STA 4 (8)

JUN 24 1997

ENGINEERING DATA TRANSMITTAL

0047494

Page 1 of 1

1. EDT 617655

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Data Assessment and Interpretation	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Tank 241-T-102/Waste Management/DAI/Process Engineering	6. Design Authority/ Design Agent/Cog. Engr.: John H. Baldwin	7. Purchase Order No.: N/A
8. Originator Remarks: This document is being released into the supporting document system for retrievability purposes.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: 241-T-102
11. Receiver Remarks: For release.	11A. Design Baseline Document? [] Yes [X] No	12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 05/08/97

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-SD-WM-ER-700	N/A	0	Tank Characterization Report for Single-Shell Tank 241-T-102	N/A	2	1	1

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN
		Design Authority	1	1	R.J. Cash [signature] 6/23/97 S7-14
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		QA			
		Safety			
		Env.			

18.	19.	20.	21. DOE APPROVAL (if required)
A.E. Young [signature] 5-8-97 Signature of EDT Originator Date	N/A Authorized Representative for Receiving Organization Date	K.M. Hall [signature] 6/23/97 Design Authority/ Cognizant Manager Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

BD-7400-172-1

Tank Characterization Report for Single-Shell Tank 241-T-102

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U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: EDT-617655 UC: 2070
Org Code: 74620 Charge Code: E61977
B&R Code: EW 3120074 Total Pages: 170

Key Words: Waste Characterization, Single-Shell Tank, SST, Tank 241-T-102, Tank T-102, T-102, T 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-T-102. This report supports the requirements of the Tri-Party Agreement Milestone M-44-05.

Karol Broz 6/24/97

Release Approval Date

Approved for Public Release

HNF-SD-WM-ER-700, Rev. 0
Formerly PNL-10101/UC-2070

Tank Characterization Report for Single-Shell Tank 241-T-102

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June 1997

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U.S. Department of Energy under Contract DE-AC06-96RL13200

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LIST OF TERMS

AEA	alpha energy analysis
Btu/hr	British thermal units per hour
CAW	current acid waste
CEO	Change Engineering Order
cc	cubic centimeters
CGM	combustible gas meter
Ci	curies
Ci/L	curies per liter
cm	centimeters
cm/hr	centimeters per hour
cP	centipoise
CSR	cesium secondary recovery
CVAA	cold vapor atomic absorption
CW	cladding waste
CWP2	PUREX cladding waste (1961 - 1972)
CWR	REDOX cladding waste
df	degrees of freedom
DQO	data quality objective
DSC	differential scanning calorimetry
ECN	Engineering Change Notice
FIC	Food Instrument Corporation
ft	feet
g	grams
GEA	gamma energy analysis
g C/mL	grams of carbon per milliliter
g/L	grams per liter
gmoles/L	grams of moles per liter
g/mL	grams per milliter
HDW	Hanford defined waste
IC	ion chromatography
ICP	inductively coupled plasma spectrometry
in.	inches
ISE	ion specific electrode
J/g	joules per gram
kgal	kilogallon
kg	kilograms
kg/L	kilograms per liter
LF	lazar fluorimetry
kL	kiloliter
LFL	lower flammability limit
LL	lower limit
m	meter

LIST OF TERMS (Continued)

M	moles
mg	milligrams
mL	milliliters
mL/hr	milliliters per hour
MTU	metric ton of uranium
MW	metal waste
n/a	not applicable
NR	not reported
PNL	Pacific Northwest Laboratory
PSN	PUREX supernatant (waste)
PSS	PUREX supernatants from sluicing
QC	quality control
RPD	relative percent difference
RSN	REDOX supernatant (waste)
SMM	supernatant mixing model
SST	single-shell tank
TC	total carbon
TCD	tank characterization database
TCR	tank characterization report
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TWRS	Tank Waste Remediation System
UL	upper limit
UR	uranium recovery waste
W	watts
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg/g	micrograms per gram
μg/L	micrograms per liter
μg/mL	micrograms per milliliter
μm	micrometers (microns)

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1.0 INTRODUCTION

A major function of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis, along with other available information about a tank, are compiled and maintained in a tank characterization report (TCR). This report and its appendixes serve as the TCR for single-shell tank 241-T-102.

The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-T-102 waste; and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. The response to technical issues is summarized in Section 2.0, and the best-basis inventory estimate is presented in Section 3.0. Recommendations regarding safety status and additional sampling needs are provided in Section 4.0. Supporting data and information are contained in the appendixes. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Orders* (Ecology et al. 1996) milestone M-44-05.

1.1 SCOPE

Characterization information presented in this report originated from sample analyses and known historical sources. The most recent core sampling of tank 241-T-102 (March 1993) predated the existence of data quality objectives (DQOs). An assessment of the technical issues from the currently applicable DQOs was made using data from the 1993 push mode core sampling event, a July 1994 grab sampling event, and a May 1996 vapor flammability measurement. Historical information for tank 241-T-102, provided in Appendix A, includes surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

Table 1-1 describes the tank 241-T-102 sampling events. Appendix B contains further sampling and analysis data from the March 1993 push mode core sampling event and data from the grab sampling event in August 1994 and May 1996 vapor flammability measurement. Of the two push mode cores taken in March of 1993, cores 55 and 56, only core 55 had sufficient recovery for analysis. Therefore, only the results from the analysis of core 55 can be used to partially satisfy the requirments of the safety DQO. The sampling and analysis of the 1994 grab samples were performed in accordance with Schreiber (1994) and the results were originally reported in WHC (1994). Appendix C provides information on the statistical analysis and numerical manipulation of data used in issue resolution. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. Appendix E is the bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-T-102 and its respective waste type. The reports listed in Appendix E may be found in the Tank Characterization and Safety Resource Center.

Table 1-1. Summary of Recent Sampling.

Sample/Date	Phase	Location	Segmentation	% Recovery
Vapor flammability[1] (5/09/96)	Gas	Tank headspace, 6 m (20 ft) below top of riser	n/a	n/a
Core 55 (3/25/93)	Solid	Riser 2	1 segment	65%
Core 56 (3/28/93)	Solid	Riser 8	1 segment	10%
Grab sample (7/15/94)	Liquid	Riser 2	3 grab bottles	100%

Note:

n/a = not applicable

[1]Wilkins et al. 1996

Dates are provided in mm/dd/yy format.

1.2 TANK BACKGROUND

Tank 241-T-102 was constructed in 1943 and put into service in 1945. It is the second tank in a cascade system with tanks T-101 and T-103. During its process history, tank 241-T-102 received mostly metal waste (MW) from the Bismuth Phosphate Process and coating waste (CW) from the REDOX Process through the cascade from tank 241-T-101 and in transfers from tank 241-C-102. In 1956, the MW was removed from tank 241-T-102 by pumping and sluicing. This tank was declared inactive and removed from service in 1976. In 1981, intrusion prevention and stabilization measures were taken to isolate the waste in tank 241-T-102.

A description of tank 241-T-102 is summarized in Table 1-2. The tank has an operating capacity of 2,010 kL (530 kgal), and presently contains an estimated 121 kL (32 kgal) of non-complexed waste (Hanlon 1997). The tank is not on the Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-T-102.

TANK DESCRIPTION	
Type	Single-Shell
Constructed	1943-1944
In-service	1945
Diameter	22.9 m (75.0 ft)
Operating depth	5.2 m (17 ft)
Capacity	2,010 kL (530 kgal)
Bottom Shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Non-complexed
Total waste volume[1]	121 kL (32 kgal)
Supernatant volume	49 kL (13 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	72 kL (19 kgal)
Drainable interstitial liquid volume	0 kL (0 kgal)
Waste surface level (February, 28, 1997)	48.41 cm (19.06 in.)
Temperature (February 1976) to (February 1981)[2]	11.7 °C (53 °F) to 26.7 °C (80 °F)
Integrity	Sound
Watch List	None
SAMPLING DATE	
Push mode core samples	March 1993
Grab samples	July 1994
Vapor flammability measurement	May 1996
SERVICE STATUS	
Declared inactive	1976
Interim stabilization	1981
Intrusion prevention	1981

Notes:

[1]Waste volume is estimated from surface level measurements.

[2]No temperature data is available after February 1981.

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2.0 RESPONSE TO TECHNICAL ISSUES

The following technical issues have been identified for tank 241-T-102.

Safety screening:

- Does the waste pose or contribute to any recognized potential safety problems?

Hazardous vapor safety screening:

- Does a potential exist for worker hazards associated with the toxicity of constituents in tank fugitive vapor emissions?

Organic Solvents:

- Does an organic solvent pool exist that may cause an organic solvent pool fire or ignition of organic solvents entrained in waste solids?

Because one of the push mode core samples had insufficient recovery for analysis, the safety screening of tank 241-T-102 is incomplete with exception of the issue of flammability. Sections 2.1, 2.2 and 2.3 address the above issues. The organic solvents issue cannot be addressed at this time because vapor sampling beyond flammability screening has not been conducted. The worker toxicity issue has been resolved (Hewitt 1996). The organic solvents issue can not be addressed due to the lack of information.

Section 2.4 addresses other technical issues (heat generation in the waste).

2.1 SAFETY SCREENING

The requirements needed to screen the waste in tank 241-T-102 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste; flammable gases in the waste and/or tank headspace; and criticality conditions in the waste. Each of these conditions is addressed separately below.

Although core sampling of tank 241-T-102 preceded the implementation of the DQO process for addressing tank waste issues, the core sampling and analytical direction was consistent with the guidance of the DQO. The data collected can be used to partially address the safety screening issues.

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to determine if fuel is present in tank 241-T-102 that could cause a safety hazard. Because of this requirement, energetics in the tank 241-T-102 waste were evaluated. The safety screening DQO required that the waste sample profile be tested for energetics every (24 cm [9.5 in.]) to determine if the energetics exceed the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry weight basis. The samples did not exhibit exotherms.

Historically, there is no evidence that any exothermic agent should exist in this waste. Waste transfer records indicate that the major waste type expected to be in the tank is PUREX cladding waste (CWP2) above a shallow layer of metal waste. Neither of these waste types is expected to have organic or ferrocyanide constituents.

The safety screening DQO requires measurements for two core samples, therefore this DSC safety issue has not been resolved with respect to the DQO. A second core is required to resolve this issue.

2.1.2 Flammable Gas

Combustible gas monitoring of the tank headspace on May 9, 1996 (Wilkins et al. 1996) indicated that no flammable gas was detected (zero percent of the lower flammability limit). Appendix B provides data from this vapor phase measurement. These data satisfy the safety screening DQO for addressing tank vapor flammability concerns.

2.1.3 Criticality

The safety threshold limit is 1 g ^{239}Pu per liter of waste. Assuming that all alpha is from ^{239}Pu with a measured density of 1.79 g/mL, 1 g/L of ^{239}Pu is equivalent to 34 μCi/g of alpha activity. According to the safety screening DQO, each sample must be under the limit when compared to a 95 percent upper confidence interval on the mean. The upper limit of the one-sided 95 percent confidence interval for the push mode core sample was 0.24 μCi/g. The method used to calculate confidence limits is contained in Appendix C.

Plutonium-239/240 was measured directly for the grab sample. That upper limit of the one-sided 95 percent confidence interval on the mean was 6.28 μg/L.

Both measurements indicate the Pu in the tank is well below the level for criticality to be a concern. However, the safety screening DQO requires measurements for two core samples, therefore this criticality safety issue has not been resolved with respect to the DQO. A second core is required to resolve this issue.

2.2 HAZARDOUS VAPOR SAFETY SCREENING

The data required to support vapor screening were documented in *Data Quality Objective for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995). Does the vapor headspace exceed 25 percent of the lower flammability limit (LFL)? If so, what are the principal fuel components? Are compounds of technological significance present in the tank at such a level that the industrial hygiene group shall be alerted to their presence so adequate breathing zone monitoring can be accomplished and future activities in and around the tank can be performed in a safe manner?

2.2.1 Flammable Gas

This is the same requirement as the safety screening flammability requirement. The flammability issue is addressed in Section 2.1.2.

2.2.2 Toxicity

The vapor screening DQO requires the analysis of ammonia, carbon dioxide (CO_2), carbon monoxide (CO), nitric oxide (NO), nitrous oxide (N_2O), and nitrogen dioxide (NO_2) from a sample. The vapor screening DQO specifies a threshold limit for each of the above listed compounds. The toxicity issue has been resolved and the resolution is documented in Hewitt (1996).

2.3 ORGANIC SOLVENTS

A new DQO is currently being developed to address the organic solvent issue. In the interim, tanks are to be sampled for total non-methane hydrocarbon to determine if an organic extractant pool greater than $1m^2$ exists (Cash 1996). The purpose of this assessment is to ensure that the organic solvent pool is sufficiently small to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur. The size of the organic extract and pool will be determined by the organic program, based on the vapor data, tank headspace temperature and the tank ventilation rate. The organic solvent screening issue cannot be addressed at this time because vapor sampling has not been conducted.

2.4 OTHER TECHNICAL ISSUES

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load based on the 1993 sample event was 225 W (819 Btu/hr) (Pool 1993). The heat load estimate based on the tank process history was 1.61 W (5.51 Btu/hr) (Agnew et al. 1997). The heat load estimate based on the tank headspace temperature was 1,126 W (3,843 Btu/hr)

(Kummerer 1995). All of these estimates are low, and are well below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat-load tanks (Smith 1986). The major contributors to the tank heat load are listed in Table 2-1. Radionuclides were chosen for the heat load calculation based on measurement above the detection limit and for contribution to the heat load greater than 1.0 W (3 Btu/hr).

Table 2-1. Tank 241-T-104 Projected Heat Load.

Radionuclide	Watts/Curie	Liquid		Solid	
		Curies	Watts	Curies	Watts
^{241}Am	0.0328	2.05E-01	6.70E-03	3.30E+01	1.08
^{137}Cs	0.00472	3.19E+03	15.1	4.10E+03	19.4
^{90}Sr	0.00670	6.10E+01	4.00E-01	3.06E+04	205
Total Watts					225

2.5 SUMMARY

The results from all analyses performed to address potential safety issues showed that no primary analytes exceeded safety decision threshold limits. Only one core sample was analyzed. A grab sample was also analyzed. A second core is required to resolve the safety issue. The analyses results are summarized in Table 2-2.

Table 2-2. Summary of Safety Screening Results.

Issue	Sub-issue	Result
Safety screening	Energetics	No exotherms observed in sample.
	Flammable gas	Vapor measurement reported 0 percent of lower flammability limit. (Combustible gas meter).
	Criticality	All analyses well below 34 μCi/g total alpha (within 95 percent confidence limit on each sample).
Vapor	Toxicity	This issue has been resolved.
	Organic solvents	Vapor data needed.

3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, risk assessments associated with waste management activities, and 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 suitable for long-term storage.

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

An effort is currently underway to provide waste inventory estimates that will serve as the standard characterization data for various waste management activities. As part of this effort, a survey and analysis of various sources of information relating to the chemical and Radionuclide component inventories in tank 241-T-102 were performed, including the following:

1. Data from one core sample obtained in 1993 (Pool 1993)

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

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

4. Analysis of CWP2 sludge based on common sludge layers in tanks 241-C-102 and 241-C-105, together with waste transaction records for these tanks.

5. Analysis of residual metal waste based on the composition of tank 241-T-101 MW (GE 1951).

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

Based on this analysis, a best-basis inventory was developed. The 1993 core sample was used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-T-102 primarily consists of secondary (Al-clad) PUREX coating (CWP2) waste, CSR ion exchange waste and a small amount of residual MW from the $BiPO_4$ process. The best-basis inventory for tank 241-T-102 is presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	38,500	S	Tank 241-T-102 Sample Results
Bi	<716	S	
Ca	95.1	S	
Cl	70.3	S	
CO_3	3,688	S	
Cr	188	S	
F	42	S	
Fe	2,320	S	
Hg	0.8	S	
K	<530	S	
La	<71.6	S	
Mn	123	S	
Na	7,215	S	
Ni	9	S	
NO_2	2,161	S	
NO_3	9,873	S	
OH	<3.1	S	
Pb	247	S	
P as PO_4	805	S	
Si	417	S	
S as SO_4	443	S	
Sr	<7.2	S	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
TOC	106	S	
U_{TOTAL}	<2,860	S	
Zr	<14.3	S	

Notes:

[1]S = sample-based (See Appendix B), M = HDW model-based, and E = engineering assessment-based.

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-T-102 (Decayed to January 1, 1994). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.9	S	Pool 1993
^{14}C	5.9	S	
^{60}Co	<12.4	S	
^{90}Sr	30,690	S	Pool 1993, 1994 supernatant grab sample
^{90}Y	30,690	E	Based on ^{90}Sr analysis
^{99}Tc	2.3	S	
^{106}Ru	<19.9	S	
^{134}Cs	<1.5	S	
^{137}Cs	7,300	S	Pool 1993, 1974 supernatant grab sample
^{137m}Ba	6,900	E	Based on ^{137}Cs analysis
^{154}Eu	63	S	1974 supernatant grab sample
^{155}Eu	70	S	1974 supernatant grab sample
^{237}Np	0.07	S	
^{238}Pu	NR		
^{238}U	NR		

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-T-102 (Decayed to January 1, 1994). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{239}Pu	7.9	S	
^{241}Am	32.9	S	
^{243}Cm	0.17	S	

Notes:

NR = not reported

[1]S = Sample-based on 1993 core sample unless noted otherwise, M = HDW model-based, and E = engineering assessment-based.

4.0 RECOMMENDATIONS

Core sampling of tank 241-T-102 occurred before the implementation of the DQO process for TWRS characterization. Nevertheless the data collected may be evaluated against the requirements of the current safety screening DQO. All analytical results were well within the safety notification limits. However, the results were only from a single-core sample and a grab sample (both from riser 2). Because only the material below one riser has been sampled, the safety screening DQO has been only partially completed. The waste that has been sampled and analyzed in accordance with the safety screening DQO has been accepted by the responsible TWRS program. Therefore, according to the safety screening DQO, the tank cannot yet be classified as "safe." A second core sample from this tank is required to satisfy the safety screening DQO requirements. Vapor sampling and analysis is also required to address the organic solvent issue. The hazardous vapor issue (toxicity) has been resolved.

Table 4-1 summarizes the TWRS Program review status and acceptance of the sampling and analysis results reported in this TCR. All DQO issues required to be addressed by sampling and analysis are listed in column one of Table 4-1. The second column indicates with a "yes" or a "no" whether the DQO requirements were met by the sampling and analysis activities performed. The third column indicates concurrence and acceptance by the program in TWRS that is responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" in column three indicates acceptance or disapproval of the sampling and analysis information presented in the TCR.

Table 4-1. Acceptance of Tank 241-T-102 Sampling and Analysis.

Issue	Sampling and Analysis Performed	PHMC[1] Program Acceptance
Safety screening DQO	Partial	Partial
Hazardous vapor DQO	n/a	Resolved
Organic solvent	No	No

Notes:

N/A =

[1]PHMC Program Office

Table 4-2 summarizes the status of TWRS Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations specifically outlined in this report are the evaluation to determine whether the tank is safe, conditionally safe, or unsafe. Column one lists the different evaluations performed in this report. Columns two and three are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as that in Table 4-1. The safety categorization of the tank is listed as "partial" in Table 4-2 because only the material below one riser has been sampled. However, none of the analyses performed, including those for criticality, indicate any safety problems.

Resampling of tank 241-T-102 using push-mode core sampling (including a center tank location) is recommended in order to provide the two full depth profiles required by the safety screening DQO.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-T-102.

Issue	Evaluation Performed	PHMC Program Acceptance[1]
Safety categorization (tank is safe)	Partial	Partial
Hazardous vapor DQO	n/a	Resolved
Organic solvent	No	No

Notes:

[1]PHMC Program Office

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APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-T-102 based on historical information. For this report, historical information includes any information about the fill history, waste types, surveillance, or modeling data about the tank. This information is necessary for providing a balanced assessment of the sampling and analytical results.

This appendix contains the following information:

- **Section A1**: Current status of the tank, including the current waste levels and the stabilization and isolation status of the tank
- **Section A2**: Information about the tank design
- **Section A3**: Process knowledge of the tank; the waste transfer history and the estimated contents of the tank based on modeling data
- **Section A4**: Surveillance data for tank 241-T-102, including surface-level readings, temperatures, and a description of the waste surface based on photographs
- **Section A5**: References for Appendix A.

Historical sampling results (results from samples obtained before 1989) are included in Appendix B.

A1.0 CURRENT TANK STATUS

As of February 28, 1997, tank 241-T-102 contained an estimated 121 kL (32 kgal) of non-complexed waste (Hanlon 1997). The waste volumes were estimated using a surface-level gauge and photographic evaluation. The volumes of the waste phases found in the tank are shown in Table A1-1.

Tank 241-T-102 is categorized as a sound tank. It was removed from service in 1976, had intrusion prevention completed in August 1981, and was also interim stabilized in 1981. The tank is passively ventilated and is not on the Watch List (Public Law 101-510).

Table A1-1. Tank Contents Status Summary (Hanlon 1997).

Waste Type	kL (kgal)
Total waste	121 (32)
Supernatant	49 (13)
Sludge	72 (19)
Saltcake	0 (0)
Drainable interstitial liquid	0 (0)
Drainable liquid remaining	49 (13)
Pumpable liquid remaining	49 (13)

A2.0 TANK DESIGN AND BACKGROUND

Tank 241-T-102 was constructed during 1943 and 1944. It is one of twelve 2,010-kL (530-kgal) tanks in T Farm. These tanks were designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F). A typical T Farm tank contains 9 to 11 risers ranging in size from 10 cm (4 in.) to 1.1 m (42 in.) in diameter that provide surface-level access to the underground tank. Generally, there is one riser through the center of the tank dome and four or five each on opposite sides of the dome.

Tank 241-T-102 entered service in 1945 and is second in a three-tank cascading series. These tanks are connected by a 7.6-cm (3-in.) cascade line. The cascade overflow height is approximately 4.78 m (188 in.) from the tank bottom and 60 cm (2 ft) below the top of the steel liner. These single-shell tanks (SSTs) are constructed of 30-cm (1-ft)-thick reinforced concrete with a 6.4 mm (1/4 in.) mild carbon steel liner (ASTM A283 Grade C) on the bottom and sides and a 38-cm (1.25-ft)-thick domed concrete top. These tanks have a dished bottom with a 1.2-m (4-ft) radius knuckle and a 5.18-m (17-ft) operating depth. The tanks are set on a reinforced concrete foundation.

A three-ply cotton fabric waterproofing was applied over the foundation and the steel tank. Four coats of primer paint were sprayed on all exposed interior tank surfaces. Tank ceiling domes were covered with three applications of magnesium zincfluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the access holes in the tank dome. The tanks were waterproofed on the sides and top with tar and a cement-like mixture. Each tank was covered with approximately 2.1 m (7 ft) of overburden.

The surface level is monitored through riser 8 with an ENRAF[1] gauge. Riser 4 contains a thermocouple tree. Figure A2-1 is a plan view of the riser configuration. A list of tank 241-T-102 risers showing their sizes and general use is provided in Table A2-1.

Table A2-1. Tank 241-T-102 Risers.[1] (2 sheets)

Number	Diameter (inches)	Description and Comments
1	4	Breather filter, (bench mark CEO-36937 December 11, 1986)
2[2]	12	B-222 observation port
3	12	Empty, weather covered
4	4	Thermocouple tree, weather covered
5	4	Drain, weather covered
6	12	Empty, weather covered
7[2]	12	Concrete plug, weather covered
8	4	ENRAF® (ECN-609246)
9	42	Manhole, weather covered
10	12	Salt well pump, below grade
N1	3	Overflow
N2	3	Spare
N3	3	Spare
N4	3	Drain line-6172 sealed in diversion box tank 241-T-153
N5	3	Spare
N6	3	Overflow

Notes:

CEO = Change Engineering Order
ECN = Engineering Change Notice

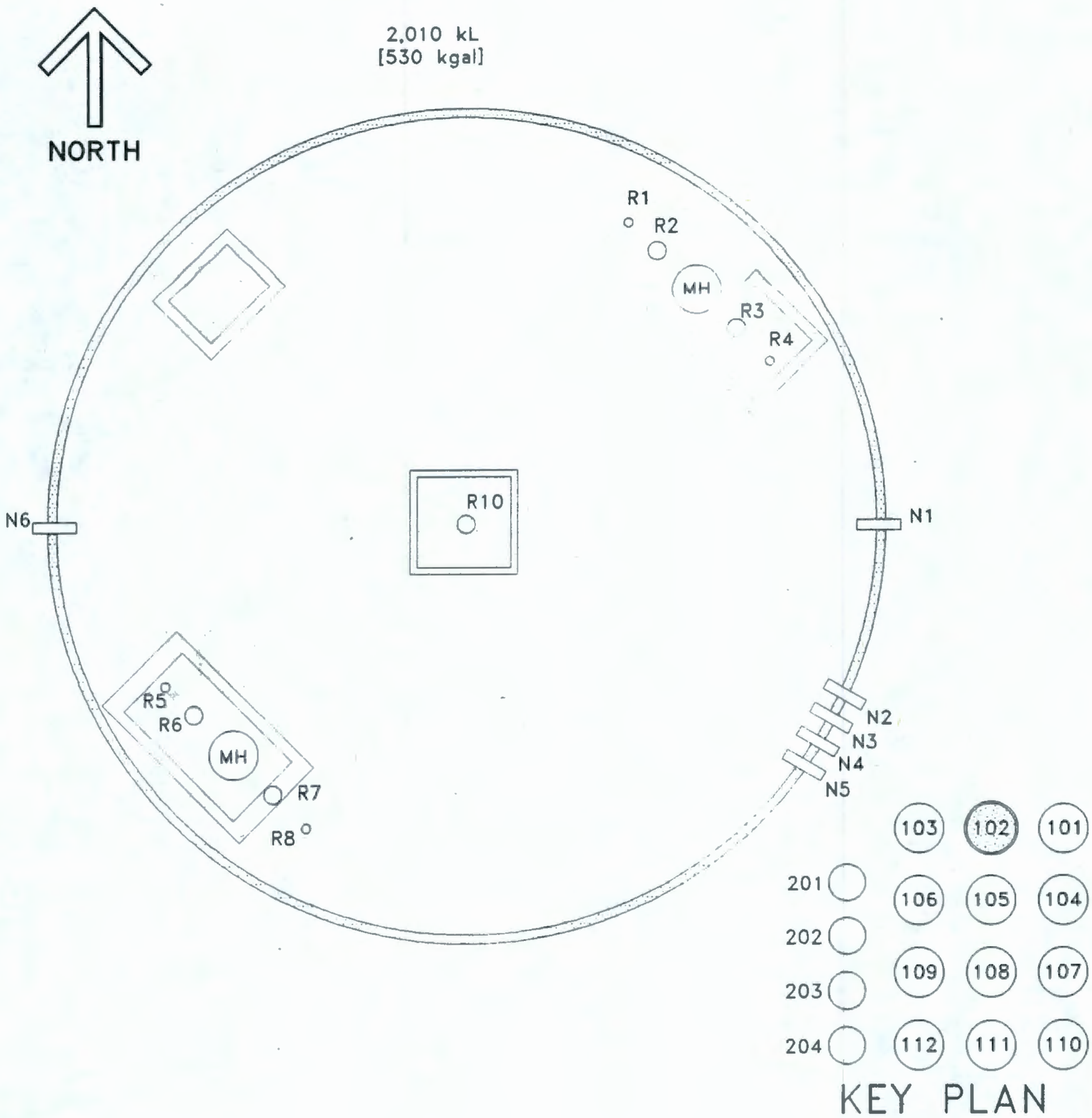
[1]Alstad (1993), Lipnicki (1997), and Vitro (1986).
[2]Denotes risers tentatively available for sampling (Lipnicki 1997).

