S 0049967

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 644478

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	7/15/98
	6. Project Title/No./Work Order No. Tank 241-AN-103	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-702, Rev. 0	10. Related ECN No(s). NA	11. Related PO No. NA

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

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

This ECN compiles all reconciliation changes to the Best-Basis Inventory made in FY98. Revisions were made to Section 3.0 and Appendix D, Evaluation to Establish Best-Basis Inventory for Double-Shell Tank 241-AN-103. Changes were made to both text and tables. The inventory estimates of several waste components were revised. 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. Replace Section 3.0 and Appendix D with this ECN.

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
DIMC	H6-15
DOE Reading Room	H2-53
TCSRC	R1-10
K. M. Hall	R2-12
K. M. Hodgson	R2-11
M. J. Kupfer	H5-49
M. D. LeClair (3)	H5-49
N. E. Wilkins	R2-12

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A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1) 644478

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

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. N. J. Kupfer	J Gammam for	7/30/98	PE		
Cog. Mgr. K. M. Hodgson	K. M. Hodgson	7-28-98	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other N. E. Wilkins R2-12	N. E. Wilkins	7/20/98	Other		
			DEPARTMENT OF ENERGY		
			Signature or a Control Number that tracks the Approval Signature		
			ADDITIONAL		

S

HNF-SD-WM-ER-702, Rev. 0C

Tank Characterization Report for Double-Shell Tank 241-AN-103

S. L. Lambert
COGEMA Engineering Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 644478 UC: 721, uc-2000
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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 double-shell tank 241-AN-103, 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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Christine Willingham 8-5-98
Release Approval Date

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RECORD OF REVISION	(1) Document Number HNF-SD-WM-ER-702	Page 1

(2) Title
Tank Characterization Report for Double-Shell Tank 241-AN-103

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 08/25/97 on EDT-617663.	N.E. Wilkins	K.M. Hall
0-A RS	Incorporate per ECN-635582.	N.E. Wilkins N.E. Wilkins	K.M. Hall Kathleen M. Hall
0-B RS	Incorporate per ECN-635590.	N.E. Wilkins N.E. Wilkins	K.M. Hall Kathleen M. Hall
OC RS	Incorporate per ECN-644478	M.J. Kupfer 7/30/98	K. M. Hodgson 7-28-98

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3.0 BEST-BASIS INVENTORY ESTIMATE

Inventories based on the September 1996 sampling event should serve as the basis for the best estimate inventory to tank 241-AN-103 for the following reasons:

1. The September 1996 sampling event provides the most recent data for the waste.

2. Estimates based on the 1988 core sampling event agree with the September 1996 data.

3. The HDW model estimates, although in reasonable agreement with the 1996 sampling data, do not check as well with the 1988 data.

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

Best-basis inventory estimates for tank 241-AN-103 are presented in Tables 3-1 through 3-2. A tank volume of 3,622 kL (957 kgal) was used to generate the sample-based and HDW inventories (Hanlon 1997). Radionuclide values are decayed to January 1, 1994.

The inventory values reported in Tables 3-1 and 3-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or (total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997). Model generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result, if available. For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10. Appendix D contains the complete narrative regarding the derivation of the inventory estimates shown in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Total Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	240,000	S	
Bi	0	E	Bi relatively insoluble in supernates added to tank 241-AN-103
Ca	430	S	Reported lower value from Table D2-1
Cl	27,500	S	
TIC as CO_3	92,300	S	
Cr	2,840	S	
F	3,890	S	
Fe	516	S	Reported lower value from Table D2-1
K	46,500	S	
La	464	S	Reported lower value from Table D2-1
Mn	43	S	Reported lower value from Table D2-1
Na	1.27E+06	S	
Ni	86	S	Reported lower value from Table D2-1
NO_2	496,000	S	
NO_3	776,000	S	
OH_{TOTAL}	932,000	C	
Pb	464	S	Reported lower value from Table D2-1
PO_4	9,860	S	IC Analysis
Si	2,360	S	
SO_4	13,300	S	IC Analysis
Sr	43	S	Reported lower value from Table D2-1
TOC	12,000	S	

