0050236

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 644561

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, 376-6631	[] Yes [X] No	9/15/98
	6. Project Title/No./Work Order No. Tank 241-C-110	7. Bldg./Sys./Fac. No. NA	8. Approval Designator NA
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-367, Rev. 1A	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

This ECN compiles all reconciliation changes made to the Best-Basis Inventory in FY 1998 and should replace Section 3.0 and Appendix D, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-C-110, of the Tank Characterization Report. The reconciliation process involved correction of errata, reassessment of data outlyers, verification of uranium isotopic distribution and other alpha isotope distribution, and removal of "less than" values, etc. Changes were made to both text and tables. The inventory estimates of several waste components were revised.

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

Tank waste inventory estimates are being provided as standard source term for the various waste management activities. FY 1997 evaluation of available information for all 177 underground storage tanks was performed and published in TCRs, preliminary TCRs, or revisions to existing TCRs. In FY 1998, a reconciliation process is being performed to update the best-basis inventories. This process ensures that the latest inventory estimates are available as a consistent source-term to support the activities of TWRS disposal and other users.

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

Central Files	B1-07	K. M. Hodgson	R2-11
DIMC	R1-41 ~~H6-15~~	M. J. Kupfer	R3-75
DOE Reading Room	H2-53	M. D. LeClair (3)	R3-75
TCSRC	R1-10	J. M. Conner	R2-11
K. M. Hall	R2-12		

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SEP 30 1998

DATE: HANFORD RELEASE ID:

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1. ECN (use no. from pg. 1): 644561

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	[]	Other	[X]
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	8-15-98	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	9-16-98	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other J. M. Conner R2-11	J M Conner	9-15-98	Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Tank Characterization Report for Single-Shell Tank 241-C-110

D. E. Place
COGEMA Engineering Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 644561 UC: 721
Org Code: 7A110 Charge Code: N4G3A
B&R Code: EW3120074 Total Pages: 168

Key Words: TCR, best-basis inventory, standard inventory

Abstract: The best-basis inventory provides waste inventory estimates that serve as standard characterization source terms for the various waste management activities. To establish a best-basis inventory for single-shell tank 241-C-110, an evaluation of available information was performed. This work follows the methodology established in *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0A (Kupfer et al. 1997).

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RECORD OF REVISION	(1) Document Number ~~WHC~~-SD-WM-ER-367	Page 1

(2) Title
TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-C-110 HNF 6/24/97

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) WHC-SD-WM-ER-367, REV. 0, EDT 608062, SEPTEMBER 7,1994		
0A RS	CHANGED PAGE ii OF EXECUTIVE SUMMARY	Brett Gaughan	C. Haller 10/11/4
	PER ECN 615025		
		Cheryl J. Benar	Kathleen M. Hall
1 RS	Incorporate per ECN-635468.	C.J. Benar	K.M. Hall
1-A RS	Incorporate per ECN-635542.	C.J. Benar	K.M. Hall
		C.J. Benar 8/20/97	Kathleen M. Hall 8/20/97
1-B RS	Incorporate per ECN-644561.	M.J. Kupfer	K.M. Hodgson
		M.J. Kupfer 9-15-98	K.M. Hodgson 9-16-98

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3.0 BEST-BASIS INVENTORY ESTIMATE

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 to address 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 suitable for long-term storage.

Chemical and radiological inventory information is 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. Not surprisingly, the information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-C-110 was performed that used:

1. Data from three full-depth core samples obtained in 1992 (Kocher 1993).

2. An inventory estimate generated by the HDW model (Agnew et al. 1997).

3. An evaluation of 1C waste based on the $BiPO_4$ flowsheet, fuel records for B Plant and tank waste transactions for tank 241-C-110.

4. An analysis of UR sludge based on common sludge layers in tank 241-TY-105 and the waste transaction records for tanks 241-C-110 and 241-TY-105.

5. An analysis of the PUREX flowsheet and the composition of OWW1 waste, together with the waste transaction records for tank 241-C-110.

6. An evaluation of the estimated thermal loads provided by the sample-based inventories of ^{90}Sr and ^{137}Cs relative thermal modeling results for this tank.