[1]ENRAF is a trademark of the ENRAF Corporation, Houston, Texas.

A tank cross section showing the approximate waste level, along with a schematic of the tank equipment, is shown in Figure A2-2. Tank 241-T-102 has ten risers. Risers 2 and 7 are tentatively available for sampling (Lipnicki 1997). Risers 2 and 7 are both 30 cm (12 in.) in diameter. If used as sampling ports, the risers would give access to opposite sides of the tank.

Tank 241-T-102 has four process inlet nozzles, one cascade overflow inlet and one cascade overflow outlet. Locations are shown on Figure A2-1.

Figure A2-1. Riser Configuration for Tank 241-T-102.



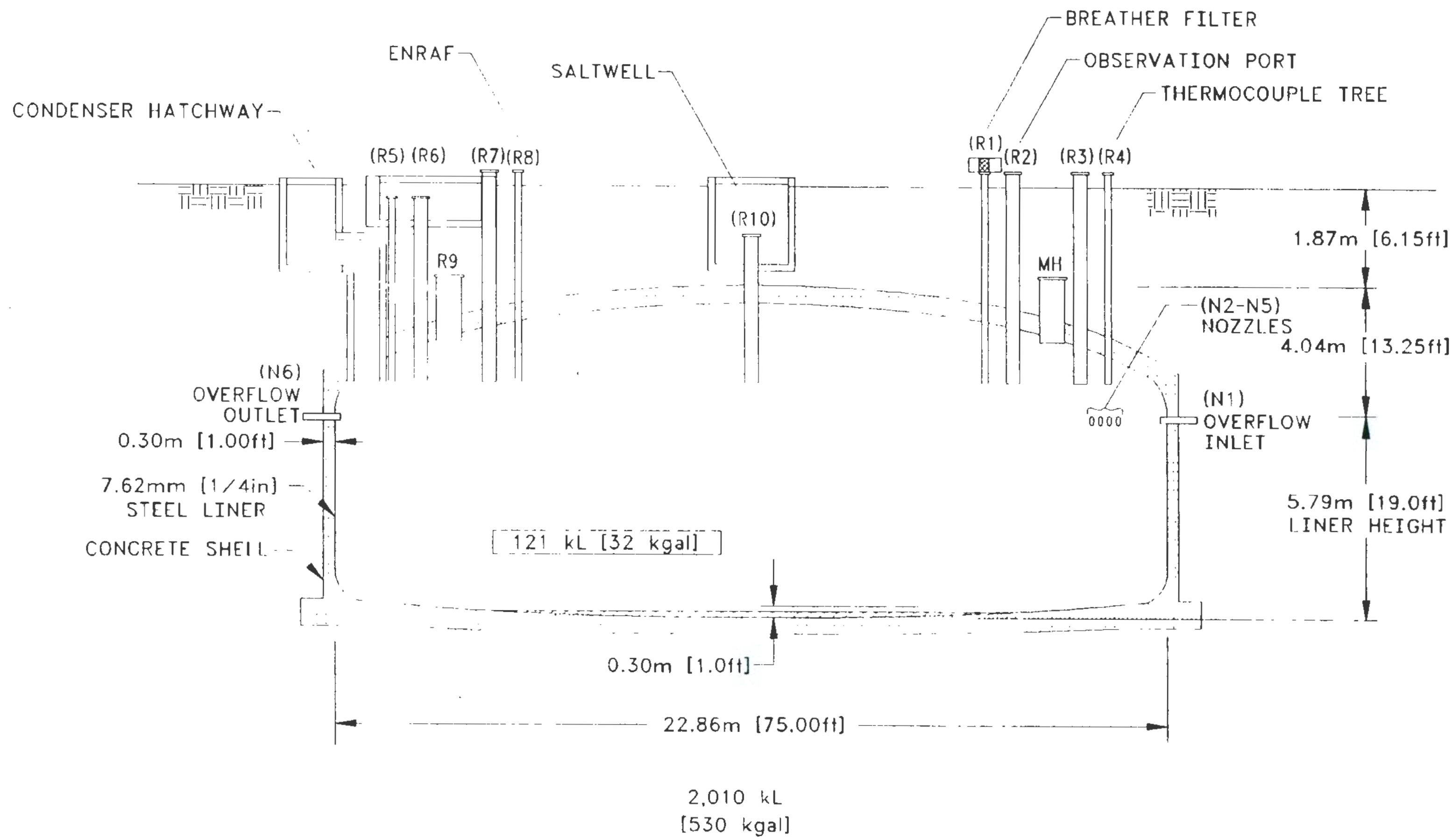


Figure A2-2. Tank 241-T-102 Cross Section and Schematic.

A3.0 PROCESS KNOWLEDGE

The sections below: 1) provide information about the transfer history of tank 241-T-102; 2) describe the process wastes that made up the transfers; and 3) give an estimate of the current tank contents based on transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-T-102 (Agnew et al. 1997a). Waste was initially added to tank 241-T-102 in the second quarter of 1945 with the cascade from tank 241-T-101 of metal waste initially from the bismuth phosphate process. The cascade was full in the first quarter of 1946. In the second quarter of 1953, all of the waste in tank 241-T-102 was transferred to tank 241-T-103. The tank was declared empty at the end of 1953.

In the second quarter of 1955, metal waste was again cascaded to tank 241-T-102 from tank 241-T-101. The tank was full again by the end of that quarter. From the second quarter of 1956 to the third quarter of 1957, the tank received flush water from miscellaneous sources and most of the waste was sent to the uranium recovery process either directly or through tank 241-T-103.

From the fourth quarter of 1964 to the second quarter of 1965, the tank received PUREX cladding waste from tank 241-C-102. In the third quarter of 1969, most of this waste was then sent to tank 241-T-103 to be processed in the 242-T Evaporator. In the third quarter of 1972, the tank received supernatant waste from tank 242-T-101. In the second quarter of 1974, most of this waste was sent to tank 241-S-110 to be processed in the 242-S Evaporator.

In the first and second quarters of 1976, small amounts of supernatant waste were sent to tank 241-T-101. Salt well liquor was sent from the tank to tank 241-SY-102 in the third and fourth quarters of 1978. No additions or transfers have been made since that time.

Table A3-1. Tank 241-T-102 Major Transfers.[1,2]

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
Tank 241-T-101	--	Metal waste	1945 - 1946	3929	1038
--	Tank 241-T-103	Metal waste	1945 - 1946	1915	506
--	Tank 241-T-103	Metal waste	1953	2006	530
Tank 241-T-101	--	Metal waste	1955	3978	1051
--	Tank 241-T-103	Metal waste	1956	3978	1051
Miscellaneous Sources	--	Flush water	1956 - 1957	246	65
--	Uranium Recovery	Metal waste	1957	148	39
Tank 241-C-102	--	PUREX cladding waste	1964 - 1965	1836	485
--	Tank 241-T-103	Supernatant	1969	1881	497
Tank 241-T-101	--	Supernatant	1972	1851	489
--	Tank 241-S-110	Supernatant	1974	1798	475
--	Tank 241-T-101	Supernatant	1976	15	4
--	Tank 241-SY-102	Salt well liquor	1978	114	30

Notes:

[1]Agnew et al. 1997a

[2]Because only major transfers are listed, the sum of these transfers will not equal the current tank waste volume.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The historical transfer data used for this estimate are from the following sources:

- *Waste Status and transaction Record Summary (WSTRS Rev. 4)* (Agnew et al. 1997a). WSTRS is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4* (Agnew et al. 1997b). This document contains the HDW list, the supernatant mixing model (SMM), the tank layer model (TLM), and the Historical Tank Inventory Estimates.

- The HDW list is comprised of approximately 50 waste types defined by concentration for major analytes/compounds for both sludge and supernatant layers.

- The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

- The SMM is a subroutine within the HDW model that calculates the volume and composition of certain supernatant blends and concentrates.

Using these records, the TLM defines the sludge and saltcake layers in each tank. The SMM uses information from the Waste Status and Transaction Record Summary (WSTRS), the TLM, and the HDW list to describe the supernatants and concentrates in each tank. Together the WSTRS, TLM, SMM, and HDW list determine each tank's inventory estimate. These model predictions are considered estimates that require further evaluation using analytical data.

Based on Agnew et al. (1997b), tank 241-T-102 contains a 64.3 kL (17 kgal) layer of PUREX cladding waste (CWP2) above a 7.6 kL (2 kgal) layer of MW. The CWP2 layer is expected to contain above 1 weight percent of sodium, aluminum, iron, lead, hydroxide, nitrate, fluoride, and uranium. The MW layer is expected to contain above 1 weight percent of sodium, hydroxide, carbonate, phosphate and uranium. Figure A3-1 shows a graphical representation of the estimated waste type and volume for the tank layer. Tables A3-2 and A3-3 show the historical estimate of the expected waste constituents and their concentrations for chemical constituents and radionuclides, respectively.

Figure A3-1. Tank Layer Model.

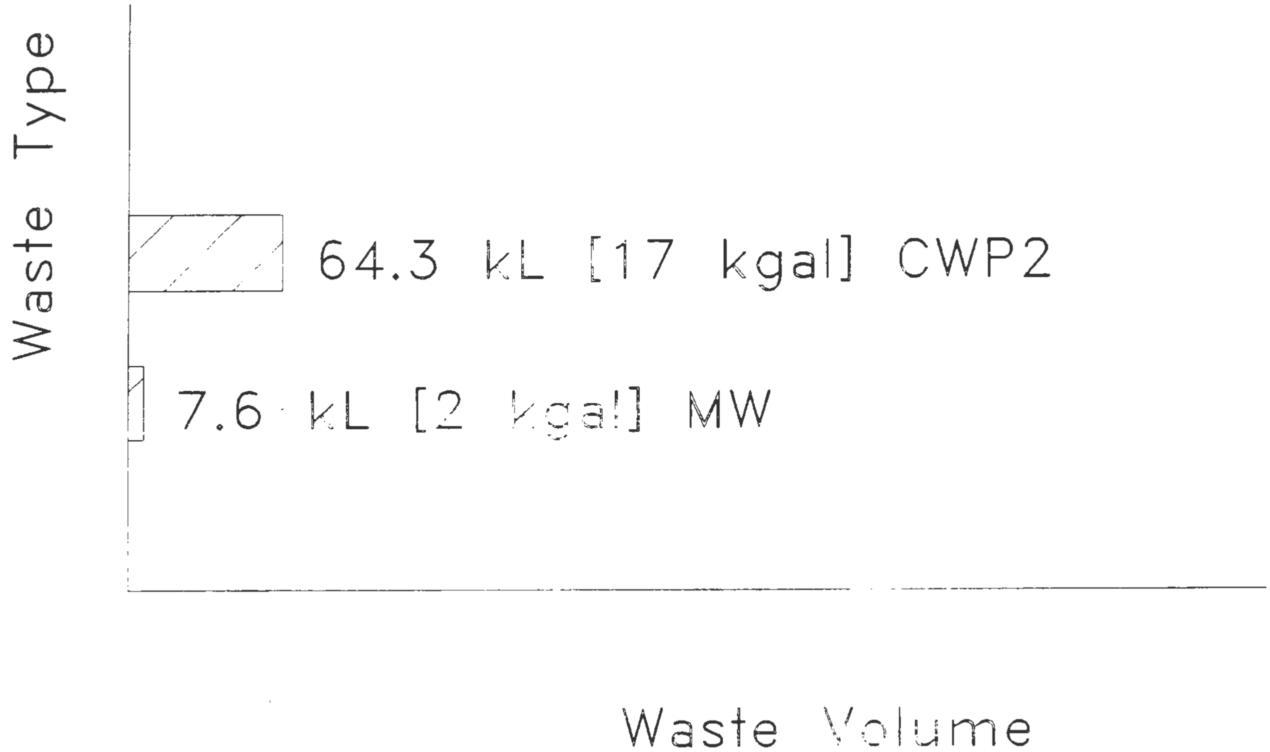


Table A3-2. Historical Tank Inventory Estimate (Chemicals).[1,2] (2 sheets)

Total Inventory Estimate					
Physical Properties				**-95 CI**	**+95 CI**
Total Waste	1.60E+05 (kg) (32.0 kgal)			----	----
Heat Load	1.61E-03 (kW) (5.51 Btu/hr)			6.13E-04	2.60E-03
Bulk Density[3]	1.32 (g/cc)			1.22	1.37
Water wt%[3]	66.0			62.9	72.4
TOC wt% C (wet)[3]	0			0	0
Chemical Constituents	***M***	**μg/g**	**kg[4]**	**-95 CI (*M*)**	**+95 CI (*M*)**
Na^{+}	0.974	1.70E+04	2.71E+03	0.514	1.42
Al^{3+}	3.11	6.37E+04	1.02E+04	2.93	3.29
Fe^{3+} (total Fe)	0.250	1.06E+04	1.69E+03	0.158	0.266
Cr^{3+}	1.33E-03	52.3	8.35	4.59E-04	2.18E-03
Bi^{3+}	0	0	0	0	0
La^{3+}	0	0	0	0	0
Hg^{2+}	3.14E-03	478	76.3	2.68E-03	3.22E-03
Zr (as $ZrO(OH)_2$)	0	0	0	0	0
Pb^{2+}	0.173	2.72E+04	4.34E+03	9.94E-02	0.186
Ni^{2+}	6.63E-04	29.5	4.72	2.29E-04	9.62E-03
Sr^{2+}	0	0	0	0	0
Mn^{4+}	0	0	0	0	0
Ca^{2+}	0.176	5.35E+03	854	7.48E-03	0.245
K^{+}	1.04E-03	30.7	4.91	3.25E-04	1.73E-03
OH^{-}	11.9	1.53E+05	2.45E+04	10.2	12.9
NO_3^{-}	0.279	1.31E+04	2.10E+03	8.82E-02	0.462
NO_2^{-}	0.120	4.17E+03	666	3.51E-02	0.207
CO_3^{2-}	0.289	1.31E+04	2.10E+03	0.120	0.358
PO_4^{3-}	2.50E-02	1.80E+03	288	1.07E-02	3.54E-02
SO_4^{2-}	1.08E-02	784	125	7.18E-03	1.43E-02
Si (as SiO_3^{2-})	1.07E-04	2.27	0.363	9.11E-05	1.21E-04
F^{-}	0	0	0	0	0
Cl^{-}	4.77E-03	128	20.5	1.49E-03	7.98E-03
$C_6H_5O_7^{3-}$	0	0	0	0	0
$EDTA^{4-}$	0	0	0	0	0
$HEDTA^{3-}$	0	0	0	0	0

Table A3-2. Historical Tank Inventory Estimate (Chemicals).[1,2] (2 sheets)

Chemical Constituents	*M*	μg/g	kg[3]	-95 CI (*M*)	+95 CI (*M*)
glycolate$^-$	0	0	0	0	0
acetate$^-$	0	0	0	0	0
oxalate^{2-}	0	0	0	0	0
DBP	0	0	0	0	0
butanol	0	0	0	0	0
NH_3	1.71E-05	0.220	3.52E-02	1.64E-06	4.92E-05
$Fe(CN)_6^{4-}$	0	0	0	0	0

Notes:

TOC = total organic carbon

[1]Agnew et al. (1997b)

[2]The Historical Tank Inventory Estimate predictions have not been validated and should be used with caution.

[3]Water weight percent derived from the difference of density and total dissolved species.

[4]Differences exist among the inventories in this column and the inventories calculated from the two sets of concentrations.

Table A3-3. Historical Tank Inventory Estimate (Radionuclides).[1,2] (2 sheets)

Total Inventory Estimate					
Physical Properties				**-95 CI**	**+95 CI**
Total Waste	1.60E+05 (kg) (32.0 kgal)			----	----
Heat Load	1.61E-03 (kW) (5.51 Btu/hr)			6.13E-04	2.60E-03
Bulk Density[3]	1.32 (g/cc)			1.22	1.37
Water wt%[3]	66.0			62.9	72.4
TOC wt% C (wet)[3]	0			0	0
Radiological Constituents	**Ci/L**	**μCi/g**	**Ci[4]**	**-95 CI (Ci/L)**	**+95 CI (Ci/L)**
^{3}H	3.53E-07	2.68E-04	4.28E-02	8.44E-08	9.15E-07
^{14}C	2.12E-07	1.60E-04	2.56E-02	1.61E-07	2.48E-07
^{59}Ni	1.77E-08	1.34E-05	2.14E-03	9.51E-09	1.86E-07
^{63}Ni	1.70E-06	1.29E-03	0.206	8.80E-07	1.86E-05
^{60}Co	6.30E-08	4.78E-05	7.63E-03	2.10E-08	1.04E-07
^{79}Se	1.36E-08	1.03E-05	1.65E-03	7.19E-09	1.99E-08
^{90}Sr	1.10E-03	0.835	133	4.18E-04	1.77E-03
^{90}Y	1.10E-03	0.835	133	4.18E-04	1.77E-03
^{93}Zr	6.43E-08	4.88E-05	7.79E-03	3.41E-08	9.39E-08
^{93m}Nb	4.97E-08	3.77E-05	6.03E-03	2.77E-08	7.14E-08
^{99}Tc	4.49E-07	3.41E-04	5.44E-02	2.37E-07	6.57E-07
^{106}Ru	9.93E-11	7.54E-08	1.20E-05	2.99E-11	1.67E-10
^{113m}Cd	2.52E-07	1.91E-04	3.06E-02	1.06E-07	3.96E-07
^{125}Sb	3.29E-07	2.49E-04	3.98E-02	1.00E-07	5.53E-07
^{126}Sn	2.06E-08	1.56E-05	2.50E-03	1.08E-08	3.02E-08
^{129}I	8.56E-10	6.50E-07	1.04E-04	4.48E-10	1.26E-09
^{134}Cs	2.17E-08	1.65E-05	2.63E-03	6.53E-09	3.66E-08
^{137}Cs	1.26E-03	0.958	153	4.78E-04	2.03E-03
^{137m}Ba	1.19E-03	0.906	145	4.53E-04	1.92E-03
^{151}Sm	4.98E-05	3.78E-02	6.04	2.67E-05	7.25E-05
^{152}Eu	3.52E-07	2.67E-04	4.26E-02	3.47E-07	3.57E-07
^{154}Eu	1.23E-06	9.31E-04	0.149	3.97E-07	2.04E-06
^{155}Eu	2.54E-05	1.93E-02	3.08	2.50E-05	2.58E-05
^{226}Ra	9.18E-12	6.96E-09	1.11E-06	2.49E-12	2.93E-11
^{228}Ra	2.86E-08	2.17E-05	3.46E-03	2.82E-08	2.90E-08

Table A3-3. Historical Tank Inventory Estimate (Radionuclides).[1,2] (2 sheets)

Radiological Constituents	Ci/L	μCi/g	Ci[4]	-95 CI (Ci/L)	+95 CI (Ci/L)
^{227}Ac	8.76E-08	6.65E-05	1.06E-02	7.10E-08	9.21E-08
^{231}Pa	1.30E-07	9.84E-05	1.57E-02	3.76E-08	1.55E-07
^{229}Th	1.29E-08	9.82E-06	1.57E-03	1.27E-08	1.31E-08
^{232}Th	1.33E-09	1.01E-06	1.61E-04	4.01E-10	2.25E-09
^{232}U	1.47E-06	1.12E-03	0.179	1.77E-08	1.97E-06
^{233}U	5.73E-06	4.35E-03	0.694	6.82E-08	7.64E-06
^{234}U	1.63E-05	1.24E-02	1.97	8.68E-06	1.89E-05
^{235}U	7.02E-07	5.33E-04	8.51E-02	3.90E-07	8.08E-07
^{236}U	2.86E-07	2.17E-04	3.47E-02	5.76E-08	3.63E-07
^{238}U	1.60E-05	1.21E-02	1.93	8.78E-06	1.84E-05
^{237}Np	3.14E-09	2.38E-06	3.80E-04	1.56E-09	4.69E-09
^{238}Pu	3.30E-05	2.50E-02	4.00	2.33E-05	3.56E-05
^{239}Pu	1.37E-03	1.04	167	9.72E-04	1.49E-03
^{240}Pu	2.44E-04	0.185	29.6	1.73E-04	2.64E-04
^{241}Pu	2.64E-03	2.00	320	1.87E-03	2.85E-03
^{242}Pu	7.44E-09	5.64E-06	9.01E-04	5.25E-09	8.03E-09
^{241}Am	2.65E-07	2.01E-04	3.21E-02	8.48E-08	4.42E-07
^{243}Am	2.74E-12	2.08E-09	3.32E-07	8.39E-13	4.61E-12
^{242}Cm	5.04E-09	3.83E-06	6.11E-04	4.97E-09	5.12E-09
^{243}Cm	1.39E-10	1.05E-07	1.68E-05	1.37E-10	1.41E-10
^{244}Cm	1.04E-10	7.88E-08	1.26E-05	3.14E-11	1.75E-10
Totals	***M***	**μg/g**	**kg[4]**	**-95 CI (*M* or g/L)**	**+95 CI (*M* or g/L)**
Pu	2.32E-02 (g/L)	----	2.81	1.64E-02	2.51E-02
U	0.201	3.63E+04	5.80E+03	0.111	0.232

Notes:

[1]Agnew et al. (1997b)

[2]The Historical Tank Inventory Estimate predictions have not been validated and should be used with caution.

[3]Water weight percent derived from the difference of density and total dissolved species.

[4]Differences exist among the inventories in this column and the inventories calculated from the two sets of concentrations.

A4.0 SURVEILLANCE DATA

Tank 241-T-102 surveillance consists of surface-level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and leak detection well (dry well) monitoring for radioactivity outside the tank. Surveillance data provide the basis for determining tank integrity.

Liquid-level measurements can indicate if the tank has a major leak. Solid surface-level measurements provide an indication of physical changes in and consistencies of the solid layers of a tank. Dry wells located around the tank perimeter may show increased radioactivity due to leaks.

A4.1 SURFACE-LEVEL READINGS

An ENRAF® gauge installed in riser 8 has replaced the Food Instrument Corporation (FIC) gauge in riser 1 as of June 1994 for monitoring the waste surface level in tank 241-T-102. The ENRAF® reading on February 28, 1997 taken in automatic and manual modes was 48.41 cm (19.06 in.). A level history graph of the volume measurements is presented in Figure A4-1.

Tank 241-T-102 has no liquid observation well and has six identified dry wells.

A4.2 INTERNAL TANK TEMPERATURES

Tank 241-T-102 has a single thermocouple tree with 12 thermocouples to monitor the waste temperature through riser 4. Temperature readings are available from the Surveillance Analysis Computer System from February 1976 to February 1981. No data are available after the thermocouple tree was removed from the tank on February 7, 1981. Figure A4-2 shows a graph of the weekly high temperature.

A4.3 TANK 241-T-109 PHOTOGRAPHS

From the June 1989 photograph (Brevick et al. 1997), only a small amount of liquid appears to remain in this tank. The curved portion at the bottom of the tank is visible and the tank bottom can be seen through the liquid. A waste level probe, a liquid observation well, a salt well screen, nozzles, and risers are visible in the photos. Because no change in tank level has occurred since the photographs were taken, the picture should represent existing tank contents.

Figure A4-1. Tank 241-T-102 Level History.

