasonable. This value is used for the components assumed to fully precipitate in 1C waste. The CF value of Al is greater than that of Bi, so Al is treated as fully precipitated in the 1C waste, modifying the assumptions. The CF value of Bi is used to calculate the inventory of Al in the tank.

Once the CF values for fully precipitated components for a waste type are determined, the sample analysis can be used to establish how other components partition between solids and liquids. Concentration factors for components not expected to precipitate 100 percent in 1C waste can be ratioed to CF_{Bi} to obtain the partitioning factor (PF) for each component.

$$PF_{PO4(1C)} = \frac{CF_{PO4(1C)}}{CF_{Bi(1C)}} = 0.755$$

This indicates that 75.5 percent of all PO_4 added to the tank from the 1C waste stream precipitated and 24.5 percent remained in solution. The PF values of other components expected to partition in the 1C waste are as follows:

$PF_{Cr(1C)}$	0.467	$PF_{F(1C)}$	0.764
$PF_{NO2(1C)}$	0.954	$PF_{Na(1C)}$	0.400

The CF value of Fe is used for the basis in the TBP waste. From Table D2-1, the analytical-based inventory for Fe is 27,000 kg. Assuming the iron is evenly distributed in both layers of waste, there are 6,550 kg of Fe in the TBP waste. The TBP waste solids volume in the tank is treated as 159 kL. The Fe concentration in the TBP solids is 0.738*M*. The flowsheet concentration for Fe is 0.03*M* (see Table D3-2). The $CF_{Fe(TBP)}$ is as follows:

$$CF_{Fe(TBP)} = \frac{0.738 \text{ mole Fe/L}}{0.03 \text{ mole Fe/L}} = 24.6$$

The PF values for components expected to partition in the TBP waste are as follows:

$PF_{PO4(TBP)}$	1.012	$PF_{Na(TBP)}$	0.103

The PF values for tank 241-T-107 are different than those expected for 1C waste, but this tank contains a mixture of waste types. The NO_2 would appear to almost completely precipitate and is treated as fully precipitated for this assessment. The Al was already shown to have a CF larger than that of Bi and is treated as fully precipitated. Phosphate appears to partition in the 1C waste but to precipitate fully in the TBP waste. Sodium appears to precipitate more in the 1C waste than in the TBP waste.

D3.5 CALCULATION OF ASSESSMENT-BASED INVENTORIES IN TANK 241-T-107

Assessment-based inventories are calculated in this section. These are determined by combining the assumptions with the product of the PF values calculated in the previous section, the flowsheet values in Table D3-2, the waste porosity values, and the component molecular weight. Sample calculations are shown. The components expected to partition between the solid and liquid phases are not shown.

Components assumed to precipitate (Al, Bi, Si, Zr, Fe, U, NO_2)

$Al_{(Total)}$: 0.0826 mole Al/L x 496 kL x 1000 L/kL x 27 g Al/mole x kg/ 1000 g x $9.31(CF_{1C})$ = 10,300 kg Al

Similarly,

$Bi_{(Total)}$: 11,100 kg Bi
$Si_{(Total)}$: 4,030 kg Si
$Zr_{(Total)}$: 125 kg Zr
$NO_{2(Total)}$: 12,300 kg NO_2

The amounts of Fe and U are the sum of the amounts precipitated from 1C and TBP:

$Fe_{(Total)}$: 15,000 kg Fe
$U_{(Total)}$: 6,740 kg U

Components assumed to remain dissolved in the aqueous phase (NO_3, SO_4)

$NO_{3(1C)}$: 1.44 mole NO_3/L x 496 kL x 1000 L/kL x 62 g NO_3 / mole x kg / 1000 g x $0.6948_{porosity}$ = 30,800 kg NO_3

$NO_{3(TBP)}$: 7.35 mole NO_3/L x 159 kL x 1000 L/kL x 62 g NO_3 / mole x kg / 1000 g x $0.91417_{porosity}$ = 66,200 kg NO_3

$NO_{3(Total)}$: 97,000 kg NO_3

$SO_{4(Total)}$: 7,620 kg SO_4

D3.6 COMPARISON OF SELECTED INVENTORY ESTIMATES

The estimated component inventories from this evaluation are compared with sampling and HDW model-based inventories for selected components in Table D3-3. Components that partition are not included in the table. Observations regarding these inventories are also noted.

Table D3-3. Comparison of Selected Inventory Estimates for Tank 241-T-107 Waste.

