0049680

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 643402

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 []	D. E. Place, SESC, H5-27 376-0176	[] Yes [X] No	08/14/97
	6. Project Title/No./Work Order No. Tank 241-BX-108	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-407, 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 C, Evaluation to Establish Best-Basis Inventory for Single-Shell Tank 241-BX-108.

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-BX-108 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		
File	H5-49	K. E. Bell	R2-12
D. E. Place	H5-27		
M. J. Kupfer	H5-49		
M. D. LeClair (3)	H0-50		

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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	8-15-97	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	8-18-97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other K. E. Bell	Kevin E. Bell	8-20-97	Other		
			DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

Tank Characterization Report for Single-Shell Tank 241-BX-108

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

EDT/ECN: 643402 UC: 712
Org Code: 74610 Charge Code: N4G3A
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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-BX-108 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-407	Page 1

(2) Title
Tank Characterization Report for Single-Shell Tank 241-BX-108

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 08/07/95 on EDT-612548.	J.P. Sederburg	J.G. Kristofzski
RS 0-A	Incorporate per ECN-623844.	L.M. Sasaki	J.G. Kristofzski
		L.M. Sasaki	7/1/95
0-B RS	Incorporate per ECN-625683.	S.E. Kelly	J.G. Kristofzski
		S.E. Kelly	1/18/
0-C RS	Incorporate per ECN-642402.	M.J. Kupfer	K.M. Hodgson
		8-15-97	8/18/97

A-7320-005 (08/91) WEF168

APPENDIX C

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BX-108

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APPENDIX C

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-BX-108

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-BX-108 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.

C1.0 CHEMICAL INFORMATION SOURCES

Available chemical and radiological inventory estimates for tank 241-BX-108 consist only of the inventory estimate generated by the Hanford Defined Waste (HDW) model (Agnew et al. 1997a). This Tank Characterization Report (TCR) was issued for tank 241-BX-108 based on two auger samples taken during July 1994. However, only safety screening analyses were performed. No chemical or radionuclide analyses were performed on the auger samples. The tank 241-BX-108 best-basis inventory, therefore, will be based primarily on composition data from other Hanford Site tanks containing similar waste types. These estimates will be supplemented with the HDW model predictions where no other data is available.

C2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The tank 241-BX-108 chemical and radionuclide inventory predicted by the HDW model (Agnew et al. 1997a) is provided in Table C2-1. The chemical species are reported without charge designation per the best-basis inventory convention. The HDW model inventory estimate is based on a 1C sludge volume of 98 kL (26 kgal) and a sludge density of 1.37 g/mL.

Table C2-1. Hanford Defined Waste Model Prediction of Tank 241-BX-108 Inventory. (2 Sheets)

Analyte	HDW model[a] (kg)	Analyte	HDW model[a] (kg)
Al	1,370	Na	11,600
Bi	1,260	Ni	6.99
Ca	295	NO_2	1,210
Cl	110	NO_3	6,170
CO_3	442	OH	6,270
Cr	25.2	Pb	0
F	263	PO_4	10,600
Fe	1,900	Si	539
Hg	1.97	SO_4	498
K	26.3	Sr	0
La	0	U	4,570
Mn	0	Zr	2.17
Radionuclides[b] (Ci)			
^{137}Cs	1,190	^{90}Sr	1,040

HDW = Hanford Defined Waste

[a] Agnew et al. (1997a), radionuclides decayed to January 1, 1994

[b] Revision 4 of the HDW model contains estimates for 46 radionuclides. Only the two most prevalent are listed in the table. HDW model radionuclide estimates are baselined to January 1, 1994.

C3.0 COMPONENT INVENTORY EVALUATION

C3.1 CONTRIBUTING WASTE TYPES

Available information concerning the types and volumes of wastes contained in tank 241-BX-108 is relatively consistent. The HDW model (Agnew et al. 1997a), the Sort on Radioactive Waste Type (SORWT) model (Hill et al. 1995), and the waste tank summary report (Hanlon 1997) indicate that the tank inventory consists of 98 kL (26 kgal) of sludge, although there is some disagreement between the HDW and SORWT models as to the types of sludges remaining in the tank.

The HDW model (Agnew et al. 1997a) predicts that the tank contains entirely first decontamination cycle waste from the bismuth phosphate process (49 kL [13 kgal] of defined waste 1C1 sludge and 49 kL [13 kgal] of defined waste 1C2 sludge). Since these 1C wastes were generated prior to 1955, the coating wastes associated with the aluminum-clad reactor fuel being processed were combined with the 1C waste in the underground storage tank (Anderson 1990).

The SORWT model (Hill et al. 1995) lists tri-butyl phosphate (TBP) (U Plant uranium recovery wastes), coating wastes (CW), and first cycle $BiPO_4$ waste (1C) as the primary, secondary, and tertiary waste types (respectively) contributing to the waste tank contents. B Plant ion exchange waste is listed as an additional contributing waste type. The SORWT model qualitatively indicates that both TBP and CW wastes contribute more significantly to the sludge than 1C waste. No quantitative estimate of the contribution of each waste type is provided. The entire tank 241-BX-108 volume (98 kL [26 kgal]) is attributed to sludge, with 4 kL (1 kgal) of interstitial liquid.