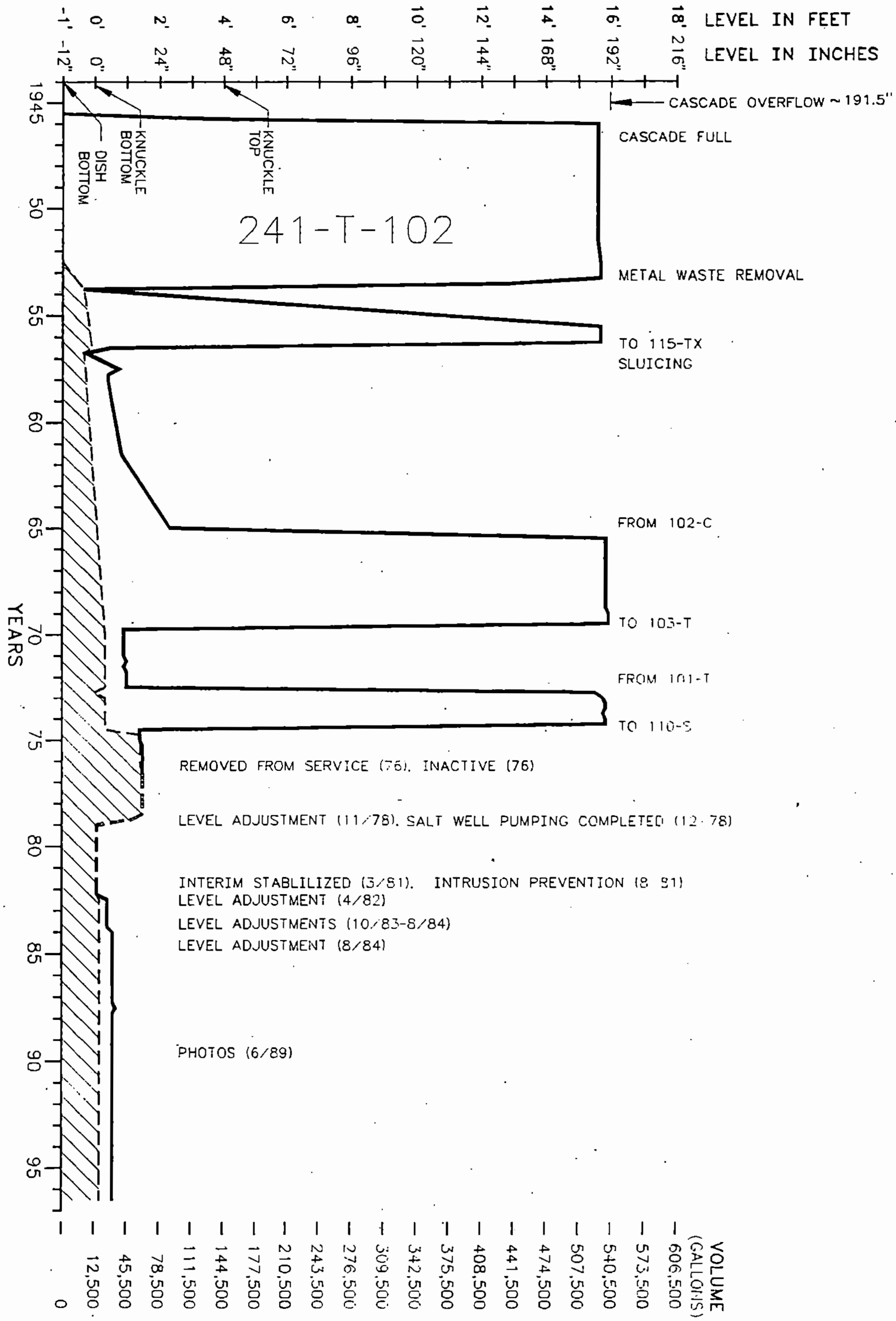
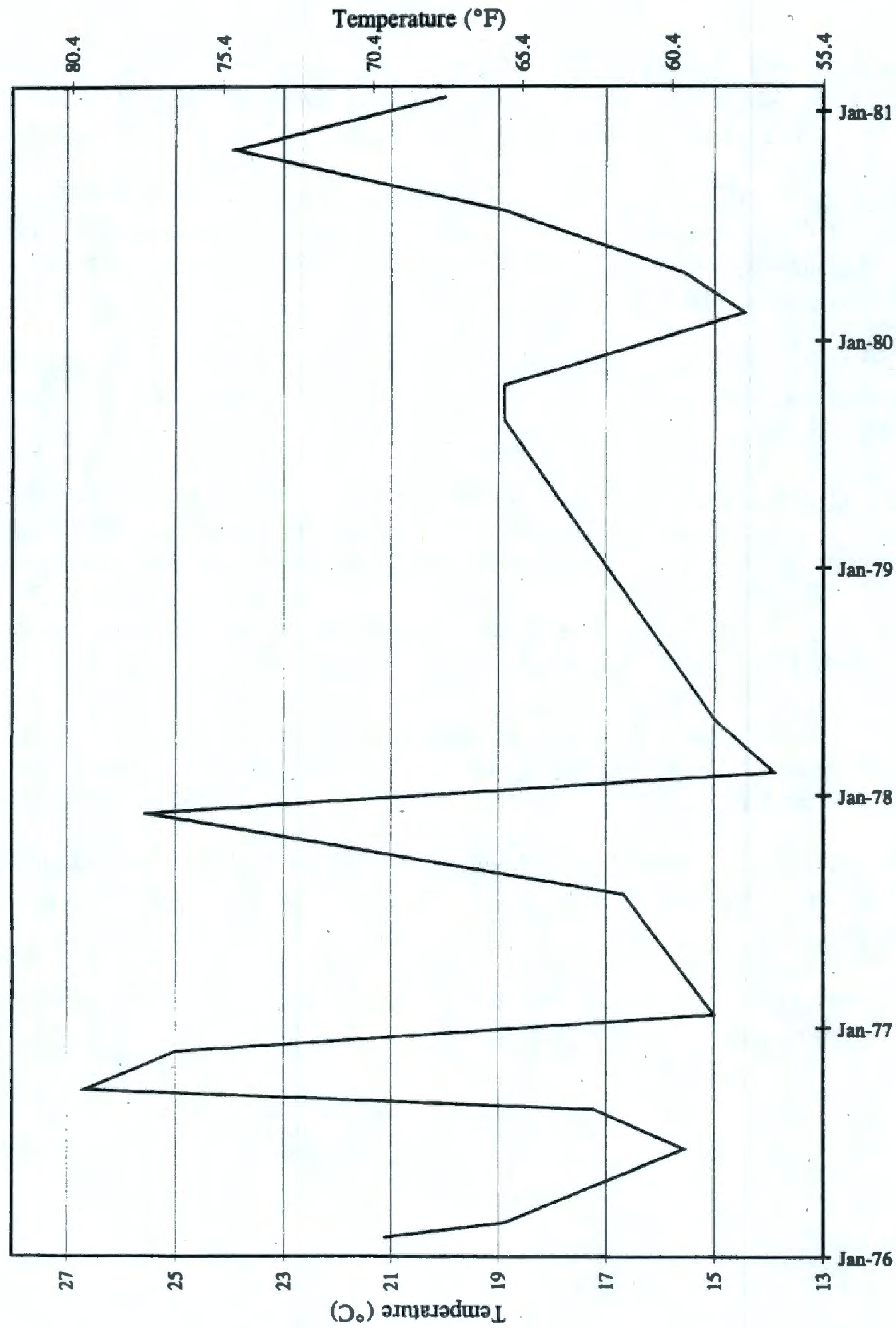


Figure A4-2. Tank 241-T-102 High Temperature Plot.



A5.0 APPENDIX A REFERENCES

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APPENDIX B

SAMPLING OF TANK 241-T-102

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APPENDIX B

SAMPLING OF TANK 241-T-102

Appendix B provides sampling and analysis information for each known sampling event for tank 241-T-102 and provides an assessment of the push mode and grab sampling results.

- **Section B1**: Tank Sampling Overview
- **Section B2**: Analytical Results
- **Section B3**: Assessment of Characterization Results
- **Section B4**: References for Appendix B

Future sampling of tank 241-T-102 will be appended to the above list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the March 1993 push mode sampling and analysis event for tank 241-T-102. Sampling and analyses were performed in accordance with the requirements of the *Tank Waste Remediation System Tank Characterization Plan* (Bell 1993). Because the sampling event predated DQOs, no DQOs were applicable. For further discussions of the sampling and analysis procedures, refer to the *Tank Characterization Reference Guide* (Delorenzo et al. 1994). A liquid grab sample was taken from this tank in July 1994. The grab sample was taken and analyses were performed in accordance with the requirements of the *Tank 241-T-102 Tank Characterization Plan* (Schreiber 1994). A vapor flammability measurement was taken on May 9, 1996.

Although current DQO's were not in evidence at the time of the push mode sampling event, the sampling and analytical direction would meet the requirements of the current safety DQO. The sampling riser locations were separated radially to the maximum extent possible. Unfortunately, sample recovery for core 56 was insufficient for analysis so only the results from the analysis of core 55 can be used to partially satisfy the requirements of the safety DQO.

A vertical profile is used to satisfy the safety screening DQO. Safety screening analyses include: total alpha to determine criticality, DSC to ascertain the fuel energy value, and thermogravimetric analysis (TGA) to obtain the total moisture content. The data were reported in Pool (1993). In addition, combustible gas meter readings in the tank headspace are required to measure flammability.

Sampling and analytical requirements from the safety screening DQO is summarized in Table B1-1.

Table B1-1. Integrated Data Quality Objective Requirements for Tank 241-T-102.

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Push Mode Sampling	Safety Screening	Core samples from a minimum of two risers separated radially to the maximum extent possible.	▸Energetics ▸Moisture Content ▸Total Alpha
Combustible Gas Meter Reading	Safety Screening	Measurement in a minimum of one location within tank vapor space.	▸Flammable Gas Concentration
Vapor Sampling	Vapor	Measurement in a minimum of one location within tank headspace.	▸Gases (Ammonia, CO2, CO, NO, NO2, N2O, TOC, tributyl phosphate, n-dodecane, and n-tridecane)

B1.1 DESCRIPTION OF SAMPLING EVENTS

B1.1.1 Push Mode Sampling Event

Two push mode core samples were collected from tank 241-T-102. Core 55 was obtained from riser 2 March 25 and core 56 was obtained from riser 8 on March 26, 1993. The core samples were sent to the Pacific Northwest Laboratory (PNL) on April 1 and May 4, 1993 and extruded on May 14 and April 21, 1993.

Push Mode Core sampling was used because the waste was expected to be relatively soft. The core samples, however, did not recover a full vertical profile of the waste. The waste depth was expected to be 18 cm to 20 (7 to 8 in.) under risers 2 and 8. Core 55 had a core recovery of 65 percent and core 56 had a recovery of approximately 10 percent. Due to the small amount of waste recovered in the core 56 sample, no chemical analyses were performed on it.

B1.1.2 Grab Sampling Event

Three 100 mL grab samples were taken from riser 2 on July 15, 1994. One sample was analyzed and two samples were archived. Analysis was conducted at the 222-S Laboratory.

B1.1.3 Vapor Flammability Measurement

On May 9, 1996 a flammability measurement was made in the dome space of tank 241-B-201 using a combustible gas meter (CGM). The results of that test showed the flammability limit to be 0 percent (Willkins et al. 1996).

B1.2 SAMPLE HANDLING

B1.2.1 Push Mode Sample Handling

The two cores sampled from tank 241-T-102, cores 55 and 56, had recoveries of 65 percent and 10 percent of the expected volume, respectively. Minimal drainable liquid (less than 10 mL) was associated with the core 55 sample; this drainable liquid was not separated from the solids.

During homogenization of core 55, dark specks were observed. After further investigation, the dark specks were determined to have magnetic properties, which were probably shavings or filings from equipment that was discarded into the tank.

It is assumed that the obtained sample is representative of the tank content and that the waste in the tank is uniformly distributed. Therefore, the amount of drainable liquid found in the sample is expected to be proportionally equal to the amount of drainable liquid observed in the tank. It is estimated that the 121,100 liters (32,000 gallons) of waste in the tank contains approximately 49,200 liters (13,000 gallons) of supernatant (or 40 percent) and the 80-gram core 55 sample contains approximately 13 grams (9.85 mL) of drainable liquid (or 16 percent).

From this distribution information, the core 55 sample did not appear to provide an adequate representation of this tank's contents. After inspection of a photographic montage (Brevick et al. 1997) of the tank's interior it was concluded that the spatial variability in the waste, and the locations of the sampling risers (which were at the edges of the tank, while most of the drainable liquid was located near the center), were the major contributors to the inadequacy of the sample.

The limited core 56 sample precluded any analysis of physical or rheological properties, and was archived without any homogenization. As a result, only one core, core 55, was prepared for chemical and radiological analysis.

Table B1-2 gives the sample description. Figure B1-1 contains a flowchart of the steps taken by the PNL's 325-A Laboratory to analyze tank core samples.

Table B1-2. Tank 241-T-102 Sample Description.[1]

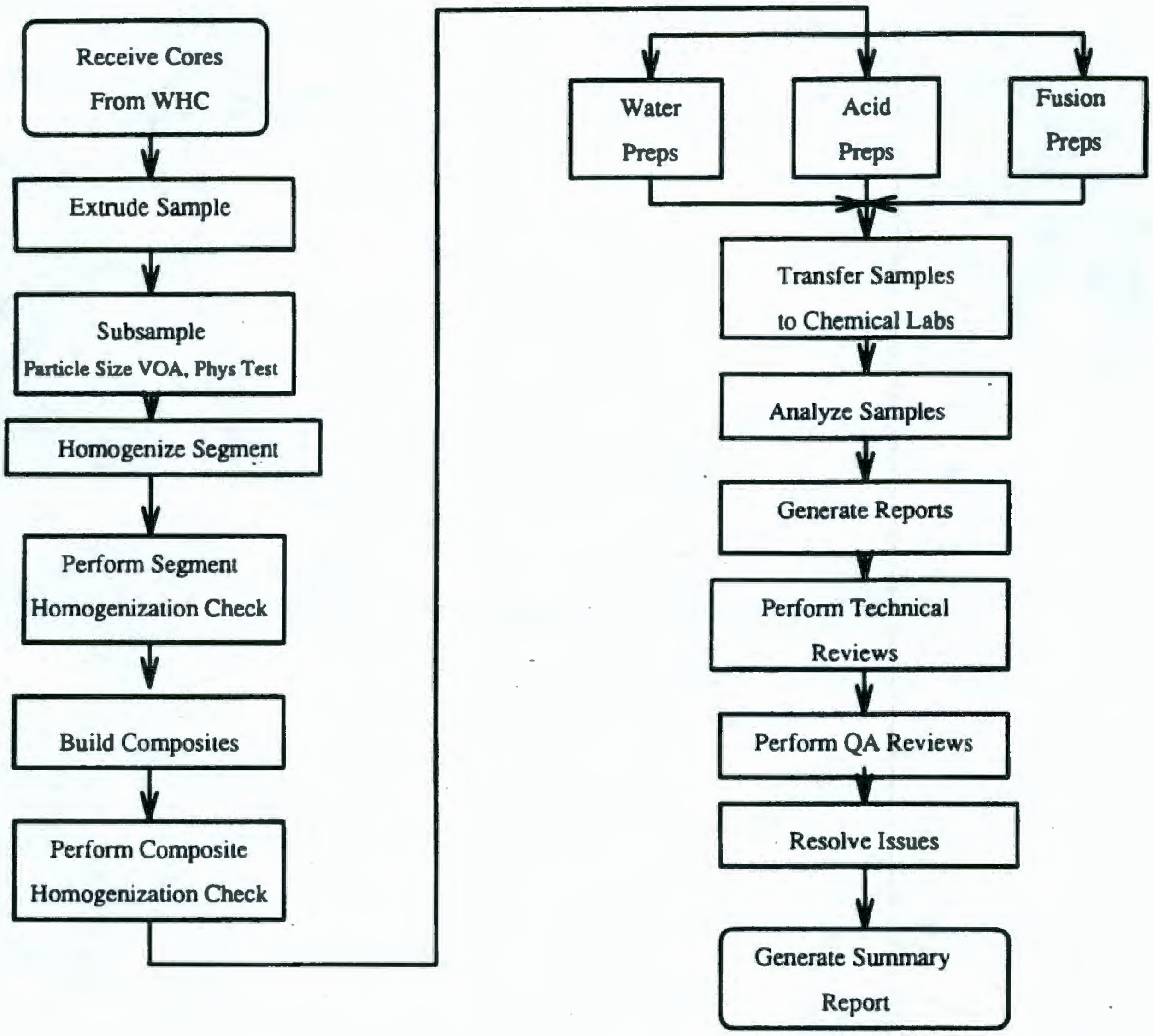
Riser	Sample Identification	Weight (grams)	Sample Recovery (%)[2]	Sample Portion	Sample Characteristics
2	Core 55	80.6	65	Top	Top 5.08 cm (2 in.) were dry and crumbly, brown with streaks of white.
				Middle	Next 5.08 cm (2 in.) were a white sticky sludge with brown streaks.
				Bottom	The bottom 2.54 cm (1 in.) of the segment had a similar consistency to the top 5.08 cm (2 in.) - dry and crumbly - but the entire sample was brown.
8	Core 56	8.42	10	Whole	Brown with a dry granular texture

Notes:

[1]Pool 1993

[2]Sample recovery calculated using an expected sample length of 18 cm (7 in.).

Figure B1-1. Sample Preparation Flowchart.



B1.2.2 Grab Sample Handling

Only an electronic printout report is available for the grab sample handling (WHC 1994). Sample description is not available. Sample data are provided in Table B2-100. These data are not available in the Tank Characterization Database (TCD).

B1.2.3 Vapor Flammability Measurement

On May 9, 1996 a flammability measurement was made in the dome space of tank 241-B-201 using a CGM. The results of that test showed the flammability limit to be 0 percent (Willkins et al. 1996).

B1.3 SAMPLE ANALYSIS

B1.3.1 Push Mode Sample Analysis

Differential scanning calorimetry and TGA were performed on 8.665-mg to 45.550-mg samples. Quality control tests included performing the analyses in duplicate and the use of standards.

Total alpha activity measurements were performed on samples that had been fused in a solution of potassium hydroxide and then dissolved in acid. The resulting solution was then dried on a counting planchet and counted in an alpha proportional counter. Quality control tests included standards, spikes, blanks, and duplicate analyses.

Ion chromatography (IC) was performed on samples that had been prepared by water digestion. Quality control tests included standards, spikes, blanks, and duplicate analyses. Bell (1993) required that the full suite of IC analytes be measured.

Inductively coupled plasma spectrometry (ICP) was performed on samples that had been prepared by a fusion procedure, followed by dissolution in acid. ICP analysis was performed on fusion samples for phosphate, beryllium, iron, molybdenum, silicon, and sodium. All other ICP analytes were prepared by an acid digestion procedure. Quality control tests included standards, blanks, spikes, and duplicate analyses. Bell (1993) required that the full suite of ICP elements be analyzed.

All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table B1-3. The procedure numbers are presented in the discussion in Section B2.0

Table B1-3. Tank 241-T-102 Push Mode Sample Analysis Summary. (2 sheets)

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
2	Core 55	Core composite	93-08755	Physical properties, percent solids
			93-05874-P	Persulfate oxidation, pH, OH, CN
			93-05874-Q	IC
			93-05874-R	ISE
			93-05874-R1	Alpha Rad, Beta Rad, GEA
			93-05874r1	ICP
			93-08755-C	Colorimetric, ISE, TIC/TOC/TC, IC
			93-08755-C1	Liq. Scin., Alpha Rad, Beta Rad, GEA
			93-08755-CH1	GEA
			93-08755-D	CVAA (Hg)
			93-08755-G	CN
			93-08755-H1	Mass Spec., Beta Rad, Alpha, GEA, LF
			93-08755-J	Persulfate oxidation
			93-08755-M	pH, OH, DSC, TGA
			93-08755a1	ICP
			93-09774-P	Persulfate oxidation, pH, OH, CN

Table B1-3. Tank 241-T-102 Push Mode Sample Analysis Summary. (2 sheets)

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
2 (Cont'd)	Core 55 (Cont'd)	Core composite (Cont'd)	93-09774-Q	IC
			93-09774-R	ISE
			93-09774-R1	Alpha Rad, Beta Rad, GEA
			93-09774r1	ICP
			93-09804-P	Persulfate oxidation, pH, OH, CN
			93-09804-Q	IC
			93-09804-R	ISE
			93-09804-R1	Alpha Rad, Beta Rad, GEA
			93-09804r1	ICP
			93-8755h-1B	ICP
			93-8755h-1T	ICP

Notes:

CVAA = cold vapor atomic absorption
GEA = gamma energy analysis
ISE = ion specific electrode
LF = lazar fluorimetry
TC = total carbon
TIC = total inorganic carbon

B1.3.2 Grab Sample Analysis

All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table B1-4.

B1.3.3 Vapor Flammability Measurement

On May 9, 1996 a flammability measurement was made in the dome space of tank 241-B-201 using a CGM. The results of that test showed the flammability limit to be 0 percent (Willkins et al. 1996). The vapor flammability issue of the safety screening DQO (Dukelow et al. 1995) can be closed.

Table B1-4. Tank 241-T-102 Grab Sample Analysis Summary.

Riser	Sample Identification	Sample Portion	Sample Number	Analyses
2	R 6088	Grab Sample Liquid	5706, 5806	SPG
			5710, 5810	Percent solids
			5711, 5811	DSC
			5712, 5812	TGA
			5713, 5813	pH
			5726, 5826	TOC
			5727, 5827	TIC
			5729, 5829	OH LIQ
			5730, 5830	GEA
			5750, 5850	ICP-LIQ
			5771, 5871	IC
			5781, 5881	Pu 239/240
			5782, 5882	Am 241
			5786, 5886	Sr 90

B1.4 DESCRIPTION OF HISTORICAL SAMPLING EVENT

Four sampling events occurred for tank 241-T-102 in 1973 through 1974. Details of these events are sketchy. For two of the events it is unclear what type of sample was analyzed. The other two events were measurements of supernatant which no longer exists in the tank. The data from these events is available in the Tank Characterization and Safety Resource Center in the folder for tank 241-T-102.

B2.0 ANALYTICAL RESULTS

B2.1 OVERVIEW

This section summarizes the sampling and analytical results associated with the March 1993 push mode sampling and the July 1995 grab sampling and analysis of tank 241-T-102. The location of the analytical results associated with this tank are presented in Table B2-1. The push mode sample results are documented in Pool (1993). As only an electronic report exists for the grab sample analysis (WHC 1994), the following sections deal only with the push mode core sampling event with exception of the grab sample results provided in Table B2-100.

B2.2 QUALITY CONTROL ASSESSMENT

The four quality control (QC) parameters assessed in conjunction with the tank 241-T-102 push mode samples were standard recoveries, spike recoveries, duplicate analyses (relative percent difference [RPDs]), and blanks. The QC criteria specified in Bell (1993) were 90 to 110 percent recovery for standards and 80 to 120 percent for spikes and ≤ 20 percent for RPDs. These criteria applied to all of the analytes. The only QC parameter for which limits are not specified is blank contamination. The limits for blanks are set forth in guidelines followed by the laboratory, and all data results presented in this report have met those guidelines. Sample and duplicate pairs in which any of the QC parameters were outside of these limits are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, or e as follows:

- "a" indicates that the standard recovery was below the QC limit.
- "b" indicates that the standard recovery was above the QC limit.
- "c" indicates that the spike recovery was below the QC limit.
- "d" indicates that the spike recovery was above the QC limit.
- "e" indicates that the RPD was above the QC limit.
- "f" indicates that there was blank contamination.

Table B2-1. Analytical Presentation Tables. (2 sheets)

Analysis	Table Number
Mercury	B2-2
Summary data for metals by ICP	B2-3 through B2-48
Total uranium	B2-49
Cyanide	B2-50

Table B2-1. Analytical Presentation Tables. (2 sheets)

Analysis	Table Number
Anions by IC	B2-51 through B2-56
Ammonia (nitrogen)	B2-57
Uranium isotopes	B2-58 through B2-61
Weight percent solids	B2-62
pH	B2-63
Physical properties	B2-64
Differential scanning calorimetry	B2-65
Scanning thermogravimetric (TGA)	B2-66
Total alpha Pu	B2-67
Alpha isotopes	B2-68 through B2-73
Total alpha	B2-74
Beta isotopes	B2-75 through B2-76
Total beta	B2-77
Radio isotopes by GEA	B2-78 through B2-89
Carbon-14	B2-90
Tritium	B2-91
Hexavalent chromium	B2-92
Total carbon/total inorganic carbon/total organic carbon	B2-93 through B2-98
Power law fit parameters	B2-99
Grab sample results	B2-100

B2.3 INORGANIC ANALYSES

B2.3.1 Cold Vapor Atomic Absorption

Mercury was analyzed in the core composite samples by cold vapor atomic absorption (CVAA) following a modification of procedure PNL-ALO-213, "Mercury in Water, Solids, and Sludges by Manual Cold Vapor Technique" (Pool 1993).

B2.3.2 Inductively Coupled Plasma

Analyses for the waste metallic constituents were performed by ICP. The ICP analyses were run after fusion, acid, and water digestions. The ICP analyses were performed following procedure PNL-ALO-211, "Determination of Elements by Inductively Coupled Argon Plasma Atomic Emission Spectrometry." All inter-element corrections for spectral interferences were performed online and the reported instrument detection limits were determined in accordance with the statement of work and technical project plan requirements (Pool 1993).

B2.3.3 Colorimetry

Analyses for chromium (VI) were performed by colorimetry on composite samples which had been water leached. The analyses were performed according to procedure PNL-ALO-227, "Determination of Cr(VI) in Aqueous Samples" (Pool 1993).

B2.3.4 Laser Fluorimetry

Total uranium concentrations were measured in the fusion composite samples using laser fluorimetry. No procedure number was provided in Pool (1993).

B2.3.5 Ion Chromatography

The IC analyses were performed according to procedure PNL-ALO-212 ("Determination of Inorganic Anions by Ion Chromatography") after a water digestion per PNL-ALO-103 ("Water Leach of Sludges, Soils and Other Solid Samples") (Pool 1993).

B2.3.6 Ion Selective Electrode

Using procedure PNL-ALO-226 ("Ammonia [Nitrogen] in Aqueous Samples"), analyses for ammonia were performed on core composite samples which had been water leached. It should be noted that no distillation procedure is performed on the samples and the ISE analysis is performed directly on the leachates. Also, ammonia is reported as μg/g nitrogen (that is, NH_3-N), not μg/g ammonia (Pool 1993).

B2.3.7 Total Cyanide

Total CN analyses were performed "directly". The core composite samples were distilled following procedure PNL-ALO-285, "Total Cyanide by Remote Micro Distillation and Argentometric Titration"; however, because high CN was not expected, the pretreatment steps were omitted and the distillate was measured calorimetrically using a Lachat Autoanalyzer following the manufacturer's CN procedure (Pool 1993).

B2.3.8 PH and OH^-

The pH was determined following procedure PNL-ALO-225, "Measurement of pH in Aqueous Solution" and the OH^- was analyzed following procedure PNL-ALO-228, "Determination of Hydroxyl (OH^-) and Alkalinity of Solutions, Leachates, and Supernates."

B2.4 CARBON ANALYSES

Results for TOC, TIC, and TC were obtained during the same analysis. Therefore, the discussion of the analytical method for the three analytes has been combined.

B2.4.1 TOC/TIC/TC

The TOC/TIC/TC analyses were performed on water leach solutions from the core composite samples and on the "direct" material from the composite samples. After leaching, the samples were analyzed following procedure PNL-ALO-382, "Solution Analysis: Carbon." Direct TOC/TIC/TC analyses on each core composite sample were performed following procedure PNL-ALO-381, "Determination of TC, TOC, and TIC in Radioactive Liquids, Soils, and Sludges by Hot Persulfate Method."

