ENGINEERING CHANGE NOTICE

0049708

Page 1 of 2

1. ECN 644452

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [X] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	S. L. Lambert, SESC, H5-27 376-8730	[] Yes [X] No	08/23/97
	6. Project Title/No./Work Order No. Tank 241-C-107	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-474, Rev. 0B	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 F, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-C-107.

SEP 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-C-107 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	K. E. Bell	R2-12
File	H5-49		
S. L. Lambert	H5-27		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 644452

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 K. E. Bell	B. C. Simpson for K. E. Bell	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-C-107

S. L. Lambert
SGN Eurisys Services Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 644452 UC: 712
Org Code: 74610 Charge Code: N4G3A
B&R Code: EW3120074 Total Pages: 144

Key Words: TCR, best-basis inventory

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-C-107 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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DATE: 1
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AUG 28 1997

Christine L. McNeill 8/28/97
Release Approval Date Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-474	Page 1

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

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 08/08/95 on EDT-613105.	K.E. Bell	J.G. Kristofzski
0-A RS	Incorporate per ECN-625680.	L.M. Sasaki L M Sasaki	J.G. Kristofzski J. Kristofzski 8/31/95
0-B RS	Incorporate per ECN-625700.	S.E. Kelly S E Kelly	J.G. Kristofzski J G Kristofzski 9/14/95
0C RS	Incorporate per ECN-644452	M.J. Kupfer M J Kupfer 8-27-97	K.M. Hodgson K.M. Hodgson 8-27-97

A-7320-005 (08/91) WEF168

APPENDIX F

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

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APPENDIX F

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

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-C-107 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.

F1.0 CHEMICAL INFORMATION SOURCES

This section describes the sampling campaign that was performed to establish the waste composition profile in tank 241-C-107. In March 1995, three push-mode core samples were obtained from risers 3 and 7 of tank 241-C-107, while several supernatant grab samples were taken in 1990 and 1991. Several grab samples of sludge were obtained in 1977 which were not characterized as to sample location and depth. The five segments of core 68 from riser 7 contained 1,893 g of sludge and no drainable liquid. Core 69 from riser 3 also consisted of 5 segments with 1,735 g of solids and only 27.8 g of drainable liquid. The last core, core 71, consisted of only two representative segments, segments 1 and 2, with partial or totally unsatisfactory recoveries from the remaining segments. Taken together, these two segments captured 665.8 g or 78 cm (30.7 in.) of solids from the upper sludge layer in the tank. Cores 68 and 69 were used for tank safety screening analysis to determine chemical reactivity (by differential scan calorimetry [DSC] and thermo-gravimetric analysis [TGA] analysis) and total alpha. A composite of core 71 was made for pretreatment development studies (Lumetta et al. 1996, Temer and Vallarreal 1996). Various sample preparation methods were used for the core 71 composite, including water, acid, and potassium hydroxide (KOH) fusion digestions to dissolve the solids. Analyses performed included inductively coupled plasma spectroscopy (ICP) analysis of metals, ion chromatography (IC) analysis of anions, gamma energy analysis (GEA), alpha energy analysis (AEA), and mass spectroscopy for analysis of radionuclides.

The waste history of this tank is provided in other references (Anderson 1990 and Agnew et al. 1997b). Tank 241-C-107 received first cycle (1C) bismuth phosphate process waste from the second quarter of 1946 until the third quarter of 1948. From the fourth quarter of 1952 to the third quarter of 1953, tank 241-C-107 was used as a Uranium Recovery (UR) waste receiver, with the UR supernatant being transferred during the fourth quarter of 1956 to tank 241-C-109 for ferrocyanide scavenging of cesium.

Plutonium-Uranium Extraction (PUREX) process coating (CWP2) waste was introduced to this tank from the third quarter of 1961 to the second quarter of 1962, followed by Hot-Semiworks (HS) waste from 1964 to 1967 and Strontium Recovery (SRR) waste in 1977 and 1978. Several salt well pumping campaigns have taken place since 1976, effectively removing all of the supernatant and most of the drainable liquid from this tank. The 1995 cores represent the current waste inventory in the tank. Component inventories can be calculated by multiplying the concentration of an analyte by the volume and density of the sludge layers in the tank. The Hanford Defined Waste (HDW) model (Agnew et al. 1997a) also provides an independent set of estimates for component inventories in this tank.