C3.2 EVALUATION OF WASTE TRANSACTIONS

Waste transaction records (Agnew et al. 1997b) show that the cascade, consisting of tanks 241-BX-107 through 241-BX-109, received 1C wastes between the third quarter of 1948 and the third quarter of 1949, and in the fourth quarter of 1950. A total of 6,018 kL (1,590 kgal) of combined 1C/CW waste was received into tank 241-BX-107 (Agnew et al.). Tank 241-BX-108 was filled with the supernate overflowing from tank 241-BX-107 through the cascade piping, and in turn overflowed to tank 241-BX-109. The 1C/CW supernate remaining in tank 241-BX-108 was transferred to tank 241-B-106 during the fourth quarter of 1952 and the first quarter of 1953.

Waste transaction records also indicate that 1,968 kL (520 kgal) of TBP waste was received in tank 241-BX-108 during second quarter of 1953. The TBP waste was originally transferred from 200 West Area to tank 241-BX-107, which overflowed to tank 241-BX-108 via the cascade piping. Approximately one-half of this TBP waste was transferred to tank 241-B-106 in the first quarter of 1954. The waste transaction records (Agnew et al. 1997b)

indicate that the remaining TBP waste was diluted with water in the second quarter of 1954. However, Anderson (1990) indicates that the 961 kL (254 kgal) transfer volume indicated was received from tank 241-BX-109 in the second quarter of 1954. Tank 241-BX-109 was receiving TBP waste and accumulating settled solids at this time (Agnew et al. 1997b). The TBP waste supernate was removed from tank 241-BX-108 in the fourth quarter of 1957 for ferrocyanide scavenging.

Tank 241-BX-108 received 1,718 kL (454 kgal) of coating waste supernate from tank 241-C-108 in the second quarter of 1964. The coating waste supernate was transferred to tank 241-BX-106 in the fourth quarter of 1968.

Tank 241-BX-108 was refilled with B Plant cesium recovery ion exchange waste (CSR) in the second quarter of 1969. The solids volume in tank 241-BX-108 began decreasing after the addition of ion exchange wastes (Anderson 1990), suggesting that dissolution of solids was occurring. The ion exchange waste was removed in the first quarter of 1973. The tank was classified as a suspect leaker in the first quarter of 1973 and the remaining liquid (178 kL [47 kgal]) was transferred to tank 241-BX-106 in 1974.

C3.3 DETERMINATION OF WASTE VOLUMES

B Plant processed approximately 456 metric tons of uranium (MTU) in reactor fuel during the 1948-1949 time period when 1C wastes were being routed to tank 241-BX-107. The estimated 1C/CW waste volume based on the $BiPO_4$ flowsheet (Schneider 1951) would be 6,730 kL (1,778 kgal), which is 12 percent higher than that indicated by the waste transaction records, but still in reasonably good agreement.

The 1C/CW volumes routed to tank 241-BX-107 would result in approximately 602 kL (159 kgal) of sludge based on a concentration factor of approximately 10 observed for tanks 241-T-104 and 241-BX-107 which contain only 1C/CW sludge (Sasaki et al. 1997a and Winkelman et al. 1997). This volume is inadequate to account for the current 241-BX-107 solids inventory of 1,306 kL (345 kgal) reported by Hanlon (1997).

A probable explanation for this discrepancy is that waste transaction records (Agnew et al. 1997b) incorrectly distribute B Plant 1C wastes to tanks 241-BY-107, 241-BY-110, and 241-B-104. Sample analyses clearly show that 1C sludge layers are not present in these tanks (McCain et al. 1997, Simpson et al. 1996, and Field et al. 1996a). The volumes reported are likely 1C supernate volumes that overflowed from the 241-BX-107/241-BX-108/241-BX-109 or the 241-BX-110/241-BX-111/241-BX-112 cascades. The 5,719 kL (1,511 kgal) of B Plant 1C waste attributed to tank 241-BY-107 in 1950-1951 and the 1,840 kL (486 kgal) of 1C waste attributed to tank 241-B-104 in 1950 were likely originally routed to tank 241-BX-107.

Assuming that 13,577 kL (3,587 kgal) of 1C waste was transferred from B Plant to tank 241-BX-107, approximately 1,358 kL (359 kgal) of sludge would be expected in tank

241-BX-107 and 241-BX-108. This corresponds very closely to the sum of the 1,306 kL (345 kgal) found in tank 241-BX-107 (Hanlon 1997) and the 38 kL (10 kgal) predicted for tank 241-BX-108 in this evaluation. The HDW model predicts an additional 129 kL (34 kgal) of 1C sludge in tank 241-BX-109 (the third tank in this cascade), however sample data (Field et al. 1996b) show that a significant 1C sludge layer is not present.

The tank 241-BX-107 solids volume was reported 1,654 kL (437 kgal) for the first quarter of 1953 (Anderson 1990). Since the tank capacity is 2,006 kL (530 kgal), entrainment of 1C sludge in the cascade overflow to tank 241-BX-108 would be expected. The tank 241-BX-107 sludge volume has been reduced to the current 1,306 kL (345 kgal) by sludge compaction and salt well pumping.

Anderson (1990) reports a tank 241-BX-108 solids volume of 38 kL (10 kgal) for the first quarter of 1953, which would be attributable to 1C sludge. This measurement is considered reliable since Anderson indicates that supernate had been decanted to the solids heel. A 1C sludge volume of 38 kL (10 kgal) will be assumed for inventory calculations.

