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ACCESSION # D197245530

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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 635516

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 []	Kevin E. Bell, Data Assessment and Interpretation, R2-12, 373-1629	[] Yes [X] No	07/28/97
	6. Project Title/No./Work Order No. Tank 241-U-108	7. Bldg./Sys./Fac. No. 241-U-108	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF-SD-WM-ER-639, Rev. 0-A	10. Related ECN No(s). ECN-635454	11. Related PO No. N/A

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

13a. Description of Change

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

This ECN was generated to include additional explanatory text in the best-basis narrative, and to update the comprehensive radionuclide inventory estimates for the tank.

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[X]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Initial release of this document was deficient.

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

See attached distribution.

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SEP 1997 RECEIVED EDMC

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ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): ECN-635516

16. Design Verification Required	17. Cost Impact						18. Schedule Impact (days)	
	ENGINEERING			CONSTRUCTION				
[] Yes	Additional	[]	$	Additional	[]	$	Improvement	[]
[X] No	Savings	[]	$	Savings	[]	$	Delay	[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. K.E. Bell	Kevin E. Bell	8-20-97	PE		
Cog. Mgr. K.M. Hall	Kathleen M. Hall	8/20/97	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

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

Kevin E. Bell
Lockheed Martin Hanford, Corp., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ECN-635516 UC: 2070
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Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-U-108, 241-U-108, U-108, U Farm, Tank Characterization Report, TCR, Waste Inventory, TPA Milestone M-44

Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-U-108. This report supports the requirements of the Tri-Party Agreement Milestone M-44-10.

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

CHANGE CONTROL RECORD

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3.0 BEST-BASIS INVENTORY ESTIMATE

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

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

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

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-U-108 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E)[1]	Comment
Al	51,190	S	Average segment sample data plus liquid data
Bi	437	E	Average based on S1 and S2 TCR saltcake data
Ca	447	S	Average based on acid digest of core composite data
Cl	10,914	S	Average segment sample data plus liquid data
TIC as CO_3	118,500	S	Average segment sample data plus liquid data
Cr	12,116	S	Average segment sample data plus liquid data
F	2,836	S	Average segment sample data plus liquid data
Fe	507	S	Core composite acid digest samples
Hg	221	M	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-U-108 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E)[1]	Comment
K	4,800	S	Core composite samples
La	<117	S	Core composite samples below detection limit
Mn	185	S	Core composite acid digest samples
Na	726,100	S	Average segment sample data plus liquid data
Ni	150	S	Core composite acid digest samples
NO_2	157,800	S	Average segment sample data plus liquid data
NO_3	879,500	S	Average segment sample data plus liquid data
OH	225,000	C	Charge balance calculation
Pb	<234	S	Core composite samples below detection limit
PO_4	50,527	S	Average segment sample data plus liquid data
Si	830	S	Average core composite water wash sample plus liquid
SO_4	44,430	S	Average segment sample data plus liquid data
Sr	<23.4	S	Core composite below detection limit
TOC	12,850	S	Average segment sample data plus liquid data
U_{TOTAL}	538	S	Laser phosphorescence data from core composite samples
Zr	<23.4	S	Core composite below detection limit

Notes:

[1]S = Sample-based (see Appendix B)
M = Hanford Defined Waste model-based
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-U-108 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{3}H	513	M	
^{14}C	76.3	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-108 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{59}Ni	4.7	M	
^{60}Co	< 61.5	S	Average solid segment data
^{63}Ni	462	M	
^{79}Se	7.31	M	
^{90}Sr	29,400	S	Average solid segment data
^{90}Y	29,400	S	Based on ^{90}Sr
^{93m}Nb	26	M	
^{93}Zr	35.9	M	
^{99}Tc	542	M	
^{106}Ru	0.0151	M	
^{113m}Cd	190	M	
^{125}Sb	368	M	
^{126}Sn	11.1	M	
^{129}I	1.05	M	
^{134}Cs	5.17	M	
^{137m}Ba	390,000	S	Based on ^{137}Cs
^{137}Cs	411,000	S	Average core segment data
^{151}Sm	25,700	M	
^{152}Eu	8.68	M	
^{154}Eu	< 241	S	Average core segment data
^{155}Eu	< 884	S	Average core segment data
^{226}Ra	3.04 E-04	M	
^{227}Ac	0.00192	M	
^{228}Ra	0.269	M	
^{229}Th	0.00634	M	
^{231}Pa	0.0089	M	
^{232}Th	0.0183	M	
^{232}U	1.4	M	
^{233}U	5.39	M	
^{234}U	8.72	M	
^{235}U	0.346	M	
^{236}U	0.423	M	