F2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Table F2-1 provides data on the core segment recoveries for each core from 1995 core sampling (Section 3) based on the physical dimensions of the sampler. The segment sampler is 48.3 cm (19 in.) long, 2.54 cm (1 in.) in diameter, and has a maximum volume of 244.7 cm^3 (14.9 $in.^3$). Segment recovery is based on the actual length of the sample divided by the theoretical length of the sampler, expressed as a percent. The average sludge depth appears to be 225.3 cm (88.7 in.), which is 17 cm (6.7 in.) lower than the measured depth of 242.3 cm (95.4 in.) as of January 1993, (Swaney 1993, Hanlon 1993). This depth was probably reduced to the current level of 225.3 cm (88.7 in.) due to the salt well pumping campaigns that have occurred since 1993.

Table F2-1. Core Segment Recoveries and Sludge Layer Depth Estimates for Tank 241-C-107.[a] (2 Sheets)

Date	Riser	Core	Segment	Percent recovered	Percent solids	Percent liquids	Segment depth cm (in.)
1995	7	68	1	75	100	0	36 (14.2)
			2	100	100	0	48.3 (19)
			3	100	100	0	48.3 (19)
			4	100	100	0	48.3 (19)
			5	100	100	0	48.3 (19)
						Total	229.2 (90.2)
1995	3	69	1	68	100	0	33 (13)
			2	100	100	0	48.3 (19)
			3	100	93	7	48.3 (19)
			4	100	100	0	48.3 (19)
			5	95	100	0	46 (18)

Table F2-1. Core Segment Recoveries and Sludge Layer Depth Estimates for Tank 241-C-107.[a] (2 Sheets)

Date	Riser	Core	Segment	Percent recovered	Percent solids	Percent liquids	Segment depth cm (in.)
						Total	223.9 (88)
1995	3	71[b]	1	62	100	0	30 (11.8)
			2	100	100	0	48.3 (19)
			3	47	100	53	48.3 (19)
			4	0	0	100	48.3 (19)
			5	0	0	0	48.3 (19)
						Total	223.2 (87.8)

[a] Section 3, this Tank Characterization Report

[b] Core 71 was not a full-depth core but the total sludge depth can be estimated from the number of segments in the core and the physical dimensions of the sampler.

Based on the average sludge depth of the core samples (225.3 cm [88.7 in.]), tank 241-C-107 apparently contains about 973.2 kL (257.1 kgal) of waste, including 47.3 kL (12.5 kgal) due to the dished bottom configuration of the 22.86 m (75 ft) diameter tank. All of this waste consists of sludge, with only a minimal amount of drainable liquid. This inventory is about 8.5 percent higher than the tank farm surveillance estimate of 897 kL (237 kgal) (Hanlon 1997). Both values are lower than the 1,041 kL (275 kgal) inventory cited for this tank in the HDW model (Agnew et al. 1997a). For purposes of this analysis, the best-basis inventory will be developed from the core sample results cited in Table F2-1 (973.2 kL or 257.1 kgal of sludge).

The inventories in earlier revisions of this Tank Characterization Report (TCR) were derived from an early version of the HDW model (Agnew 1994). Since the analytical results from core 71 are now available (Lumetta et al. 1996, Temer and Vallarreal 1996), a sample-based estimate can be generated by combining the analytical results from core 71 with common sludge layer estimates for the 1C sludge layer that lies below the sludge layers sampled by core 71. The 1C layer in this analysis will be represented by the 1C waste composition in tank 241-T-104, which matches the flowsheet estimates for 1C waste from the bismuth phosphate process.

A review of the waste transaction records (Agnew et al. 1997b) shows that tank 241-C-107 received the following wastes:

- 6,013 kL (1,588 kgal) of first cycle (1C) bismuth phosphate waste
- 799 kL (211 kgal) of UR process waste

- 5,185 kL (1,370 kgal) of PUREX coating (CWP2) waste
- 916 kL (242 kgal) of HS waste
- 1,488 kL (393 kgal) of SRR waste.

From the waste transactions, Agnew et al. (1997a) predicts the following solids volumes for tank 241-C-107:

- 825 kL (218 kgal) of $BiPO_4$ first cycle (1C) sludge
- 140 kL (37 kgal) of PUREX coating waste (CWP2) sludge
- 75.7 kL (20 kgal) of SRR sludge.