Table 3-1. Best-Basis Total Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
U_{TOTAL}	413	S	Reported lower value from Table D2-1
Zr	43	S	

Notes:

Volume basis = 3,622 kL (955 kgal)

[1]S = Sample-based, M = HDW model-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, and E = Engineering assessment-based.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	9.31	S	Slurry/Crust only
^{14}C	112	S	
^{59}Ni	7.58	M	
^{60}Co	43	S	Based on 1986 core sample
^{63}Ni	747	M	
^{79}Se	12.3	M	
^{90}Sr	8,030	S	
^{90}Y	8,030	S	Referenced to ^{90}Sr
^{93}Zr	59.6	M	
^{93m}Nb	43.8	M	
^{99}Tc	456	S	
^{106}Ru	0.0533	M	
^{113m}Cd	302	M	
^{125}Sb	865	M	
^{126}Sn	18.8	M	
^{129}I	8.32	S	
^{134}Cs	189	M	
^{137}Cs	2.31E+06	S	
^{137m}Ba	2.19E+06	S	Referenced to ^{137}Cs
^{151}Sm	43,600	M	
^{152}Eu	15.8	M	
^{154}Eu	2,200	M	
^{155}Eu	991	M	
^{226}Ra	5.81E-04	M	
^{227}Ac	0.00355	M	
^{228}Ra	1.05	M	
^{229}Th	0.0243	M	
^{231}Pa	0.0143	M	
^{232}Th	0.103	M	

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}U	0.130	M/S	Based on total U: Used HDW isotopic ratios
^{233}U	0.497	M/S	Based on total U: Used HDW isotopic ratios
^{234}U	0.176	M/S	Based on total U: Used HDW isotopic ratios
^{235}U	6.82E-03	M/S	Based on total U: Used HDW isotopic ratios
^{236}U	0.0103	M/S	Based on total U: Used HDW isotopic ratios
^{237}Np	31.0	S	Upper bounding estimate
^{238}Pu	0.546	M/S	Based on ^{239}Pu: Used HDW isotopic ratios
^{238}U	0.138	M/S	Based on total U
^{239}Pu	10.2	M/S	Based on $^{239/240}Pu$: Used HDW isotopic ratios
^{240}Pu	2.12	M/S	Based on HDW isotopic ratios
^{241}Am	21.7	S	Slurry = 9.04 Ci
^{241}Pu	46.0	M/S	Based on ^{239}Pu: Used HDW isotopic ratios
^{242}Cm	0.0438	M/S	Based on ^{241}Am: Used HDW isotopic ratios
^{242}Pu	2.16E-04	M/S	Based on ^{239}Pu: Used HDW isotopic ratios
^{243}Am	1.47E-03	M/S	Based on ^{241}Am: Used HDW isotopic ratios
^{243}Cm	4.45E-03	M/S	Based on ^{241}Am: Used HDW isotopic ratios

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{244}Cm	0.0607	M/S	Based on ^{241}Am: Used HDW isotopic ratios

Notes:

Volume basis = 3,615 kL (955 kgal)

[1]S = Sample-based, M = HDW model-based, and E = Engineering assessment-based.

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AN-103

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR DOUBLE-SHELL TANK 241-AN-103

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-AN-103 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

Available composition information for the waste in tank 241-AN-103 is as follows:

- Appendix B of this report provides characterization results from the September 1996 core sampling event.
- A feed projection document that supported grout treatment facility studies provides estimates of the waste in tank 241-AN-103 based on a 1986 push core sample. (Hendrickson 1994).
- The HDW model document (Agnew et al. 1997) provides tank content estimates derived from the LANL model, in terms of component concentrations and inventories. A complete list of data sources used in this evaluation is provided at the end of this section.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

There have been no transfers into or out of tank 241-AN-103 since 1986. The HDW model provides composition estimates for the waste in tank 241-AN-103 as of January 1, 1994. Sample-based inventories derived from the September 1996 push core samples are compared to sample based-inventories derived from a 1988 push core sample and inventories generated by the HDW model (Agnew et al. 1997), in Tables D2-1 and D2-2. A tank volume of 3,615 kL (955 kgal) was used to generate the sample-based and HDW inventories (Hanlon 1997). The chemical species are reported without charge designation per the best-basis inventory convention.