The tank 241-BX-108 solids volume increased to 333 kL (88 kgal) following the additions of TBP wastes (Anderson 1990). Most of the TBP solids likely were contained in the transfer from tank 241-BX-109, which was accumulating TBP solids. The TBP waste supernate was transferred to tank 241-C-112 in the fourth quarter of 1957, leaving 329 kL (87 kgal) of solids in the tank (Anderson). The solids volume increase of 291 kL (77 kgal) is attributable to TBP sludge.

Coating waste supernate was added to tank 241-BX-108 in the second quarter of 1964 and transferred to tank 241-BX-104 in the fourth quarter of 1968. The solids volume reported following this transfer was 329 kL (87 kgal) (Anderson 1990), which is identical to the solids volume reported before the addition of the coating waste.

B Plant cesium recovery wastes (CSR, ion exchange wastes) were transferred to tank 241-BX-108 in the second quarter of 1969. The reported solids levels began decreasing thereafter, suggesting the probable dissolution of sludge components in this relatively dilute supernate. The ion exchange wastes were removed in the first quarter of quarter of 1973.

The waste tank summary report (Hanlon 1997) indicates that the current sludge volume is reported as 98 kL (26 kgal) based on a July 31, 1979 solids volume measurement. More recent operational waste level measurements (Swaney 1993) confirm the Hanlon (1997) sludge inventory.

The tank 241-BX-108 sludge inventory will be assumed to include 38 kL (10 kgal) of 1C sludge and 61 kL (16 kgal) of TBP sludge. There is a possibility that aluminum precipitated during the extended storage of coating waste supernate in this tank, but it is presumed that this material (as well as most of the TBP sludge layer) was redissolved in the B Plant ion exchange wastes later stored in the tank.

C3.4 COMPOSITION OF 1C SLUDGES

Nine tanks are reported to have received 1C/CW waste directly from B Plant including tanks 241-B-104, 241-B-107, 241-BX-107, 241-BX-110, 241-BX-112, 241-BY-107, 241-BY-110, 241-C-107, and 241-C-110 (Agnew et al. 1997b). Sample-based composition data is not available for tank 241-B-107 (no core samples has been taken), nor for tank 241-C-107 because only safety screening analyses were performed on the core samples (Bell et al. 1995). The 1C/CW waste was mixed with substantial quantities of other wastes in tank 241-BX-110 (Schreiber and Tran 1996), consequently the composite sludge analyses performed on this waste would not provide a good example of 1C/CW sludge. The analytical data from three tanks (241-B-104, 241-BY-107 and 241-BY-110) show that a significant 1C sludge layer is not present in these tanks (Field et al. 1996a, McCain et al. 1997, and Simpson et al. 1996, respectively). Only three of the tanks that reportedly received B Plant 1C waste (241-BX-107, 241-BX-112, and 241-C-110) have composition data suitable for deriving a basis composition for 1C/CW sludge resulting from B Plant operations (Winkelman et al. 1997, Winkelman and Morris 1996, and Benar et al. 1997, respectively).

Additional analytical data is available for two 200 West Area tanks, 241-T-104 and 241-T-107 (Sasaki et al. 1997a and Sasaki et al. 1997b), which contain 1C/CW sludges resulting from T Plant operation.

The mean compositions reported for 1C tanks 241-BX-107, 241-BX-112, 241-C-110, 241-T-104, and 241-T-107 by the respective TCRs (Winkelman et al. 1997, Winkelman and Morris 1996, Benar et al. 1997, Sasaki 1997a and Sasaki 1997b) are provided in Table C3-1. The HDW model compositions for the 1C1 and 1C2 defined waste sludges are also provided in Table C3-1 for comparison.

The compositions of the 1C/CW sludges are fairly consistent with some minor variations. The tanks which later were used for storage of TBP supernates (241-BX-107, 241-C-110 and 241-T-107) exhibit higher uranium and iron concentrations. Since the 1C/CW waste received in tank 241-BX-108 was cascaded from tank 241-BX-107, the analytical data for tank 241-BX-107 will be used to represent the tank 241-BX-108 1C sludge layer. The mean analyte concentration derived from other 1C/CW sludges will be used for analytes that were not measured in the tank 241-BX-107 core samples.

Table C3-1. Compositions of 1C/CW Sludges. (2 Sheets)