The projected volumes of 1C, UR, and CWP2 waste can be estimated from common sludge layers in tanks 241-T-104, 241-TY-105, and 241-C-105, respectively. The sludge inventories in these tanks are known to have been produced almost exclusively by the indicated wastes, with minor exceptions for tank 241-C-105. Table F2-2 provides a summary of the estimated waste volume and comparable sludge volume for each of the indicated waste types and the projected volume of each waste in tank 241-C-107.

Table F2-2. Projected Volume of 1C, UR, and CWP2 Sludge in Tank 241-C-107 Based on Common Sludge Layers in Other Tanks.

Waste type	Tank	Waste volume[a] (kL)	Sludge volume[b] (kL)	Projected sludge volume in tank 241-C-107[c] (kL)
First cycle bismuth phosphate (1C)	241-T-104	13,096	1,673	768
Uranium recovery (UR)	241-TY-105	23,607	874	29.6
PUREX coating waste (CWP2)	241-C-105	11,926	306.6	133.3

[a] Waste volumes taken from Agnew (1997b)

[b] Sludge volumes derived from tank sludge level measurements for 1C and UR waste and from the Hanford Defined Waste model for tank 241-C-105 CWP2 waste (Agnew et al. 1997a)

[c] Projected inventories based on the volume of each waste transferred to tank 241-C-107 divided by the volume of waste sent to each of the indicated tanks multiplied by the volume of sludge produced in each tank.

Based on the estimates in Table F2-2, about 931 kL (246 kgal) of 1C, UR, and CWP2 sludge should have been produced in tank 241-C-107. Since the total sludge inventory in this tank is 973 kL (257 kgal), the HS and SRR sludge layers combined should equal 42 kL (11 kgal), compared to the HDW model estimate of 75.7 kL (20 kgal) of SRR sludge (Agnew et al. 1997a). The depth of each sludge layer can also be estimated from the physical dimensions of the tank. The results are shown in Table F2-3.

Table F2-3. Estimated Volume and Depth of Various Sludge Layers in Tank 241-C-107.

Waste type	Sludge volume (kL)	Sludge depth[a] (cm)
First cycle bismuth phosphate (1C)	768	175.3
Uranium recovery (UR)	29.6	7.2
PUREX coating waste (CWP2)	133.3	32.4
Hot-semiworks/strontium recovery (HS/SRR)	42	10.3
Total	973	225.2

[a] Sludge depth for 1C sludge layer corrected for volume of 1C sludge in the heel of the tank (47.3 kL [12.5 kgal]).

According to the estimates in Table F2-1, core 71 represents the upper 101 cm (39.7 in.) of the sludge layer or 415 kL of 973 kL (109.6 kgal of 257 kgal) of sludge in tank 241-C-107. Core 71 thus represents the HS/SRR, CWP2, UR, and 29 percent of the measurable 1C sludge layer in this tank. If the heel is included, core 71 represents all of the HS/SRR, CWP2 and UR layers and 27.3 percent of the 1C layer or 415 kL (109.6 kgal) of sludge, with the remaining balance of 558.2 kL (147.5 kgal) of 1C sludge being represented by tank 241-T-104 1C waste.

Table F2-4 provides a summary of the composite sludge analytical values and tank inventory estimates developed from core 71 and comparable sludge compositions in tank 241-T-104, normalized to the corresponding volume of 1C sludge in tank 241-C-107. The tank inventory estimates for core 71 are based on measured density of 1.55 kg/L from tank 241-C-105, which contains CWP and UR waste (Tusler et al. 1995). Because salt well pumping is the only activity that has taken place since 1978, core sample 71 should represent the general composition of the upper sludge layers in this tank. The chemical species are reported without charge designations per the best-basis inventory convention.

Table F2-4. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-C-107. (2 Sheets)