B2.5 RADIONUCLIDE ANALYSES

Procedure numbers were not provided in Pool (1993) for the radiochemical analyses. Winters et al. (1990) contains the full set of procedure numbers.

B2.5.1 Alpha Activity

The total alpha activity was determined on both fusion digested and water digested core composite samples by drying a small aliquot on a counting planchet and counting. Pool (1993) states that for the fusion digested samples, the Pu, Am/Cm, and Np fractions were separated by ion exchange and/or solvent extraction procedures and counted by alpha proportional counting.

The plutonium analyses are reported as total alpha Pu and because the Pu concentration of the samples was too low for isotopic determination by Mass Spectrometry, $^{239/240}Pu$ and ^{238}Pu from Alpha Energy Analysis (AEA) of the separated Pu are also reported. Alpha Energy

Analysis was also used to determine ^{241}Am and $^{243/244}Cm$ ratios for Am. These ratios were used to report separate activities for each isotope.

B2.5.2 Mass Spectrometry

Thermal ionization mass spectrometry was used to determine the presence of all isotopes of U. Because of the low plutonium content of these samples, plutonium isotopic composition by mass spectrometry was not possible. However, isotopic composition is available from AEA of the separated plutonium (Pool 1993).

B2.5.3 Total Beta Activity

Analysis of the total beta activity was performed on the composite samples after a fusion digestion and after a water digestion. Only the KOH fusion was analyzed for ^{90}Sr and ^{99}Tc. The total beta values were determined by drying a small aliquot of each solution and counting in a beta proportional counter. ^{90}Sr and ^{99}Tc were also measured by beta counting after separating each fraction by ion exchange and/or solvent extraction (Pool 1993).

B2.5.4 Gamma Energy Analysis

A GEA was performed on core composite samples and homogenization test samples after fusion digestion. Results were obtained for ^{241}Am, ^{144}Ce, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{40}K, ^{103}Ru, ^{106}Ru, and ^{228}Th (Pool 1993).

B2.5.5 Tritium

Tritium was measured on core composite samples which had been water leached. The leachate was distilled before the liquid scintillation counting was performed (Pool 1993).

B2.5.6 Strontium-90

Strontium-90 was determined on fused samples by separation followed by beta counting (Pool 1993).

B2.5.7 Technetium-99

Technetium-99 was determined on fused samples by beta proportional counting (Pool 1993).

B2.5.8 Carbon-14

Carbon-14 was determined on core composite samples that had been water leached. The leachate was distilled before liquid scintillation counting was performed (Pool 1993).

B2.6 PHYSICAL PROPERTIES

Tests performed on core 55 include weight percent solids, weight percent oxides, particle size, sample density, centrifuged supernatant, density and solids density, settling behavior, weight percent centrifuged solids and volume percent centrifuged solids. Shear stress as a function of shear rate (viscosity) could not be performed on the as received core sample. Viscosity measurements are applicable to materials which flow; not to dry non-fluid samples. The limited amount of sample available also precluded analysis of penetration resistance and shear strength.

Shear stress as a function of shear rate, settling velocity and volume percent settled solids were performed on 1:1 and 1:3 sample to water dilutions. Shear stress as a function of shear rate was performed at both 25 °C (77 °F) and 90 °C (194 °F).

Table B2-64 provides a summary of the physical properties measurements.

B2.6.1 Density

Upon extrusion, the samples were placed in preweighed, volume-graduated, centrifuge tubes where they were weighed and then centrifuged for one hour at greater than 1000 gravities to remove voids. A density calculation was made by dividing the mass recovered by its volume.

B2.6.2 Solids Settling Rate and Volume Percent Settled Solids

Settling rates and volume percent settled solids measurements were conducted in preweighed, volume-graduated, centrifuge tubes. The cross-sectional area in the upper portion of the centrifuge tubes was constant thus allowing the conversion of settling rate data from mL/hr to cm/hr. After settling rates were determined, the volume percent settled solids were calculated by dividing the final settled solids volume by the total sample volume (Pool 1993).

Settling was not observed for the undiluted core 55 sample, but settling was observed on the 1:1 and 1:3 sample:water dilution. If this sample were composed of 100 percent insoluble solids, the packing density of the settled solids was the same for the undiluted and diluted sample, and the added water was not associated with the solid particles; the expected volume percent settled solids for the 1:1 dilution would be near 36 percent. The value of 15.7 percent for the 1:1 dilution indicates that at least half the solids in core 55 are soluble. The water leach data indicate much lower solubility than was observed on the 1:1 dilution.

The inorganic data indicate that the primary compound in the sample is aluminum hydroxide which is amphoteric (exhibits both basic and acidic properties). The increased solubility in the 1:1 dilution compared to the water leach (100:1 dilution) is due to the differences in the pH. At the higher pH present in the 1:1 dilution, the equilibrium is pushed toward the formation of $AL(OH)_4$- where in lower pH solutions like the water leach solution $Al(OH)_3$ is favored.

The data in Table B2-64, shows a two-fold decrease in the volume percent settled solids between the 1:1 and the 1:3 dilution. This behavior suggests that the solids remaining after the 1:1 dilution are essentially insoluble or that the pH has been decreased enough to decrease the solubility of the remaining solids.

The volume percent settled solids as a function of time for both the 1:1 (dilution 1) and 1:3 (dilution 2) dilutions are reported in Figure B2-1. Duplicate measurements for each of the dilutions are plotted in this figure. Significant settling for both dilutions were observed over 30 hours, but the settling velocities decreased sharply over the first hour as reported in Figure B2-2.

Figure B2-1. T-102 Core 55, Volume Percent Settled Solids for the 1:1 and 1:3 Sample to Water Dilutions.

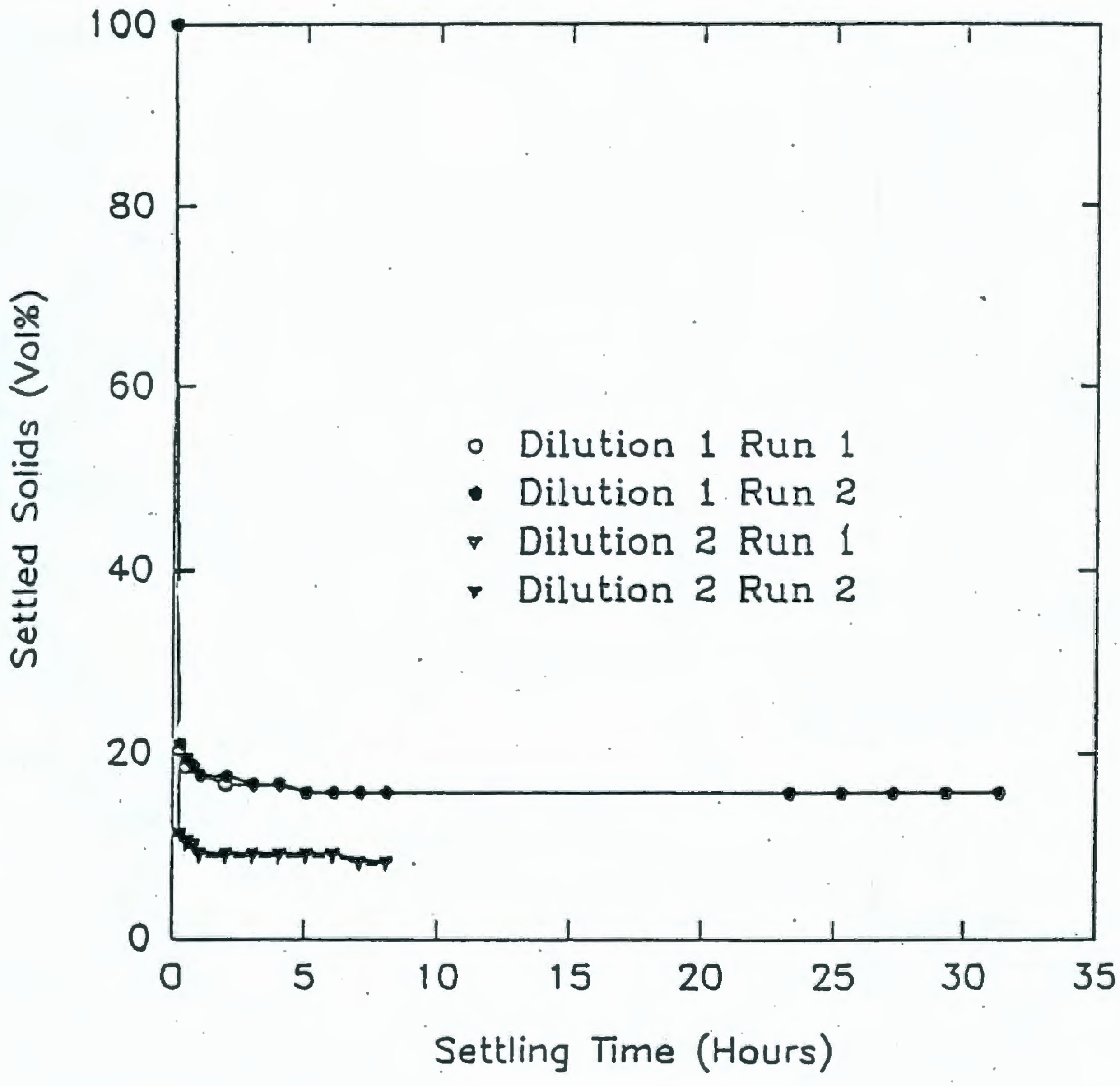
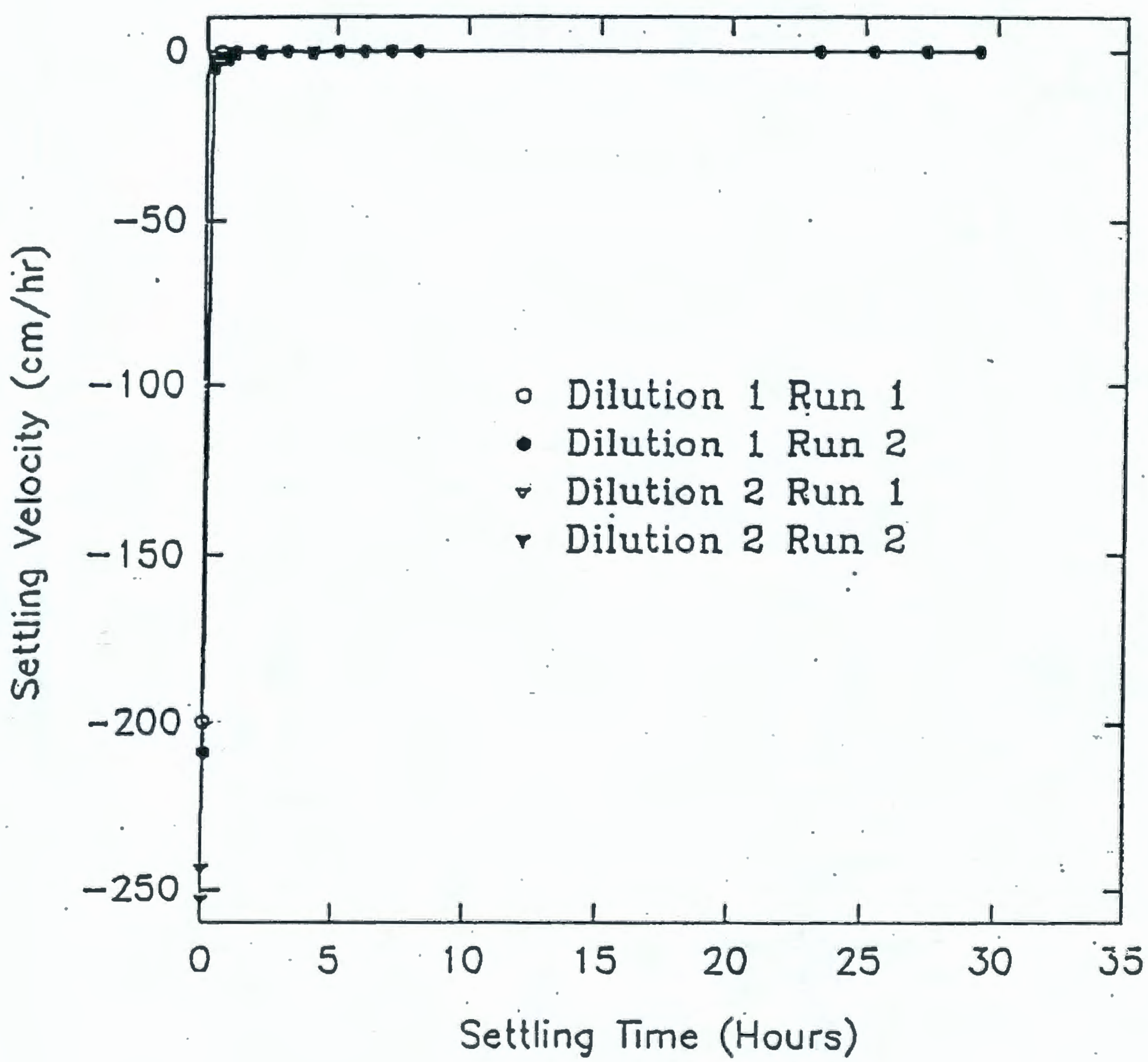


Figure B2-2. T-102 Core 55, Settling Velocity for the 1:1 and 1:3 Sample to Water Dilutions.



B2.6.3 Weight Percent Solids and Weight Percent Oxides

Samples were placed into preweighed vials, weighed and allowed to air-dry overnight to remove free liquid to prevent splattering in the oven. The samples were then transferred to a muffle furnace or drying oven at 105 °C (221 °F) where they were dried for 24 hours. The dried samples were removed from the oven, placed in a desiccator to cool to room temperature, reweighed, and the weight percent total solids was calculated.

The weight percent solids was initially measured on two portions of the extruded core 55 sample. The two subsegments were taken from different portions of the segment which appeared to have different amounts of moisture; therefore, there is significant variability in the measured weight percent solids of these two subsamples. Table B2-62 provides the results of the weight percent solids measurements.

For determination of weight percent oxides, the samples were placed into preweighed crucibles, weighed and allowed to air-dry overnight to remove free liquid to prevent splattering in the oven, The samples were then transferred to a muffle furnace at between 1000 °C (1832 °F) and 1050 °C (1922 °F) for 30 minutes. The calcined samples were removed from the oven, placed in a desiccator to cool to room temperature, reweighed, and the weight percent oxides was calculated.

B2.6.4 Particle Size Analysis

The particle size distribution was measured on unhomogenized material from core 55. This analysis was performed according to PNL-ALO-530, Rev. 0. The particle size analyzer determined particle sizes from 0.5 to 150 μm by measuring the time required for a rapidly moving laser beam to traverse selected particles maintained in a stirred suspension. A glass sphere reference was measured before running the samples to ensure proper operation of the instrument.

The median and mean particle sizes of the core 55 sample based on volume density are 35 μm and 36 μm respectively, with 90 percent of the particles between 10 μm and 60 μm. The median and mean particle size for the core 55 sample based on number density are 0.93 μm and 2.35 μm respectively, with 90 percent of the particles less than 4 μm and 99.99 percent less than 60 μm. Analysis in duplicate confirmed these results.

B2.6.5 Shear Stress verses Shear Rate

Dilutions were analyzed in duplicate for shear stress as a function of shear rate using a viscometer. Technical Procedure PNL-ALO-501, "Laboratory Procedure for Measurement of Physical and Rheological Properties of Solution, Slurries and Sludges" was used to perform these measurements (Pool 1993).

B2.6.6 Rheological Properties

Rheological properties were measured in duplicate on the 1:1 and 3:1 water-to-sample dilutions at ambient temperature. Both dilutions exhibited some dilatant behavior over the measured range (0 s^{-1} to 500 s^{-1}). Dilatancy generally occurs in concentrated suspensions which tend to gel upon mixing. The dilatant behavior is identified by an increase in viscosity with increasing shear rate. Because of the low viscosities observed for these two dilutions, the significance of this dilatant behavior is limited. None of the dilutions, 1:1 or 1:3, exhibited yield points. This rheology data were fit to the power law equation (see equation below), and the curve fit parameters are given in Table B2-99.

$$\tau = \tau_y + K\gamma^n$$

where:

τ	=	shear stress
τ_y	=	yield point
K	=	consistency parameter
γ	=	shear rate
n	=	flow behavior index.

The viscosity of the 1:1 dilutions at ambient temperature varied between 1 cP and 4 cP over a shear rate of 50 s-1 to 400 s-1. At 90 °C (194 °F), the viscosity of the 1:1 dilutions varied between 0.5 cP and 2 cP over a shear rate range of 50 s^{-1} to 400 s^{-1}.

The viscosity of the 1:3 dilution at 25 °C (77 °F) increased from 1 cP to 3.5 cP in the shear range from 50 s^{-1} to 400 s^{-1}. At 90 °C (194 °F), the viscosity of this dilution increased from 0.6 cP to 1.3 cP over the same shear rate range. Plots of shear stress and viscosity as a function of shear rate for the dilutions are in Pool (1993).

B2.7 THERMODYNAMIC ANALYSES

DSC and TGA were performed in duplicate on the unhomogenized material from core 55. These two thermal analysis techniques are useful in determining the thermal stability and reactivity of a material. DSC measures heat released or absorbed while the temperature of the sample is increased at a constant rate. TGA measures the mass of a sample while the temperature of the sample is increased at a constant rate. No exotheric reactions were observed in the tank 241-T-201 waste.

The results from the DSC and TGA analyses of the core 55 sample are reported in Tables B2-65 and B2-66, respectively. The temperature range of the DSC scan was from ambient to 500 °C (932 °F), with a scan rate of 5 °C (41 °F) per minute. Two endothermic transitions were observed in this temperature range. A minor endothermic region was observed between 70 °C (158 °F) and 100 °C (212 °F). The onset temperature of this event was 76 °C (169 °F), with an enthalpy of 2.4 calories per gram of sample (10 J/ g). An associated mass loss of between 1 and 2 percent was observed in the TGA. This mass loss compares well with the 99.1 weight percent solids measured on this same sample (see Table B2-62). The temperature of this event and the mass loss observed by the TGA analysis suggests the loss of free water.

The major endothermic region was observed between 200 °C (392 °F) and 365 °C (689 °F). This endothermic event includes at least two unresolved peaks. The onset temperature of this event was 255 °C (491 °F). This onset temperature is based on the major peak which is actually the second peak in this region; therefore, the first reaction in this region begins at a lower temperature than the onset temperature. The onset temperature for this reaction is estimated to be about 219 °C (462 °F). The enthalpy of transition region averaged 315 calories per gram of sample (1320 J/g). The TGA analysis showed this transition was accompanied by a 24 percent loss in mass. This endotherm and its associated mass loss is probably due to the decomposition of aluminum hydroxide to produce aluminum oxide and water. Based on the mass loss observed and the aluminum concentration measured on the fused sample, 1.2 moles of water were lost during this transition per mole of Al.

A third endothermic event was noted on the DSC and TGA analyses starting at approximately 410 °C (770 °F) and running beyond the end of the analysis (500 °C [932 °F] for DSC and 550 °C [1022 °F] for TGA). The TGA observed a 7.3 percent mass loss before the upper temperature limit of the instrument halted the analysis. No analysis can be performed on the front end of the peak observed by DSC.

B2.8 ANALYTICAL DATA TABLES

For most analytes (except for some physical and rheological measurements), the data tables consist of six columns. The first column lists the sample number. Note that for each primary/duplicate pair, the sample number is for the primary result (designated as "Result"). Sample numbers for duplicates are the same as for primaries, with a different extension. For example, if a primary run has a sample number of 92-03254-A1, the duplicate would have a sample number of 92-03254-A2. The second column lists the core and/or segment from which the samples were derived. The third column lists the sample portion from which the aliquots were taken. No distinction was made between composites I and II from each core. For the ICP analytes, results from both fusions have been included; no distinction has been made between the two fusion digestions. The final three columns display the primary and duplicate analytical values and a mean for each sample/duplicate pair. Because of validation issues with the data, the data validation section (see Section B3.3.4) should be consulted before using the data.

Table B2-2. Tank 241-T-102 Analytical Results: Mercury (CVAA [Hg]).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			**µg/g**	**µg/g**	**µg/g**
93-08755-D	Core 55	Solid composite	7.7	4.8	6.25[QC:e]

Table B2-3. Tank 241-T-102 Analytical Results: Aluminum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	1.453E+05	1.654E+05	1.553E+05[QC:c]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	3.113E+05	2.872E+05	2.993E+05
93-8755h-1B		Solid composite	2.661E+05	2.946E+05	2.803E+05
93-8755h-1T		Solid composite	2.840E+05	2.795E+05	2.818E+05
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	950	788	869[QC:d]

Table B2-4. Tank 241-T-102 Analytical Results: Antimony (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	40	50	45[QC:e]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<553.1	<559	<556.05
93-8755h-1B		Solid composite	<180.6	<181.7	<181.15
93-8755h-1T		Solid composite	<182.7	<181.5	<182.1
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<100.8	<101.4	<101.1

Table B2-5. Tank 241-T-102 Analytical Results: Arsenic (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	156	194	175[QC:e]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-8755h-1B	Core 55	Solid composite	<289	<290.8	<289.9
93-8755h-1T		Solid composite	<292.3	<290.4	<291.35

Table B2-6. Tank 241-T-102 Analytical Results: Barium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	12	12	12
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<110.6	<111.8	<111.2
93-8755h-1B		Solid composite	<36.12	<36.35	<36.235
93-8755h-1T		Solid composite	<36.53	<36.3	<36.415
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<20.16	<20.28	<20.22

Table B2-7. Tank 241-T-102 Analytical Results: Beryllium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<19.95	<20.01	<19.98
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<55.31	<55.9	<55.605
93-8755h-1B		Solid composite	<18.06	<18.17	<18.115
93-8755h-1T		Solid composite	<18.27	<18.15	<18.21
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<10.08	<10.14	<10.11

Table B2-8. Tank 241-T-102 Analytical Results: Bismuth (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
93-08755a1	Core 55	Solid composite	<1,995	<2,001	<1,998[QC:f]
Solids: fusion			μg/g	μg/g	μg/g
93-08755h1	Core 55	Solid composite	<5,531	<5,590	<5,560.5
93-8755h-1B		Solid composite	<1,806	<1,817	<1,811.5
93-8755h-1T		Solid composite	<1,827	<1,815	<1,821
Solids: water digest			μg/g	μg/g	μg/g
93-08755c1	Core 55	Solid composite	<1,008	<1,014	<1,011[QC:c]

Table B2-9. Tank 241-T-102 Analytical Results: Boron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			μg/g	μg/g	μg/g
93-08755a1	Core 55	Solid composite	201	153	177[QC:e,f]
Solids: fusion			μg/g	μg/g	μg/g
93-08755h1	Core 55	Solid composite	406	306	356[QC:e,f]
93-8755h-1B		Solid composite	216	300	258[QC:e]
93-8755h-1T		Solid composite	348	142	245[QC:e,f]
Solids: water digest			μg/g	μg/g	μg/g
93-08755c1	Core 55	Solid composite	<40.32	<40.56	<40.44

Table B2-10. Tank 241-T-102 Analytical Results: Cadmium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	11	11	11
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	258	239	248.5[QC:f]
93-8755h-1B		Solid composite	19	<18.17	<18.585
93-8755h-1T		Solid composite	25	<18.15	<21.575[QC:e,f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<10.08	<10.14	<10.11[QC:d]

Table B2-11. Tank 241-T-102 Analytical Results: Calcium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	625	556	590.5[QC:f]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	781	697	739
93-8755h-1B		Solid composite	733	716	724.5
93-8755h-1T		Solid composite	828	770	799[QC:f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	14	13	13.5[QC:d]

Table B2-12. Tank 241-T-102 Analytical Results: Cerium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-08755a1	Core 55	Solid composite	<399	<400.2	<399.6
Solids: fusion			µg/g	µg/g	µg/g
93-08755h1	Core 55	Solid composite	<1,106	<1,118	<1,112
93-8755h-1B		Solid composite	<361.2	<363.5	<362.35
93-8755h-1T		Solid composite	<365.3	<363	<364.15
Solids: water digest			µg/g	µg/g	µg/g
93-08755c1	Core 55	Solid composite	<201.6	<202.8	<202.2

Table B2-13. Tank 241-T-102 Analytical Results: Chromium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-08755a1	Core 55	Solid composite	737	748	742.5[QC:c]
Solids: fusion			µg/g	µg/g	µg/g
93-08755h1	Core 55	Solid composite	806	767	786.5
93-8755h-1B		Solid composite	786	654	720
93-8755h-1T		Solid composite	735	779	757
Solids: water digest			µg/g	µg/g	µg/g
93-08755c1	Core 55	Solid composite	767	776	771.5[QC:c]

Table B2-14. Tank 241-T-102 Analytical Results: Cobalt (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<39.9	4	<21.95[QC:e]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<110.6	<111.8	<111.2
93-8755h-1B		Solid composite	<36.12	<36.35	<36.235
93-8755h-1T		Solid composite	<36.53	<36.3	<36.415
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<20.16	<20.28	<20.22

Table B2-15. Tank 241-T-102 Analytical Results: Copper (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	14	14	14[QC:f]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	55	60	57.5[QC:f]
93-8755h-1B		Solid composite	36	34	35
93-8755h-1T		Solid composite	49	37	43[QC:e,f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<10.08	<10.14	<10.11

Table B2-16. Tank 241-T-102 Analytical Results: Dysprosium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<199.5	<200.1	<199.8
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<553.1	<559	<556.05
93-8755h-1B		Solid composite	<180.6	<181.7	<181.15
93-8755h-1T		Solid composite	<182.7	<181.5	<182.1
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<100.8	<101.4	<101.1

Table B2-17. Tank 241-T-102 Analytical Results: Europium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<797.9	<800.5	<799.2
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<2,212	<2,236	<2,224
93-8755h-1B		Solid composite	<722.4	<727	<724.7
93-8755h-1T		Solid composite	<730.6	<726	<728.3
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<403.2	<405.6	<404.4

Table B2-18. Tank 241-T-102 Analytical Results: Gadolinium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<1,995	<2,001	<1,998
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<5,531	<5,590	<5,560.5
93-8755h-1B		Solid composite	<1,806	<1,817	<1,811.5
93-8755h-1T		Solid composite	<1,827	<1,815	<1,821
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<1,008	<1,014	<1,011