Analyte	Tank 241-BX-107 conc.[a] (μg/g)	Tank 241-BX-112 conc.[b] (μg/g)	Tank 241-C-110 conc.[c] (μg/g)	Tank 241-T-104 conc.[d] (μg/g)	Tank 241-T-107 conc.[e] (μg/g)	1C/CW Mean Sludge conc.[f] (μg/g)	HDW Model 1C1[g] (μg/g)	HDW Model 1C2[g] (μg/g)
Ag	<0.942	<46.4	<0.690	<1.09	7.37	<11.3	NR	NR
Al	14,300	13,600	14,300	16,200	16,400	15,000	11,695	8,633
Bi	22,300	17,500	13,500	18,900	11,200	16,700	9,443	9,245
Ca	396	2,510	<385	1,450	1,500	<1,250	2,213	2,172
Cd	2.27	<59.5	5.20	5.44	6.40	<15.8	NR	NR
Cl	1,140	1,050	1,090	670	547	899	794	834
CO_3	5,800	10,500	10,500	<500	14,800	8,430	3,314	3,252
Cr	968	1,290	464	901	354	795	183	191
F	9,190	10,700	7,590	8,570	11,500	9,510	1,912	1,997
Fe	11,100	9,460	10,700	9,020	31,500	14,400	14,252	13,917
Hg	0.565	NR	0.446	<0.125	0.134	<0.318	15.4	13.8
K	263	406	559	89.0	31.6	270	190	200
La	<1.51	<156	7.69	<10.2	<2	<35.5	0	0
Mn	64.6	323	35.8	61.8	222	141	0	0
Na	102,000	81,800	82,800	64,500	130,200	92,300	87,005	85,046
Ni	12.2	<2.76	<24.2	11.3	292	<68.5	50.8	53.1
NO_2	12,300	25,600	9,290	4,080	11,800	12,600	7,857	10,148
NO_3	137,000	75,100	110,000	58,000	75,400	91,100	46,495	45,104
OH_{Total}	NR	NR	NR	NR	NR	NR	50,046	42,977
Pb	62.8	<331	258	49.8	796	<300	0	0
P as PO_4	71,700	59,200	62,600	75,700	114,000	76,600	79,166	77,726
Si	6,780	8,400	7,160	6,520	6,070	6,990	4,549	3,455
S as SO_4	13,700	6,480	11,900	3,840	10,600	9,300	3,618	3,779
Sr	168	132	130	99.1	962	298	0	0
TOC	798	959	<676	<570	1,700	<941	0	0
U	4,840	1,040	2,140	897	22,600	6,300	35,100	32,786
Zr	136	<78.1	172	67.5	113	<113	15.8	16.5

Table C3-1. Compositions of 1C/CW Sludges. (2 Sheets)

Radio-nuclides[h]	Tank 241-BX-107 conc.[a] (μCi/g)	Tank 241-BX-112 conc.[b] (μCi/g)	Tank 241-C-110 conc.[c] (μCi/g)	Tank 241-T-104 conc.[d] (μCi/g)	Tank 241-T-107 conc.[e] (μCi/g)	1C/CW Mean sludge conc.[f] (μCi/g)	HDW Model 1C1[g] (μCi/g)	HDW Model 1C2[g] (μCi/g)
^{241}Am	0.0130	<0.167	<0.00953	<0.0173	<0.0722	<0.0558	2.2E-05	2.7E-04
^{14}C	2.60E-04	NR	3.20E-04	<4.5E-05	<1.91E-04	<2.04E-04	6.3E-05	1.02E-04
^{60}Co	<0.0057	<0.0122	<0.0297	<2.18E-04	<0.0132	<0.0122	8.7E-06	2.76E-05
^{134}Cs	NR	<0.0740	NR	NR	<0.0108	<0.0424	7.5E-08	1.25E-06
^{137}Cs	16.9	51.8	18.8	0.193	12.1	20.0	6.21	11.4
^{154}Eu	<0.0154	<0.0336	<0.0827	2.95 E-03	<0.0497	<0.0369	1.2E-04	5.27E-04
^{155}Eu	<0.0294	<0.168	<0.0910	0.00288	<0.0586	<0.0700	9.3E-04	0.00266
^{3}H	5.41E-04	NR	0.00109	<3.13E-04	<7.74E-04	<6.81E-04	2.5E-04	5.31E-04
^{129}I	NR	NR	<0.0141	<0.0184	<5.16E-05	<0.0109	8.1E-07	1.35E-06
^{237}Np	<0.0173	NR	<0.0366	<0.0326	NR	<0.0288	2.6E-06	4.45E-06
^{238}Pu	<0.00446	NR	<0.00408	<0.0178	<0.0113	<0.00942	3.9E-05	3.3E-04
$^{239/240}Pu$	0.0572	NR	0.0800	NR	NR	0.0686	0.0129	0.0450
^{106}Ru	NR	NR	NR	NR	<0.223	<0.223	2.1E-13	1.4E-11
^{79}Se	NR	NR	<0.00185	<1.52E-04	NR	<0.00100	1.3E-05	2.16E-05
^{90}Sr	9.58	6.05	4.76	2.55	106	25.8	5.51	10.0
^{99}Tc	0.0369	NR	0.0330	<6.30E-04	<0.0505	<0.0303	4.3E-04	7.12E-04
Physical Data	**Tank 241-BX-107[a]**	**Tank 241-BX-112[b]**	**Tank 241-C-110[c]**	**Tank 241-T-104[d]**	**Tank 241-T-107[e]**	**1C/CW mean sludge[f]**	**HDW model 1C1[g]**	**HDW model 1C2[g]**
Density g/mL	1.44	1.31	1.45	1.29	1.51	1.40	1.38	1.36
H_2O (wt%)	59.1	63.7	60.2	70.5	46.0	59.9	64.0	65.6

HDW = Hanford Defined Waste
NR = Not reported
NA = Not applicable
[a] Winkelman et al. (1997)
[b] Winkelman and Morris (1996)
[c] Benar et al. (1997)
[d] Sasaki et al. (1997a)
[e] Sasaki et al. (1997b)
[f] Average of tanks 241-BX-107, 241-BX-112, 241-C-110, 241-T-104, and 241-T-107 concentrations.
[g] Agnew et al. (1997a)
[h] Radionuclides decayed to January 1, 1994.