Analyte	Core 71 composite average for C-107 upper sludge[a] (μg/g)	Projected inventory for top 415 kL sludge with density of 1.55 g/mL[b] (kg)	Inventory of tank 241-T-104 of 1673 kL as 1C waste[c] (kg)	Projected inventory for 558.2 kL of 1C waste in tank 241-C-107[d] (kg)	Projected total inventory (kg)
Al	43,184	27,778	35,000	11,678	39,456
As	43	28	NR	NR	28
Ba	514	331	NR	NR	331
Bi	5,671	3,648	40,800	13,613	17,261
B	100	64	NR	NR	64
Cd	81.7	52.6	NR	NR	52.6
Ca	833	536	3,120	1,041	1,577
Ce	299	192	NR	NR	192
Cl	506	326	1,450	484	809
Co	25.5	16.4	NR	NR	16.4
Cr	440	283	1,940	647	931
Cu	173	111	NR	NR	111
F	2,461	1,583	18,500	6,173	7,756
Fe	61,091	39,297	19,500	6,506	45,803
La	176	113	0	0	113
Pb	3,520	2,265	1	0	2,265
Li	94.8	61.0	NR	NR	61.0
Mg	285	183	NR	NR	183
Mn	2,759	1,775	133	44	1,819
Mo	56.1	36.1	NR	NR	36.1
Ni	2,343	1,507	24	8	1,515
NO_3	15,499	9,970	125,000	41,707	51,676
NO_2	27,606	17,757	8,810	2,939	20,697
Pd	20	13	NR	NR	13
PO_4	24,200	15,567	162,000	54,052	69,618
K	329	212	192	64	276
Rh	21.9	14.1	NR	NR	14.1
Ru	384	247	NR	NR	247
Si	9,522	6,125	14,100	4,704	10,830

Table F2-4. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-C-107. (2 Sheets)

Analyte	Core 71 composite average for C-107 upper sludge[a] (μg/g)	Projected inventory for top 415 kL sludge with density of 1.55 g/mL[b] (kg)	Inventory of tank 241-T-104 of 1673 kL as 1C waste[c] (kg)	Projected inventory for 558.2 kL of 1C waste in tank 241-C-107[d] (kg)	Projected total inventory (kg)
Ag	323	208	NR	NR	208
Na	52,329	33,661	139,000	46,378	80,039
Sr	106	68.5	213	71.1	140
SO_4	4,447	2,860	8,420	2,809	5,670
Te	30.1	19.3	NR	NR	19.3
Sn	31.5	20.3	NR	NR	20.3
Ti	187	121	NR	NR	121
TOC	NR	NR	NR	NR	NR
W	200	128	NR	NR	128
U	4,995	3,213	1,940	647	3,860
Zn	163	105	NR	NR	105
Zr	2,565	1,650	146	48.7	1,699

1C = First cycle bismuth phosphate
CWP2 = PUREX coating waste
HS/SRR = Hot-semiworks/strontium recovery
UR = Uranium recovery
NA = Not applicable
NR = Not reported

[a] Average of core 71 composite sample direct analysis results (Lumetta et al. 1996, Temer and Vallarreal 1996). For some elements, sample results are based only on Temer and Vallarreal. The direct analysis of dry sludge data was converted to wet sludge basis with solid wt% of 45% calculated from the process flow diagram

[b] Sludge inventories based on 415 kL (109.6 kgal) of sludge with an average density of 1.55 kg/L (Tusler et al. 1995)

[c] Sasaki et al. (1997)

[d] Sludge inventory estimated by multiplying the expected fraction of 1C waste (0.727) by the volume of 1C sludge added to tank 241-C-107 (768 kL [202.9 kgal]) divided by the volume added to tank 241-T-104 (Sasaki et al. 1997) (1,673 kL [442 kgal]) and multiplying this fraction (0.3337) by the mass of each component in tank 241-T-104 1C sludge.

Table F2-5 provides a summary of the composite sludge radionuclide concentrations and tank inventory estimates based on core 71 and 1C sludge from tank 241-T-104 normalized to the relevant volume of 1C sludge in tank 241-C-107.

Table F2-5. Analytical Results and Sludge Inventory Estimates for Radioactive Components in Tank 241-C-107[a].

Radionuclide	Core 71 composite average for C-107 upper sludge[a] (μCi/g)	Projected inventory for top 415 kL sludge with density of 1.55 g/ml[b] (Ci)	Inventory of tank 241-T-104 of 1673 kL as 1C waste[c] (Ci)	Projected inventory for 558.2 kL of 1C waste in tank 241-C-107[d] (Ci)	Projected total inventory (Ci)
^{60}Co	0.941	605	0.342	0.114	605
^{90}Sr	2,494	1.60 E+06	5,660	1,888	1.61 E+06
^{99}Tc	0.163	105	1.24	0.414	105
^{137}Cs	45.57	29,313	428	143	29,456
^{154}Eu	4.64	2,985	7.35	2.45	2,987
^{155}Eu	4.12	2,649	6.36	2.12	2,651
$^{239/240}$Pu	1.95	1,255	301	100	1,356
$^{243/244}$Cm	0.225	144	NR	NR	144
^{241}Am	2.47	1,588	37.2	12.4	1,600