Table B2-19. Tank 241-T-102 Analytical Results: Iron (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	19,254	20,204	19,729[QC:c]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	19,813	16,300	18,056.5
93-8755h-1B		Solid composite	15,221	8,949	12,085[QC:e]
93-8755h-1T		Solid composite	16,878	16,905	16,891.5
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	130	91	110.5[QC:c,e]

Table B2-20. Tank 241-T-102 Analytical Results: Lanthanum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<199.5	<200.1	<199.8
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<553.1	<559	<556.05
93-8755h-1B		Solid composite	<180.6	<181.7	<181.15
93-8755h-1T		Solid composite	<182.7	<181.5	<182.1
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<100.8	<101.4	<101.1

Table B2-21. Tank 241-T-102 Analytical Results: Lead (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	374	421	397.5
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	2,008	1,836	1,922[QC:f]
93-8755h-1B		Solid composite	509	410	459.5[QC:e]
93-8755h-1T		Solid composite	593	695	644
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<120.9	<121.7	<121.3[QC:d]

Table B2-22. Tank 241-T-102 Analytical Results: Lithium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<119.7	<120.1	<119.9
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<331.9	<335.4	<333.65
93-8755h-1B		Solid composite	<108.4	<109	<108.7
93-8755h-1T		Solid composite	<109.6	<108.9	<109.25
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<60.47	<60.84	<60.655

Table B2-23. Tank 241-T-102 Analytical Results: Magnesium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	107	107	107[QC:f]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<1,106	<1,118	<1,112
93-8755h-1B		Solid composite	<361.2	<363.5	<362.35
93-8755h-1T		Solid composite	<365.3	<363	<364.15
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<201.6	<202.8	<202.2

Table B2-24. Tank 241-T-102 Analytical Results: Manganese (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	755	807	781[QC:c]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	1,010	903	956.5[QC:f]
93-8755h-1B		Solid composite	1,187	672	929.5[QC:e]
93-8755h-1T		Solid composite	705	981	843[QC:e,f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	10	6	8[QC:d,e]

Table B2-25. Tank 241-T-102 Analytical Results: Molybdenum (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<119.7	<120.1	<119.9
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<331.9	<335.4	<333.65
93-8755h-1B		Solid composite	<108.4	<109	<108.7
93-8755h-1T		Solid composite	<109.6	<108.9	<109.25
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	7	7	7

Table B2-26. Tank 241-T-102 Analytical Results: Neodymium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	263	283	273
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	1,302	1,939	1,620.5[QC:e,f]
93-8755h-1B		Solid composite	354	<181.7	<267.85[QC:e]
93-8755h-1T		Solid composite	389	198	293.5[QC:e,f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<100.8	<101.4	<101.1

Table B2-27. Tank 241-T-102 Analytical Results: Nickel (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	66	70	68
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<60.47	<60.84	<60.655[QC:d]

Table B2-28. Tank 241-T-102 Analytical Results: Palladium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<1,197	<1,201	<1,199
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<3,319	<3,354	<3,336.5
93-8755h-1B		Solid composite	<1,084	<1,090	<1,087
93-8755h-1T		Solid composite	<1,096	<1,089	<1,092.5
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<604.7	<608.4	<606.55

Table B2-29. Tank 241-T-102 Analytical Results: Phosphorus (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	552	586	569
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	1,621	1,446	1,533.5
93-8755h-1B		Solid composite	833	840	836.5
93-8755h-1T		Solid composite	952	870	911
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	408	423	415.5

Table B2-30. Tank 241-T-102 Analytical Results: Potassium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<3,990	<4,002	<3,996[QC:c]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<2,016	<2,028	<2,022

Table B2-31. Tank 241-T-102 Analytical Results: Rhodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<1,197	<1,201	<1,199
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<3,319	<3,354	<3,336.5
93-8755h-1B		Solid composite	<1,084	<1,090	<1,087
93-8755h-1T		Solid composite	<1,096	<1,089	<1,092.5
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<604.7	<608.4	<606.55

Table B2-32. Tank 241-T-102 Analytical Results: Ruthenium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<797.9	<800.5	<799.2
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<2,212	<2,236	<2,224
93-8755h-1B		Solid composite	<722.4	<727	<724.7
93-8755h-1T		Solid composite	<730.6	<726	<728.3
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<403.2	<405.6	<404.4

Table B2-33. Tank 241-T-102 Analytical Results: Selenium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	63	74	68.5
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<1,106	<1,118	<1,112
93-8755h-1B		Solid composite	<361.2	<363.5	<362.35
93-8755h-1T		Solid composite	<365.3	<363	<364.15
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<201.6	<202.8	<202.2[QC:d]

Table B2-34. Tank 241-T-102 Analytical Results: Silicon (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	853	820	836.5[QC:c,f]
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	3,534	2,945	3,239.5
93-8755h-1B		Solid composite	2,839	2,571	2,705
93-8755h-1T		Solid composite	2,647	3,201	2,924[QC:f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	45	47	46[QC:d]

Table B2-35. Tank 241-T-102 Analytical Results: Silver (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	15	18	16.5
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<110.6	<111.8	<111.2[QC:f]
93-8755h-1B		Solid composite	306	309	307.5
93-8755h-1T		Solid composite	329	314	321.5[QC:f]
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<20.16	<20.28	<20.22

Table B2-36. Tank 241-T-102 Analytical Results: Sodium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**μg/g**	**μg/g**	**μg/g**
93-08755a1	Core 55	Solid composite	27,221	27,745	27,483[QC:c]
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
93-08755h1	Core 55	Solid composite	34,238	28,598	31,418[QC:f]
93-8755h-1B		Solid composite	34,682	25,270	29,976[QC:e]
93-8755h-1T		Solid composite	30,160	28,590	29,375[QC:f]
Solids: water digest			**μg/g**	**μg/g**	**μg/g**
93-08755c1	Core 55	Solid composite	28,121	29,569	28,845[QC:c]

Table B2-37. Tank 241-T-102 Analytical Results: Strontium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**μg/g**	**μg/g**	**μg/g**
93-08755a1	Core 55	Solid composite	17	18	17.5
Solids: fusion			**μg/g**	**μg/g**	**μg/g**
93-08755h1	Core 55	Solid composite	<55.31	<55.9	<55.605
93-8755h-1B		Solid composite	25	21	23
93-8755h-1T		Solid composite	23	24	23.5
Solids: water digest			**μg/g**	**μg/g**	**μg/g**
93-08755c1	Core 55	Solid composite	<10.08	<10.14	<10.11

Table B2-38. Tank 241-T-102 Analytical Results: Tellurium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<1,995	<2,001	<1,998
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<5,531	<5,590	<5,560.5
93-8755h-1B		Solid composite	<1,806	<1,817	<1,811.5
93-8755h-1T		Solid composite	<1,827	<1,815	<1,821
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<1,008	<1,014	<1,011

Table B2-39. Tank 241-T-102 Analytical Results: Thallium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<1,995	<2,001	<1,998
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<5,531	<5,590	<5,560.5
93-8755h-1B		Solid composite	<1,806	<1,817	<1,811.5
93-8755h-1T		Solid composite	<1,827	<1,815	<1,821
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<1,008	<1,014	<1,011

Table B2-40. Tank 241-T-102 Analytical Results: Thorium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<3,192	<3,202	<3,197
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<8,850	<8,944	<8,897
93-8755h-1B		Solid composite	<2,890	<2,908	<2,899
93-8755h-1T		Solid composite	<2,923	<2,904	<2,913.5
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<1,613	<1,622	<1,617.5

Table B2-41. Tank 241-T-102 Analytical Results: Tin (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<3,990	<4,002	<3,996
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<11,060	<11,180	<11,120
93-8755h-1B		Solid composite	<3,612	<3,635	<3,623.5
93-8755h-1T		Solid composite	<3,653	<3,630	<3,641.5
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<2,016	<2,028	<2,022

Table B2-42. Tank 241-T-102 Analytical Results: Titanium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	9	11	10
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	61	59	60
93-8755h-1B		Solid composite	44	53	48.5
93-8755h-1T		Solid composite	50	46	48
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<10.08	<10.14	<10.11

Table B2-43. Tank 241-T-102 Analytical Results: Total Uranium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<7,979	<8,005	<7,992
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<22,120	<22,360	<22,240
93-8755h-1B		Solid composite	<7,224	<7,270	<7,247
93-8755h-1T		Solid composite	<7,306	<7,260	<7,283
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<4,032	<4,056	<4,044[QC:d]

Table B2-44. Tank 241-T-102 Analytical Results: Tungsten (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<797.9	<800.5	<799.2
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<2,212	<2,236	<2,224
93-8755h-1B		Solid composite	<722.4	<727	<724.7
93-8755h-1T		Solid composite	<730.6	<726	<728.3
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<403.2	<405.6	<404.4

Table B2-45. Tank 241-T-102 Analytical Results: Vanadium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	<39.9	<40.02	<39.96
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<110.6	<111.8	<111.2
93-8755h-1B		Solid composite	<36.12	<36.35	<36.235
93-8755h-1T		Solid composite	<36.53	<36.3	<36.415
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<20.16	<20.28	<20.22[QC:c]

Table B2-46. Tank 241-T-102 Analytical Results: Yttrium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-08755a1	Core 55	Solid composite	6	6	6
Solids: fusion			µg/g	µg/g	µg/g
93-08755h1	Core 55	Solid composite	<110.6	<111.8	<111.2
93-8755h-1B		Solid composite	<36.12	<36.35	<36.235
93-8755h-1T		Solid composite	<36.53	<36.3	<36.415
Solids: water digest			µg/g	µg/g	µg/g
93-08755c1	Core 55	Solid composite	<20.16	<20.28	<20.22

Table B2-47. Tank 241-T-102 Analytical Results: Zinc (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			µg/g	µg/g	µg/g
93-08755a1	Core 55	Solid composite	98	123	110.5[QC:e]
Solids: fusion			µg/g	µg/g	µg/g
93-08755h1	Core 55	Solid composite	926	678	802[QC:e,f]
93-8755h-1B		Solid composite	332	363	347.5
93-8755h-1T		Solid composite	518	916	717[QC:e,f]
Solids: water digest			µg/g	µg/g	µg/g
93-08755c1	Core 55	Solid composite	<40.32	<40.56	<40.44

Table B2-48. Tank 241-T-102 Analytical Results: Zirconium (ICP).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid digest			**µg/g**	**µg/g**	**µg/g**
93-08755a1	Core 55	Solid composite	42	44	43
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755h1	Core 55	Solid composite	<110.6	<111.8	<111.2
93-8755h-1B		Solid composite	<36.12	<36.35	<36.235
93-8755h-1T		Solid composite	<36.53	<36.3	<36.415
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755c1	Core 55	Solid composite	<20.16	<20.28	<20.22[QC:c]

Table B2-49. Tank 241-T-102 Analytical Results: Total Uranium (LF).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µg/g**	**µg/g**	**µg/g**
93-08755-H1	Core 55	Solid composite	734	680	707

Table B2-50. Tank 241-T-102 Analytical Results: Cyanide (CN).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755-G1	Core 55	Solid composite	3.9	4.4	4.15

Table B2-51. Tank 241-T-102 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
93-08755-C	Core 55	Solid composite	300	300	300

Table B2-52. Tank 241-T-102 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
93-08755-C	Core 55	Solid composite	220	220	220

Table B2-53. Tank 241-T-102 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
93-08755-C	Core 55	Solid composite	34,000	36,000	35,000

Table B2-54. Tank 241-T-102 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
93-08755-C	Core 55	Solid composite	8,000	8,000	8,000

Table B2-55. Tank 241-T-102 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-08755-C	Core 55	Solid composite	1,110	1,150	1,130

Table B2-56. Tank 241-T-102 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-08755-C	Core 55	Solid composite	1,620	1,520	1,570

Table B2-57. Tank 241-T-102 Analytical Results: Ammonia (Nitrogen) (ISE).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-08755-C	Core 55	Solid composite	<27	n/a	<27

Table B2-58. Tank 241-T-102 Analytical Results: U234 to U Isotopic Percent (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			mass%	mass%	mass%
93-08755-H1	Core 55	Solid composite	0.006	0.005	0.0055

Table B2-59. Tank 241-T-102 Analytical Results: U235 to U Isotopic Percent (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			mass%	mass%	mass%
93-08755-H1	Core 55	Solid composite	0.689	0.706	0.6975

Table B2-60. Tank 241-T-102 Analytical Results: U236 to U Isotopic Percent (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			mass%	mass%	mass%
93-08755-H1	Core 55	Solid composite	0.013	0.013	0.013

Table B2-61. Tank 241-T-102 Analytical Results: U238 to U Isotopic Percent (Mass Spec.).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			mass%	mass%	mass%
93-08755-H1	Core 55	Solid composite	99.292	99.276	99.284

Table B2-62. Tank 241-T-102 Analytical Results: Weight percent solids (Percent Solids).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
93-08755-K1	Core 55	Rheology Sample	72.1	72.4	72.25
93-08755-K1		Extrusion Sample	74.2	69	71.6

Table B2-63. Tank 241-T-102 Analytical Results: pH Measurement.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**unitless**	**unitless**	**unitless**
93-08755-M	Core 55	Solid composite	9.8	9.8	9.8

Table B2-64. Tank 241-T-102 Core 55, Physical Properties Summary (93-08755).

Physical Properties	As-Received	1:1 Dilution	1:3 Dilution
Settled solids (vol%)	100	15.7	8.3
Centrifuged solids (vol%)	96		
Centrifuged solids (wt%)	97		
Sample density (g/mL)	1.79	1.11	1.05
Centrifuged supernate density (g/mL)	1.1		
Centrifuged solids density (g/mL)	1.8		
Total solids (wt%)[1]	72.3		
Oxides (wt%)[2]	65.7		

Notes:

[1]This weight percent total solids value is the measured value of the sample used for the rheological and settling properties of the waste. This is not the sample used for the chemical, radiochemical, energetics, or weight percent oxides. Additional data is given in Table B2-62 (Weight Percent Solids).

[2]Weight percent oxides was measured on the homogenized sample.

Table B2-65. Tank 241-T-102 Differential Scanning Calorimetric Data.

	Transition #1			Transition #2		
Run	Enthalpy (cal/g)	Onset (°C)	Range	Enthalpy[1]	Onset	Range
1	2.6	76	70-103	-315	255	200-365
2	2.3	76	70-111	-323	255	190-380

Note:

Negative sign indicates an endothermic reaction.

Table B2-66. Tank 241-T-102 Scanning Thermogravimetric Analysis Data.

	Transition #1		Transition #2		Transition #3	
Run	**Range (°C)**	**Mass Loss**	**Range (°C)**	**Mass Loss (%)**	**Range (°C)**	**Mass Loss (%)**
1	30-190	2.0	190-370	23.5	370-545	7.4
2	30-190	1.0	190-370	25.2	370-545	7.2

Table B2-67. Tank 241-T-102 Analytical Results: Total alpha Pu (Alpha Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-C1	Core 55	Solid composite	0.00582	0.0066	0.00621

Table B2-68. Tank 241-T-102 Analytical Results: Americium-241 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-H1	Core 55	Solid composite	0.244	0.269	0.2565

Table B2-69. Tank 241-T-102 Analytical Results: Cm-243/244 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-H1	Core 55	Solid composite	0.0014	0.0011	0.00125[QC:e]

Table B2-70. Tank 241-T-102 Analytical Results: Neptunium-237 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-H1	Core 55	Solid composite	6.360E-04	4.400E-04	5.380E-04[QC:e]

Table B2-71. Tank 241-T-102 Analytical Results: Plutonium-238 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-H1	Core 55	Solid composite	0.0063	0.00538	0.00584

Table B2-72. Tank 241-T-102 Analytical Results: Plutonium-239/240 (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-H1	Core 55	Solid composite	0.0596	0.051	0.0553

Table B2-73. Tank 241-T-102 Analytical Results: Total alpha Pu (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-H1	Core 55	Solid composite	0.0659	0.0564	0.06115

Table B2-74. Tank 241-T-102 Analytical Results: Total Alpha (Alpha).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-H1	Core 55	Solid composite	0.227	0.23	0.2285

Table B2-75. Tank 241-T-102 Analytical Results: Strontium-90 (Beta Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-H1	Core 55	Solid composite	256	220	238

Table B2-76. Tank 241-T-102 Analytical Results: Technetium-99 (Beta Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-H1	Core 55	Solid composite	0.017	0.0188	0.0179

Table B2-77. Tank 241-T-102 Analytical Results: Total Beta (Beta Rad).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-H1	Core 55	Solid composite	490	487	488.5
Solids: water digest			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-C1	Core 55	Solid composite	39.5	35.3	37.4

Table B2-78. Tank 241-T-102 Analytical Results: Americium-241 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-CH1	Core 55	Solid composite	0.0829	0.0731	0.078
93-08755-H1		Solid composite	0.233	0.246	0.2395
Solids: water digest			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-C1	Core 55	Solid composite	0.00657	0.0144	0.010485[QC:e]

Table B2-79. Tank 241-T-102 Analytical Results: Cerium-144 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-CH1	Core 55	Solid composite	<0.067	<0.059	<0.063
93-08755-H1		Solid composite	<0.13	<0.13	<0.13
Solids: water digest			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-C1	Core 55	Solid composite	<0.041	<0.042	<0.0415

Table B2-80. Tank 241-T-102 Analytical Results: Cesium-134 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-CH1	Core 55	Solid composite	<0.0064	<0.0057	<0.00605
93-08755-H1		Solid composite	<0.013	<0.012	<0.0125
Solids: water digest			**μCi/g**	**μCi/g**	**μCi/g**
93-08755-C1	Core 55	Solid composite	<0.0044	<0.0044	<0.0044

Table B2-81. Tank 241-T-102 Analytical Results: Cesium-137 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-CH1	Core 55	Solid composite	4.74	4.09	4.415[QC:f]
93-08755-H1		Solid composite	32.7	31	31.85
Solids: water digest			µCi/g	µCi/g	µCi/g
93-08755-C1	Core 55	Solid composite	26.3	26.6	26.45

Table B2-82. Tank 241-T-102 Analytical Results: Cobalt-60 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-CH1	Core 55	Solid composite	0.0162	0.0346	0.0254[QC:e,f]
93-08755-H1		Solid composite	0.0288	0.0268	0.0278
Solids: water digest			µCi/g	µCi/g	µCi/g
93-08755-C1	Core 55	Solid composite	8.520E-04	<4.600E-04	<6.560E-04[QC:e]

Table B2-83. Tank 241-T-102 Analytical Results: Europium-152 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-CH1	Core 55	Solid composite	<0.0056	<0.0066	<0.0061
93-08755-H1		Solid composite	<0.009	<0.008	<0.0085
Solids: water digest			µCi/g	µCi/g	µCi/g
93-08755-C1	Core 55	Solid composite	<4.400E-04	<0.0012	<8.200E-04[QC:e]

Table B2-84. Tank 241-T-102 Analytical Results: Europium-154 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-CH1	Core 55	Solid composite	0.19	0.152	0.171[QC:e]
93-08755-H1		Solid composite	0.497	0.482	0.4895
Solids: water digest			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-C1	Core 55	Solid composite	0.0186	0.012	0.0153[QC:e]

Table B2-85. Tank 241-T-102 Analytical Results: Europium-155 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-CH1	Core 55	Solid composite	0.215	0.165	0.19[QC:e]
93-08755-H1		Solid composite	0.557	0.528	0.5425
Solids: water digest			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-C1	Core 55	Solid composite	0.0181	0.0138	0.01595[QC:e]

Table B2-86. Tank 241-T-102 Analytical Results: Potassium-40 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-CH1	Core 55	Solid composite	<0.0095	<0.0096	<0.00955
93-08755-H1		Solid composite	<0.016	<0.015	<0.0155
Solids: water digest			µCi/g	µCi/g	µCi/g
93-08755-C1	Core 55	Solid composite	<0.0025	<0.0016	<0.00205[QC:e]

Table B2-87. Tank 241-T-102 Analytical Results: Ruthenium-103 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-CH1	Core 55	Solid composite	<0.41	<0.38	<0.395
93-08755-H1		Solid composite	<0.88	<0.88	<0.88
Solids: water digest			µCi/g	µCi/g	µCi/g
93-08755-C1	Core 55	Solid composite	<0.37	<0.38	<0.375

Table B2-88. Tank 241-T-102 Analytical Results: Ruthenium-106 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
93-08755-CH1	Core 55	Solid composite	<0.072	<0.067	<0.0695
93-08755-H1		Solid composite	<0.16	<0.15	<0.155
Solids: water digest			µCi/g	µCi/g	µCi/g
93-08755-C1	Core 55	Solid composite	<0.055	<0.055	<0.055

Table B2-89. Tank 241-T-102 Analytical Results: Thorium-228 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-CH1	Core 55	Solid composite	<0.014	<0.012	<0.013
93-08755-H1		Solid composite	<0.031	<0.031	<0.031
Solids: water digest			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-C1	Core 55	Solid composite	<0.011	<0.011	<0.011

Table B2-90. Tank 241-T-102 Analytical Results: Carbon-14 (Liquid Scintillation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-C1	Core 55	Solid composite	0.049	0.044	0.0465[QC:f]

Table B2-91. Tank 241-T-102 Analytical Results: Tritium (Liquid Scintillation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µCi/g**	**µCi/g**	**µCi/g**
93-08755-C1	Core 55	Solid composite	0.00794	0.00625	0.007095[QC:e]

Table B2-92. Tank 241-T-102 Analytical Results: Hexavalent Chromium (Colorimetric).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
93-08755-C	Core 55	Solid composite	741	745	743

Table B2-93. Tank 241-T-102 Analytical Results: Total Carbon (Persulfate Oxidation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			**μg/g**	**μg/g**	**μg/g**
93-08755-J1	Core 55	Solid composite	2,800	3,350	3,075

Table B2-94. Tank 241-T-102 Analytical Results: Total Inorganic Carbon (Persulfate Oxidation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			**μg/g**	**μg/g**	**μg/g**
93-08755-J1	Core 55	Solid composite	2,280	2,660	2,470

Table B2-95. Tank 241-T-102 Analytical Results: Total Organic Carbon (Persulfate Oxidation).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			**μg/g**	**μg/g**	**μg/g**
93-08755-J1	Core 55	Solid composite	520	680	600[QC:c,e]

Table B2-96. Tank 241-T-102 Analytical Results: Total Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			**μg/g**	**μg/g**	**μg/g**
93-08755-C1	Core 55	Solid composite	4,150	3,980	4,065

Table B2-97. Tank 241-T-102 Analytical Results: Total Inorganic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-08755-C1	Core 55	Solid composite	3,500	3,410	3,455

Table B2-98. Tank 241-T-102 Analytical Results: Total Organic Carbon.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
93-08755-C1	Core 55	Solid composite	650	660	655[QC:f]

Table B2-99. Tank 241-T-102 Core 55, Power Law Fit Parameters for 1:1 and 1:3 Dilutions.

Dilution	Temperature (°C)	Run	Consistency Parameter (Pa·s)	Flow Behavior Index
1:1	25	1	0.039	1.8
		2	0.078	1.6
	90	1	0.10	1.5
		2	0.082	1.5
1:3	25	1	0.13	1.5
		2	0.10	1.6
	90	1	0.13	1.4
		2	0.14	1.4

Table B2-100. Analytical Results for Liquid Grab Sample R6088.

Analyte	Primary	Duplicate	Mean
Physical Properties			
SpG	1.136	1.147	1.142
Weight percent solids	18.3	18.5	18.4
DSC	no exotherms	no exotherms	no exotherms
Weight percent water (TGA)	79.29	80.24	79.77
pH	11.15	11.16	11.16
Chemicals (μg/mL)			
TOC (μg C/mL)	447	450	449
TIC (μg C/mL)	5,950	5,930	5,940
Hydroxide	<62.5	<62.5	<62.5
Chromium	1,760	1,750	1,760
Phosphorus	991	1,020	1,010
Sulfur	1,190	1,190	1,190
Sodium	64,800	64,200	64,500
Molybdenum	15.3	14.9	15.1
Potassium	309	326	318
Fluoride	285	271	278
Chloride	637	650	644
Nitrite	23,000	23,000	23,000
Nitrate	109,000	108,000	109,000
Phosphate	4,090	4,110	4,100
Sulfate	4,920	4,860	4,890
Radionuclides (μCi/mL)			
Cobalt-60	<18.7	<16.8	<17.8
Cesium-137	56.5	73.2	64.9
Plutonium-239/240	0.00634	0.00616	0.00625
Americium-241	<0.00357	<0.00477	<0.00417
Strontium-90	1.24	1.24	1.24

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

This chapter discusses the overall quality and consistency of the push mode sampling results for tank 241-T-102. Because no report exists for the grab sample analysis, the following sections deal only with the push mode core sampling event

This section also evaluates sampling and analysis factors that may impact interpretation of the data. These factors are used to assess the data's overall quality and consistency and to identify any limitations in its use.

B3.1 FIELD OBSERVATIONS

Using the push mode method, core 55 was taken through Riser 2 and core 56 was taken through Riser 8. The locations of the risers are shown in Figure A2-1.

The sampling casks containing the core samples were sent to the PNL 325-A Laboratory for extrusion and analysis on April 1, 1993. One sample cask was found to be empty. The cask containing core 55 had been accidentally sent to SX Tank Farm, but was later retrieved by the 325-A Building Laboratory on May 4, 1993. The chain of custody was broken due to the mis-placing of the sample.

Although this irregularity probably does not have substantial implications for the analytical results (some analytical results could be unsuitable for certain purposes) and interpretation, they do warrant concern with regard to conduct of operations and safety. However, the chain of custody for the sample was re-established, the double-containment strategy employed in the handling of the samples was successful in preventing any excessive radiological exposure to personnel, and no material escaped confinement.

B3.1.1 Evaluation of Spikes and Blanks

Spikes and blanks are regularly run in the laboratory to determine whether or not the analysis procedures are producing unbiased measurements. If the results for the blanks are too high, or if the spike recoveries deviate substantially from 100 percent ($\pm$25 percent), then the associated measurements are either re-run or flagged in the database.

In this section, an overview of the blank and spike measurements is presented. These measurements provide a good indication of laboratory performance. There was no attempt to correct any of the data for high blanks or low spike recovery.