The sample-based densities reported in Appendix B are 1.53 g/mL for the liquid and 1.76 g/mL for the slurry. The slurry density is based on measurements of centrifuged solids; it is not necessarily the same as the density of the slurry in the tank. Gases generated in the tank are trapped in the slurry layer and form gas pockets. Because of this, a lower density than was found in the laboratory is expected for the waste in the tank. In tank 241-AN-103, the retained gas is 6.7 vol% of the slurry volume (Shekarriz et al. 1996). The mean slurry density was corrected by multiplying by 0.933 (1 - vol% retained gas). The corrected slurry density is 1.64 g/mL. The HDW model bulk density is 1.60 g/mL.

The slurry volume, determined from temperature profiles, rheometer and push core sample data is 1,552 kL (410 kgal) (Stauffer 1997). Based on the extrusion reports, there is a considerable crust layer in tank 241-AN-103. Approximately 35.6 cm (14 in.) of solids and no drainable liquid was extruded from the first segment of core 167 and 15.2 cm (6 in.) of solids were found in segment two of core 167 with 190 mL of drainable liquid. Segment 1 of core 166 was found to contain only 6.4 cm (2.5 in.) of solids and no drainable liquid. Segment 2 of core 166 was taken for retained gas analysis; the solid content is not known.

Based on core 167, the crust layer would be 50.8 cm (20 in.) deep. However, it is evident that salts precipitated from supernatant after samples were removed from the tank and allowed to cool to ambient temperatures. The average temperature in tank 241-AN-103 is 41.1 °C (106 °F) (Brevick 1997). Samples from both cores that were expected to contain only liquid contained from 1 to 5 inches of solids. It was assumed that 7.6 cm (3 in.) of the 15.2 cm (6 in.) of solids in the second segment of core 167, which contained 15.2 cm (6 in.) of solids, precipitated after the segment was taken from the tank. The fourteen inches of solids in segment 1 of core 167 are assumed to be crust. The total crust layer is assumed therefore to be 43.2 cm (17 in.) or 177 kL (46.7 kgal) with a density of 1.50 (an assumed density that is slightly lower than the mean liquid density).

The supernatant volume, equal to the total volume minus the slurry and crust volumes, is estimated to be 1,885 kL (498 kgal) from these observations. The supernatant volume in Hanlon (1997) of 2,063 kL (545 kgal) is expected to be updated to the newer basis in the future.

Table D2-1. Sampling and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Double-Shell Tank 241-AN-103. (2 sheets)

Analyte	Inventory based on segment data from both push core samples (kg)	Inventory based on composite of core 166 (kg)	HDW model inventory[1] (kg)	Inventory based on 1986 push core sample[2] (kg)
Al	239,000	181,000	152,000	208,000
Bi	<1,120	<358	874	174
Ca	<6,100	<430	6,810	314
Cl	27,500	29,120	30,900	34,800
CO3	NR	84,600	146,000	32,400
Cr	2,820	2,860	20,800	3,070
F	3,860	11,900	12,700	2,660
Fe	<774	<516	3,440	255
Hg	0	0	10	58
K	46,300	51,100	26,100	55,100
La	<811	<464	6.19	NR
Mn	<112	<42.8	1,830	NR
Na	1.27E+06	1.12E+06	1.18E+06	1.21E+06
Ni	<225	<86.1	2,250	87
NO2	494,000	458,000	330,000	498,000
NO3	771,000	597,000	1.11E+06	579,000
OH	NR	270,000	577,000	353,000
Pb	<795	<464	862	260
P as PO4	9,800	11,300	55,700	3,360
Si	2,350	2,840	8,330	985
S as SO4	13,200	17,300	85,000	5,810
Sr	<112	<43.0	0	NR
TOC	NR	12,000	60,200	2,220
U	<5,620	413	11,400	1.88

Table D2-1. Sampling and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Double-Shell Tank 241-AN-103. (2 sheets)

Analyte	Inventory based on segment data from both push core samples (kg)	Inventory based on composite of core 166 (kg)	HDW model inventory[1] (kg)	Inventory based on 1986 push core sample[2] (kg)
Zr	<113	<42.9	566	426
% water	48	41.0	32.6	NR
density, g/mL	1.54	1.62	1.60	1.6

Notes:

HDW = Hanford Defined Waste
NR = Not reported

[1] Agnew et al. (1997)
[2] Hendrickson (1994).