1C = First cycle bismuth phosphate
CWP2 = PUREX coating waste
HS/SRR = Hot-semiworks/strontium recovery
UR = Uranium recovery
NR = Not reported

[a] Average of core 71 composite sample direct analysis results (Lumetta et al. 1996, Temer and Vallarreal 1996). For some elements, sample results are based only on Temer and Vallarreal. The direct analysis of dry sludge data was converted to wet sludge basis with solid wt % of 45% calculated from the process flow diagram

[b] Sludge inventories based on 415 kL (109.6 kgal) of sludge with an average density of 1.55 kg/L (Tusler et al. 1995)

[c] Sasaki et al. (1997)

[d] Sludge inventory estimated by multiplying the expected fraction of 1C waste (0.727) by the volume of 1C sludge added to tank 241-C-107 (768 kL [202.9 kgal]) divided by the volume added to tank 241-T-104 (Sasaki et al. 1997) (1,673 kL [442 kgal]) and multiplying this fraction (0.3337) by the Ci of each radionuclide in tank 241-T-104 1C sludge.

Sample-based estimates developed from analytical data and HDW model estimates (Agnew et al. 1997a) are both potentially useful for estimating component inventories in the tank. The HDW model is mainly based on process production records and waste transaction records for each tank. According to this model, the following sludge layers have accumulated in this tank:

- 825 kL (218 kgal) of $BiPO_4$ first cycle (1C) sludge.
- 140 kL (37 kgal) of PUREX coating waste (CWP2) sludge.
- 75.7 kL (20 kgal) of SRR sludge.

The sludge inventories developed from the HDW model are based on an inventory of 1,041 kL (275 kgal), compared to a revised inventory of 973 kL (257 kgal) based on 1995 core sample measurements. Table F2-6 compares the sample-based and HDW model estimates for chemical components, while Table F2-7 provides a similar comparison for radioactive components in tank 241-C-107. These results are reported to three significant figures.

Table F2-6. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-C-107. (2 Sheets)

Analyte	Sample-based inventory[a] (kg)	HDW model-based inventory[b] (kg)
Al	39,500	35,500
Bi	17,300	10,800
Ca	1,580	4,740
Cl	809	1,090
CO_3	NR	8,030
Cr	931	225
F	7,760	2,180
Fe	45,800	25,200
Hg	NR	184
K	212	262
La	113	0
Mn	1,770	0
Ni	1,520	67.5
OH	NR	112,000
NO_3	51,700	57,500
NO_2	20,700	12,300

Table F2-6. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-C-107. (2 Sheets)

Analyte	Sample-based inventory[a] (kg)	HDW model-based inventory[b] (kg)
Pb	2,260	9,450
PO_4	69,700	90,200
Si	10,800	9,010
Na	80,000	114,000
Sr	140	0
SO_4	5,670	4,890
TOC	NR	3,990
U	3,860	45,700
Zr	1,700	18

HDW = Hanford Defined Waste
NR = Not reported
[a] From Table F2-4
[b] Agnew et al. (1997a)

Table F2-7. Comparison of Sample-Based and Hanford Defined Waste Model Estimates for Radioactive Components in Tank 241-C-107 (Decayed to January 1, 1994).

Radionuclide	Sample-based inventory[a] (Ci)	HDW model-based inventory (Ci)
^{90}Sr	1.68 E+06	731,000
^{137}Cs	30,800	20,700
$^{239/240}Pu$	1,360	1,580

HDW = Hanford Defined Waste
[a] From Table F2-5. Assume sample analysis dated January 1, 1996 and value decay corrected to January 1, 1994.

Note that significant differences exist between the sample- and HDW model-based estimates for Ca, F, Fe, Ni, Pb, U, and Zr. However, reasonable agreement was found for Al, Na, NO_3, NO_2, PO_4, Si, and SO_4. Among the radionuclides, substantial differences were noted. In the following section, flowsheet, fuel production, and waste transaction records (Agnew et al. 1997b) will be used to independently evaluate the credibility of the sample and HDW model-based estimates for this waste.

F3.0 COMPONENT INVENTORY EVALUATION

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

F3.1 WASTE TYPES

Generally, three different types of wastes were added to tank 241-C-107. The most important from a volume perspective are 1C waste and PUREX coating (CWP2) waste.