C3.5 COMPOSITION OF TBP SLUDGES

Only two tanks containing TBP sludges, tanks 241-BX-109 and 241-TY-105, have reasonably comprehensive analytical data available for the waste and are relatively uncontaminated by other waste types. The reported compositions based on core samples (Weiss and Mauss 1987 and Field et al. 1996b) are provided in Table C3-2. The HDW model composition for TBP sludge is also provided in the table for comparison.

Tank 241-TY-105 received only TBP waste, hence the sludge layer is entirely TBP sludge. Tank 241-BX-109 primarily received TBP waste, but also received a large volume of 1C/CW waste from tank 241-BX-108 via cascade overflow. The analytical data for tank 241-BX-109 indicates that a significant 1C/CW sludge layer is not present (bismuth concentration below detection limits for all core segments). Waste transaction records indicate that tank 241-BX-109 also received aluminum cladding waste supernates and B Plant ion exchange wastes, but the composition of the sludge was apparently not significantly altered based on evaluation of the analytical data and comparison with 241-TY-105. Tank 241-BX-109 does exhibit lower phosphate and higher uranium concentrations than tank 241-TY-105, but otherwise the two tanks have a similar composition.

The composition of TBP sludge predicted by the HDW model is substantially different from the analytical results for tanks 241-BX-109 and 241-TY-105. The HDW model predicts a much more salt-like waste (87 wt% sodium, nitrate and water). The sodium, nitrate and iron concentrations predicted by the HDW model are much higher, whereas the aluminum, uranium, sulfate, phosphate, total organic carbon and ^{90}Sr concentrations are much lower. Although the HDW model does not predict a TBP sludge layer for tank 241-BX-108, the comparison does indicate a potential problem in HDW model predictions for tanks that do contain TBP sludge layers.

Since most of the tank 241-BX-108 TBP sludge layer is thought to have been entrained in a transfer from 241-BX-109, the 241-BX-109 composition will be assumed for the 241-BX-108 TBP sludge layer. Data from tank 241-TY-105 will be used for analyses that were not performed on the 241-BX-109 core samples.

Table C3-2. Composition of TBP Waste Sludges. (3 sheets)

Analyte	Tank 241-BX-109 sludge conc.[a] (μg/g)	Tank 241-TY-105 sludge conc.[b] (μg/g)	Mean TBP sludge conc.[c] (μg/g)	HDW model TBP sludge[d] (μg/g)
Ag	NR	<1.59	<1.59	NR
Al	2,480	1,910	2,195	0
Bi	<494	383	<439	0
Ca	3,030	NR	3,030	7,772

Table C3-2. Composition of TBP Waste Sludges. (3 sheets)

Analyte	Tank 241-BX-109 sludge conc.[a] (μg/g)	Tank 241-TY-105 sludge conc.[b] (μg/g)	Mean TBP sludge conc.[c] (μg/g)	HDW model TBP sludge[d] (μg/g)
Cd	<49.4	3.83	<26.6	NR
Cl	1,320	NR	1,320	877
CO_3	NR	NR	NR	14,463
Cr	137	133	135	43.1
F	<528	NR	<528	0
Fe	21,900	20,900	21,400	49,561
Hg	NR	NR	NR	0
K	NR	NR	NR	160
La	<247	NR	<247	0
Mn	149	150	150	0
Na	105,000	115,000	110,000	182,030
Ni	NR	84.1	84.1	24.4
NO_2	18,100	NR	18,100	3,941
NO_3	193,000	178,000	185,500	467,916
OH (free)	NR	0.533	0.533	48.7
Pb	668	383	526	0
P as PO_4	25,200	119,000	72,100	3,202
Si	739	368	554	0
S as SO_4	17,600	NR	17,600	3,527
Sr	592	NR	592	0
TOC	410	805	608	1.13
U	16,400	5,400	10,900	94.1
Zr	<49.8	<7.31	<28.6	0

Table C3-2. Composition of TBP Waste Sludges. (3 sheets)

Analyte	Tank 241-BX-109 sludge conc.[a] (μg/g)	Tank 241-TY-105 sludge conc.[b] (μg/g)	Mean TBP sludge conc.[c] (μg/g)	HDW model TBP sludge[d] (μg/g)
Radionuclides[e] (μCi/g)				
^{241}Am	<0.284	<0.0315	<0.158	3.44 E-04
^{14}C	NR	<7.84 E-04	<7.84 E-04	1.79 E-04
^{60}Co	<0.0157	<0.0050	<0.0103	4.10 E-05
^{137}Cs	12.6	7.86	10.2	5.84
^{154}Eu	<0.0548	NR	<0.0548	7.38 E-04
^{155}Eu	<0.135	NR	<0.135	0.0309
^{129}I	NR	3.44 E-05	3.44 E-05	2.34 E-06
$^{239/240}Pu$	NR	0.0235	0.0235	0.00168
^{90}Sr	154	188	171	2.91
^{99}Tc	NR	0.0329	0.0329	0.00124
Density	1.48 g/mL	1.53 g/mL	1.51 g/mL	1.77 g/mL
% H_2O	50.3	39.4[f]	44.9	22.1

HDW = Hanford Defined Waste
NR = Not reported
NA = Not applicable
[a] Field et al. (1996b)
[b] Weiss and Mauss (1987)
[c] Average of tank 241-BX-109 and 241-TY-105 sludge concentrations
[d] Agnew et al. (1997a)
[e] Radionuclides decayed to January 1, 1994
[f] Heated from room temperature to 400 °C.