Table 3-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-108 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{237}Np	1.96	M	
^{238}Pu	21.5	M	
^{238}U	7.33	M	
^{239}Pu	615	M	
^{240}Pu	102	M	
^{241}Am	< 1,930	S	Average core segment data
^{241}Pu	962	M	
^{242}Cm	0.328	M	
^{242}Pu	0.00314	M	
^{243}Am	0.00438	M	
^{243}Cm	0.0305	M	
^{244}Cm	0.303	M	

[1]S=Sample-based
M=Hanford Defined Waste model-based
E=Engineering assessment-based

APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-U-108

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR TANK 241-U-108

An effort is underway to provide waste inventory estimates that will serve as standard characterization information for the various waste management activities (Kupfer et al. 1995). As part of this effort, an evaluation of available chemical information for tank 241-U-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.

D1.0 CHEMICAL INFORMATION SOURCES

Available chemical information for tank 241-U-108 included:

- Data from recent analyses of three core samples collected in April/May 1996 (Bell 1996). See Appendix B, Section B2.0 for data.
- The solids composite inventory estimate for this tank generated from the Hanford Defined Waste (HDW) model (Agnew et al. 1996a), developed at Los Alamos National Laboratory.

A list of references used in this evaluation is provided at the end of this Appendix.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The sample-based inventory estimate (Section B3.2), derived from the analytical concentration data from the three 1996 core samples, and the inventory estimate from the HDW (Section A3.2), are compared in Tables D2-1 and D2-2. (The chemical species are reported without charge designation per the best-basis inventory convention). The HDW provides tank content estimates derived from process flowsheets and waste volume records. The waste volume used to generate both estimates is 1,771 kL (468 kgal). However, the sample- and HDW-based estimates use different waste densities. The sample-based inventory was generated using a measured bulk density of 1.74 g/mL for segment sample data and 1.40 g/mL for drainable liquid samples, and a density of 1.71 g/mL for core composites. The HDW model uses a lower waste density of 1.62 g/mL. The differences attributable to density result in a relative percent difference of 7.1 for analytes with roughly the same concentration.

The sample-based values in Table D2-1 were obtained either from the mass-weighted average of the solid segment data (Table B3-9) plus the drainable liquid data (Table B3-10), or from the core composite results (Table B3-8) as indicated. The segment/drainable liquid data were used preferentially because they provided a more comprehensive description of the tank. The component inventories were calculated by multiplying the mean analyte concentration value by the current tank waste volume and the appropriate density of the waste.

There are several differences between the sample-based and HDW inventories for some analytes. Analyte inventories that vary by about a factor of two between the two bases are Al, phosphate, Cr, and carbonate. Analytes that vary by an order of magnitude or more are La and U. Of the radionuclides, Sr-90 is reported to be about an order of magnitude less in the sampling inventory than in the HDW.

Table D2-1. Sampling and HDW-Based Inventory Estimates for Nonradioactive Components in Tank 241-U-108. (2 sheets)

Analyte	Sampling Inventory Estimate (kg)	HDW Inventory Estimate (kg)	Analyte	Sampling Inventory Estimate (kg)	HDW Inventory Estimate (kg)
Al	51,190[1]	96,800	NH_3	n/r	1,790
Ag	1.48[2]	n/r	Ni	150	734
As	<234	n/r	NO_2	157,800[1]	210,000
B	239	n/r	NO_3	879,500[1]	594,000
Ba	<117	n/r	oxalate	12,700[1]	5.63
Be	<11.7	n/r	Pb	<234	7,020
Bi	<5,930[1]	436	PO_4	50,527[1]	16,800
Ca	447[3]	3,940	Sb	<152	n/r
Cr	12,116[1]	5,980	Se	<234	n/r
Ce	<234	n/r	SO_4	44,430[1]	45,000
Co	<46.8	n/r	Si	830	4330
Cl	10,914[1]	13,800	Sr	<23.4	2.19
Cd	12.8	n/r	TIC as CO_3	118,500[1]	54,900
Cu	<23.8	n/r	Te	n/r	n/r
F	2,836[1]	2,230	Ti	<23.4	n/r