F3.1.1 BISMUTH PHOSPHATE FIRST CYCLE (1C) WASTE

About 6,013 kL (1,588 kgal) of 1C waste were transferred to tank 241-C-107 from 1946 to 1948. The bismuth phosphate process flowsheet (Schneider 1951) was used to establish the composition of this waste. Table F3-1 provides the estimated chemical composition profile for the major analytes, together with the estimated amount of each component in tank 241-C-107 1C waste.

Table F3-1. Estimated Composition of Bismuth Phosphate 1C Waste Sent to Tank 241-C-107. (2 Sheets)

Analyte/property	Concentration[a] (g-moles/L)	Mass in 1C waste added to tank 241-C-107[b] (kg)
Bi	0.0124	15,557
Ce	2.14 E-04	93
Cr	0.00308	961
Fe	0.0245	8,214
Hg	1.66 E-05	20
PO_4	0.276	157,400
Si	0.0306	5,160
SO_4	0.0492	28,353
Zr	3.29 E-04	180

[a] Schneider (1951)
[b] Based on 6,013 kL (1,588 kgal) of 1C waste.

F3.1.2 PUREX COATING WASTE

Approximately 5,185 kL (1,370 kgal) of PUREX coating (CWP2) waste were added to tank 241-C-107 from 1947 to 1948. According to the HDW model, PUREX coating waste makes up about 13 percent of the sludge in tank 241-C-107.

A spreadsheet analysis of the PUREX fuel fabrication and production records and waste transaction records (Agnew et al. 1997b) shows that 3,751.8 MTU of (aluminum-clad) PUREX coating waste were transferred to tank 241-C-107. The MTU number was computed by allocating the amount of fuel for each of these quarters based on the volumetric ratio of PUREX coating waste sent to tank 241-C-107 divided by the total volume of waste transferred to all of the tanks during these quarters. On average, about 365 gal/MTU of PUREX coating waste were produced, including flushes and dilution water, compared to the nominal flowsheet estimates of 250 to 350 gal/MTU. These values can be used to estimate the amounts of Al, Ni, and Si added in CWP2 waste to tank 241-C-107.

F3.2 SILICA

The aluminum alloy jacket around the fuel typically contains 0.046 kg Si/MTU, while the Al-Si braze metal used in the bonding layer adds another 1.269 kg Si/MTU (Kupfer et al. 1997). Therefore, about 4,933 kg of Si were added to this tank with PUREX coating waste. Based on the bismuth phosphate flowsheet, about 3.06 E-02 g-moles/L of Si were produced in the first cycle (1C) waste. Altogether, 1.08 E+08 L of 1C waste were produced from 7,800 MTU of fuel in the bismuth phosphate process. On this basis, about 5,160 kg of Si were added to this tank in the 1C waste. Together, the 1C and CWP2 wastes added 10,093 kg of Si, compared to the sample-based estimate of 10,800 kg and the HDW model prediction of 9,010 kg.

F3.3 ALUMINUM AND NICKEL

Other components were also contained in the PUREX coating waste, including 39,500 kg of Al and 395 kg of Ni (47.1 kg of Al and 0.47 kg of Ni per MTU, Kupfer et al. 1997). Aluminum-clad fuels produced after 1959 contained about 1 percent Ni in the Al alloy jacket (Kupfer et al.).

Most of the Al was dissolved as sodium aluminate and transferred as such to one of the downstream receiver tanks. The upper bounding Al inventory is about 176,700 kg., but most of this inventory was transferred to tanks 241-BY-101, 241-BY-104, 241-BY-105, 241-BY-106, and 241-BY-109.

In contrast to Al, about 98 percent of the Ni tends to precipitate in the primary receiver tank. The PUREX coating wastes added to this tank contained about 1,763 kg of Ni,

compared to the sample-based estimate of 1,520 kg and the HDW model prediction of 67.5 kg.

F3.4 OTHER COMPONENTS

Bismuth phosphate first cycle (1C) wastes also contained other components, including Bi, Ce, Cr, Fe, Hg, PO_4, SO_4, and Zr. Table F3-2 compares the flowsheet derived estimates to the sample-based estimates and HDW model prediction for these components.

Table F3-2. Comparison of 1C Flowsheet Estimates to Sample-Based and HDW Model Estimates for Tank 241-C-107.