Based on this analysis, a best-basis inventory was developed. The 1992 core sample results were used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-C-110 primarily consists of 1C waste, with small amounts of UR and OWW1 waste. The best-basis inventory estimates for tank 241-C-110 are presented in Tables 3-1 and 3-2. The inventory values reported in Tables 3-1 and 3-2 are subject to change.

Refer to the Tank Characterization Database (TCD) (LMHC 1998) for the most current inventory values. Appendix D contains the complete narrative regarding the derivation of the inventory estimates shown in Tables 3-1 and 3-2.

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. For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-110 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S,M,E, or C)[1]	Comment
Al	14,300	S	
Bi	16,600	S	
Ca	1,150	S	
Cl	1,080	S	
CO_3	10,400	S	
Cr	464	S	
F	7,490	S	
Fe	10,900	S	
Hg	0.40	S	Engineering estimate was 59.6 kgs., Simpson 1998
K	551	S	
La	0	M	
Mn	52	S	
Na	81,700	S	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-110 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S,M,E, or C)[1]	Comment
Ni	24	S	
NO_2	9,170	S	
NO_3	109,000	S	
OH_{TOTAL}	11,100	C	
Pb	255	S	
PO_4	61,000	S	
Si	7,070	S	
SO_4	14,700	S	
Sr	128	S	
TOC	668	S	
U_{TOTAL}	2,110	S	
Zr	170	S	

Notes:

[1]S=Sample-based (see Appendix B)
M=HDW 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 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-C-110 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	1.07	S	
^{14}C	0.316	S	
^{59}Ni	0.0175	M	
^{60}Co	0.00855	M	
^{63}Ni	1.53	M	
^{79}Se	1.34	S	
^{90}Sr	4690	S	
^{90}Y	4690	S	based on ^{90}Sr
^{93m}Nb	0.053	M	
^{93}Zr	0.0615	M	
^{99}Tc	34.1	S	
^{106}Ru	2.01E-10	M	
^{113m}Cd	0.125	M	
^{125}Sb	0.00461	M	
^{126}Sn	0.0192	M	
^{129}I	7.9E-04	M	
^{134}Cs	7.32E-05	M	
^{137m}Ba	17600	S	based on ^{137}Cs
^{137}Cs	18600	S	
^{151}Sm	48.8	M	
^{152}Eu	0.00599	M	
^{154}Eu	0.115	M	
^{155}Eu	0.905	M	
^{226}Ra	5.50E-06	M	
^{227}Ac	2.77E-05	M	
^{228}Ra	8.15E-11	M	
^{229}Th	1.57E-08	M	
^{231}Pa	5.78E-05	M	
^{232}Th	1.91E-11	M	
^{232}U	8.25E-06	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{233}U	4.94E-07	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-C-110 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{234}U	0.696	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{235}U	0.0313	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{236}U	0.00444	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{237}Np	0.00255	M	
^{238}Pu	0.238	S/M	Based on ^{239}Pu and HDW model isotopic distribution.
^{238}U	0.704	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{239}Pu	74.6	S/M	Based on $^{239/240}Pu$ and HDW model isotopic distribution.
^{240}Pu	4.4	S/M	Based on $^{239/240}Pu$ and HDW model isotopic distribution.
^{241}Am	0.0213	M	
^{241}Pu	2.81	S/M	Based on ^{239}Pu and HDW model isotopic distribution.
^{242}Cm	2.40E-05	M	
^{242}Pu	8.60E-06	S/M	Based on ^{239}Pu and HDW model isotopic distribution.
^{243}Am	5.96E-08	M	
^{243}Cm	3.56E-07	M	
^{244}Cm	9.12E-07	M	

Notes:

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

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR TANK 241-C-110

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-C-110

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for tank 241-C-110 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

The data for tank 241-C-110 (Kocher 1993) provide characterization results from the most recent sampling event for this tank. Three full-depth core samples were obtained in April 1992 from risers 2, 5, and 7. The sample-based inventory presented in this report uses the core sample analytical results. The sludge and supernatant volumes used to calculate the sample-based inventory are 681 kL and 27 kL (180 and 7 kgal), respectively, based on sample recoveries. The average densities for the sludge and supernatant used in this report are 1.45 g/mL and 1.09 g/mL, based on analytical data from the cores. Because of recent salt well pumping activities, the waste volume has now been reduced to 673 kL (178 kgal), including 4 kL (1 kgal) of supernatant. This small change in the relative volumes of sludge and supernatant has only a very small effect on the current inventory projections based on the 1992 sampling data. The HDW model (Agnew et al. 1997a) provides tank content estimates in terms of component concentrations and inventories. A projected inventory of waste components in tank 241-C-110 has been prepared from the process flow sheet, production records and waste volume records.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