Table D2-1. Sampling and HDW-Based Inventory Estimates for Nonradioactive Components in Tank 241-U-108. (2 sheets)

Analyte	Sampling Inventory Estimate (kg)	HDW Inventory Estimate (kg)	Analyte	Sampling Inventory Estimate (kg)	HDW Inventory Estimate (kg)
Fe	507	3,390	TOC	12,850[1]	n/r
Hg	n/r	221	U_{TOTAL}	538[4]	22,400
K	4,800	4,100	V	<117	n/r
La	<117	10.4	W	n/r	n/r
Mg	<234	n/r	Zn	131	n/r
Mn	185	435	Zr	<23.4	129
Mo	177	n/r	H_2O(Wt%)	34.3	33.0
Na	726,100[1]	513,000	Density (kg/L)	1.71	1.62
Nd	<234	n/r			

Notes:

[1]Average of solid segment data plus liquid segment data.
[2]From liquid sample only.
[3]Acid digest value from core composite data.
[4]Total uranium value based on the three core composite averages using the laser phosphorescence analysis method on fusion digestions.
n/r = not reported

< = "less than" values are average detection limits for analytical method used.

Table D2-2. Sampling and HDW Model-Based Inventory Estimates for Radioactive Components in Tank 241-U-108. (2 sheets)

Analyte	Sampling Inventory Estimate (Ci)	HDW Inventory Estimate (Ci)	Analyte	Sampling Inventory Estimate (Ci)	HDW Inventory Estimate (Ci)
^{14}C	n/r	n/r	^{155}Eu	<884	n/r
^{60}Co	<61.5	n/r	^{237}Np	n/r	n/r
^{90}Sr	29,400[1]	243,000	$^{239/240}Pu$	n/r	11.0

Table D2-2. Sampling and HDW Model-Based Inventory Estimates for Radioactive Components in Tank 241-U-108. (2 sheets)

Analyte	Sampling Inventory Estimate (Ci)	HDW Inventory Estimate (Ci)	Analyte	Sampling Inventory Estimate (Ci)	HDW Inventory Estimate (Ci)
^{99}Tc	n/r	n/r	^{241}Am	<1930	n/r
^{129}I	n/r	n/r	Total α	154	n/r
^{137}Cs	411,000[1]	463,000	Total β	479,000[2]	n/r
^{154}Eu	<241	n/r			

Notes:
[1]Average of solid segment data plus liquid segment data.
[2]Fusion digest value from core composite data.
n/r = not reported

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents was performed in order to identify potential errors and/or missing information that could influence the sampling and/or the HDW-based component inventories.

D3.1 CONTRIBUTING WASTE TYPES

Tank 241-U-108 was the second tank in the 241-U-107, 241-U-108, and 241-U-109 cascade and it began receiving metal waste (MW) in the first quarter of 1949. In the mid 1950's, most of the MW was transferred out for uranium recovery.

From the second quarter of 1959 until the fourth quarter of 1964, the tank received REDOX cladding waste. Numerous transfers out of the tank took place during the 1960's. In the second quarter of 1964, the tank again received cladding waste from the REDOX plant. It received a combination of N-Reactor, REDOX cladding, and evaporator bottoms waste from the third quarter of 1968 until the first quarter of 1976. Some of these wastes were transferred out of tank 241-U-108 during the second quarter of 1972 and the fourth quarter of 1973. From the second quarter of 1975 through the first quarter of 1977, the tank exchanged

evaporator bottoms waste with tank 241-S-102. This was the final major transfer of waste involving tank 241-U-108.

Refer to Appendix A, Section A3.1 for a more detailed summary of the waste transfer history of tank 241-U-108.