B3.1.1.1 Blank Measurements. Method blanks were run for each duplicate pair of samples for the ICP analytical method. In all but three cases, the amount of the analyte measured in the blank was less than the method detection limit. The three cases were from the ICP analysis on the acid-digested core 55 composite sample. The three constituents and their associated blank-to measurement ratios were boron (126 percent), calcium (49 percent), and sodium (2 percent). Boron and calcium had low concentrations; and therefore, their associated blank measurements do not warrant concern about contamination. Sodium did have a high concentration, but its blank measurement was only 2 percent. Because the analytical RSD was 10 percent, any contribution to the uncertainty from the blank is likely overwhelmed by the analytical variability; and therefore, does not warrant action.

B3.1.1.2 Spike Measurements. Spike recovery percentages are generally between 75 and 125 percent. Even though most of the recoveries are within the desired 80 to 120 percent, one should consider whether this information should be used to correct for biases. For several important measurement methods (for example, ICP), the results are consistently above or below 100 percent recovery. This consistency in the recoveries indicates that a bias may exist in these measurements. The variability in the recovery percentages is surprisingly small for several analysis methods.

B3.1.2 Data Validation Summary

Validation of the tank 241-T-102 data package was performed by Hanford Analytical Services to the requirements provided in Sections 2.0, 2.2, and 2.4 of *Sample Management and Administration* (WHC-CM-5-3). The data validation was performed at level "C" as defined in Section 2.0 of WHC-CM-5-3. The overriding quality assurance document was Bell (1993) (Pool 1993).

The primary objective of the data validation effort was to ensure the usability and defensibility of data produced for the single-shell tank characterization project. This was accomplished through a detailed examination of the data package to recreate the analytical process and verify that proper and acceptable analytical techniques had been applied. Additionally, the data package was checked for correct submission of required deliverables, correct data transcriptions from the raw data to the data summary forms, and proper calculation of a number of parameters.

Pool (1993) contains the results of the data validation including summary tables which show the data qualifiers and sub-qualifiers assigned to all analytical results. Validation of the chemical analyses data package was performed to the requirements provided in Section 2.0 of WHC-CM-5-3. The qualification categories for nonradiochemical analyses are as follows:

1 Chain of Custody
2 Holding Time
3 Instrument Calibration
4 Initial and Continuing Calibration Verification
5 Analytical Blanks
6 Preparation Blanks
7 Interference Check Sample
8 Laboratory Control Sample
9 Duplicate Analysis
10 Matrix Spike or Post-Digestion Spike
11 Retention Time
12 Contract Required Detection Limit Standard
13 Serial Dilution

Validation of the alpha plutonium and isotopic uranium and plutonium analyses of the data package was performed to the requirements provided in Section 2.4 of WHC-CM-5-3, Rev. 0. The unique qualification categories for radiochemical data validation are as follows:

1 Chain of Custody
2 Instrument Calibration
3 Efficiency Checks
4 Background Checks
5 Preparation Blanks
6 Laboratory Control Sample

7 Duplicate Analysis
8 Matrix Spike/Tracers/Surrogates

If a quality assurance criterion was not met for a particular category for a sample result, the data was qualified nondetected, estimated, or rejected (unusable). For the purposes of this tank characterization report, all data were used and no Hanford Analytical Services-flagged data were deleted. The following summary of the data validation findings was taken from Pool (1993).

B3.2 DATA CONSISTENCY CHECKS

Comparisons of different analytical methods can help to assess the consistency and quality of the data. Several comparisons were possible with the data set provided by the core sample. A comparison of phosphorous as analyzed by ICP with phosphate as analyzed by IC, and a comparison of the total alpha and total beta activities with the sums of their individual emitters. In addition, mass and charge balances were calculated to help assess the overall data consistency.

B3.2.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two different analytical methods. A close agreement between the two methods strengthens the credibility of both results, whereas poor agreement brings the reliability of the data into question. All analytical mean results were taken from tables in Section B2.0.

The analytical water digested phosphorous mean result as determined by ICP was 415.5 μg/g, which converts to 1,271 μg/g of phosphate. This compared well with the IC phosphate mean result of 1,130 μg/g. The ratio between these results is 1.12 demonstrating data consistency.

Another internal data check is the comparison of the gross alpha and beta measurements with the respective activities of the individual emitters. The gross alpha result from the fusion digestion was 0.2285 μCi/g. This value compared with the sum of the individual alpha emitters (^{241}Am, $^{243/244}$Cm, ^{237}Np, ^{238}Pu, and $^{239/240}$Pu), 0.3776 μCi/g. The ratio of these two results is 1.66 which probably reflects some self shielding in the gross alpha result.

The gross beta result from the fusion digestion was 488.5 μCi/g. This result was compared to the analytical results for the primary beta emitters, ^{137}Cs and ^{90}Sr. Because ^{90}Sr is in equilibrium with its daughter product ^{90}Y, the ^{90}Sr activity must be multiplied by 2 to account for all beta emitters. The sum of the beta emitters was 507.85 μCi/g, comparing well with the gross beta result as evidenced by the ratio of 1.04 for the two numbers.

A final internal data check is the comparison of the ^{241}Am results by alpha proportional counting and GEA. The ^{241}Am means from these two methods were 0.2565 μCi/g from alpha proportional counting and 0.2395 μCi/g from GEA. The numbers agreed quite well, with a ratio of 1.07.

B3.2.2 Mass and Charge Balance

The principal objective in performing mass and charge balances is to determine if the measurements are self-consistent. In calculating the balances, only analytes listed in Section B3.4 detected at a concentration of 1,000 μg/g or greater were considered.

Except sodium, all cations listed in Table B3-1 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Because precipitates are neutral species, all positive charge was attributed to the sodium cation. The anions listed in Table B3-2 were assumed to be present as sodium salts and were expected to balance the positive charge exhibited by the cations. Phosphate, as determined by IC, is assumed to be completely water soluble and appears only in the anion mass and charge calculations. The concentrations of cationic species in Table B3-1, the anionic species in Table B3-2, and the percent water were ultimately used to calculate the mass balance.

The mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from μg/g to weight percent.

$$\text{Mass balance} = \%\ \text{Water} + 0.0001 \times \{\text{Total Analyte Concentration}\}$$

$$= \%\ \text{Water} + 0.0001 \times \{Al(OH)_3 + FeO(OH) + Pb(OH)_2 + Nd_2O_3 + Na^+ + SiO_3^{-2} + NO_3^- + NO_2^- + PO_4^{-3} + SO_4^{-2} + CO_3^{-2} + C_2H_3O_3^-\}$$

The total analyte concentrations calculated from the above equation is 998,500 μg/g. The mean weight percent water is 1.5 percent, or 15,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 101 percent (Table B3-3).

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of these two values.

$$\underline{\text{Total cations}}\ (\mu eq/g) = [Na^+]/23.0 = 1{,}365\ \mu eq/g$$

$$\underline{\text{Total anions}}\ (\mu eq/g) = [NO_3^-]/62 + [NO_2^-]/46 + 3[PO_4^{-3}]/95 + 2[SO_4^{-2}]/96 + 2[CO_3^{-2}]/60 + [C_2H_3O_3^-]/75 = 1{,}448\ \mu eq/g$$

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.94.

In summary, the above calculations yield reasonable mass and charge balance values (close to 1.00 for charge balance and 100 percent for mass balance), indicating that the analytical results are generally self-consistent.

Table B3-1. Cation Mass and Charge Data.

Analyte	Concentration ($\mu g/g$)	Assumed Species	Concentration of Assumed Species ($\mu g/g$)	Charge ($\mu eq/g$)
Aluminum	2.99E+05	$Al(OH)_3$	8.64E+05	
Lead	1.92E+03	$Pb(OH)_2$	2.23E+03	
Iron	1.81E+04	FeO(OH)	2.88E+04	
Neodymium	1.62E+03	Nd_2O_3	3.78E+03	
Sodium	3.14E+04	Na^+	3.14E+04	1365
Total			930,000	1365

Table B3-2. Anion Mass and Charge Data.

Analyte	Concentration ($\mu g/g$)	Assumed Species	Concentration of Assumed Species ($\mu g/g$)	Charge ($\mu eq/g$)
Nitrate	3.50E+04	NO_3^-	3.50E+04	565
Nitrite	8.00E+03	NO_2^-	8.00E+03	174
Phosphate	1.13E+03	PO_4^{-3}	1.13E+03	35
Silicon	3.24E+03	SiO_2	6.94E+03	
Sulphate	1.57E+03	SO_4^{-2}	1.57E+03	32
TIC	3.46E+03	CO_3^{-2}	1.73E+04	577
TOC	6.55E+02	$C_2H_3O_3^-$	4.94E+03	65
Total			66700	1448

Table B3-3. Mass Balance Totals.

Totals	Concentrations ($\mu g/g$)
Total from Table B3-1	930,000
Total from Table B3-2	66,700
Percent water	15,000
Grand total	1,011,700

B3.3 Mean Concentrations and Confidence Intervals

The following evaluation was performed on the analytical data from the samples from tank 241-T-102.

Because an inventory estimate is needed without comparing it to a threshold value, two-sided 95 percent confidence intervals on the mean inventory are computed. This was done with core composite data and liquid grab sample data.

The lower and upper limits (LL and UL) to a two-sided 95 percent confidence interval for the mean are

$$\hat{\mu} \pm t_{(df,0.025)} \times \hat{\sigma}_{\hat{\mu}}.$$

In these equations, $\hat{\mu}$ is the estimate of the mean concentration, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean concentration, and $t_{(df,0.025)}$ is the quantile from Student's t distribution with df degrees of freedom for a two-sided 95 percent confidence interval.

The degrees of freedom (df), for tank 241-T-102, is the number of observations minus one.

B3.3.1 Core Composite and Liquid Grab Sample Means

The statistics in this section were based on analytical data from the most recent sampling event of tank 241-T-102. If at least 50 percent of the reported values were above the detection limit, all of the data was used in the computations. The detection limit was used as the value for nondetected results.

No ANOVA estimates were computed for any of the analytes. Only arithmetic means were computed for the analytes with less than 50 percent detected values. Arithmetic means, as well as the standard deviation of the arithmetic mean and confidence intervals of the arithmetic mean, were computed for the analytes with at least 50 percent detected values.

The results given below are confidence intervals based on the core composite data from core 55 for tank 241-T-102. Estimates of the mean concentration, and confidence interval on the mean concentration, are given in Tables B3-4 for core composite data and Table B3-5 for liquid grab sample data. The LL to a 95 percent confidence interval can be negative. Because an actual concentration of less than zero is not possible, the lower limit is reported as zero, whenever this occurred.

The following are words of caution. Only one core was analyzed for tank 241-T-102. Multiple core samples are needed in order to estimate spatial variability. Typically, the spatial variability is the greatest source of variability in the data. Also, when an analyte is measured from one sample, only the variability between the sample and the duplicate can be estimated; whereas, when an analyte is measured from two samples, the variability between the primary and the duplicate as well as the variability between core samples could be estimated.

The width of the confidence interval and standard deviation of the mean, reported in Table B3-4 and B3-5, do not include the spatial variability. They only include the variability between the primary and duplicate observations. The confidence intervals are estimates of the variability of the analyte mean concentration within the core composite sample. They are not estimates of the variability of the mean concentration within the waste in the tank.

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.Al	µg/g	1.55E+05	1.01E+04	1	2.73E+04	2.83E+05
ICP.f.Al	µg/g	2.99E+05	1.20E+04	1	1.46E+05	4.52E+05
ICP.w.Al	µg/g	8.69E+02	8.10E+01	1	0.00E+00	1.90E+03
Ammonia[1,3]	µg/g	<2.70E+01	n/a	n/a	n/a	n/a
ICP.a.Sb	µg/g	4.50E+01	5.00E+00	1	0.00E+00	1.09E+02
ICP.f.Sb[1]	µg/g	<5.56E+02	n/a	n/a	n/a	n/a
ICP.w.Sb[1]	µg/g	<1.01E+02	n/a	n/a	n/a	n/a
ICP.a.Ba	µg/g	1.20E+01	1.26E-15	1	1.20E+01	1.20E+01
ICP.f.Ba[1]	µg/g	<1.11E+02	n/a	n/a	n/a	n/a
ICP.w.Ba[1]	µg/g	<2.02E+01	n/a	n/a	n/a	n/a
ICP.a.Be[1]	µg/g	<2.00E+01	n/a	n/a	n/a	n/a
ICP.f.Be[1]	µg/g	<5.56E+01	n/a	n/a	n/a	n/a
ICP.w.Be[1]	µg/g	<1.01E+01	n/a	n/a	n/a	n/a
ICP.a.Bi[1]	µg/g	<2.00E+03	n/a	n/a	n/a	n/a
ICP.f.Bi[1]	µg/g	<5.56E+03	n/a	n/a	n/a	n/a
ICP.w.Bi[1]	µg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.a.B	µg/g	1.77E+02	2.40E+01	1	0.00E+00	4.82E+02
ICP.f.B	µg/g	3.56E+02	5.00E+01	1	0.00E+00	9.91E+02
ICP.w.B[1]	µg/g	<4.04E+01	n/a	n/a	n/a	n/a
ICP.a.Cd	µg/g	1.10E+01	1.26E-15	1	1.10E+01	1.10E+01
ICP.f.Cd	µg/g	2.49E+02	9.50E+00	1	1.28E+02	3.69E+02
ICP.w.Cd[1]	µg/g	<1.01E+01	n/a	n/a	n/a	n/a
ICP.a.Ca	µg/g	5.91E+02	3.45E+01	1	1.52E+02	1.03E+03
ICP.f.Ca	µg/g	7.39E+02	4.20E+01	1	2.05E+02	1.27E+03
ICP.w.Ca	µg/g	1.35E+01	5.00E-01	1	7.15E+00	1.99E+01
ICP.a.Ce[1]	µg/g	<4.00E+02	n/a	n/a	n/a	n/a
ICP.f.Ce[1]	µg/g	<1.11E+03	n/a	n/a	n/a	n/a
ICP.w.Ce[1]	µg/g	<2.02E+02	n/a	n/a	n/a	n/a
Chloride	µg/g	3.00E+02	0.00E+00	1	3.00E+02	3.00E+02
ICP.a.Cr	µg/g	7.43E+02	5.50E+00	1	6.73E+02	8.12E+02

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.f.Cr	µg/g	7.87E+02	1.95E+01	1	5.39E+02	1.03E+03
ICP.w.Cr	µg/g	7.72E+02	4.50E+00	1	7.14E+02	8.29E+02
ICP.a.Co[2]	µg/g	2.19E+01	1.79E+01	1	0.00E+00	2.50E+02
ICP.f.Co[1]	µg/g	<1.11E+02	n/a	n/a	n/a	n/a
ICP.w.Co[1]	µg/g	<2.02E+01	n/a	n/a	n/a	n/a
ICP.a.Cu	µg/g	1.40E+01	1.26E-15	1	1.40E+01	1.40E+01
ICP.f.Cu	µg/g	5.75E+01	2.50E+00	1	2.57E+01	8.93E+01
ICP.w.Cu[1]	µg/g	<1.01E+01	n/a	n/a	n/a	n/a
Cyanide	µg/g	4.15E+00	2.50E-01	1	9.73E-01	7.33E+00
ICP.a.Dy[1]	µg/g	<2.00E+02	n/a	n/a	n/a	n/a
ICP.f.Dy[1]	µg/g	<5.56E+02	n/a	n/a	n/a	n/a
ICP.w.Dy[1]	µg/g	<1.01E+02	n/a	n/a	n/a	n/a
ICP.a.Eu[1]	µg/g	<7.99E+02	n/a	n/a	n/a	n/a
ICP.f.Eu[1]	µg/g	<2.22E+03	n/a	n/a	n/a	n/a
ICP.w.Eu[1]	µg/g	<4.04E+02	n/a	n/a	n/a	n/a
Fluoride	µg/g	2.20E+02	0.00E+00	1	2.20E+02	2.20E+02
ICP.a.Gd[1]	µg/g	<2.00E+03	n/a	n/a	n/a	n/a
ICP.f.Gd[1]	µg/g	<5.56E+03	n/a	n/a	n/a	n/a
ICP.w.Gd[1]	µg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.a.Fe	µg/g	1.97E+04	4.75E+02	1	1.37E+04	2.58E+04
ICP.f.Fe	µg/g	1.81E+04	1.76E+03	1	0.00E+00	4.04E+04
ICP.w.Fe	µg/g	1.11E+02	1.95E+01	1	0.00E+00	3.58E+02
ICP.a.La[1]	µg/g	<2.00E+02	n/a	n/a	n/a	n/a
ICP.f.La[1]	µg/g	<5.56E+02	n/a	n/a	n/a	n/a
ICP.w.La[1]	µg/g	<1.01E+02	n/a	n/a	n/a	n/a
ICP.a.Pb	µg/g	3.98E+02	2.35E+01	1	9.89E+01	6.96E+02
ICP.f.Pb	µg/g	1.92E+03	8.60E+01	1	8.29E+02	3.01E+03
ICP.w.Pb[1]	µg/g	<1.21E+02	n/a	n/a	n/a	n/a
ICP.a.Li[1]	µg/g	<1.20E+02	n/a	n/a	n/a	n/a
ICP.f.Li[1]	µg/g	<3.34E+02	n/a	n/a	n/a	n/a

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.w.Li[1]	μg/g	<6.07E+01	n/a	n/a	n/a	n/a
ICP.a.Mg	μg/g	1.07E+02	1.00E-14	1	1.07E+02	1.07E+02
ICP.f.Mg[1]	μg/g	<1.11E+03	n/a	n/a	n/a	n/a
ICP.w.Mg[1]	μg/g	<2.02E+02	n/a	n/a	n/a	n/a
ICP.a.Mn	μg/g	7.81E+02	2.60E+01	1	4.51E+02	1.11E+03
ICP.f.Mn	μg/g	9.57E+02	5.35E+01	1	2.77E+02	1.64E+03
ICP.w.Mn	μg/g	8.00E+00	2.00E+00	1	0.00E+00	3.34E+01
Hg(CVAA)	μg/g	6.25E+00	1.45E+00	1	0.00E+00	2.47E+01
ICP.a.Mo[1]	μg/g	<1.20E+02	n/a	n/a	n/a	n/a
ICP.f.Mo[1]	μg/g	<3.34E+02	n/a	n/a	n/a	n/a
ICP.w.Mo	μg/g	7.00E+00	6.28E-16	1	7.00E+00	7.00E+00
ICP.a.Nd	μg/g	2.73E+02	1.00E+01	1	1.46E+02	4.00E+02
ICP.f.Nd	μg/g	1.62E+03	3.19E+02	1	0.00E+00	5.67E+03
ICP.w.Nd[1]	μg/g	<1.01E+02	n/a	n/a	n/a	n/a
ICP.a.Ni	μg/g	6.80E+01	2.00E+00	1	4.26E+01	9.34E+01
ICP.w.Ni[1]	μg/g	<6.07E+01	n/a	n/a	n/a	n/a
Nitrate	μg/g	3.50E+04	1.00E+03	1	2.23E+04	4.77E+04
Nitrite	μg/g	8.00E+03	0.00E+00	1	8.00E+03	8.00E+03
ICP.a.Pd[1]	μg/g	<1.20E+03	n/a	n/a	n/a	n/a
ICP.f.Pd[1]	μg/g	<3.34E+03	n/a	n/a	n/a	n/a
ICP.w.Pd[1]	μg/g	<6.07E+02	n/a	n/a	n/a	n/a
Phosphate	μg/g	1.13E+03	2.00E+01	1	8.76E+02	1.38E+03
ICP.a.P	μg/g	5.69E+02	1.70E+01	1	3.53E+02	7.85E+02
ICP.f.P	μg/g	1.53E+03	8.75E+01	1	4.22E+02	2.65E+03
ICP.w.P	μg/g	4.16E+02	7.50E+00	1	3.20E+02	5.11E+02
ICP.a.K[1]	μg/g	<4.00E+03	n/a	n/a	n/a	n/a
ICP.w.K[1]	μg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.a.Rh[1]	μg/g	<1.20E+03	n/a	n/a	n/a	n/a
ICP.f.Rh[1]	μg/g	<3.34E+03	n/a	n/a	n/a	n/a
ICP.w.Rh[1]	μg/g	<6.07E+02	n/a	n/a	n/a	n/a

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.Ru[1]	μg/g	<7.99E+02	n/a	n/a	n/a	n/a
ICP.f.Ru[1]	μg/g	<2.22E+03	n/a	n/a	n/a	n/a
ICP.w.Ru[1]	μg/g	<4.04E+02	n/a	n/a	n/a	n/a
ICP.a.Se	μg/g	6.85E+01	5.50E+00	1	0.00E+00	1.38E+02
ICP.f.Se[1]	μg/g	<1.11E+03	n/a	n/a	n/a	n/a
ICP.w.Se[1]	μg/g	<2.02E+02	n/a	n/a	n/a	n/a
ICP.a.Si	μg/g	8.37E+02	1.65E+01	1	6.27E+02	1.05E+03
ICP.f.Si	μg/g	3.24E+03	2.95E+02	1	0.00E+00	6.98E+03
ICP.w.Si	μg/g	4.60E+01	1.00E+00	1	3.33E+01	5.87E+01
ICP.a.Ag	μg/g	1.65E+01	1.50E+00	1	0.00E+00	3.56E+01
ICP.f.Ag[1]	μg/g	<1.11E+02	n/a	n/a	n/a	n/a
ICP.w.Ag[1]	μg/g	<2.02E+01	n/a	n/a	n/a	n/a
ICP.a.Na	μg/g	2.75E+04	2.62E+02	1	2.42E+04	3.08E+04
ICP.f.Na	μg/g	3.14E+04	2.82E+03	1	0.00E+00	6.72E+04
ICP.w.Na	μg/g	2.88E+04	7.24E+02	1	1.96E+04	3.80E+04
ICP.a.Sr	μg/g	1.75E+01	5.00E-01	1	1.11E+01	2.39E+01
ICP.f.Sr[1]	μg/g	<5.56E+01	n/a	n/a	n/a	n/a
ICP.w.Sr[1]	μg/g	<1.01E+01	n/a	n/a	n/a	n/a
Sulfate	μg/g	1.57E+03	5.00E+01	1	9.35E+02	2.21E+03
ICP.a.Te[1]	μg/g	<2.00E+03	n/a	n/a	n/a	n/a
ICP.f.Te[1]	μg/g	<5.56E+03	n/a	n/a	n/a	n/a
ICP.w.Te[1]	μg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.a.Tl[1]	μg/g	<2.00E+03	n/a	n/a	n/a	n/a
ICP.f.Tl[1]	μg/g	<5.56E+03	n/a	n/a	n/a	n/a
ICP.w.Tl[1]	μg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.a.Th[1]	μg/g	<3.20E+03	n/a	n/a	n/a	n/a
ICP.f.Th[1]	μg/g	<8.90E+03	n/a	n/a	n/a	n/a
ICP.w.Th[1]	μg/g	<1.62E+03	n/a	n/a	n/a	n/a
ICP.a.Sn[1]	μg/g	<4.00E+03	n/a	n/a	n/a	n/a
ICP.f.Sn[1]	μg/g	<1.11E+04	n/a	n/a	n/a	n/a

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.w.Sn[1]	µg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.a.Ti	µg/g	1.00E+01	1.00E+00	1	0.00E+00	2.27E+01
ICP.f.Ti	µg/g	6.00E+01	1.00E+00	1	4.73E+01	7.27E+01
ICP.w.Ti[1]	µg/g	<1.01E+01	n/a	n/a	n/a	n/a
TC.Persulfate	µg/g	3.08E+03	2.75E+02	1	0.00E+00	6.57E+03
TC.w	µg/g	4.07E+03	8.50E+01	1	2.98E+03	5.15E+03
TIC.Persulfate	µg/g	2.47E+03	1.90E+02	1	5.58E+01	4.88E+03
TIC.w	µg/g	3.46E+03	4.50E+01	1	2.88E+03	4.03E+03
TOC.Persulfate	µg/g	6.00E+02	8.00E+01	1	0.00E+00	1.62E+03
TOC.w	µg/g	6.55E+02	5.00E+00	1	5.91E+02	7.19E+02
ICP.a.W[1]	µg/g	<7.99E+02	n/a	n/a	n/a	n/a
ICP.f.W[1]	µg/g	<2.22E+03	n/a	n/a	n/a	n/a
ICP.w.W[1]	µg/g	<4.04E+02	n/a	n/a	n/a	n/a
ICP.a.U[1]	µg/g	<7.99E+03	n/a	n/a	n/a	n/a
ICP.f.U[1]	µg/g	<2.22E+04	n/a	n/a	n/a	n/a
ICP.w.U[1]	µg/g	<4.04E+03	n/a	n/a	n/a	n/a
Uranium	µg/g	7.07E+02	2.70E+01	1	3.64E+02	1.05E+03
ICP.a.V[1]	µg/g	<4.00E+01	n/a	n/a	n/a	n/a
ICP.f.V[1]	µg/g	<1.11E+02	n/a	n/a	n/a	n/a
ICP.w.V[1]	µg/g	<2.02E+01	n/a	n/a	n/a	n/a
ICP.a.Y	µg/g	6.00E+00	6.28E-16	1	6.00E+00	6.00E+00
ICP.f.Y[1]	µg/g	<1.11E+02	n/a	n/a	n/a	n/a
ICP.w.Y[1]	µg/g	<2.02E+01	n/a	n/a	n/a	n/a
ICP.a.Zn	µg/g	1.11E+02	1.25E+01	1	0.00E+00	2.69E+02
ICP.f.Zn	µg/g	8.02E+02	1.24E+02	1	0.00E+00	2.38E+03
ICP.w.Zn[1]	µg/g	<4.04E+01	n/a	n/a	n/a	n/a
ICP.a.Zr	µg/g	4.30E+01	1.00E+00	1	3.03E+01	5.57E+01
ICP.f.Zr[1]	µg/g	<1.11E+02	n/a	n/a	n/a	n/a
ICP.w.Zr[1]	µg/g	<2.02E+01	n/a	n/a	n/a	n/a
Am-241.f.Alpha	µCi/g	2.57E-01	1.25E-02	1	9.77E-02	4.15E-01