C3.6 ESTIMATED INVENTORY FOR TANK 241-BX-108

The chemical and radionuclide inventory of tank 241-BX-108 can be estimated from the sludge volumes (38 kL [10 kgal] of 1C sludge and 61 kL [16 kgal] of TBP sludge) and the chemical/radionuclide concentrations and sludge densities for tanks 241-BX-107 (1C sludge) and 241-BX-109 (TBP sludge). When composition data are not available for these two adjacent tanks in the cascade, mean analytical data from other tanks containing 1C or TBP sludges are used. The resulting inventories are provided in Table C3-3. The tank 241-BX-108 inventories estimated by the HDW model (Agnew et al. 1997a) is included in the table for comparison.

Table C3-3. Estimated Chemical and Radionuclide Inventory for Tank 241-BX-108. (2 Sheets)

Analyte	1C/CW sludge layer inventory (kg)	TBP sludge layer inventory (kg)	241-BX-108 inventory (kg)	HDW model inventory[a] (kg)
Ag	<0.0513	<0.143	<0.194	NR
Al	779	222	1,000	1,370
Bi	1,220	<44.3	<1,260	1,260
Ca	21.6	272	293	295
Cd	0.124	<4.43	<4.55	NR
Cl	62.1	118	180	110
TIC as CO_3	316	NR	NA	442
Cr	52.8	12.3	65.0	25.2
F	501	<47.3	<548	263
Fe	605	1,960	2,570	1,900
Hg	0.0308	NR	NA	1.97
K	14.3	NR	NA	26.3
La	<0.0823	<22.1	<22.2	0
Mn	3.52	13.4	16.9	0
Na	5,560	9,410	15,000	11,600
Ni	0.665	7.54	8.20	6.99
NO_2	670	1,620	2,290	1,210
NO_3	7,470	17,300	24,800	6,170
OH_{Total}	NR	NR	NR	6,270
Pb	3.42	59.9	63.3	0
P as PO_4	3,910	2,260	6,170	10,600
Si	370	66.2	436	539
S as SO_4	747	1,580	2,300	498
Sr	9.16	53.1	62.2	0
TOC	43.5	36.7	80.2	0
U	264	1,470	1,730	4,570
Zr	7.41	<4.46	<11.9	2.17

Table C3-3. Estimated Chemical and Radionuclide Inventory for Tank 241-BX-108. (2 Sheets)

Analyte	1C/CW sludge layer inventory (kg)	TBP sludge layer inventory (kg)	241-BX-108 inventory (kg)	HDW model inventory[a] (kg)
Radionuclides[b] (Ci)				
^{241}Am	0.707	<25.5	<26.2	0.0195
^{14}C	0.0142	<0.070	<0.0842	0.0111
^{60}Co	<0.310	<1.41	<1.72	0.00243
^{134}Cs	<2.31	NR	NA	8.88 E-05
^{137}Cs	921	1,130	2,050	1,190
^{154}Eu	<0.838	<4.91	<5.75	0.0431
^{155}Eu	<1.60	<12.1	<13.7	0.240
^{3}H	0.0295	NR	0.0295	0.0521
^{129}I	<0.591	0.00308	<0.594	1.45 E-04
^{237}Np	<0.943	NR	<0.943	4.74 E-04
^{238}Pu	<0.243	NR	<0.243	0.0247
$^{239/240}Pu$	3.12	2.11	5.22	3.88
^{106}Ru	<12.2	NR	NA	9.50 E-10
^{79}Se	<0.0546	NR	NA	0.00234
^{90}Sr	522	13,800	14,300	1,040
^{99}Tc	2.01	2.95	4.96	0.0769
Density	1.44 g/mL	1.48 g/mL	1.46 g/mL	1.37 g/mL
wt% H_2O	59.1	44.9	52.0	64.8
Volume	38 kL (10 kgal)	61 kL (16 kgal)	98 kL (26 kgal)	98 kL (26 kgal)

HDW = Hanford Defined Waste
NR = Not reported
NA = Not applicable
[a] Agnew et al. (1997a)
[b] Radionuclides decayed to January 1, 1994.

C3.7 COMPARISON OF TANK 241-BX-108 INVENTORY ESTIMATES

The lack of sample-based inventory data adds considerable uncertainty to estimation of chemical and radionuclide inventories for tank 241-BX-108. The use of composition data from other tanks (especially tanks 241-BX-107 and 241-BX-109 from the same cascade) to represent the 1C/CW and TBP sludges in tank 241-BX-108 is a reasonable approach. However, it should be noted that the operating history of tank 241-BX-108 is different than the other two tanks. In particular, the sludge composition may have been altered by the coating waste supernates and B Plant ion exchange wastes that were stored in the tank.