The types of solids accumulated in tank 241-U-108 during its history, as reported by various authors, are compiled in tables D3-1 and D3-2.

Table D3-1. Expected Solids for Tank 241-U-108.

Reference	Waste Type
(Anderson 1990)	MW, REDOX CW, EB, N, BNW, DW, HDRL, PNF, NCPLX
SORWT Model (Hill et al. 1995)	EB and CW mixture
WSTRS (Agnew et al. 1996b)	MW, CW, EB, N, BNW, PNF, HDRL, NCPLX
HDW Model (Agnew et al. 1996a)	MW, CWR2, SMMS1, SMMS2

Notes:

MW = [Bismuth phosphate process U] metal waste
DW = Dilute waste
N = N-Reactor Waste
BNW = Battelle Northwest Laboratory Waste
HDRL = Hanford Defense Residual Liquor
NCPLX = Non-Complexed Waste
PNF = Partially Neutralized Waste
SMMS1 and SMMS2 = Supernatant mixing model 242-S Evaporator waste. WSTRS Waste Status and Transaction Record Summary (Agnew et al. 1996b).
SORWT = Sort on radioactive waste type

The WSTRS document (Agnew et al. 1996b) as well as Anderson (1990) support the position that metal waste was removed from tank 241-U-108 before receipt of REDOX cladding wastes and evaporator bottoms. However, Appendix C and Appendix D of Agnew et al. (1996b) assign the sludge heel as $BiPO_4$ metal waste.

D3.2 EVALUATION OF PROCESS FLOWSHEET INFORMATION

Detailed review of Agnew et al. (1996b) indicates that a considerable amount of transfer activity occurred with 241-U-108, but the dominant waste type currently is saltcake derived primarily from REDOX cladding wastes and evaporator bottoms. Essentially all the MW was

removed during sluicing, but some traces of residual MW occur in the lower core sample segments.

Table D3-2. HDW Solids for Tank 241-U-108.

Tank Layer Model Solids Layer	kL	kgal
MW	11.3	3
CWR2	98.4	26
SMMS1	874.3	231
SMMS2	696.4	184

[1]From Agnew et al (1996a)

D3.2.1 Metal Wastes

Although very little MW is estimated to be in tank 241-U-108 (3 kgal) there is a significant discrepancy in the uranium inventory between the HDW (22,400 kg) and the sample data (538 kg). Tank 241-U-108 has a dished bottom, and all cores were taken from the outer edges of the tank. Thus, a heel of MW would not have been sampled. Nevertheless, all cores exhibited an increase in phosphorous concentration in segment 9. Because of sampling location and an increase in phosphorous concentration in the lower segments, there is a possibility that undetected uranium inventory could be in the dished bottom. The uranium recovery manual and declassified sluicing records, as well as Agnew et al. (1996b) data, were used in an attempt to evaluate this discrepancy.

The uranium recovery waste (UR) manual lists approximate sludge levels (1.2 m [4 ft], 0.6 m [1.9 ft], 0 m [0 ft], respectively) expected to develop for a three-tank cascade after transfer of uranium effluent from the bismuth phosphate process. For a dish-bottomed tank with a 23-m (75-ft) diameter and the approximate sludge levels, it is estimated that 70 volume percent of the sludge was in the first tank and 30 volume percent was in the second. Declassified sluicing records for the 241-U-107, -U-108, -U-109 cascade indicate a total of 74 short tons of uranium remained in the total cascade after sluicing (Rodenhizer 1987). Assuming 30 percent of this inventory may have been left in tank 241-U-108 yields a value of 20,140 kg of uranium, which is comparable to the HDW value of 22,400 kg. However, neither of these values are compatible with a uranium inventory of 4,957 kg obtained as a product of the HDW MW2 sludge concentration of 269.5 g/kg and 11.4 kL (3 kgal) of waste at a HDW sludge density of 1.62 kg/L.

A uranium inventory of <29,700 kg from average segment ICP-fusion data where all segments were below detection limits and uranium inventories varying from <1,117 kg (acid

digestion ICP) to <27,600 kg (fusion digestion ICP) from core composite data also does not provide a basis for comparison because all results were below analytical detection limits. The laser phosphorescence data from core composite samples were all above detection limits and are considered the more reliable data. Because of the uncertainty associated with the sludge level estimates and remaining inventory after sluicing, as well as the inconsistency of the HDW estimates, and the relatively small amount of estimated MW, the sampling values for uranium in tank 241-U-108 obtained by laser-phosphorescence analytical methods were adopted.