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Am-241.f.GEA	µCi/g	2.40E-01	6.50E-03	1	1.57E-01	3.22E-01
Am-241.w.GEA	µCi/g	1.05E-02	3.92E-03	1	0.00E+00	6.02E-02
C-14	µCi/g	4.65E-02	2.50E-03	1	1.47E-02	7.83E-02
Ce-144.f.GEA[1]	µCi/g	<1.30E-01	n/a	n/a	n/a	n/a
Ce-144.w.GEA[1]	µCi/g	<4.15E-02	n/a	n/a	n/a	n/a
Cs-134.f.GEA[1]	µCi/g	<1.25E-02	n/a	n/a	n/a	n/a
Cs-134.w.GEA[1]	µCi/g	<4.40E-03	n/a	n/a	n/a	n/a
Cs-137.f.GEA	µCi/g	3.19E+01	8.50E-01	1	2.10E+01	4.27E+01
Cs-137.w.GEA	µCi/g	2.65E+01	1.50E-01	1	2.45E+01	2.84E+01
Co-60.f.GEA	µCi/g	2.78E-02	1.00E-03	1	1.51E-02	4.05E-02
Co-60.w.GEA[2]	µCi/g	6.56E-04	1.96E-04	1	0.00E+00	3.15E-03
Cm-243/244.f.Alpha	µCi/g	1.25E-03	1.50E-04	1	0.00E+00	3.16E-03
Eu-152.f.GEA[1]	µCi/g	<8.50E-03	n/a	n/a	n/a	n/a
Eu-152.w.GEA[1]	µCi/g	<8.20E-04	n/a	n/a	n/a	n/a
Eu-154.f.GEA	µCi/g	4.90E-01	7.50E-03	1	3.94E-01	5.85E-01
Eu-154.w.GEA	µCi/g	1.53E-02	3.30E-03	1	0.00E+00	5.72E-02
Eu-155.f.GEA	µCi/g	5.43E-01	1.45E-02	1	3.58E-01	7.27E-01
Eu-155.w.GEA	µCi/g	1.60E-02	2.15E-03	1	0.00E+00	4.33E-02
Gross.Alpha.f	µCi/g	2.29E-01	1.50E-03	1	2.09E-01	2.48E-01
Total.Alpha.f	µCi/g	6.12E-03	3.90E-04	1	7.96E-04	1.22E-01
Total.Alpha.w	µCi/g	6.21E-03	3.90E-04	1	1.25E-03	1.12E-02
Beta.f	µCi/g	4.89E+02	1.50E+00	1	4.69E+02	5.08E+02
Beta.w	µCi/g	3.74E+01	2.10E+00	1	1.07E+01	6.41E+01
Np-237.f.alpha	µCi/g	5.38E-04	9.80E-05	1	0.00E+00	1.78E-03
Pu-238.f.alpha	µCi/g	5.84E-03	4.60E-04	1	0.00E+00	1.17E-02
Pu-239/40.f.alpha	µCi/g	5.53E-02	4.30E-03	1	6.63E-04	1.10E-01
K-40.f.GEA[1]	µCi/g	<1.55E-02	n/a	n/a	n/a	n/a
K-40.w.GEA[1]	µCi/g	<2.05E-03	n/a	n/a	n/a	n/a
Ru-103.f.GEA[1]	µCi/g	<8.80E-01	n/a	n/a	n/a	n/a
Ru-103.w.GEA[1]	µCi/g	<3.75E-01	n/a	n/a	n/a	n/a

Table B3-4. 95 percent Two-Sided Confidence Interval for the Mean Concentration for Core Composite Sample Data. (7 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Ru-106.f.GEA[1]	μCi/g	<1.55E-01	n/a	n/a	n/a	n/a
Ru-106.w.GEA[1]	μCi/g	<5.50E-02	n/a	n/a	n/a	n/a
Sr-90.f.beta	μCi/g	2.38E+02	1.80E+01	1	9.29E+00	4.67E+02
Tc-99.f.beta	μCi/g	1.79E-02	9.00E-04	1	6.46E-03	2.93E-02
Th-228.f.GEA[1]	μCi/g	<3.10E-02	n/a	n/a	n/a	n/a
Th-228.w.GEA[1]	μCi/g	<1.10E-02	n/a	n/a	n/a	n/a
Tritium	μCi/g	7.10E-03	8.45E-04	1	0.00E+00	1.78E-02
Density[3]	g/mL	1.79E+00	n/a	n/a	n/a	n/a
Uranium-234	%	5.50E-03	5.00E-04	1	0.00E+00	1.19E-02
Uranium-235	%	6.98E-01	8.50E-03	1	5.89E-01	8.06E-01
Uranium-236	%	1.30E-02	0.00E+00	1	1.30E-02	1.30E-02
Uranium-238	%	9.93E+01	8.00E-03	1	9.92E+01	9.94E+01
TGA (190-370 °C)	%	2.44E+01	8.50E-01	1	1.35E+01	3.52E+01
TGA (30-190 °C)	%	1.5E+00	5.00E-01	1	0.00E+00	7.85E+00
TGA (370-545 °C)	%	7.3E+00	1.00E-01	1	6.03E+00	8.57E+00
Wt.%.solids[4]	%	7.19E+01	1.08E+00	3	6.85E+01	7.54E+01
pH	pH	9.80E+00	0.00E+00	1	9.80E+00	9.80E+00

Notes:

n/a = not applicable

[1]More than 50% of the analytical results were less than values; therefore, confidence intervals were not computed.

[2]Some "less-than" values are in the analytical results.

[3]Analyte was measured from only one observation.

[4]Unlike the other analytes, four measurements were analyzed for weight percent solids.

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Grab Sample Data.

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
SpG	-----	1.14E+00	5.50E-03	1	1.07E+00	1.21E+00
wt% solids	%	1.84E+01	1.00E-01	1	1.71E+01	1.97E+01
DSC	J/g	n/a	n/a	n/a	n/a	n/a
wt% water	wt%	7.98E+01	4.75E-01	1	7.37E+01	8.58E+01
pH	pH	1.12E+01	5.00E-03	1	1.11E+01	1.12E+01
TOC[2]	g C/mL	4.49E+02	1.50E+00	1	4.29E+02	4.68E+02
TIC	g C/mL	5.94E+03	1.00E+01	1	5.81E+03	6.07E+03
OH^- [1]	μg/mL	<6.25E+01	n/a	n/a	n/a	n/a
Cr	μg/mL	1.76E+03	5.00E+00	1	1.69E+03	1.82E+03
P	μg/mL	1.01E+03	1.45E+01	1	8.21E+02	1.19E+03
S	μg/mL	1.19E+03	0.00E+00	1	1.19E+03	1.19E+03
Na	μg/mL	6.45E+04	3.00E+02	1	6.07E+04	6.83E+04
Mo	μg/mL	1.51E+01	2.00E-01	1	1.26E+01	1.76E+01
K	μg/mL	3.18E+02	8.50E+00	1	2.09E+02	4.26E+02
F^-	μg/mL	2.78E+02	7.00E+00	1	1.89E+02	3.67E+02
Cl^-	μg/mL	6.44E+02	6.50E+00	1	5.61E+02	7.26E+02
NO_2^-	μg/mL	2.30E+04	0.00E+00	1	2.30E+04	2.30E+04
NO_3^-	μg/mL	1.09E+05	5.00E+02	1	1.02E+05	1.15E+05
PO_4^{-3}	μg/mL	4.10E+03	1.00E+01	1	3.97E+03	4.23E+03
SO_4^{-2}	μg/mL	4.89E+03	3.00E+01	1	4.51E+03	5.27E+03
$^{239/240}Pu$	μCi/mL	6.25E-03	9.00E-05	1	5.11E-03	7.39E-03
^{241}Am[1]	μCi/mL	<4.17E-03	n/a	n/a	n/a	n/a
^{90}Sr	μCi/mL	1.24E+00	0.00E+00	1	1.24E+00	1.24E+00
^{60}Co[1]	μCi/mL	<1.78E+01	n/a	n/a	n/a	n/a
^{137}Cs	μCi/mL	6.49E+01	8.35E+00	1	0.00E+00	1.71E+02

Notes:

n/a = not applicable

[1]More than 50 percent of the analytical results were less than values; therefore, confidence intervals were not computed.

[2]Wet Basis

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

C1.0 STATISTICS FOR SAFETY SCREENING DATA QUALITY OBJECTIVE

The safety screening DQO (Dukelow et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. In this appendix, one-sided confidence limits supporting the safety screening DQO are calculated for tank 241-T-102. All data in this section are from Pool (1993) and WHC (1994).

Confidence intervals were computed for each sample number from tank 241-T-102 composite sample data and liquid grab sample data. The sample numbers and confidence intervals are provided in Table C1-1 for Alpha using core composite data and Table C1-2 for $^{239/240}Pu$ using liquid grab sample data. No DSC exotherms were reported from tank 241-T-102.

The UL of a one-sided 95 percent confidence interval on the mean is

$$\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}.$$

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with df degrees of freedom for a one-sided 95 percent confidence interval.

For the tank 241-T-102 data (per sample number), df equals the number of observations minus one.

The upper limit of the 95 percent confidence interval for the sample number based on alpha data is listed in Table C1-1. The confidence interval can be used to make the following statement. If the upper limit is less than 41 μCi/g, then one would reject the null hypothesis that the alpha is greater than or equal to 41 μCi/g at the 0.05 level of significance.

Because alpha was not measured in the liquid grab sample, the measurements for $^{239/240}Pu$ are used for the safety screening DQO for the liquid grab sample. If assumed that the $^{239/240}Pu$ measured in the grab sample is all ^{239}Pu, we can compare the UL of the confidence interval to the threshold value of 61.5 μCi/mL. The UL of the 95 percent confidence interval for the sample number based on $^{239/240}Pu$ data is listed in Table C1-2. The confidence interval can be used to make the following statement. If the upper limit is less than 61.5 μCi/mL, then one would reject the null hypothesis that the $^{239/240}Pu$ is greater than or equal to 61.5 μCi/mL at the 0.05 level of significance and conclude that there is no issue with respect to criticality.

Table C1-1. 95 Percent Confidence Interval Upper Limits for Alpha for Tank 241-T-102. (Units are μCi/g).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
93-08755-H1	Core 55, Core Composite	2.29E-01	1.50E-03	2.38E-01

Table C1-2. 95 Percent Confidence Interval Upper Limits for Pu-239/240 for Tank 241-T-102. (Units are μCi/mL).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
R 6088	Core 55, Liquid Grab Sample	6.25E-03	9.00E-05	6.82E-03

C2.0 APPENDIX C REFERENCES

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR TANK 241-T-102

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APPENDIX D

BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-T-102

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 tank 241-T-102 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

This section describes the sampling campaign that was performed to establish the waste composition profile in tank 241-T-102 (Pool 1993). In 1993, two push mode core samples were obtained from risers 2 and 8 of tank 241-T-102, while three supernatant grab samples were taken from riser from 2 in July, 1994. Core 55, from riser 2, contained only a small amount of material (80.59 g), while core 56, from riser 8, consisted of so little material (8.42 g) that the core was placed into archive for later analysis. This section also discusses the HDW model estimates of the waste composition profile based on process records and transaction records for the tank.

D2.0 COMPARISONS OF COMPONENT INVENTORY VALUES

Based on the sample sludge level (12.7 cm), tank 241-T-102 apparently contains about 99.5 kL (26.3 kgal) of waste, including 47.3 kL (12.5 kgal) in the dished bottom of the tank. All of this waste evidently consists of sludge, with only a minimal amount of drainable liquid (13 volume percent). Based on these values, the waste consists of 86.6 kL (22.9 kgal) of sludge and 12.9 kL (3.4 kgal) of drainable liquid. This inventory is about 21.7 percent lower than the tank farm surveillance estimate of 121.1 kL (32 kgal), which consists of 71.9 kL (19 kgal) of sludge and 49.2 kL (13 kgal) of drainable liquid or supernatant (Hanlon 1997).

From a study of a photographic montage of the tank's interior, it appears that most of the drainable liquid or supernatant exist in the center of the tank, while the risers from which the samples were taken are located around the periphery of the tank. Therefore, the sludge level is nonuniform and probably concave in the middle following the dished bottom profile of the tank. Based on these observations, the actual sludge volume could vary from as little as 52.2 kL to the Hanlon value of 71.9 kL (19 kgal).

For the purpose of this analysis, the best-basis inventory will be developed from Hanlon 1997 estimates (71.9 kL of sludge and 49.2 kL of supernatant). Because TCR inventories are based only on the composition of the sludge, the best basis inventory estimates will be higher for certain components, such as Al, NO_3, NO_2 and Na, because of the added supernatant contribution for these components.

Table D2-1 provides a summary of the composite sludge and supernatant analytical values and tank inventory estimates developed from the sludge volume and sample density data (71.9 kL [19 kgal] and 1.79 kg/L, respectively), and supernatant volume and density data (49.2 kL (13 kgal) and 1.1 kg/L, respectively). The supernatant composition is based on a 1994 supernatant sample from this tank. Because saltwell pumping was the only activity that occurred after 1974, the 1994 supernatant sample should represent the general composition of the excess supernatant in this tank.

Table D2-1. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-T-102. (3 Sheets)

Component	Mean Sludge Concentration in 1993 Core[1] (µg/g)	Mean Supernatant Concentration in 1994[2] (µg/mL)	Total Tank Inventory[3] (kg)
Al	299,000	NR	38,500
Sb	<556	NR	<71.6
As	890	NR	115
Ba	<111	NR	<14.3
Be	<55.6	NR	<7.16
Bi	<5,560	NR	<716
B	356	NR	45.8
Cd	249	NR	32
Ca	739	NR	95.1
Ce	<1,110	NR	<143
Cl	300	644	70.3
Cr	787	1,760	188
Co	<111	NR	<14.3
CN	4.15	NR	0.53
Cu	57.5	NR	7.4
Dy	<556	NR	<71.6
Eu	<2,200	NR	<286
F	220	278	42

Table D2-1. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-T-102. (3 Sheets)

Component	Mean Sludge Concentration in 1993 Core[1] (µg/g)	Mean Supernatant Concentration in 1994[2] (µg/mL)	Total Tank Inventory[3] (kg)
Fe	18,100	NR	2,320
Gd	<5,560	NR	<716
La	<556	NR	<71.6
Pb	1,920	NR	247
Li	<334	NR	<42.9
Mg	<1,110	NR	<143
Mn	957	NR	123
Hg	6.25	NR	0.8
Mo	<334	15.1	<42.9
Nd	1,620	NR	209
Ni	68	NR	8.75
NO_3	35,000	109,000	9,873
NO_2	8,000	23,000	2,161
OH	NR	<62.5	<3.1
Pd	<3,340	NR	<429
P as PO_4	4,689	4,100	805.2
K	<4,000	318	<530
Rh	<3,340	NR	<429
Ru	<2,220	NR	<286
Se	<1,110	NR	<143
Si	3,240	NR	417
AG	<111	NR	<14.3
Na	31,400	64,500	7,215
Sr	<55.6	NR	<7.2
SO_4	1,570	4,890	443
Te	<5,560	NR	<716
Tl	<5,560	NR	<716
Th	<8,900	NR	<1,150
Sn	<11,100	NR	<1,430

Table D2-1. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-T-102. (3 Sheets)

Component	Mean Sludge Concentration in 1993 Core[1] ($\mu g/g$)	Mean Supernatant Concentration in 1994[2] ($\mu g/mL$)	Total Tank Inventory[3] (kg)
Ti	60	NR	7.7
TIC as CO_3	17,300	29,700	3,688
TOC	655	449	106.4
W	<2,220	NR	<286
U	<22,200	NR	<2,860
V	<110	NR	<14.3
Zn	802	NR	103
Zr	<111	NR	<14.3
Density	1.79 g/mL	1.14 g/mL[3]	

Notes:

[1]Mean sludge concentrations for core 55 from the TCR (Pool 1993).

[2]Supernatant composition from 1994 grab sample.

[3]Tank inventory based on 71.9 kL of sludge with an average density of 1.79 kg/L, and 49.2 kL of supernatant with a density of 1.14 kg/L.

Table D2-2 provides a summary of the mean composite sludge and supernatant radionuclide concentrations and tank inventory estimates based on the 1993 core sample and 1994 supernatant grab sample from this tank. Radionuclide results in Table D3-2 are reported as mean values and have been decayed to January 1, 1994.

Table D2-2. Analytical Results and Tank Inventory Estimates for Radioactive Components in Tank 241-T-102 (Decayed to January 1, 1994, Except Total Alpha, Beta and Gamma)[1].

Radionuclide	1993 Core[1] (μCi/g)	1994 Supernatant[2] (μCi/ml)	Tank Inventory[3] (Ci)
^{3}H	0.007	NR	0.9
^{14}C	0.046	NR	5.9
^{60}Co	0.028	<0.178	<12.4
^{90}Sr	238	1.24	30,690
^{99}Tc	0.018	NR	2.3
^{103}Ru	<0.88	NR	113
^{106}Ru	<0.155	NR	<19.9
^{134}Cs	<0.012	NR	<1.5
^{137}Cs	31.9	64.9	7,299
^{144}Ce	<0.13	NR	<16.7
^{154}Eu	0.49	NR	63.1
^{155}Eu	0.54	NR	69.5
^{237}Np	5.4E-04	NR	0.07
$^{239/240}Pu$	0.055	6.3E-03	7.9
$^{243/244}Cm$	1.25E-03	NR	0.17
^{241}Am	0.256	<4.17E-03	32.9
Total Alpha	0.229	NR	29.5
Total Beta	489	NR	62,930

Notes:

[1]Based on decayed mean of core 55 (Pool 1993).

[2]Based on mean of 1994 supernatant grab sample.

[3]Tank inventory based on 71.9 kL (19 kgal) of sludge and 49.2 kL (13 kgal) of supernatant, with densities of 1.79 kg/L and 1.1 kg/L, respectively.

D3.0 COMPONENT INVENTORY EVALUATION

Sample-based estimates developed from analytical data and HDW model estimates from Los Alamos National Laboratory (LANL) (Agnew et al. 1996) are both potentially useful for estimating component inventories in the tank. The HDW model is mainly based on process production records and waste transaction records for each tank. Primary wastes are process wastes added directly from a plant to tank 241-T-102, while secondary wastes are transferred to the tank from another tank. A review of these records shows that tank 241-T-102 received the following wastes (Agnew 1997):

- 7,907 kL (2,089 kgal) of secondary $BiPO_4$ metal waste (MW) from tank 241-T-101, most of which was later sluiced for Uranium Recovery (UR).

- 1,836 kL (485 kgal) of secondary plutonium uranium extraction (PUREX) coating waste (CWP2) from tank 241-C-102.

- 1,851 kL (489 kgal) of secondary B-Plant cesium recovery (CSR) ion exchange effluent from tank 241-T-101 through tank 241-BX-101 and tanks 241-BX-101/241-SX-105/241-SX-106/241-SX-114 (a five tank 241-Transfer to tank 241-T-101).

Based on analysis of the original supernatant inventories and source of wastes in the five tank 241-Transfer, 88.4 volume percent of the waste transferred to tank 241-T-101 consists of CSR-IX waste from tank 241-BX-101, 4.3 volume percent consists of REDOX high level (R) waste supernatant from tank 241-SX-114 and 5.2 volume percent consists of REDOX coating waste (CWR) supernatant.

The HDW model (Agnew et al. 1996) assumes that 71.9 kL (19 kgal) of sludge and 49.2 kL (13 kgal) of supernatant have accumulated in tank 241-T-102, including:

- 7.6 kL (2 kgal) of $BiPO_4$ metal waste (MW) sludge
- 64.3 kL (17 kgal) of PUREX coating waste (CWP2) sludge
- 49.2 kL (13 kgal) of supernatant.

The sludge and supernatant inventories developed from the HDW model are consistent with the tank farm surveillance data for this tank (121.1 kL or 32 kgal of sludge and supernatant) (Hanlon 1997). Table D3-1 compares the sample-based and HDW model estimates for chemical components, while Table D3-2 provides a similar comparison for radioactive components in tank 241-T-102.

Table D3-1. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-T-102.

Analyte	Sample-based Inventory[1] (kg)	HDW Model-based Inventory (kg)
Al	38,500	10,200
Bi	<716	0
Ca	95.1	853
Cl	70.3	19.6
CO_3	3,688	2,100
Cr	188	8.3
F	42	0
Fe	2,320	1,690
Hg	0.8	76.3
K	<530	4.7
La	<71.6	0
Mn	123	0
Ni	8.75	4.7
OH	<3.1	24,900
NO_3	9,873	2,090
NO_2	2,161	668
Pb	247	4,340
PO_4	805	287
Si	417	0.3
Na	7,215	2,680
Sr	<7.2	0
SO_4	443	119
TOC	106.4	0
U	<2,860	6,750
Zr	<14.3	0

Notes:

HDW = Hanford defined waste
NR = not reported.

[1]From Table D2-1.

Table D3-2. Comparison of Sample-Based and Hanford Defined Waste Model Estimates for Radioactive Components in Tank 241-T-102 (Decayed to January 1, 1994).

Radionuclide	Sample-based Inventory[1] (Ci)	HDW Model-based Inventory (Ci)
^{90}Sr	30,690	161
^{137}Cs	7,299	135
$^{239/240}Pu$	7.9	122.8

Note:

[1]From Table D2-2.

Note that significant differences exist between the sample- and HDW model-based estimates for Al, Ca, Cr, Hg, Mn, Ni, NO_3, NO_2, OH, Pb, PO_4, Si, Na, SO_4, TOC, and U. Among the radionuclides, substantial differences are apparent between ^{90}Sr, ^{137}Cs, and $^{239/240}Pu$. In the next section flowsheet, fuel production, and Waste Status and Transaction Record Summary (Agnew 1996) will be used to independently evaluate the credibility of the sample- and HDW model-based estimates for this waste.

D3.1 WASTE TYPES

Generally, three different types of wastes were added to tank 241-T-102. The most important from a volume perspective are secondary PUREX coating waste (CWP2) and secondary cesium recovery (CSR) ion exchange waste.

D3.1.1 SECONDARY PUREX COATING WASTE

Approximately 1,836 kL (485 kgal) of secondary PUREX coating waste were added to tank 241-T-102 from 1964 to 1965 (in two batches from tank 241-C-102, with coating wastes remaining in this tank until a subsequent transfer to tank 241-T-103 in 1969). According to the HDW model, PUREX coating waste makes up about 89 percent of the sludge in tank 241-T-102, with the balance consisting of residual metal waste. Because tank 241-T-102 was a secondary receiver, one cannot predict from the flowsheet the absolute quantities of such waste that might have been added to this downstream tank. However, one can generate upper bounding estimates as if all of the components in this waste were routed directly to tank 241-T-102 (that is, assuming that tank 241-T-102 was the primary receiver of such wastes).

A spreadsheet analysis of the PUREX fuel fabrication and production records and waste transaction records (Agnew 1996) shows that 838.5 metric tons of uranium of (aluminum-clad) PUREX coating waste were transferred to tank 241-C-102 and subsequently to tank 241-T-102 (in two batches of 40 kgal and 445 kgal each during the fourth quarter of 1964 and second quarter of 1965, respectively). The number of metric tons of uranium (MTUs) was computed by allocating the amount of fuel for each of these quarters based on the volumetric ratio of PUREX coating waste sent to tank 241-T-102 divided by the total volume of waste transferred to all of the tanks during these quarters. On this basis, tank 241-T-102 received 49.4 MTUs (809.6 gal/MTU) of secondary PUREX coating waste in 1964 and 789.1 MTUs (563.9 gal/MTU) of such waste in 1965. These values were derived from a spreadsheet analysis of the waste transaction records and fuel production records for the indicated periods, with the coating waste volumes (in gal/MTU) being computed from this data for each quarter. On average, about 404 gal/MTU of PUREX coating waste were produced, including flushes and dilution water, compared to the nominal flowsheet estimates of 250 to 350 gal/MTU.

D3.1.1.1 Silica. The aluminum alloy jacket around the fuel typically contains 0.046 kg Si/MTU, while the Al-Si braze metal used in the bonding layer adds another 1.269 kg Si/MTU (Kupfer et al. 1997). Therefore, the upper bounding limit for Si in the PUREX coating waste should be 1,102 kg (compared to the sample-based estimate of 417 kg and HDW estimate of 0.3 kg).

According to the PUREX flowsheet (Matheison and Nicholson 1968), 1,069 kg of Si were added to this tank based on 0.07 gmoles/L of Si in the concentrated coating waste (171.9 gal of coating waste per MTU of dissolved fuel) and correcting for the amount of dilution water in this waste (which increases the total volume to 809.6 gal/MTU for the 1964 transfer and 563.9 gal/MTU for 1965). For example, in 1964 151.4 kL (40 kgal) of such waste was transferred with 0.07 gmoles/L of Si diluted by the ratio of actual waste (809.6 gal/MTU) to theoretical waste (171.9 gal/MTU). Therefore, in 1964 only 63 kg of Si could have been transferred, while in 1965, 1,006.4 kg of Si could have been transferred to this tank. The total amount of Si (1,069.4 kg) is in close agreement with the fuel and waste transaction records derived estimate (1,102 kg). Unless all of the Si quantitatively precipitated in the first tank of the cascade (241-C-102), the sample-based Si estimate (417 kg) appears to be more reasonable value than the HDW estimate for this component (0.3 kg).

D3.1.1.2 Aluminum and Nickel. Other components were also contained in the PUREX coating waste, including 39,500 kg of Al and 395 kg of Ni (47.1 kg of Al and 0.47 kg of Ni per MTU, Kupfer et. al. 1997). Aluminum-clad fuels produced after 1959 contained about 1 percent Ni in the Al alloy jacket (Kupfer et. al. 1997).

Most of the Al was dissolved as sodium aluminate and transferred as such to one of the downstream receiver tanks. The upper bounding Al inventory can be estimated by subtracting the proportional amount of Al that precipitated in tank 241-C-102 (3,606 kg) from the total amount of Al transferred or added to tanks 241-C-102 and 241-T-102 in 1964 and 1965 (39,500 kg). The amount that precipitated in the sludge can be estimated by multiplying the total amount of Al added to tank 241-C-102 (97,000 kg) by the volume of coating waste transferred to tank 241-T-102 (485 kgal) divided by the total volume of such waste added to tank 241-C-102 (13,044 kgal) (485/13,044 x 97,000 = 3,606 kg of Al) (Kupfer et. al. 1997). The results show that the upper bounding Al estimate for tank 241-T-102 should be 35,890 kg (39,500 - 3,606 = 35,894 kg) (compared to the sample-based estimate of 38,500 kg and HDW estimate of 10,200 kg). The sample-based Al inventory appears to be in good agreement with the upper bounding estimate for Al (38,500 kg compared to 35,890 kg). Because of atmospheric absorption of CO_2, and decreasing pH conditions in the supernatant, most of the Al in the PUREX coating waste supernatant must have precipitated over the five year period from 1964 to 1969.