Analyte	Assessment Inventory Estimate (kg)	Sampling[1] Inventory Estimate (kg)	HDW[2] Inventory Estimate (kg)
Al	10,300	16,200	9,910
Bi	11,100	11,100	12,400
Fe	14,700	27,000	14,000
NO_2	12,300	11,700	6,370
NO_3	97,000	74,600	17,900
Si	4,030	6,000	1,370
SO_4	7,620	9,860	3,320
U	6,740	22,400	105
Zr	125	112	726

Notes:

[1]Table D2-1

[2]Agnew et al. (1996a); adjusted to a tank volume of 655 kL and density of 1.51 g/mL.

Comparison of the assessment inventory and the sampling inventory shows that 3 of the 9 constituents are very close (within 20 percent). All constituents except U are within a factor of two when the assessment inventory is compared to the sampling inventories. This is not unexpected because the evaluation was based on the sampling results and used assumptions that the 1C and TBP flowsheets each apply to only some constituents. The most notable difference between the sampling inventory and the assessment inventory is the U. The U in the sample inventory is unexpectedly high for 1C waste, but was only 30% of that value in the assessment.

The HDW inventory, adjusted to correct the waste volume and density to the sample value, was also compared to the sampling inventory. Only 1 of 9 constituents are within 20 percent, and 4 additional constituents are within a factor of two.

The comparisons in Table D3-2 demonstrate that adding a second waste type helps to rectify some problems caused by using only the 1C flowsheet or the HDW model to determine the inventory in tank 241-T-107. Modifying the assumptions could increase the accuracy of the assessment inventories. The HDW model assigned 159 kL of the waste as 1C, but its origin is unknown. The assessment treated this amount as TBP waste. It would be helpful to adjust the division of the total waste volume into 1C and TBP waste types. Better results may be expected if the contributions to the solids inventory of the cladding waste could be quantified.

Brief discussions about individual constituents follow.

Aluminum. The assessment and sample-based inventories are within 35 percent. The HDW inventory is slightly lower (approximately 61 percent of the sample-based inventory). This constituent was not assumed to fully precipitate in the 1C waste, although the CF indicated that it had. The higher sample value was probably influenced by Al cladding waste added to the tank late in its transfer history. This is confirmed by examining the segment level data.

Bismuth. The sampling-based inventory was used as a basis to determine the CF used for this tank. All three inventory values compare well; the HDW estimated inventory was smallest. The assessment assumed Bi to precipitate 100 percent. Bismuth was used to determine the CF for this tank. An assumption was made that Bi is evenly distributed in the 1C waste only. In reality, if the 1C waste was laid down as a sludge layer before the TBP waste was added, it would be expected that the highest concentration of Bi was at the tank bottom. Core segment data indicate that in two of three cores analyzed, this is true (that is, the Bi increases with depth, and the highest concentrations of Bi are in the lowest segments). In the third core, the highest value of Bi was in the top segment of the core; the lowest segment of the core was not retrieved.

Chromium. The assessment PF value for Cr is 0.467 indicating almost one half the Cr had precipitated. The HDW inventory is approximately 44 percent of the sample-based inventory. This constituent is expected to partition in the 1C waste.

Fluoride. The assessment PF value for F is 0.764. The HDW inventory is approximately 21 percent of the sample-based inventory. This constituent is expected to partition in the 1C waste.

Iron. The assessment and sample-based inventories are within 54 percent. The HDW inventory is slightly lower (approximately 52 percent of the sample-based inventory). This constituent is expected to fully precipitate in the 1C and the TBP wastes.

Nitrite. The assessment and sample-based inventories are within 5 percent. The HDW inventory is significantly lower (approximately 54 percent of the sample-based inventory). This constituent is expected to remain in solution.

Nitrate. The assessment and sample-based inventories are within 30 percent. The HDW inventory is significantly lower (approximately 24 percent of the sample-based inventory). This constituent is expected to remain in solution.

Phosphate. The PF values for PO_4 are 0.755 and 1.012 in 1C and TBP waste, respectively. In both cases, PO_4 appears to precipitate more than is expected. The HDW and sample-based inventories are within about 15 percent. This constituent is expected to partition in the waste.

Sodium. The assessment PF values for Na are 0.400 and 0.103 for 1C and TBP waste, respectively. This indicates the Na precipitates differently in 1C and TBP wastes. The HDW inventory is approximately 71 percent of the sample-based inventory. This constituent is expected to partition in the waste.

Sulfate. The assessment and sample-based inventories are within 30 percent. The HDW inventory is significantly lower (approximately 34 percent of the sample-based inventory). This constituent is expected to remain in solution.