Analyte	Flowsheet based estimate for 1C waste[a] (kg)	Sample-based estimate[b] (kg)	HDW model prediction[c] (kg)
Bi	15,667	17,300	10,800
Ce	93	192	NR
Cr	961	931	225
Fe	8,214	45,800	25,200
Hg	20	NR	184
PO_4	157,400	69,700	90,200
SO_4	28,353	5,670	4,890
Zr	180	1,700	18

HDW = Hanford Defined Waste
NR = Not reported
[a] Table F3-1
[b] Table F2-4
[c] Agnew et al. (1997a)

Since Bi was predominately added in the 1C waste, the flowsheet and sample-based estimates are in close agreement with one another. PO_4 and SO_4 are partially soluble so the flowsheet estimates should be higher than the sample-based estimates for these components. The high values for Fe and Zr in the samples indicates that these components were probably added with the SRR wastes introduced to this tank in 1977 and 1978. The fuel production records also show that Zr containing Zirflex fuels were not processed until 1967, while all of the PUREX coating wastes added to tank 241-C-107 were produced during the 1961 to 1962 era. In general, the sample-based estimates appear to be in good agreement with the flowsheet generated values for Bi and Cr, and are high but reasonably consistent with the PO_4 and SO_4 inventories in tank 241-C-107.

F3.5 CESIUM AND STRONTIUM

Tank 241-C-107 has an estimated heat load of 19,783 BTU/h or 5,796 watts (Kummerer 1995). This heat load corresponds to 1.23 E+06 Ci of ^{137}Cs or 865,000 Ci of ^{90}Sr, values that are well above or below the sample-based estimates for ^{137}Cs and ^{90}Sr, respectively (30,800 Ci and 1.68 E+06 Ci, Table F2-7). The sample-based inventory is equivalent to a heat load of 11,590 watts, based on a vapor space temperature of 108.7 °F and waste temperature of 121.9 °F. Since the reliability of the tank thermal model has not been independently verified for this tank, it will be assumed for purposes of the standard inventory estimate that the sample-based estimates for ^{137}Cs and ^{90}Sr are correct. The sample-based estimates, on balance, seem to be more reasonable than the HDW model estimates for this tank (20,700 Ci of ^{137}Cs and 731,000 Ci of ^{90}Sr, also decayed to January 1, 1994).

F3.6 SUMMARY

The sample-based estimates for Bi, Cr, Ni, and Si appear to be in the correct range and are generally consistent with estimates developed from other sources of information, including process flowsheets and fuel and waste transaction records. Sample results for PO_4 and SO_4 are consistent with the expected values from the bismuth phosphate flowsheet. The HDW model predictions for Bi, Cr, and Zr are well below the flowsheet predictions for these components, while HDW estimates for Ni are clearly inferior to fuel composition derived estimates that tend to confirm the validity of sample-based estimates for Ni. Based on the indicated matches, it appears that the flowsheet and fuel production records support the credibility of the sample-based estimates for this tank. Sample-based estimates for ^{137}Cs are well below the value that might be expected from thermal modelling results, while the sample-based ^{90}Sr value is nearly twice the upper bounding value predicted from the thermal model.

Based on this comparison, the 1995 core sample (core 71), together with the common sludge layer from tank 241-T-104 (1C waste) will be used to develop the best-basis inventory for tank 241-C-107.

F4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-C-107 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.

Chemical and radionuclide inventory estimates are generally derived from one of three sources of information: (1) sample analyses and sample derived inventory estimates, (2) component inventories predicted by the HDW model based on process knowledge and historical tank transfer information, or (3) a tank-specific process estimate based on process flowsheets, reactor fuel data, essential materials records, or comparable sludge layers and sample information from other tanks.

An effort is currently underway to provide waste inventory estimates that will serve as the standard characterization data for various waste management activities. As part of this effort, a survey and analysis of various sources of information relating to the chemical and radionuclide component inventories in tank 241-C-107 was performed, including the following:

1. Data from one core sample obtained in 1995 (core 71) (Lumetta et al. 1996, Temer and Vallarreal 1996).

2. Component inventory estimates provided by the HDW model (Agnew et al. 1997a).

3. Evaluation of upper bounding estimates for (Al-clad) PUREX coating (CWP2) waste, based on process flowsheets, fuel and waste transaction records for this tank.

4. Analysis of 1C sludge based on the common sludge layer in tank 241-T-104 (Sasaki et al. 1997), together with the flowsheet derived compositions for this waste.