In a parallel set of estimates for Ni, it appears that 395 kg of Ni from PUREX coating waste was added to tanks 241-C-102 and 241-T-102, but 326 kg apparently precipitated in tank 241-C-102 based on the best-basis inventory estimate (Kupfer et. al. 1997). By difference, approximately 69 kg of Ni may have been added to tank 241-T-102 from this source (compared to the sample-based estimate of 8.75 kg).

D3.1.1.3 Common Sludge Layers. Another approach that might be considered is to estimate the composition of tank 241-T-102 waste (a secondary PUREX coating waste receiver) based on the proportional amount of such waste in tanks 241-C-102 and 241-C-105 (both primary PUREX coating waste receivers). Tank 241-C-104 also received PUREX coating waste, but this waste only represents 56 percent of the total waste in this tank. In the other tanks, PUREX coating waste is thought to represent about 90 percent of the sludge in tank 241-C-105 and 85 percent of the sludge in tank 241-C-102. This approach also assumes that all of the waste transferred to tanks 241-C-102 and 241-T-102 actually precipitated in tank 241-T-102 (and therefore represents the upper bounding limit for such waste). These estimates were generated by multiplying the amount of each component in tanks 241-C-102 and 241-C-105 by the volume of coating waste sent to tank 241-T-102 (485 kgal) divided by the total volume of such waste added to tanks 241-C-102 (13,044 kgal) or 241-C-105 (3,151 kgal) (Kupfer et. al. 1997). The results are summarized in Table D3-3, together with sample and HDW estimates for tank 241-T-102 waste.

Table D3-3. Comparison of Common Sludge Layer Derived Estimates for PUREX Coating Waste in Tank 241-T-102 to Sample and Hanford Defined Waste Based Estimates for This Tank. (2 sheets)

Component	Tank 241-C-102 Based Estimates for Tank 241-T-102[1], kg	Tank 241-C-105 Based Estimates for Tank 241-T-102[2], kg	Sample Based Estimates for Tank 241-T-102[3], kg	HDW Model Estimates for Tank 241-T-102[4], kg
Al	2,912	2,355	38,500	10,200
Bi	126	25	<716	0
Cr	27	51	188	8
Fe	438	404	2,320	1,690
Pb	42	36	247	4,340

Table D3-3. Comparison of Common Sludge Layer Derived Estimates for PUREX Coating Waste in Tank 241-T-102 to Sample and Hanford Defined Waste Based Estimates for This Tank. (2 sheets)

Component	Tank 241-C-102 Based Estimates for Tank 241-T-102[1], kg	Tank 241-C-105 Based Estimates for Tank 241-T-102[2], kg	Sample Based Estimates for Tank 241-T-102[3], kg	HDW Model Estimates for Tank 241-T-102[4], kg
Mg	141	135	<143	NR
Mn	75	94	123	0
Ni	326	82	9	5
NO_3	2,024	844	9,873	2,090
NO_2	661	NR	2,161	668
PO_4	138	396	805	287
Si	1,769	1,517	417	0.3
Na	4,065	4,223	7,215	2,680
SO_4	171	<835	443	119
U	111	387	<2,860	6,750
Zn	452	0.6	103	NR
Zr	268	32	<14.3	0

Notes:

[1]Common sludge layer estimate based on tank 241-C-102 sludge composition multiplied by fraction of PUREX coating waste routed to tank 241-T-102 (485 kgal) divided by volume routed to tank 241-C-102 (13,044 kgal).

[2]Common sludge layer estimate based on tank 241-C-105 sludge composition multiplied by fraction of PUREX coating waste routed to tank 241-T-102 (485 kgal) divided by volume routed to tank 241-C-105 (3,151 kgal).

[3]Sample-based inventory estimate from Table D2-1.

[4]HDW based inventory estimate from Table D3-1.

Results in Table D3-3 show that sample-based estimates for Al, Cr, Fe, NO_3, NO_2, Pb, PO_4, Na, and U are higher than the common sludge layer derived estimates for PUREX coating waste. If the common sludge layer estimates are correct, these components must have been added from some other source, such as precipitation from B-Plant cesium recovery ion exchange (PUREX supernatant waste [PSN] and REDOX supernatant [RSN]) waste or from PUREX coating waste supernatants. It appears, based on this analysis, that only 2,600 kg of aluminum could have been added with the PUREX coating waste sludge (average of tank 241-C-102 and 241-C-105 projections in Table D3-3). Perhaps another 2,300 kg might have been added by precipitation from the cesium recovery ion exchange PUREX sludge supernatant (PSS) waste (Table D3-4). The remaining fraction of Al (33,600 kg) must have been added by precipitation from the PUREX coating waste supernatants over the period from 1964 to 1969, or from cesium recovery ion exchange supernatants (PSN and RSN derived supernatants) added in 1972. A similar comparison also suggests that large quantities of Cr, Fe and PO_4 were probably introduced with the cesium recovery (CSR) ion exchange wastes.

Other components, such as Ni, Si, and Zr appear to be at lower concentration in the tank 241-T-102 than might be inferred from the common sludge layer estimates, which is expected for those components that readily precipitate in the primary receiver tank (241-C-102). For Mg, Mn, and SO_4, the sample-based estimates are very close to the common sludge layer derived estimates based on the primary receiver tanks. This indicates that the sample-based estimates for Mg, Mn, and SO_4 are in the correct range and on balance are likely to be more representative than the HDW estimates for these components (Table D3-3).

D3.1.2 SECONDARY CESIUM RECOVERY ION EXCHANGE WASTE

About, 1,851 kL (489 kgal) of secondary cesium recovery (CSR) ion exchange waste were transferred to tank 241-T-102 in 1972 (the last transfer to tank 241-T-102). In the B-Plant flowsheets for this process, two separate feedstocks were identified as cesium ion exchange feeds, high level PUREX supernatants (PSN) and more dilute PUREX supernatants from sluicing (PSS). Table D3-4 summarizes the average concentration profiles for these feeds, together with the estimated amount of each component that might have added in 1,851 kL (489 kgal) of PSN or PSS supernatant to tank 241-T-102. While the general source of the cesium recovery supernatants can be established from flowsheets, it is not possible at this time to determine the exact fraction of PSN and PSS in the final effluent stream to tank 241-T-102. However, based on B-Plant cesium recovery records, it appears that 80.6 percent of the feed during the second and third quarters of 1972 consisted of PSN and 19.4 percent REDOX supernatant (RSN), with small amounts of current acid waste (CAW). It cannot be established from these records the fraction of aluminum rich RSN that might have been transferred to tank 241-T-102.

Table D3-4. Projected Inventory of Secondary Cesium-Strontium Recovery Waste Added to Tank 241-T-102.

Component	PSS Waste Composition (*M*)	PSN Waste Composition (*M*)	PSS Inventory Added to Tank 241-T-102 (kg)	PSN Inventory Added to Tank 241-T-102 (kg)
Al	0.046	NR	2,300	NR
Cl	0.002	0.078	130	5,055
CO_3	0.71	0.73	78,850	83,780
Cr	0.0081	NR	780	NR
NO_3	0.92	0.52	105,580	59,680
NO_2	0.47	2.8	40,020	238,410
PO_4	0.031	0.013	5,450	2,285
Si	0.005	NR	260	NR
Na	3.8	5.15	161,780	219,250
SO_4	0.37	0.13	65,750	23,100

It seems clear from this comparison that cesium recovery supernatants contained much higher inventories of Cl, CO_3, Cr, NO_3, NO_2, Na, and SO_4 than indicated in the samples from this tank (Table D3-3). In all likelihood, these components probably remained in the 1,798 kL (475 kgal) of supernatant transferred from tank 241-T-102 to tank 241-S-110 in 1974. The small amount of Al in the PSS supernatant (2,300 kg) also suggests that most of the aluminum in tank 241-T-102 sludge was probably precipitated from the PUREX coating waste supernatant, or perhaps from the REDOX (RSN) supernatants processed through B-Plant during the first quarter of 1972. The modest amounts of Si in PSS waste and PO_4 in PSN waste in Table D3-4 are also consistent with the sample-based inventories for these components, 417 kg of Si and 805 kg of PO_4, compared to HDW estimates of 0.3 and 287 kg, respectively. Therefore, the cesium recovery PSN supernatants may have been a significant source of PO_4 and possible source of Si in the tank 241-T-102 waste.

D3.1.3 $BiPO_4$ METAL WASTE (MW)

Published sluicing records show that most of the metal waste was sluiced out of this tank in 1953 and 1956. However, a residual inventory of 7.6 kL (2 kgal) of metal waste is thought to have been left in the tank (Agnew 1996, Anderson 1990). This residual inventory is generally consistent with the current analytical for this waste. According to these results, the current uranium inventory is less than 2,860 kg. This corresponds to a possible inventory of 5,610 L (1,482 gal) of metal waste, based on known composition of tank 241-T-101 metal waste (1.53 g moles of U/kg of metal waste) and assumed density of 1.74 kg/L (GE 1951, Agnew 1996). This volume of metal waste would be expected to contain 380 kg of PO_4 and 935 to 2,142 kg of CO_3 (0.51 g moles of PO_4/kg of metal waste and 1.92 to 4.4 g moles of CO_3/kg of metal waste sludge) (GE 1951). These estimates are not only consistent with the current analytical estimates for PO_4 and CO_3, but also indicate that a considerable fraction of the PO_4 and CO_3 must have been added with the residual metal waste to this tank. The current estimate for uranium (less than 2,860 kg) also appears to be consistent with the sluicing records from this era which indicate that 81,800 kg of uranium were left in tanks 241-T-101, 241-T-102, and 241-T-103 after the last sluicing campaign.

D3.2 CESIUM AND STRONTIUM

Tank 241-T-102 has an estimated heat load of 3,843 Btu/h or 1,126 watts (Kummerer 1995). This heat load corresponds to 238,600 Ci of ^{137}Cs or 168,000 Ci of ^{90}Sr, values that are well above the sample-based estimates for this tank (7,299 Ci of ^{137}Cs and 30,690 Ci of ^{90}Sr, decayed to January 1, 1994). In addition to other sources of cesium and strontium, a significant fraction of cesium may have been added from tank 241-T-101 during the third quarter of 1972 (through the REDOX supernatant from tank 241-SX-114). The sample-based inventory is equivalent to a heat load of 240 watts, based on a vapor space temperature of 24 °C (75 °F) and unknown waste temperature. Because the reliability of the tank 241-Thermal model has not been independently verified for this tank, it will be assumed for purposes of the standard inventory estimate that the sample-based estimates for ^{137}Cs and ^{90}Sr are correct. The sample-based estimates, on balance, seem to be more reasonable than the HDW model estimates for this tank (161 Ci of ^{90}Sr and 135 Ci of ^{137}Cs, also decayed to January 1, 1994).

D3.3 SUMMARY

The sample-based estimates for Si, Al, and Ni appear to be in the correct range and are generally consistent with upper bounding estimates developed from other sources of information, including process flowsheets, fuel and waste transaction records and the known composition of common sludge layers in other tanks. Sample results for Mg, Mn, and SO_4 are consistent with the composition of common sludge layers in other tanks, while Ni, Si, and Zr estimates are also consistent with the expected trend for secondary receiver tanks (that is, at lower concentration than in the primary receiver tanks). From the analysis of secondary cesium recovery wastes, it was determined that projected inventories for Si and

PO_4 are consistent with measured values in the tank 241-T-102 sludge. The analytical results for uranium also show that the residual metal waste inventory is consistent with the projected amount of residual metal waste in this tank (5,610 L versus 7,570 L) (Anderson 1990, Agnew 1996). Based on the indicated matches, it appears that the flowsheet and common sludge layer derived estimates support the credibility of the sample-based estimates for this tank. Moreover, this analysis shows that the HDW estimates for Al, Cr, Mn, PO_4, Si, and Na are low, and comparable estimates for Pb and U high with respect to sample-based inventories in tank 241-T-102 (Table D3-3). Sample-based estimates for ^{137}Cs and ^{90}Sr are generally consistent with the thermal modelling results for this tank, although the analytical results are considerably lower than might be expected from the thermal model. A significant fraction of ^{137}Cs may have been added from tank 241-T-101 during the third quarter of 1972 (through the REDOX supernatant in tank 241-SX-114).

Based on this comparison, the 1993 core sample (core 55) appears to offer the most reasonable and consistent set of estimates currently available for this tank. This sample will be used to develop the best-basis inventory for tank 241-T-102 because of the large number of analytical measurements (2,033), including 833 measurements for quality control and 230 for homogenization tests.

D4.0 BEST-BASIS INVENTORY ESTIMATE

Chemical and radionuclide inventory estimates are generally derived from one of three sources of information: (1) sample analyses and sample derived inventory estimates, (2) component inventories predicted by the HDW model based on process knowledge and historical tank 241-Transfer information, or (3) a tank-specific process estimate based on process flowsheets, reactor fuel data, essential materials records, or comparable sludge layers and sample information from other tanks.

An effort is currently underway to provide waste inventory estimates that will serve as the standard characterization data for various waste management activities. As part of this effort, a survey and analysis of various sources of information relating to the chemical and radionuclide component inventories in tank 241-T-102 was performed, including the following:

1. Data from one core sample obtained in 1993 (Pool 1993).

2. Component inventory estimates provided by the HDW model (Agnew et.al., 1996).

3. Evaluation of upper bounding estimates for secondary (Al-clad) PUREX coating (CWP2) waste and secondary cesium recovery (CSR) ion exchange

waste, based on process flowsheets, fuel and waste transaction records for this tank.

4. Analysis of CWP2 sludge based on common sludge layers in tanks 241-C-102 and 241-C-105, together with waste transaction records for these tanks.

5. Analysis of residual metal waste based on the composition of tank 241-T-101 MW (GE 1951).

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

Based on this analysis, a best-basis inventory was developed. The 1993 core sample was used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-T-102 primarily consists of secondary (Al-clad) PUREX coating (CWP2) waste, secondary cesium recovery (CSR) ion exchange waste and a small amount of residual metal waste (MW) from the $BiPO_4$ process. The best-basis inventory for tank 241-T-102 is presented in Tables D4-1 and D4-2. A medium level of confidence is assigned the chemicals and radionuclides because all of these estimates were derived from the 1993 core sample and many of these components are consistent with upper bounding estimates from other sources of information.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	38,500	S	Tank 241-T-102 Sample Results
Bi	<716	S	
Ca	95.1	S	
Cl	70.3	S	
CO_3	3,688	S	
Cr	188	S	
F	42	S	
Fe	2,320	S	
Hg	0.8	S	
K	<530	S	
La	<71.6	S	
Mn	123	S	
Na	7,215	S	

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-T-102 (February 11, 1997). (2 Sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
N	9	S	
NO_2	2,161	S	
NO_3	9,873	S	
OH	<3.1		
Pb	247	S	
P as PO_4	805	S	
Si	417	S	
S as SO_4	443	S	
Sr	<7.2	S	
TOC	106	S	
U_{TOTAL}	<2,860	S	
Zr	<14.3	S	

Notes:

[1]S = sample-based, M = HDW model-based, E = engineering assessment-based.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.9	S	Pool 1993
^{14}C	5.9	S	
^{59}Ni	NR		
^{60}Co	<12.4	S	
^{63}Ni	NR		
^{79}Se	NR		
^{90}Sr	30,690	S	Pool 1993, 1994 supernatant grab sample
^{90}Y	30,690	E	Based on ^{90}Sr analysis
^{93}Zr	NR		

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{93m}Nb	NR		
^{99}Tc	2.3	S	
^{106}Ru	<19.9	S	
^{113m}Cd	NR		
^{125}Sb	NR		
^{126}Sn	NR		
^{129}I	NR		
^{134}Cs	<1.5	S	
^{137}Cs	7,300	S	Pool 1993, 1974 supernatant grab sample
^{137m}Ba	6,900	E	Based on ^{137}Cs analysis
^{151}Sm	NR		
^{152}Eu	NR		
^{154}Eu	63	S	1974 supernatant grab sample
^{155}Eu	70	S	1974 supernatant grab sample
^{226}Ra	NR		
^{227}Ac	NR		
^{228}Ra	NR		
^{229}Th	NR		
^{231}Pa	NR		
^{232}Th	NR		
^{232}U	NR		
^{233}U	NR		
^{234}U	NR		
^{235}U	NR		
^{236}U	NR		
^{237}Np	0.07	S	
^{238}Pu	NR		
^{238}U	NR		
^{239}Pu	7.9	S	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994). (3 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{240}Pu	NR		
^{241}Am	32.9	S	
^{241}Pu	NR		
^{242}Cm	NR		
^{242}Pu	NR		
^{243}Am	NR		
^{243}Cm	0.17	S	
^{244}Cm	NR		

Notes:

[1]S = sample-based (on 1993 core sample unless noted otherwise), M = HDW model-based, and 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, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-3860, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., 1996, *Waste Status and Transaction Records Summary for the Northeast Quadrant of the Hanford 200 Area*, WHC-SD-WM-TI-615, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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

GE, 1951, Uranium Recovery Technical Manual, HW-19140, Hanford Works, Richland, Washington.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending February 28, 1997*, HNF-EP-0182-107, Lockheed Martin Hanford Company, Richland, Washington.

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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), and 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, (to be issued), Lockheed Martin Hanford Corporation, Richland, Washington.

Matheison, W. E. and G. A. Nicholson, 1968, PUREX Chemical Flowsheet Processing of Aluminum-Clad Uranium Fuels, ARH-214 DEL, Atlantic Richfield Hanford Company, Richland, Washington.

Pool, K. N., 1993, *PNL 325 Laboratory Single-Shell Tank Waste Characterization Tank 241-T-102*, WHC-SD-WM-DP-052, Addendum 1, Rev. 0, Westinghouse Hanford Company, Richland Washington.

APPENDIX E

BIBLIOGRAPHY FOR TANK 241-T-102

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-T-102

Appendix E provides a bibliography of information that supports the characterization of tank 241-T-102. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-T-102 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references broken down into subgroups. These categories and their subgroups are listed below.

I. NON-ANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives/Customers of Characterization Data

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

- IIa. Sampling of tank 241-T-102
- IIb. Sampling of similar waste types

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories using both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

This bibliography is broken down into the appropriate sections of material to use, with an annotation at the end of each reference, or set of references, describing the information source. Where possible, a reference is provided for information sources. A majority of the information listed below may be found in the Lockheed Martin Hanford Corporation Tank Characterization and Safety Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

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

- Document contains single-shell tank fill history and primary campaign/waste type information up to 1981.

Jungfleisch, F. M., and B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Document describes a model for estimating tank waste inventories using process knowledge, radioactive decay estimates using ORIGEN, and assumptions about waste types, solubility, and constraints.

Schneider, K.J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW- 23043, Hanford Atomic Products Operation, Richland, Washington.

- Document contains compositions of process stream waste before transfer to 200 Area waste tanks.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1996, *Waste Status and Transaction Record Summary, WSTRS Rev. 4*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains spreadsheets depicting all known tank additions/transfers.

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

- Document contains tank fill histories and primary campaign/waste type information up to 1981.

Ic. Surveillance/Tank Configuration

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document shows riser location in relation to tank aerial view as well as a description of each riser and its contents.

Lipnicki, J., 1996, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Document gives an assessment of riser locations for each tank; however, not all tanks are included/completed. Also included is an estimate of the risers available for sampling.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides thermocouple location and status information for double- and single-shell tanks.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-356, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides leak detection information for all single- and double-shell tanks. Liquid level, liquid observation well, and drywell readings are included.

Id. Sample Planning/Tank Prioritization

Brown, T. M., T. J. Kunthara, S. J. Eberlein, and J. W. Hunt, 1996, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Document establishes an approach to determine the priority for tank sampling and characterization and identifies high priority tanks for sampling.

Mulkey, C. H., 1996, *Single-Shell Tank System Waste Analysis Plan*, WHC-EP-0356, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document is the waste analysis plan for single-shell tanks as required by WAC-173-303 and 40 CFR Part 265.

Schreiber, R. D., 1994, *Tank 241-T-102 Tank Characterization Plan*, WHC-SD-WM-TP-225, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains detailed sampling and analysis scheme for core samples to be taken from tank 241-T-102.

Stanton, G. A., 1996, *Baseline Sampling Schedule, Change 96-04*, (internal letter 75610-96-11 to Distribution, August 22), Westinghouse Hanford Company, Richland, Washington.

- Letter provides a tank waste sampling schedule through fiscal year 2002 and lists samples taken since 1994.

Winkelman, W. D., J. W. Hunt, and L. J. Fergestrom, 1996, *Fiscal Year 1997 Tank Waste Analysis Plan*, WHC-SD-WM-PLN-120, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

- Document contains *Hanford Federal Facility Agreement and Consent Order* requirement driven TWRS characterization program information and a list of tanks addressed in fiscal year 1997.

Ie. Data Quality Objectives/Customers of Characterization Data

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tanks are under safe operating conditions.

Meacham, J. E., 1996, *Implementation Change Concerning Organic DQO, Rev. 2*, (internal memorandum 2N160-96-006 to Distribution, December 2), Duke Engineering and Services, Inc., Richland Washington.

- Memorandum changes logic of organic DQO to require total organic carbon analysis on any sample that exhibits an exotherm.

Osborne, J. W., and L. L. Buckley, 1995, *Data Quality Objective for Tank Hazardous Vapor Safety Screening*, WHC-SD-WM-DQO-002, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tank vapor spaces contain potentially hazardous gases and vapors.

Turner, D. A., H. Babad, L. L. Buckley, and J. E. Meacham, 1995, *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue*, WHC-SD-WM-DQO-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to categorize organic tanks as "safe," "conditionally safe," or "unsafe" based on fuel and moisture concentrations and to support resolution of the safety issue.

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

IIa. Sampling of tank 241-T-102

Pool, K. N., 1993, *PNL 325 Single-Shell Tank Waste Characterization For Tank 241-T-102*, WHC-SD-WM-DP-052, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains analytical results from March and April 1993 core sampling event.

Sant, W. H., 1973, *Analysis of 102T Tank Sample Number T-7892*, (internal memorandum to R. L. Walser, on July 24), Atlantic Richfield Hanford Company Operations, Richland, Washington.

- Memorandum contains historical sample analysis results.

Sant, W. H., 1974, *Analysis of Tank Farm Samples, Sample: T-2287, Tank 102-T*, (internal memorandum to R. L. Walser, on March 13), Atlantic Richfield Hanford Company Operations, Richland, Washington.

- Memorandum contains historical sample analysis results.

WHC, 1994, Sample Status Report for R 6088, T-102 Grab, (electronic report September 8), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains grab sample analysis results.

IIb. Sampling of Similar Waste Types

Hu, T. A., 1996, *Tank Characterization Report for Single-Shell Tank 241-BX-104*, WHC-SD-WM-ER-599, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains information on CWP waste type.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories using both Campaign and Analytical Information

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 4*, LA-UR-96-3860, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains waste type summaries, primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids, as well as SMM, TLM, and individual tank inventory estimates.

Agnew, S. F., R. A. Corbin, J. Boyer, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, B. L. Young, R. Anema, and C. Ungerecht, 1996, *History of Organic Carbon in Hanford HLW Tanks: HDW Model Rev. 3*, LA-UR-96-989, Los Alamos National Laboratory, Los Alamos, New Mexico.

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- Document contains major components for waste types and some assumptions. Purchase records are used to estimate chemical inventories.

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- Document contains a global inventory based on process knowledge and radioactive decay estimations using ORIGEN2. Pu and U waste contributions are taken at 1 percent of the amount used in processes. Also compares information on Tc-99 from both ORIGEN2 and analytical data.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernates*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document gives solubility ranges used for key chemical and radionuclide components based on supernatant sample analyses.

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Historical Tank Content Estimate for the Northwest Quadrant of the Hanford 200 East Area*, HNF-SD-WM-ER-351, Rev. 1, Fluor Daniel Northwest, Inc., Richland, Washington.

- Document contains summary information for tanks in B, BX, and BY Tank Farms as well as in-tank photo collages.

Brevick, C. H., J. L. Stroup, J. W. Funk, and K. Ewer, 1997, *Supporting Document for the Northwest Quadrant Historical Tank Content Estimate Report for T Tank Farm*, WHC-SD-WM-ER-320, Rev. 1, Fluor Daniel Northwest, Inc., Richland, Washington.

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- Document contains a quick reference to sampling information in spreadsheet or graphical form for 24 chemicals and 11 radionuclides for all the tanks.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending February 28, 1997*, HNF-EP-0182-107, Lockheed Martin Hanford Company, Richland, Washington.

- This document, updated monthly, contains a summary of: tank waste volumes, Watch List tanks, occurrences, tank integrity information, equipment readings, tank location, leak volumes, and other miscellaneous tank information.

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- Document contains a statistical evaluation of the HDW inventory estimate against values from 12 existing TCR reports using a select component data set.

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.

- Document describes a system of sorting single-shell tanks into groups based on the major waste types contained in each tank.

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- Document contains in-tank photos and summaries of the tank description, leak detection system, and tank status.

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- Document gives an assessment of the relative dryness of tank wastes.

Remund, K. M., and B. C. Simpson, 1996, *Hanford Waste Tank Grouping Study*, PNNL-11433, Pacific Northwest National Laboratory, Richland Washington.

- Document contains a statistical evaluation to group tanks into classes with similar waste properties.

Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single- and Double-Shell Tanks*, (internal memorandum 74A20-96-30 to D. J. Washenfelder, February 28), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995, *Chemical and Radionuclide Inventory for Single- and Double-Shell Tanks*, (internal memorandum #75520-95-007 to R. M. Orme, on Aug. 8), Westinghouse Hanford Company, Richland, Washington.

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Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories for the Single-Shell Tanks*, WHC-SD-WM-TI-565, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains selected sample analysis tables before 1993 for single-shell tanks.

Wheeler, R. E., 1975, *Analysis of Tank Farm Samples For Chlorine*, (internal memorandum to R. L. Walser, on May 29), Atlantic Richfield Hanford Company Operations, Richland, Washington.

- Memorandum contains historical chlorine sample analysis results for a few tanks.

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