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. This charge balance approach was consistent with that used by Agnew et al. (1996a).

Uranium. The assessment and sample-based inventories are widely separated. The assessment inventory is about 30 percent of the sample-based inventory. The HDW inventory is significantly lower (less than 1 percent of the sample-based inventory). This constituent is expected to fully precipitate in the 1C and TBP wastes.

Zirconium. The assessment and sample-based inventories are within 12 percent. The HDW inventory is significantly higher (approximately 650 percent of the sample-based inventory). This constituent is expected to fully precipitate in the 1C waste. The lack of zirconium in the sample may indicate the tank did not receive significant amounts of Zircaloy cladding waste.

D3.7 CONCLUSIONS

Based on the relationship of these three comparisons, it is obvious that the HDW model has incorrectly assigned all waste in tank 241-T-107 to 1C. The data strongly suggest that other waste types have left significant amounts of solids in the tank. With sampling data available, the sample-based inventory must be assumed to be a better estimate of the tank contents than the HDW model.

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

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

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

For tank 241-T-107, the sample-based inventory derived from analytical data are the best-basis inventory. Tables D4-1 and D4-2 summarize the best-basis inventory for tank 241-T-107. 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.

Best-basis tables for chemicals and only four radionuclides (^{90}Sr, ^{137}Cs, Pu and U) were being generated in 1996, using values derived from an earlier version (Rev. 3) of the Hanford Defined Waste model. When values for all 46 radionuclides became available in Rev 4 of the HDW model, they were merged with draft best-basis chemical inventory documents. Defined

scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-107. (2 sheets)

Analyte	Total Inventory (kg)	Best-Basis[1] (S, M, C or E)	Comment
Al	16,200	S	
Bi	11,100	S	
Ca	1,480	S	
Cl	541	S	
TIC as CO_3	4,180	S	
Cr	343	S	
F	11,400	S	Based on water soluble portion only.
Fe	27,000	S	
K	231	S	
Mn	201	S	
Na	1.217E+05	S	
Ni	289	S	
NO_2	11,700	S	
NO_3	74,600	S	
OH	50,500	C[2]	charge balance calculation
Pb	636	S	
P as PO_4	1.128E+05	S	
Si	6,000	S	
S as SO_4	9,860	S	
Sr	852	S	
TOC	1,680	S	
U_{TOTAL}	22,400	S	
Zr	112	S	

Note:

[1]S = sampling, M = HDW model (Agnew et al. 1996a), and E = Engineering assessment.

[2]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 Estimate for Radioactive Components in Tank 241-T-107 Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{3}H	0.219	M	
^{14}C	0.0561	M	
^{59}Ni	0.016	M	
^{60}Co	0.00782	M	
^{63}Ni	1.4	M	
^{79}Se	0.0118	M	
^{90}Sr	107000	S	
^{90}Y	107000	S	based on ^{90}Sr
^{93m}Nb	0.0485	M	
^{93}Zr	0.0562	M	
^{99}Tc	0.388	M	
^{106}Ru	1.84 E-10	M	
^{113m}Cd	0.114	M	
^{125}Sb	0.00422	M	
^{126}Sn	0.0175	M	
^{129}I	7.22 E-04	M	
^{134}Cs	6.69 E-05	M	
^{137m}Ba	11500	S	based on ^{137}Cs
^{137}Cs	12200	S	
^{151}Sm	44.6	M	
^{152}Eu	0.00547	M	
^{154}Eu	0.105	M	
^{155}Eu	0.828	M	
^{226}Ra	5.03 E-06	M	
^{227}Ac	2.54 E-05	M	
^{228}Ra	7.45 E-11	M	
^{229}Th	1.44 E-08	M	
^{231}Pa	5.28 E-05	M	
^{232}Th	1.74 E-11	M	
^{232}U	1.22 E-04	M	
^{233}U	7.33 E-06	M	
^{234}U	10.3	M	
^{235}U	0.464	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-T-107 Decayed to January 1, 1994 (Effective July 2, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{236}U	0.0659	M	
^{237}Np	0.00233	M	
^{238}Pu	0.0347	M	
^{238}U	10.5	M	
$^{239/240}Pu$	148	S	
^{241}Am	13.8	S	
^{241}Pu	0.41	M	
^{242}Cm	2.20 E-05	M	
^{242}Pu	1.25 E-06	M	
^{243}Am	5.45 E-08	M	
^{243}Cm	3.26 E-07	M	
^{244}Cm	8.34 E-07	M	

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

D5.0 APPENDIX D REFERENCES

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