D3.2.2 REDOX Cladding Waste

The WSTRS document (Agnew 1996b) indicates 749 kL (198 kgal) of CWR was received by tank 241-U-108 in 1964 and 2,839 kL (750 kgal) was received in 1968. This latter transfer in 1968 occurred about a year after REDOX ceased operations, and may have represented supernatant from REDOX cladding waste. In 1964, tank 241-S-107 received about 1,366 kL (361 kgal) of CWR which, when combined with 198 kgal of tank 241-U-108 waste in 1964, yields a total of 2,115 kL (559 kgal). The fraction of this total volume in tank 241-U-108 is 0.35. REDOX fuel processed in 1964 was 1,693 metric tons of uranium (MTU) (Kupfer et al. 1995), so the fraction received by tank 241-U-108 is 0.35 x 1,693 MTU or 599.8 MTU. This waste contained about 47 kg Al/MTU, 0.47 kg Ni/MTU and 1.31 kg Si/MTU. If the 1964 volume of REDOX cladding waste in 241-U-108, represented by the 599.8 MTU, was the main source of Al, Ni, and Si, the inventories of these constituents would be 28,193 kg Al, 282 kg Ni, and 785 kg Si. The sample-based inventories for these elements are 51,190 kg Al, 150 kg Ni, and 830 kg Si. This comparison suggests that the latter 1968 transfers of 2,840 kL (750 kgal) may have been supernatant that contributed additional Al, but the earlier transfers in 1964 may have contributed much of the Ni and Si.

D3.2.3 Saltcake

Over 90 percent of the waste in tank 241-U-108 is saltcake derived from REDOX cladding waste and 242-S evaporator bottoms. Of these saltcake wastes, cladding waste was the first type received, followed by evaporator bottoms. The HDW model separates saltcake into S1 and S2 categories based on feed source and process period with S1 assigned to the 242-S Evaporator campaign of 1973 to 1976. For some of the major elements, such as aluminum and sulfate, the core sample analysis indicates a subtle increase in concentration in the core segments in approximately the lower tank half, suggesting these lower segments may be dominated by cladding waste.

In general, complete sample recovery was obtained from the lower segments and the composition of the segments, particularly segments 5, 6, 7, and 8, was similar from core to core for all three cores. These observations suggest that the waste volume represented by these segments is relatively homogeneous and may be representative of the earlier evaporator

campaigns used for the SMMS1 HDW model. In addition, average sample-derived concentrations from TCRs for several other tanks containing wastes designated as SMMS1 saltcake have been prepared as part of the best-basis effort. This sample-based S1 saltcake concentration average is obtained from TCR's for tanks 241-S-101, 241-S-102, 241-U-106, and 241-U-109. These three data sets, the core segment data, the SMMS1 HDW model results for tank 241-U-108, and the average S1 saltcake tank data, were compared with inventories of S1 saltcake. This comparison is used to show how well tank 241-U-108 saltcake inventories compare with similar tanks.

Core segments 5, 6, 7, and 8 from tank 241-U-108 were used, and only those saltcake components reported above detection limits were used. Table D3-3 compares concentrations of 241-U-108 analytes with the average SMMS1 composition from the HDW model and an average sample-based concentrations from TCRs for saltcake dominant tanks (241-S-101, -S-102, -U-109, and -U-106). The sample concentration data for tank 241-U-108 is an average of 12 core segment analyses from 3 cores for segments 5, 6, 7, and 8. Except for phosphate and fluoride, the U-108 concentrations are in general agreement with the average sample-based tank concentrations for S1 saltcake. Except for Al, there is general consistency between tank 241-U-108 concentrations and the SMMS1 HDW model results.

Table D3-3. Comparisons of Concentrations in Segments 5, 6, 7, 8 Sample Analysis Average With S1 Saltcake Type.