Sample-based inventories derived from the analytical concentration data and HDW model inventories (Agnew et al. 1997a) are compared in Tables D2-1 and D2-2. (The chemical species are reported without charge designation per the best-basis inventory convention). Significant differences exist between the sample- and HDW model-based estimates for Al, Bi, Ca, CO_3, F, K, NO_3, NO_2, Si, SO_4, U, and Zr. Among the radionuclides, appreciable differences are apparent for ^{90}Sr, ^{137}Cs, and $^{239/240}Pu$. The total waste volume used by both

inventories is 708 kL (187 kgal); however, the HDW model (Agnew et al. 1997a) assumes the total waste volume in the tank is sludge. Radionuclides reported in Table D2-2 are mean values and have been decayed to January 1, 1994.

Table D2-1. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-C-110.

Analyte	Sample-Based Inventory[1] (kg)	HDW Model-Based Inventory[2] (kg)
Al	14,300	11,400
Bi	16,600	9,230
Ca	1,150	2,160
Cl	1,080	776
CO_3	10,400	3,240
Cr	464	179
F	7,490	1,870
Fe	10,900	13,900
Hg	0.40	15
K	551	186
La	NR	0
Mn	52	0
Ni	24	49.7
OH	NR	48,900
NO_3	109,000	45,400
NO_2	9,170	7,680
Pb	255	0
PO_4	61,600	77,400
Si	7,070	4,450
Na	81,700	85,000
Sr	128	0
SO_4	14,700	3,540
TOC	<668	0
U	2,110	34,300
Zr	170	15.4

Notes:

NR=Not Reported
[1]Appendix B, solids only
[2]Agnew et al. (1997a)

Table D2-2. Comparison of Sample-Based and Hanford Defined Waste Model Estimates for Radioactive Components in Tank 241-C-110 (Decayed to January 1, 1994).

Radionuclide	Sample-Based Inventory[1], Ci	HDW Model-Based Inventory[2], Ci
^{3}H	1.07	0.240
^{14}C	0.316	0.0613
^{60}Co	<28.9	0.00855
^{90}Sr	4,690	5,390
^{129}I	<13.9	7.90 E-04
^{137}Cs	18,600	6,070
^{238}Pu	<4.03	0.0379
$^{239/240}Pu$	79.0	12.6
^{241}Am	<9.41	0.0213

Notes:

[1]Appendix B, solids only

[2]Agnew et al. (1997a)

D3.0 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.

D3.1 CONTRIBUTING WASTE TYPES

Based on waste transaction records (Agnew et al. 1997b) tank 241-C-110 received the following wastes:

1C	=	first cycle $BiPO_4$ waste
UR	=	uranium recovery
OWW1	=	PUREX organic wash waste
CSR	=	secondary cesium recovery waste from 241-BY-104 and 241-BX-104
OWW3	=	secondary PUREX organic wash waste

Tank 241-C-110 is first in a cascade series of three tanks with tanks 241-C-111 and 241-C-112. Tank 241-C-110 received 6,007 kL (1,587 kgal) of 1C waste from 1946 to 1947. From 1952 to 1953, and in 1956, tank 241-C-110 received 1,162 kL (307 kgal) of UR waste, of which 1,029 kL (272 kgal) of supernatant was later cribbed from tank 241-C-109. In 1956, 1,007 kL (266 kgal) of OWW1 waste was sent to tank 241-C-110. In 1970, tank 241-C-110 received 5,329 kL (1,408 kgal) of CSR waste from 241-BY-104 and 241-BX-104. In 1972, 606 kL (160 kgal) of OWW3 waste was sent to tank 241-C-110. More detailed transfer information can be found in Table A3-1 of Appendix A of this report.