The HDW model and the process estimate differ significantly as to the waste types assumed to be contained in tank 241-BX-108. As a consequence, this evaluation provides only limited information that would be useful in improving the HDW model capabilities. Despite the differences in the waste types assumed to be present in tank 241-BX-108, the resulting chemical inventories are remarkably similar. Table C3-4 provides the ratio of the HDW model to process estimate inventories for major components (inventories of more than 100 kgs for chemicals or 1 Ci for radionuclides). The apparent agreement of the HDW model with the process estimate based on tank 241-BX-107 and tank 241-BX-109 compositions should be viewed with caution. The agreement noted for several species is likely coincidental considering the different waste types assumed to contribute to the tank 241-BX-108 inventory.

Table C3-4. Comparison of HDW Model Inventory Predictions to Process Estimate for Tank 241-BX-108.

Analyte/ radionuclide	Ratio of HDW model inventory to process estimate	Analyte/ radionuclide	Ratio of HDW model inventory to process estimate
Al	1.37	NO_3	0.25
Bi	1.00	P as PO_4	1.72
Ca	1.01	Si	1.24
CO_3	1.40	S as SO_4	0.22
F	<0.48	U	2.64
Fe	0.74	^{137}Cs	0.58
Na	0.77	$^{239/240}Pu$	0.74
Ni	0.85	^{90}Sr	0.073
NO_2	0.53		

HDW = Hanford Defined Waste (Agnew et al. 1997a).

The HDW model inventory predictions for tank 241-BX-108 are significantly lower (<50 percent) for fluoride, nitrite/nitrate, sulfate and ^{90}Sr. These differences are largely due to the components contained in the TBP sludge layer assumed by the process estimate. The HDW model predicts a significantly larger uranium inventory for tank 241-BX-108. This results from the high uranium concentrations for the 1C1 and 1C2 defined wastes. The five 1C/CW basis tanks (Table C3-1) have a mean uranium concentration of roughly 20 percent of the HDW model concentrations. Some adjustment of the HDW model uranium concentration or uranium solubility appear to be needed for 1C wastes.

The HDW model composition predicted for TBP sludge is significantly different than indicated by analytical data for tank 241-TY-105 and tank 241-BX-109 samples. This does not affect the HDW model prediction for the tank 241-BX-108 inventory since the HDW model did not assume that a TBP sludge layer was present. However, this does represent a concern for other tanks which do include a TBP waste layer.

The HDW model assumption that tank 241-BX-108 contains only 1C/CW sludge is incorrect based on waste level measurements in 1953 following the removal of the tank waste supernate. Only 38 kL (10 kgal) of 1C/CW sludge is indicated. This assumption should be changed.

The waste transaction summary (Agnew et al. 1997b) is inaccurate in regards to the tanks the 1C/CW was sent to from B Plant. In particular, tanks 241-BY-107, 241-BY-110 and 241-B-104 apparently did not directly receive the 1C/CW waste stream as shown by analyses of waste in these tanks. The waste transaction summary does not show sufficient 1C/CW waste being sent to tanks 241-BX-107 and 241-BX-110 to account for the existing sludge volumes. The transaction records regarding B Plant 1C/CW wastes need further investigation. It may be possible to eliminate the HDW model practice of varying the solids fraction in the 1C waste to account for observed sludge inventories and also to reduce the 1C1 and 1C2 HDW model defined wastes to a single waste type.

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 is consistent with that used by Agnew et al. (1997a). The resulting total hydroxide inventory is 3,620 kgs, which is 28 percent of that predicted by the HDW model. The difference is primarily due to the higher nitrate ion concentration in the TBP sludge layer (based on 241-BX-109 sample analyses), which reduces the hydroxide ion needed for the charge balance.

Cesium-137 and Strontium-90. The heat load for tank 241-BX-108 has been estimated at 3,273 BTU/h (Kummerer 1995) based on the waste depth and vapor space temperature. The tank 241-BX-108 heat load calculated from the ^{90}Sr and ^{137}Cs concentrations measured in tanks 241-BX-107 and 241-BX-109 is only 420 BTU/h (the HDW

model predicts an ever lower 43 BTU/h). Ninety-two percent of the heat load predicted by the process estimate results from the ^{90}Sr in the TBP sludge layer.

Four factors in the Kummerer model may be contributing to an inaccurate result for tank 241-BX-108: (1) the tank has a dished bottom, (2) the total waste depth in the tank 241-BX-108 is only 42.9 cm (16.9 in.), (3) the average vapor temperature of 65.4 °F (Kummerer 1995) is relatively close to the ambient temperature, and (4) the heat load is not uniformly distributed in the tank. The tank 241-BX-108 ^{90}Sr inventory may in fact be somewhat higher than predicted from the sample data for tanks 241-BX-107 and 241-BX-109, but the 3,273 BTU/h appears excessive for the small layer of waste in tank 241-BX-108. The 3,273 BTU/h heat load is nearly half of that predicted for tank 241-BX-109, which has a 731 kL (193 kgal) TBP waste layer. The process estimates for the ^{90}Sr and ^{137}Cs will be used for the respective tank 241-BX-108 inventories.

C4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

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

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

An effort is underway to provide waste inventory estimates that will serve as the standard characterization for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for tank 241-BX-108 was performed including the following:

- Waste transaction records and operating data to confirm the waste types transferred to tank 241-BX-108 and to predict the sludge types and solids volumes contributing to the current sludge inventory.