Analyte	Tank 241-U-108 Segment Sample Ave. (μg/g)	Tank 241-U-108 SMMS1 HDW Model (μg/g)	SMMS1 Average from TCR's (μg/g)
Na	2.55E+05	1.98E+05	1.82E+05
Al	16,489	32,089	15,083
Cr	4,270	3,166	5,441
PO_4	8,863	6,015	33,965
SO_4	17,962	14,249	13,768
F	1,043	806	6,255
Cl	3,880	2,580	3,842
NO_3	2.67E+05	2.69E+05	1.63E+05

The sample-based inventory of the components in Table D3-3 is based on the volume of tank 241-U-108 represented by the core segments. The sample-based inventory is compared to the HDW-based inventory of the tank 241-U-108 SMMS1 saltcake. A measured average density

of 1.71 kg/L was used for the sample segment data and an estimated density of 1.62 kg/L was used for the SMMS1 HDW model data for tank 241-U-108.

The estimated inventories in Table D3-4 for the presumed S1 saltcake volume of tank 241-U-108 assumed to be dominated by REDOX cladding waste are somewhat higher, except for Al, than those derived from SMMS1 HDW model results. Except for Al, the inventories differ by less than a factor of 2 and are often within 30 percent.

Table D3-4. Inventory Comparisons of Tank Volume Based on Tank 241-U-108 Selected Core Segment Analysis With HDW Model SMMS1 Saltcake Inventory.

Analyte	Tank 241-U-108 Sample Ave. Conc. (μg/g)	Tank 241-U-108 S1 Sample Inventory (kg)	Tank 241-U-108 HDW SMMS1 Conc. (μg/g)	Tank 241-U-108 HDW SMMS1 Inventory (kg)
Na	255,000	343,100	198,000	280,400
Al	16,489	22,200	32,089	45,400
Cr	4,270	5,740	3,166	4,480
PO_4	8,863	11,900	6,015	8,520
SO_4	17,962	24,200	14,249	20,200
F	1,043	1,900	806	1,140
Cl	3,880	5,200	2,580	3,650
NO_3	267,000	359,300	269,000	381,000
Density, kg/L	1.71		1.62	
Sample Mass, kg	1.345E+06		1.416E+06	

D3.3 DOCUMENT ELEMENT BASIS

Significant differences between sample-based and HDW inventories were apparent for Al, Cr, phosphate and carbonate, which vary by a factor of two, and Bi, Ca, and U which differ by an order of magnitude. A discussion of the two inventory estimates for selected analytes is given below. Only those analytes present in core samples at concentrations greater than detection limits were considered.

D3.3.1 Aluminum

The sample-based and HDW inventories for aluminum are 51,190 kg and 96,800 kg, respectively. The comparison of S1 saltcake type inventories suggests 22,200 kg and 45,400 kg, respectively, which varies by a factor of two. However, Al concentrations of 16,500 μg/g from segments 5, 6, 7, and 8 closely agree with the HDW saltcake average of 15,083 μg/g.

D3.3.2 Bismuth

The sample-based and HDW inventories for bismuth are <5,930 kg, (based on samples below detection limits) and 436 kg, respectively. Because the Bi values for core samples were below detection limits and the detection limits were high, an alternate approach was used as a basis for a best Bi estimate. Average sample-based Bi concentrations for SMMS1 saltcake based on TCRs for tanks 241-S-101, -S-102, -U-106, and -U-109 yield a Bi concentration of 161 mg/kg. The HDW model estimate for SMMS1 volume in tank 241-U-108 is 874 kL (Table D-6) and the average measured core sample density for tank 241-U-108 is 1.71 kg/L (Table D-1). The product of these values yields an estimate of 241 kg Bi for the S1 saltcake. For S2 saltcake, the average sample-derived Bi concentration from tanks 241-S-101, -S-102, -U-102, -U-107, and -U-109 is also 161 mg/kg. Using the same measured density of 1.71 kg/L and an HDW model SMMS2 volume of 696 kL (Table D-6) yields an S2 saltcake estimate of 192 kg for Bi. The sum of the S1 (241 kg) and S2 (192 kg) saltcake estimate for Bi plus a measured liquid sample value of 4 kg yields a total Bi estimate for tank 241-U-108 of 437 kg. Furthermore, process chemistry suggests that Bi concentrations will be low. Bismuth is not soluble, and thus will not be a substantial component of saltcake. Bismuth is absent from the REDOX process entirely.