5. Evaluation of the estimated thermal loads provided by the sample-based inventories of ^{137}Cs and ^{90}Sr compared to thermal modelling results for this tank.

Based on this analysis, a best-basis inventory was developed. The 1995 core sample (core 71) was used to generate estimates for the chemical and radionuclide components in the upper sludge layer (top 101 cm [39.8 in.] of waste), while the 1C sludge layer in tank 241-T-104 was used to estimate the remaining components in this tank. The waste in tank 241-C-107 primarily consists of bismuth phosphate 1C waste, (Al-clad) PUREX coating

(CWP2) waste, SRR and HS wastes. The best-basis inventory for tank 241-C-107 is presented in Tables F4-1 and F4-2. A medium level of confidence is assigned to the chemicals and radionuclides because all of these estimates were derived from the 1995 core sample (core 71) and the common 1C sludge layer in tank 241-T-104. Many of these components, including Bi, Cr, Ni, and Si, are consistent with estimates from other sources of information. The inventory values reported in Tables F4-1 and F4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

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 is consistent with that used by Agnew et al. (1997a).

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. 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.

Table F4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-107 (Effective May 16, 1997).

Analyte	Total inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	39,500	S/E	
Bi	17,300	S/E	
Ca	1,580	S/E	
Cl	809	S/E	
TIC as CO_3	8,030	M	
Cr	931	S/E	
F	7,760	S/E	
Fe	45,800	S/E	
Hg	20	E	Based on Bismuth Phosphate flowsheet
K	276	S/E	
La	113	S/E	
Mn	1,820	S/E	
Na	80,000	S/E	
Ni	1,515	S/E	
NO_2	20,700	S/E	
NO_3	51,700	S/E	
OH_{TOTAL}	101,000	C	
Pb	2,270	S	
P as PO_4	69,600	S/E	
Si	10,800	S/E	
S as SO_4	5,670	S/E	
Sr	140	S/E	
TOC	3,990	M	
U_{TOTAL}	3,860	S/E	
Zr	1,700	S/E	

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

Table F4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-C-107, Decayed to January 1, 1994 (Effective May 16, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	6.64	M	
^{14}C	0.595	M	
^{59}Ni	46.2	M	
^{60}Co	787	S/E	Lumetta et al. (1996)
^{63}Ni	4,540	M	
^{79}Se	25.7	M	
^{90}Sr	1.68 E+06	S/E	Lumetta et al. (1996), Temer and Vallarreal (1996)
^{90}Y	1.68 E+06	S/E	Based on ^{90}Sr analysis
^{93m}Nb	95.4	M	
^{93}Zr	111	M	
^{99}Tc	105	S/E	Lumetta et al. (1996)
^{106}Ru	0.199	M	
^{113m}Cd	237	M	
^{125}Sb	6.22	M	
^{126}Sn	41.4	M	
^{129}I	0.0078	M	
^{134}Cs	0.745	M	
^{137m}Ba	29,100	S/E	Based on ^{137}Cs analysis
^{137}Cs	30,800	S/E	Lumetta et al. (1996), Temer and Vallarreal (1996)
^{151}Sm	96,300	M	
^{152}Eu	24.1	M	
^{154}Eu	3,500	S/E	Lumetta et al. (1996)
^{155}Eu	3,500	S/E	Lumetta et al. (1996)
^{226}Ra	0.00311	M	
^{227}Ac	0.0392	M	
^{228}Ra	0.00754	M	
^{229}Th	0.00342	M	
^{231}Pa	0.0583	M	

Table F4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-C-107, Decayed to January 1, 1994 (Effective May 16, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}Th	3.51 E-04	M	
^{232}U	0.389	M	
^{233}U	1.51	M	
^{234}U	15.2	M	
^{235}U	0.675	M	
^{236}U	0.145	M	
^{237}Np	0.0145	M	
^{238}Pu	44.8	M	
^{238}U	15.2	M	
$^{239/240}Pu$	1,360	S/E	Lumetta et al. (1996), Temer and Vallarreal (1996)
^{241}Am	1,610	S	Lumetta et al. (1996)
^{241}Pu	3,260	M	
^{242}Cm	0.915	M	
^{242}Pu	0.017	M	
^{243}Am	0.0571	M	
$^{243/244}Cm$	155	S	Lumetta et al. (1996)

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

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D5.0 APPENDIX F REFERENCES

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