The major waste types in this tank are 1C, UR, and OWW1. These waste types are wastes that were initially added directly to tank 241-C-110 and are known as primary wastes. Secondary wastes, such as CSR and OWW3, were added to a different tank initially before being transferred. These waste types can usually be ignored because 80 to 90 percent of the solids in these wastes are likely to have already precipitated in one of the primary receiver tanks. In the 241-TY-105 and 241-TY-106 UR tank waste cascade, for example, about 81 percent of the Al, 87 percent of the Fe, 94 percent of the Na, and 97 percent of the PO_4 precipitate in the first tank of the cascade (241-TY-105) (Colton 1995).

D3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

Based on process flowsheets, fuel production, and waste transaction records, a projected inventory estimate can be made for tank 241-C-110. This inventory is presented in Table D3-1. The following section discusses the primary waste types in this tank.

Table D3-1. Projected Inventory of 1C, UR and OWW1 Wastes in Tank 241-C-110.

Analyte	1C Waste (Based on $BiPO_4$ Flowsheet) (kg/MTU)	1C Inventory[1] (kg)	UR Inventory[2] (kg)	OWW1 Inventory[3] (kg)	Projected Tank Inventory[4] (kg)
Al			126		126
Bi	36	15,552	26		15,578
Ce	0.4	173			173
Cr	2.4	1,037	8.7		1,046
F	48	20,736			20,736
Fe	26	11,232	1,376		12,608
Pb			26		26
Mn			10.7	221	232
Ni			5.6		6
NO_3	1,268	547,800	11,720	2,497	562,017
PO_4	361	155,950	7,668		163,618
Si	12	5,184	24.2		5,208
Na	1,268	279,100	7,592	3,937	290,629
SO_4	89	38,450			38,450
U			355	71.9	427
Zr	0.4	173			173

Notes:

[1]Estimated inventory of 1C waste based on 432 MTU of fuel. Projected inventory includes all soluble and semi-soluble F, Na, NO_3, PO_4, and SO_4 added to the tank.

[2]Estimated inventory of UR waste based the relative volumes of such waste added to 241-C-110 and 241-TY-105 and the measured sludge composition in 241-TY-105. This estimate includes all of the Na, NO_3, and PO_4 that precipitated in the tank but not the fraction that remained in the supernatant.

[3]Estimated inventory of OWW1 waste includes both soluble and insoluble components added to 241-C-110.

[4]Tank inventory based on 681.3 kL (180 kgal) of sludge with an average density of 1.45 g/mL and 26.5 kL (7 kgal) of supernatant with a density of 1.09 kg/L.

D3.2.1 Basis for Assessing 1C Waste Inventory in 241-C-110

According to the tank transaction records (Agnew et al. 1997b), 6,006 kL (1,587 kgal) of 1C waste was transferred to tank 241-C-110 from the second quarter of 1946 to the second quarter of 1947. Based on the fuel records from B Plant, this volume is equivalent to 432 MTU of 1C waste. Table D3-1 provides the expected composition profile of 1C waste, in kg/MTU, based on the $BiPO_4$ flowsheet, together with the estimated inventory of these components in the 241-C-110 1C waste.

D3.2.2 Basis for Assessing UR Waste Inventory in 241-C-110

The waste transaction records indicate that 1,162 kL (307 kgal) of UR waste was added to tank 241-C-110. The composition of this waste can be estimated from the known composition of UR waste in tank 241-TY-105, which received 23,600 kL (6,237 kgal) of such waste. This estimate can be generated by multiplying the volume of UR waste added to tank 241-C-110 divided by the volume added to tank 241-TY-105 multiplied by the composition of UR waste in tank 241-TY-105. The results are summarized in Table D3-1.

D3.2.3 Basis for Assessing OWW1 Waste Inventory in 241-C-110

About 1,007 kL (266 kgal) of OWW1 waste was added to tank 241-C-110 as well. The solvent used in PUREX was treated before reuse by washing with potassium permanganate and sodium carbonate, followed by dilute nitric acid and then a sodium carbonate wash (Anderson 1990).

D3.3 COMPARISON OF INVENTORY ESTIMATES

The projected inventories of key components, presented in Table D3-1, are compared with the sample-based and HDW model-based estimates for this tank in Table D3-2. Estimated inventories for the 1C, UR, and OWW1 components were added together to provide the projected inventory. The HDW model-based inventory estimate assumes all the waste to be 1C, and does not include any UR or OWW wastes that might have accumulated as well in tank 241-C-110.