- Composition data from tank 241-BX-107, which is expected to contain a similar 1C/CW sludge layer, and tank 241-BX-109, which is expected to have a similar

TBP sludge layer. Tanks 241-BX-107 and 241-BX-109 were the source of most of the waste contained in tank 241-BX-108.

- Composition data from other waste tanks containing the 1C/CW and TBP sludge layers when analyses were not performed on the tank 241-BX-107 and tank 241-BX-109 samples.

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

Based on this evaluation, a best-basis inventory was developed. No applicable analytical data are available for tank 241-BX-108 because chemical and radionuclide analyses were not performed on the 1995 auger samples. The estimated inventory was, therefore, based primarily on the composition of the 1C/CW waste in tank 241-BX-107 and TBP sludge in tank 241-BX-109 since the sludges in these tanks have been analyzed. The HDW model inventories were used when no other data were available.

The waste in tank 241-BX-108 consists of combined $BiPO_4$ first decontamination cycle and coating wastes generated by B Plant during processing of irradiated, Al-clad reactor fuel (38 kL [10 kgal]) and TBP sludge (61 kL [16 kgal]). The sludge has been contacted with coating waste supernate and B Plant ion exchange waste. Leaching of some sludge components may have occurred and remaining sludge may differ from that predicted from other tanks containing 1C/CW or TBP waste sludges. The best-basis inventory for tank 241-BX-108 is presented in Tables C4-1 and C4-2. The inventory values reported in Tables C4-1 and C4-2 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 HDW Rev. 4 model results (Agnew et al. 1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Table C4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-BX-108 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
Al	1,000	E	
Bi	1,260	E	Concentration varies between 1C wastes.
Ca	293	E	
Cl	180	E	
TIC as CO_3	442	M	
Cr	65.0	E	
F	<548	E	The 1C sludge layer is predicted to contain 501 kgs.
Fe	2,570	E	Concentration varies between 1C waste tanks.
Hg	1.97	M	
K	26.3	M	
La	<22.2	E	
Mn	16.9	E	
Na	15,000	E	Concentration varies significantly between 1C waste tanks.
Ni	8.20	E	TBP layer based on concentration in tank 241-TY-105.
NO_2	2,290	E	
NO_3	24,800	E	
OH_{TOTAL}	3,620	C	
P as PO_4	6,170	E	Concentration varies between 1C and TBP waste tanks.
Pb	63.3	E	
S as SO_4	2,300	E	
Si	436	E	
Sr	62.2	E	
TOC	80.2	E	

Table C4-1. Best-Basis Inventory Estimate for Nonradioactive Components in Tank 241-BX-108 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, E, or C)[1]	Comment
U_{TOTAL}	1,730	E	Concentration varies significantly between 1C and TBP waste tanks.
Zr	<11.9	E	

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

Table C4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-BX-108 Decayed to January 1, 1994 (Effective May 31, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (M, or E)[1]	Comment
^{3}H	0.0521	M	
^{14}C	<0.0842	E	TBP layer inventory based on concentration in tank 241-TY-105.
^{59}Ni	0.00315	M	
^{60}Co	<1.72	E	
^{63}Ni	0.284	M	
^{79}Se	0.00234	M	
^{90}Sr	14,300	E	Tank heat load calculations indicates a larger ^{90}Sr inventory.
^{90}Y	14,300	E	Based on ^{90}Sr.
^{93m}Nb	0.0094	M	
^{93}Zr	0.0111	M	
^{99}Tc	4.96	E	TBP layer inventory based on concentration in tank 241-TY-105.
^{106}Ru	9.50 E-10	M	
^{113m}Cd	0.0267	M	
^{125}Sb	0.00219	M	
^{126}Sn	0.00351	M	
^{129}I	<0.594	E	Based on mean concentration of 1C sludges and TBP sludge concentration in 241-TY-105.
^{134}Cs	8.88 E-05	M	
^{137m}Ba	1,940	E	Based on ^{137}Cs.
^{137}Cs	2,050	E	
^{151}Sm	8.72	M	
^{152}Eu	0.00306	M	
^{154}Eu	<5.75	E	
^{155}Eu	<13.7	E	
^{226}Ra	6.75 E-07	M	

Table C4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-BX-108 Decayed to January 1, 1994 (Effective May 31, 1996). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (M, or E)[1]	Comment
^{227}Ac	3.44 E-06	M	
^{228}Ra	1.30 E-11	M	
^{229}Th	2.51 E-09	M	
^{231}Pa	7.43 E-06	M	
^{232}Th	3.19 E-12	M	
^{232}U	2.66 E-05	M	
^{233}U	1.35 E-06	M	
^{234}U	1.5	M	
^{235}U	0.067	M	
^{236}U	0.0124	M	
^{237}Np	4.74 E-04	M	
^{238}Pu	0.0247	M	
^{238}U	1.52	M	
$^{239/240}Pu$	5.22	E	TBP layer inventory based on concentration in tank 241-TY-105.
^{241}Am	<26.2	E	TBP layer has high "less than" concentration.
^{241}Pu	0.998	M	
^{242}Cm	5.41 E-05	M	
^{242}Pu	4.51 E-06	M	
^{243}Am	1.34 E-07	M	
^{243}Cm	1.10 E-06	M	
^{244}Cm	3.17 E-06	M	

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

C5.0 APPENDIX C REFERENCES

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