D3.3.3 Calcium

The sample-based and HDW inventories for calcium are <5,930 (where all samples were below detection limits by the fusion method) and 3,940 kg, respectively. An acid digest value of 447 kg from core composite data was well above detection limits and is considered the best estimate. The source of Ca in the HDW would appear to be due to the hard water and supernatant mixing assumptions made for the SMMS1 and/or SMMS2 models.

D3.3.4 Chromium

The sample-based and HDW inventories for chromium are 12,116 kg and 5,980 kg, respectively. The comparison of S1 saltcake types based on sample data and HDW data suggest partial inventories of 5,740 kg and 4,480 kg, respectively. The HDW model indicates that 5,980 kg of chromium is introduced to tank 241-U-108 in the SMMS1 and SMMS2 models. The solubility assumptions in these models, especially regarding REDOX waste, have not been verified.

D3.3.5 Sulfate

The sample-based and HDW inventories for sulfate are 44,430 kg and 45,000 kg, respectively. Estimates for the S1 saltcake portion are 24,200 kg for sample-based inventory and 20,200 kg from HDW data. The HDW model indicates that 45,000 kg of sulfate are introduced to tank 241-U-108 in the SMMS1 and SMMS2 models. This number is consistent with the sample-based inventory, indicating that model assumptions about sulfate are reasonable. However, good sample recovery and consistency among cores taken from 241-U-108 suggest sample-based inventories are more reliable.

D3.3.6 Phosphate

The sample-based and HDW inventories for phosphate are 50,527 kg and 16,800 kg, respectively. Estimates for the S1 saltcake portion are 11,900 kg from sample data and 8,520 kg from HDW data, respectively. Comparison of these values suggests that the HDW model estimates are too low because the phosphate solubility assumed is too high for this waste.

D3.3.7 Total Hydroxide

Once the best basis inventories were determined, the hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments the number of significant figures is not increased. This charge balance approach was consistent with that used by Agnew et al. (1996a).

D4.0 DEFINE THE BEST BASIS AND ESTABLISH COMPONENT INVENTORIES

The results from this evaluation support using the sampling data for tank 241-U-108 for the following reasons.

1. Core sample data were available from three risers at three widely spaced positions. Recovery of sample segments was good for most samples and consistent from core to core. Also, concentrations in each segment were consistent from core to core. Upon inspection of data collection and analysis protocols, no reasons were found to reject the laboratory data.

2. The sample-based inventory reconciles better with the position that the sludge layer in the tank is REDOX CW rather than bismuth phosphate MW and that sluicing of earlier metal waste was complete.

3. The evaporator concentrate waste (SMMS1 and SMMS2) that make up the majority of the waste volume in tank 241-U-108 have no independent data source with which to they may be compared. The process of mixing and evaporating supernatants is sufficiently complex that comparison to process flowsheets or multicomponent chemical modeling is impractical.

Best-basis inventory estimates for tank 241-U-108 are presented in Tables D4-1 and D4-2. The sample-based inventory values were generated using a measured density of 1.74 g/mL for segment sample data, 1.40 g/mL for drainable liquid samples, and 1.71 g/mL for core composites.

The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}Pu$, and total uranium, or (total beta and total alpha) while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the Hanford Defined Waste Rev. 4 model results (Agnew et al. 1997). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

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

HDW model, they were merged with draft best-basis chemical inventory documents. Defined scope of work in FY 1997 did not permit Rev. 3 chemical values to be updated to Rev. 4 chemical values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-U-108 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E)[1]	Comment
Al	51,190	S	Average segment sample data plus liquid data
Bi	437	E	Average based on S1 and S2 TCR saltcake data
Ca	447	S	Average based on acid digest of core composite data
Cl	10,914	S	Average segment sample data plus liquid data
TIC as CO_3	118,500	S	Average segment sample data plus liquid data
Cr	12,116	S	Average segment sample data plus liquid data
F	2,836	S	Average segment sample data plus liquid data
Fe	507	S	Core composite acid digest samples
Hg	221	M	
K	4,800	S	Core composite samples
La	<117	S	Core composite samples below detection limit
Mn	185	S	Core composite acid digest samples
Na	726,100	S	Average segment sample data plus liquid data
Ni	150	S	Core composite acid digest samples