Table D2-2. Sampling and Hanford Defined Waste Model Inventory Estimates for Radioactive Components in Double-Shell Tank 241-AN-103 (Decayed to January 1, 1994). (2 sheets)

Analyte	September 1996 inventory based on segment data from both push core samples (Ci)	September 1996 inventory based on composite of core 166 (Ci)	HDW model inventory[1] (Ci)	Inventory based on 1986 push core sample[2] (Ci)
^{3}H	NR	9.31	805	8.8
^{14}C	NR	NR	105	7.2
^{59}Ni	NR	NR	7.58	NR
^{60}Co	NR	<112	139	43.5
^{79}Se	NR	NR	12.3	156
^{90}Sr	NR	8,030	444,000	38,000
^{90}Y	NR	8,030	444,000	NR
^{99}Tc	NR	456	784	616
^{106}Ru	NR	NR	0.0533	0.627
^{129}I	NR	8.32	1.51	1.88
^{134}Cs	NR	NR	189	20.8

Table D2-2. Sampling and Hanford Defined Waste Model Inventory Estimates for Radioactive Components in Double-Shell Tank 241-AN-103 (Decayed to January 1, 1994). (2 sheets)

Analyte	September 1996 inventory based on segment data from both push core samples (Ci)	September 1996 inventory based on composite of core 166 (Ci)	HDW model inventory[1] (Ci)	Inventory based on 1986 push core sample[2] (Ci)
^{137}Cs	NR	2.31E+06	789,000	2.22E+06
^{137m}Ba	NR	2.19E+06	746,000	2.11E+06
^{154}Eu	NR	<604	2,200	NR
^{155}Eu	NR	<3,300	991	NR
^{234}U	NR	NR	4.87	0.192
^{235}U	NR	NR	0.189	0.00398
^{237}Np	NR	<31.0	2.82	0.0724
^{238}Pu	NR	NR	12.6	3.31
^{238}U	NR	NR	4.84	0.051
$^{239/240}Pu$	NR	12.3	284	6.88
^{241}Am	NR	<21.7	308	8.22
^{243}Cm	NR	<4.85	0.0632	NR
^{244}Cm	NR	<13.0	0.863	1.09

Notes:

HDW = Hanford Defined Waste
NR= Not reported

[1] Agnew et al. (1997)
[2] Hendrickson (1994).

The HDW model estimates for tank 241-AN-103 were derived by combining the supernatant streams that were believed to have been concentrated in the 242-A evaporator and then sent to tank 241-AN-103. This part of the HDW model is called the Supernatant Mixing Model (SMM). The compositions of the supernatants are derived largely from estimates of bulk compositions for process waste streams that left the various processing facilities. To obtain the supernatant fractions, these bulk compositions are multiplied by solubility factors determined from the highest concentrations found among supernatant sample analyses.

In the case of tank 241-AN-103, inventory estimates made by the HDW model are in reasonably good agreement with the sample-based numbers in Table D2-1 for many major

(> 100,000 kg) waste constituents. Al, CO_3, Na, NO_2, and NO_3 inventories predicted by the HDW model are within a factor of 2 of the sample-based numbers. The HDW model hydroxide estimate is 2.14 times higher than the sample-based result. Cr, Fe, and Ni inventory estimates made by the HDW model are higher than the sample-based inventories because the HDW model overestimates the rate of corrosion in process vessels and storage tanks and it overestimates the solubility of these species in the alkaline environment of Hanford Site tank waste. The model estimate for Ca is much higher than the sample-based result; this is a product of the model overestimating the concentration of Ca in raw water. The agreement for ^{90}Sr and ^{137}Cs is also not close.

An earlier push core sample taken in 1986 offers more data to make comparisons with. Results of this sampling event are published in Hendrickson (1994) and are shown in column 5 of Table D2-1[1]. Less than values were reported as real values in the Hendrickson report. For major components, the agreement between the 1986 push core sample and samples taken more recently is very good (RPDs of less than 30 percent). There is less agreement for minor components, including F, PO_4, Si, SO_4, and U, and TOC. Pre-1989 sample data has not been validated and should be used with caution. However, the 1986 push core samples suggest that the inventories calculated from the 1996 push core sample data are valid.