Table D3-2. Comparison of Projected Inventory to Sample-Based and HDW Model-Based Inventory Estimates for Tank 241-C-110.

Analyte	Projected Inventory[1] (kg)	Sample-Based Inventory[2] (kg)	HDW Model-Based Inventory (kg)
Al	126	14,300	11,400
Bi	15,578	16,600	9,230
Ce	173	NR	NR
Cr	1,046	464	179
F	20,736	7,490	1,870
Fe	12,608	10,900	13,900
Pb	26	255	0
Mn	232	52	0
Ni	6	24	49.7
NO_3	547,800	109,000	45,400
PO_4	155,950	61,600	77,400
Si	5,184	7,070	4,450
Na	279,100	81,700	85,000
SO_4	38,450	14,700	3,540
U	427	2,110	34,300
Zr	173	170	15

Notes:
[1]From Table D3-1
[2]From Table D2-1

The flowsheet- and common sludge layer-derived estimates are consistent with the sample-based estimates for Bi, Fe, Si and Zr. Although projected estimates for Cr and Mn are high and estimates for Pb, Ni and U low, these estimates are generally consistent with sample-based values for these components. Most of these components (except for Pb, Cr, and possibly U) are ones that would be expected to concentrate in the 1C, UR, and OWW1 sludge layers in tank 241-C-110. Based on the indicated matches, it appears that the flowsheet- and common sludge layer-derived estimates support the credibility of the sample-based estimates. The HDW model-based estimates are generally inferior to core sample-derived estimates for this tank.

High Al concentrations in the core samples were apparently caused by atmospheric absorption of CO_2 and precipitation of Al from the supernatants routed through tank 241-C-110 (with secondary CSR waste being the likely source, because primary wastes added to tank 241-C-110 contained little Al). Soluble and semi-soluble components such as F, Na, NO_3, PO_4, and SO_4

readily distribute to the supernatant and only rarely can be used to identify the source of waste in the tank. The flowsheet estimates, however, are at least consistent, because the projected inventories of F, Na, NO_3, PO_4, and SO_4 are higher than their measured values in the 241-C-110 sludge.

Tank 241-C-110 has an estimated heat load of 3,188 Btu/hr (934 W) (Kummerer 1995). This heat load corresponds to 197,500 Ci of ^{137}Cs or 139,000 Ci of ^{90}Sr, values that are considerably higher than the sample-based estimates for this tank (19,300 Ci of ^{137}Cs and 4,880 Ci of ^{90}Sr). Sample-based values are equivalent to a heat load of 423 Btu/hr (123.8 W), only 13 percent of the estimated heat load based on a headspace temperature of 18.3 °C (64.9 °F) and a waste temperature of 18.4 °C (65.2 °F). Because 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.

Sample-based estimates for Bi, Fe, Si and Zr are in good agreement with the $BiPO_4$ flowsheet, common sludge layer estimates for UR waste, and the waste transaction records for tank 241-C-110. While flowsheet- and common sludge layer-derived estimates for Cr, Pb, Mn, Ni, and U are less satisfactory, these values are also generally consistent (within a factor of 2 to 4) with the core sample-based estimates for these components. Sample-based estimates for ^{137}Cs and ^{90}Sr are generally consistent with the thermal modeling results for this tank, although the analytical values are well below the concentrations that might be expected from the thermal model. Based on this comparison, the 1992 core samples appear to offer the most reasonable and consistent set of estimates currently available for this tank. These samples will be used to develop the best basis inventory for tank 241-C-110 because these samples are based on multiple samples from different risers, and in some cases replicate analysis of analytes.

Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. This charge balance approach was consistent with that used by Agnew et al. (1997a).

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

Information about chemical, radiological, and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessments associated with waste management activities, as well as to address 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 suitable for long-term storage.

Chemical and radiological inventory information is 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. Not surprisingly, the information derived from these different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of chemical information for tank 241-C-110 was performed that used:

1. Data from three full-depth core samples obtained in 1992 (Kocher 1993).

2. An inventory estimate generated by the HDW model (Agnew et al. 1997a).

3. An evaluation of 1C waste based on the $BiPO_4$ flowsheet, fuel records for B Plant and tank waste transactions for tank 241-C-110.