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-U-108 (Effective May 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, C or E)[1]	Comment
NO_2	157,800	S	Average segment sample data plus liquid data
NO_3	879,500	S	Average segment sample data plus liquid data
OH	225,000	C	Charge balance calculation
Pb	<234	S	Core composite samples below detection limit
PO_4	50,527	S	Average segment sample data plus liquid data
Si	830	S	Average core composite water wash sample plus liquid
SO_4	44,430	S	Average segment sample data plus liquid data
Sr	<23.4	S	Core composite below detection limit
TOC	12,850	S	Average segment sample data plus liquid data
U_{TOTAL}	538	S	Laser phosphorescence data from core composite samples
Zr	<23.4	S	Core composite below detection limit

Notes:

[1]S = Sample-based (see Appendix B)
M = Hanford Defined Waste model-based
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-U-108 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^3H	513	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-108 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{14}C	76.3	M	
^{59}Ni	4.7	M	
^{60}Co	< 61.5	S	Average solid segment data
^{63}Ni	462	M	
^{79}Se	7.31	M	
^{90}Sr	29,400	S	Average solid segment data
^{90}Y	29,400	S	Based on ^{90}Sr
^{93m}Nb	26	M	
^{93}Zr	35.9	M	
^{99}Tc	542	M	
^{106}Ru	0.0151	M	
^{113m}Cd	190	M	
^{125}Sb	368	M	
^{126}Sn	11.1	M	
^{129}I	1.05	M	
^{134}Cs	5.17	M	
^{137m}Ba	390,000	S	Based on ^{137}Cs
^{137}Cs	411,000	S	Average core segment data
^{151}Sm	25,700	M	
^{152}Eu	8.68	M	
^{154}Eu	< 241	S	Average core segment data
^{155}Eu	< 884	S	Average core segment data
^{226}Ra	3.04 E-04	M	
^{227}Ac	0.00192	M	
^{228}Ra	0.269	M	
^{229}Th	0.00634	M	
^{231}Pa	0.0089	M	
^{232}Th	0.0183	M	
^{232}U	1.4	M	
^{233}U	5.39	M	
^{234}U	8.72	M	
^{235}U	0.346	M	
^{236}U	0.423	M	

Table D4-2. Best-Basis Inventory Estimate for Radioactive Components in Tank 241-U-108 Decayed to January 1, 1994 (Effective May 31, 1997). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S,M or E)[1]	Comment
^{237}Np	1.96	M	
^{238}Pu	21.5	M	
^{238}U	7.33	M	
^{239}Pu	615	M	
^{240}Pu	102	M	
^{241}Am	< 1,930	S	Average core segment data
^{241}Pu	962	M	
^{242}Cm	0.328	M	
^{242}Pu	0.00314	M	
^{243}Am	0.00438	M	
^{243}Cm	0.0305	M	
^{244}Cm	0.303	M	

[1]S=Sample-based
M=Hanford Defined Waste model-based
E=Engineering assessment-based

D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. Corbin, T. Duran, J. FitzPatrick, K. Jurgensen, T. Ortiz, and B. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., J. Boyer, R. Corbin, T. Duran, J. FitzPatrick, K. Jurgensen, T. Ortiz, and B. Young, 1996a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, 1996, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996b, *Waste Status and Transaction Record Summary for the Southwest Quadrant of the Hanford 200 East Area*, WHC-SD-WM-TI-614, Rev. 2, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Bell, K. E., 1996, *Final Report for Tank 241-U-108, Push-Mode Core Samples 141, 145, and 146 Analytical Results for the Final Report*, WHC-SD-WM-DP-198, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Kupfer, M. J., M. D. LeClair, W. W. Schulz, and L. W. Shelton, 1995, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks,* WHC-SD-WM-WP-311, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^2S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History*, WHC-SD-WM-TI-302, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

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