D3.0 COMPONENT INVENTORY EVALUATION

In Table D3-1, concentrations for the supernatant, slurry, and crust portions based on the means of the segment data for both cores and the composite of core 166 from Appendix B are shown. The calculated liquid values from the one-way ANOVA (Table B3-9) divided by the density of the convective layer (1.46 g/mL) were used to derive the supernatant inventory. The results from the nested ANOVA without the riser term were used to derive the slurry inventory. Core 166 was taken from riser 12A and core 167 was taken from riser 21A. Mean concentrations from segment data are based on segments from both cores. Mean concentrations from composite data are based on a composite of Core 166 only.

The analytical methods used for determining several analytes for the segment data of the 1996 push cores resulted in several high "less-than" values. For this reason, the lower detection limits obtained for the core 166 components were generally used as the basis for these analytes.

Inventories based on a volume of 3,622 kL (957 kgal).

Table D3-1. Comparison of September 1996 Push Core Sample Concentrations.[1] (2 sheets)

Analyte	September 1996 liquid mean concentrations based on segment data from both push core samples (μg/mL)	September 1996 liquid mean concentrations based on composite of core 166 (μg/mL)	September 1996 slurry mean concentrations based on segment data from both push core samples (μg/g)	September 1996 slurry mean concentrations based on composite of core 166 (μg/g)	September 1996 crust mean concentrations based on segment data from both push core samples (μg/g)
Al	36,600	32,100	58,200	38,200	85,400
Bi	<261	<120	<225	<28.2	<222
Ca	<261	<120	<2,200	<56.3	<222
Cl	8,950	9,890	3,820	3,730	3,360
CO3	NR	5,800	NR	28,850	NR
Cr	632	662	552	538	890
F	634	596	982	4,140	709
Fe	<131	<60.1	<48.5 [2]	<48.5	<1,050
Hg	NR	NR	NR	NR	NR
K	15,600	17,300	6,010	6,540	6,150
La	<131	<60.1	<113	<28.2	<111
Mn	<26.1	<12	<22.5	<5.57	<22.1
Na	289,000	263,000	258,000	217,000	269,000
Ni	<52.4	<24	<45.1	<11.3	<44.6
NO2	161,000	133,000	67,800	73,400	71,300
NO3	159,000	117,000	171,000	132,000	145,000

Table D3-1. Comparison of September 1996 Push Core Sample Concentrations.[1] (2 sheets)

Analyte	September 1996 liquid mean concentrations based on segment data from both push core samples (µg/mL)	September 1996 liquid mean concentrations based on composite of core 166 (µg/mL)	September 1996 slurry mean concentrations based on segment data from both push core samples (µg/g)	September 1996 slurry mean concentrations based on composite of core 166 (µg/g)	September 1996 crust mean concentrations based on segment data from both push core samples (µg/g)
OH	NR	98,200	NR	32,900	NR
Pb	314	138	<56.3 [2]	<56.3	<222
P as PO4	1,710	840	2,390	3,590	2,045
Si	353	191	531	838	1,290
S as SO4	1,920	1,310	3,510	5,530	2,873
Sr	<26.1	<12	<22.5	<5.63	<22.2
TOC	NR	3,050	NR	2,440	NR
U	<1,310	1.84	<1,130	45.1	<1,110
Zr	26.6	<12	<22.5	<5.63	<22.1
% water	49.0	48.8	31.8	33.0	35.0
density	1.46	1.49	1.76	NR	NR

Notes:

[1]Data taken from Appendix B

[2]Core composite value. No less-than values reported for the segment-based acid digestion.

Acid and fusion digests were performed on the individual segments to obtain cation concentrations, but only acid digests were performed on the core composite. Fusion digests with KOH or NaOH are usually a more complete method of dissolving solids than acid dissolution. However, the detection limits from the fusion procedure are up to 10 times higher than the limits set in the acid digestion procedure. Although complete digestion does not always occur with the use of acid, the less-than values reported from this procedure for many analytes are more accurate than the fusion digest less-than values.