4. An analysis of UR sludge based on common sludge layers in tank 241-TY-105 and the waste transaction records for tanks 241-C-110 and 241-TY-105.

5. An analysis of the PUREX flowsheet and the composition of OWW1 waste, together with the waste transaction records for tank 241-C-110.

6. An evaluation of the estimated thermal loads provided by the sample-based inventories of ^{90}Sr and ^{137}Cs relative thermal modeling results for this tank.

Based on this analysis, a best-basis inventory was developed. The 1992 core sample results were used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-C-110 primarily consists of 1C waste, with small amounts of UR and OWW1 waste. The best-basis inventory estimates for tank 241-C-110 are presented in

Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) (LMHC 1998) 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. 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. For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-110 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S,M,E, or C)[1]	Comment
Al	14,300	S	
Bi	16,600	S	
Ca	1,150	S	
Cl	1,080	S	
CO_3	10,400	S	
Cr	464	S	
F	7,490	S	
Fe	10,900	S	
Hg	0.40	S	Engineering estimate was 59.6 kgs., Simpson 1998
K	551	S	
La	0	M	
Mn	52	S	
Na	81,700	S	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-110 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S,M,E, or C)[1]	Comment
Ni	24	S	
NO_2	9,170	S	
NO_3	109,000	S	
OH_{TOTAL}	11,100	C	
Pb	255	S	
PO_4	61,000	S	
Si	7,070	S	
SO_4	14,700	S	
Sr	128	S	
TOC	668	S	
U_{TOTAL}	2,110	S	
Zr	170	S	

Notes:

[1]S = Sample-based (see Appendix B)
M = HDW 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 D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-C-110 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{3}H	1.07	S	
^{14}C	0.316	S	
^{59}Ni	0.0175	M	
^{60}Co	0.00855	M	
^{63}Ni	1.53	M	
^{79}Se	1.34	S	
^{90}Sr	4690	S	
^{90}Y	4690	S	based on ^{90}Sr
^{93m}Nb	0.053	M	
^{93}Zr	0.0615	M	
^{99}Tc	34.1	S	
^{106}Ru	2.01E-10	M	
^{113m}Cd	0.125	M	
^{125}Sb	0.00461	M	
^{126}Sn	0.0192	M	
^{129}I	7.9E-04	M	
^{134}Cs	7.32E-05	M	
^{137m}Ba	17600	S	based on ^{137}Cs
^{137}Cs	18600	S	
^{151}Sm	48.8	M	
^{152}Eu	0.00599	M	
^{154}Eu	0.115	M	
^{155}Eu	0.905	M	
^{226}Ra	5.50E-06	M	
^{227}Ac	2.77E-05	M	
^{228}Ra	8.15E-11	M	
^{229}Th	1.57E-08	M	
^{231}Pa	5.78E-05	M	
^{232}Th	1.91E-11	M	
^{232}U	8.25E-06	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{233}U	4.94E-07	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-C-110 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M, or E)[1]	Comment
^{234}U	0.696	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{235}U	0.0313	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{236}U	0.00444	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{237}Np	0.00255	M	
^{238}Pu	0.238	S/M	Based on ^{239}Pu and HDW model isotopic distribution.
^{238}U	0.704	S/M	Based on U_{TOTAL} and HDW model isotopic distribution.
^{239}Pu	74.6	S/M	Based on $^{239/240}Pu$ and HDW model isotopic distribution.
^{240}Pu	4.4	S/M	Based on $^{239/240}Pu$ and HDW model isotopic distribution.
^{241}Am	0.0213	M	
^{241}Pu	2.81	S/M	Based on ^{239}Pu and HDW model isotopic distribution.
^{242}Cm	2.40E-05	M	
^{242}Pu	8.60E-06	S/M	Based on ^{239}Pu and HDW model isotopic distribution.
^{243}Am	5.96E-08	M	
^{243}Cm	3.56E-07	M	
^{244}Cm	9.12E-07	M	

Notes:

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

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D5.0 APPENDIX D REFERENCES

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