The mean concentrations from the segment data are a better source of information than the core composite data. The mean concentrations calculated from the segment data were obtained from a large number of data points as opposed to one, and these segments were treated with the more complete fusion digest as opposed to acid digest. Also, the segment data were taken from two cores as opposed to one. The largest discrepancies between the two sets of data occur for F, NO_3 and SO_4. The ratio of the segment inventory to the composite inventory for these three components is 0.33, 1.29, and 0.76, respectively. The fluoride concentration from the core composite (4,140 μg/g) is at least 3 times greater than all the individual segment analyses for fluoride with the exception of segment 17 of core 167 and is therefore not reliable. The differences for NO_3 and SO_4 are not significant; the segment-based data is assumed to be more accurate because there were more analyses.

The composite core data contains information on several chemicals not found in the segment-based data or the analysis of the crust. These analytes include CO_3, OH, and TOC. The composite data are also the only source of individual radionuclide concentrations from the 1996 sampling event. The composite concentrations were used in these instances for both the segment-based inventory and the crust layer.

The best-basis inventory is therefore a combination of both segment level data and core composite data. Core composite concentrations are used for components not included in the segment analyses.

Concentrations for the 43.8 cm (17 in.) of crust are included in Table D3-1 which shows that this material is similar to the slurry below it, except for the higher aluminum concentration in the crust.

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

Inventories based on the September 1996 sampling event should serve as the basis for the best estimate inventory to tank 241-AN-103 for the following reasons:

1. The September 1996 sampling event provides the most recent data for the waste.

2. Estimates based on the 1988 core sampling event agree with the September 1996 data.

3. The HDW model estimates, although in reasonable agreement with the 1996 sampling data, do not check as well with the 1988 data.

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

Best-basis inventory estimates for tank 241-AN-103 are presented in Tables D4-7 through D4-8. A tank volume of 3,622 kL (957 kgal) was used to generate the sample-based and HDW inventories (Hanlon 1997). Radionuclide values are decayed to January 1, 1994. Estimated inventories for supernatant, crust, and slurry layers are provided in Tables D4-1 through D4-6.

The inventory values reported in Tables D4-7 and D4-8 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or (total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997). Model generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result, if available. 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. Supernatant Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Supernatant inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	69,300	S	
Bi	<495	S	
Ca	<495	S	
Cl	16,900	S	
TIC as CO_3	11,000	S	Not reported in segment-level data.
Cr	1,200	S	
F	1,200	S	
Fe	<248	S	
K	29,600	S	
La	<248	S	
Mn	<49.4	S	
Na	547,000	S	
Ni	<99.2	S	
NO_2	304,000	S	
NO_3	301,000	S	
OH	344,000	C	
Pb	<594	S	
PO_4	3,240	S	IC Analysis
Si	669	S	
SO_4	3,630	S	IC Analysis
Sr	<49.4	S	
TOC	5,770	S	Not reported in segment-level data.
U_{TOTAL}	<2,480	S	

Table D4-1. Supernatant Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Supernatant inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Zr	<50.3	S	
% Water	51.1	S	
Density, g/mL	1.46	S	

Notes:

Volume basis = 1,885 kL supernatant (498 kgal)

[1]S = Sample-based, M = HDW model-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, and E = Engineering assessment-based.

Table D4-2. Supernatant Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994).

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{60}Co	<55.7	S	
^{90}Sr	42.0	S	
^{90}Y	42.0	S	Referenced to ^{90}Sr.
^{99}Tc	0.318	S	
^{129}I	0.717	S	
^{137}Cs	1.49E+06	S	
^{137m}Ba	1.41E+06	S	Referenced to ^{137}Cs
^{154}Eu	<367	S	
^{155}Eu	<1,630	S	
^{237}Np	<0.048	S	
$^{239/240}Pu$	7.23	S	
^{241}Am	<11.7	S	
^{243}Cm	<0.52	S	
^{244}Cm	<12.5	S	

Notes:

Volume basis = 1,885 kL supernatant (498 kgal)

[1]S = Sample-based, M = HDW model-based, and E = Engineering assessment-based.

Table D4-3. Salt Slurry Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 Salt Slurry as of May 31, 1997. (2 sheets)

Analyte	Salt slurry inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	148,000	S	
Bi	<574	S	
Ca	<5,610	S	
Cl	9,740	S	
TIC as CO_3	73,600	S	Not reported in segment-level data
Cr	1,410	S	
F	2,500	S	
Fe	<251	S	
K	15,300	S	
La	<288	S	
Mn	57.4	S	
Na	658,000	S	
Ni	115	S	
NO_2	173,000	S	
NO_3	436,000	S	
OH	577,000	C	
Pb	<144	S	
PO_4	6,080	S	IC Analysis
Si	1,350	S	
SO_4	8,940	S	IC Analysis
Sr	<57.4	S	
TOC	6,220	S	Not reported in segment-level data
U_{TOTAL}	<2,880	S	Not reported in segment-level data

Table D4-3. Salt Slurry Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 Salt Slurry as of May 31, 1997. (2 sheets)

Analyte	Salt slurry inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Zr	<57.4	S	
% Water	31.8	S	
Density, g/mL	1.62	S	

Notes:

Volume basis = 1,552 kL supernatant (410 kgal)

[1]S = Sample-based, M = HDW model-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, and E = Engineering assessment-based.

Table D4-4. Salt Slurry Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994).

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	8.44	S	
^{60}Co	<51.4	S	
^{90}Sr	7,240	S	
^{90}Y	7,240	S	Referenced to ^{90}Sr
^{99}Tc	413	S	
^{129}I	6.89	S	
^{137}Cs	744,000	S	
^{137m}Ba	707,000	S	Referenced to ^{137}Cs
^{154}Eu	<215	S	
^{155}Eu	<1,510	S	
^{237}Np	<28.1	S	
$^{239/240}Pu$	11.8	S	
^{241}Am	9.04	S	
^{243}Cm	<3.93	S	
^{244}Cm	<94.3	S	

Notes:

Volume basis = 1,552 kL supernatant (410 kgal)

[1]S = Sample-based, M = HDW model-based, and E = Engineering assessment-based.

Table D4-5. Crust Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Crust inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	22,700	S	
Bi	<58.9	S	
Ca	<58.9	S	
Cl	892	S	
TIC as CO_3	7,660	S	Assumed to be equal to slurry concentration
Cr	236	S	
F	188	S	
Fe	279	S	
K	1,630	S	
La	<279	S	
Mn	5.87	S	
Na	71,400	S	
Ni	11.8	S	
NO_2	18,900	S	
NO_3	38,500	S	
OH	78,100	C	
Pb	<58.9	S	
PO_4	543	S	IC Analysis
Si	342	S	
SO_4	763	S	IC Analysis
Sr	<5.89	S	
TOC	648	S	Assumed to be equal to slurry concentration
U_{TOTAL}	<295	S	

Table D4-5. Crust Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Crust inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Zr	5.87	S	
% Water	35.0	S	
Density, g/mL	1.5	E	

Notes:

Volume basis = 177 kL crust (47 kgal)

[1]S = Sample-based, M = HDW model-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, and E = Engineering assessment-based.

Table D4-6. Crust Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994).

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.878	S	
^{60}Co	<5.35	S	
^{90}Sr	753	S	
^{90}Y	753	S	Referenced to ^{90}Sr
^{99}Tc	43.0	S	
^{129}I	0.717	S	
^{137}Cs	77,400	S	
^{137m}Ba	73,500	S	Referenced to ^{137}Cs
^{154}Eu	<22.3	S	
^{155}Eu	<157	S	
^{237}Np	<2.92	S	
$^{239/240}Pu$	0.480	S	
^{241}Am	0.941	S	
^{243}Cm	<0.409	S	
^{244}Cm	<9.81	S	

Notes:

Volume basis = 177 kL crust (47 kgal)

[1]S = Sample-based, M = HDW model-based, and E = Engineering assessment-based.

Table D4-7. Best-Basis Total Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
Al	240,000	S	
Bi	0	E	Bi relatively insoluble in supernates added to tank 241-AN-103
Ca	430	S	Reported lower value from Table D2-1
Cl	27,500	S	
TIC as CO_3	92,300	S	
Cr	2,840	S	
F	3,890	S	
Fe	516	S	Reported lower value from Table D2-1
K	46,500	S	
La	464	S	Reported lower value from Table D2-1
Mn	43	S	Reported lower value from Table D2-1
Na	1.27E+06	S	
Ni	86	S	Reported lower value from Table D2-1
NO_2	496,000	S	
NO_3	776,000	S	
OH_{TOTAL}	932,000	C	
Pb	464	S	Reported lower value from Table D2-1
PO_4	9,860	S	IC Analysis
Si	2,360	S	
SO_4	13,300	S	IC Analysis
Sr	43	S	Reported lower value from Table D2-1
TOC	12,000	S	

Table D4-7. Best-Basis Total Inventory Estimates for Nonradioactive Components in Tank 241-AN-103 as of May 31, 1997. (2 sheets)

Analyte	Total inventory (kg)	Basis (S, M, C, or E)[1]	Comment
U_{TOTAL}	413	S	Reported lower value from Table D2-1
Zr	43	S	

Notes:

Volume basis = 3,622 kL (955 kgal)

[1]S = Sample-based, M = HDW model-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, and E = Engineering assessment-based.

Table D4-8. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	9.31	S	Slurry/Crust only
^{14}C	112	S	
^{59}Ni	7.58	M	
^{60}Co	43	S	Based on 1986 core sample
^{63}Ni	747	M	
^{79}Se	12.3	M	
^{90}Sr	8,030	S	
^{90}Y	8,030	S	Referenced to ^{90}Sr
^{93}Zr	59.6	M	
^{93m}Nb	43.8	M	
^{99}Tc	456	S	
^{106}Ru	0.0533	M	
^{113m}Cd	302	M	
^{125}Sb	865	M	
^{126}Sn	18.8	M	
^{129}I	8.32	S	
^{134}Cs	189	M	
^{137}Cs	2.31E+06	S	
^{137m}Ba	2.19E+06	S	Referenced to ^{137}Cs
^{151}Sm	43,600	M	
^{152}Eu	15.8	M	
^{154}Eu	2,200	M	
^{155}Eu	991	M	
^{226}Ra	5.81E-04	M	
^{227}Ac	0.00355	M	
^{228}Ra	1.05	M	
^{229}Th	0.0243	M	
^{231}Pa	0.0143	M	
^{232}Th	0.103	M	

Table D4-8. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}U	0.130	M/S	Based on total U: Used HDW isotopic ratios
^{233}U	0.497	M/S	Based on total U: Used HDW isotopic ratios
^{234}U	0.176	M/S	Based on total U: Used HDW isotopic ratios
^{235}U	6.82E-03	M/S	Based on total U: Used HDW isotopic ratios
^{236}U	0.0103	M/S	Based on total U: Used HDW isotopic ratios
^{237}Np	31.0	S	Upper bounding estimate
^{238}Pu	0.546	M/S	Based on ^{239}Pu: Used HDW isotopic ratios
^{238}U	0.138	M/S	Based on total U
^{239}Pu	10.2	M/S	Based on $^{239/240}Pu$: Used HDW isotopic ratios
^{240}Pu	2.12	M/S	Based on HDW isotopic ratios
^{241}Am	21.7	S	Slurry = 9.04 Ci
^{241}Pu	46.0	M/S	Based on ^{239}Pu: Used HDW isotopic ratios
^{242}Cm	0.0438	M/S	Based on ^{241}Am: Used HDW isotopic ratios
^{242}Pu	2.16E-04	M/S	Based on ^{239}Pu: Used HDW isotopic ratios
^{243}Am	1.47E-03	M/S	Based on ^{241}Am: Used HDW isotopic ratios

Table D4-8. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AN-103 as of May 31, 1997 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{243}Cm	4.45E-03	M/S	Based on ^{241}Am: Used HDW isotopic ratios
^{244}Cm	0.0607	M/S	Based on ^{241}Am: Used HDW isotopic ratios

Notes:

Volume basis = 3,615 kL (955 kgal)

[1]S = Sample-based, M = HDW model-based, and E = Engineering assessment-based.

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